8th ICBR
INTERNATIONAL CONFERENCE
ON **BUILDING RESILIENCE**

Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages

8th ICBR Lisbon Book of Papers

Edited by

A. Nuno Martins, Liliane Hobeica, Adib Hobeica, Pedro Pinto Santos, Nuha Eltinay, José Manuel Mendes

ORGANISED BY

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BUILDING 4HUMANITY

8th International Conference on Building Resilience

Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages

14-16 November 2018 | Lisbon, Portugal

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Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages

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A. Nuno Martins, Liliane Hobeica, Adib Hobeica, Pedro Pinto Santos, Nuha Eltinay, José Manuel Mendes

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Forward

Development agendas adopted throughout 2015 and 2016, in particular the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR), the 2030 Sustainable Development Goals (SDGs), the New Urban Agenda and the Paris Agreement represent not only a unique landmark to achieve a shift of our societies and systems towards sustainability, but perhaps the last opportunity to preserve our planet. As more people and assets are located in areas of high risk, the proportion of world population living in flood-prone river basins have increased by 114%, while those living on cyclone-exposed coastlines have grown by 192% over the past 30 years. Over half of the world's large cities, with populations ranging from 2 to 15 million, are currently located in areas highly vulnerable to seismic activity. Rapid urbanization will further increase exposure to disaster risk. The World Economic Forum (WEF) has estimated that by the year 2050, the exposure of city dwellers to various hazards, including earthquakes, tsunamis, urban floods, cyclones and storm surges will double (WEF, 2014).

Cities are complex in nature. They consist of a number of interdependent physical systems and human communities which are vulnerable to disasters in varying degrees. Cities are seen as engines of economic growth where the majority of economic activity takes place. In many cases, city centres are considered to be the preferred location for economic, providing a thriving labour market and good service facilities to support business organizations. Increased global exposure to natural hazards has largely been driven by population growth and the trend for an increased proportion of that population to live in cities rather than in rural areas. As cities grow larger and become economically more productive, they serve as magnets for rural-urban migration. As urbanization continues, more and more people settle in cities, leading to urban sprawl and also to increasing densification. Urbanization has the potential to make cities more prosperous and countries more developed, but many cities all over the world are grossly unprepared for the multi-dimensional challenges associated with urbanization. As a result, the world's population is increasingly concentrated in large cities with poor housing and a lack of basic protective infrastructure. There is thus a high risk of economic loss, damage to assets, and human casualties and injuries in disasters and extreme weather events, making cities particularly vulnerable.

Achieving the SDGs in coherence with the 2015 development agenda means strengthening collaboration and developing joint efforts within governments to the lowest possible level. This is to ensure not only that an integrated approach is delivered but also that 'policy coherence' is guaranteed. The Sendai Framework and the New Urban Agenda represent a significant step forward in safe guarding the economic prosperity and supporting cities in ably localising their efforts – from the setting of goals and targets, to determining the means of implementation and using indicators to measure and monitor progress. In order to achieve SDGs 11.5 and 11.b at the local level, the Disaster Risk Reduction (DRR) dimension needs to be integrated in local development plans, policies and budget, with clear roles and responsibilities within the local government. Local governments should conduct periodical participatory assessments to identify the most potential and worst-case scenarios including means to reduce their impact. Building codes and land-zoning regulations need to be updated and better enforced to improve the resilience of housing stock and infrastructure investments.

Local disaster risk governance must be strengthened through coalitions of local actors including public and private partners. Communities and related agencies and in particular urban planners need to be more involved in risk assessments and identification of vulnerabilities. Various tiers of governments need to set up coherent mechanisms that include financial and tax incentives that allow for engagement of private sector to invest in risk reduction. There is not a fixed blueprint. Each city has distinctive topography, population density, and vulnerabilities. Each city needs to assess its particular challenges. The good news is that it is possible for cities to overcome these crises.

Abhilash Panda
Deputy Chief of the UNISDR Regional Office for Europe and Central Asia

Preface

As we approach the *8th International Conference on Building Resilience*, news broadcasters around the world are reporting the devastating impacts of disasters. From the 7.5-magnitude earthquake that triggered a tsunami and extensive soil liquefaction in Palu, Indonesia, to Hurricane Michael in coastal areas of Florida, USA, and Typhoon Mangkhutleft in Northern Philippines, the human and economic losses mount. The region hosting this year's conference is not immune either. A hot, dry summer has led to drought across much of Europe in 2018, followed in October by flash flooding in Central Europe.

The future looks even worse. The world's leading climate scientists have warned there is only a dozen years for global warming to be kept to a maximum of 1.5ºC, beyond which even half a degree will significantly worsen the risks of drought, floods, extreme heat and poverty for hundreds of millions of people. In October, the authors of the report by the UN Intergovernmental Panel on Climate Change (IPCC) emphasised that urgent and unprecedented changes are needed to reach the target, which they say is affordable and feasible although it lies at the most ambitious end of the Paris agreement pledge to keep the increase in temperatures between 1.5ºC and 2ºC.

Policymakers commissioned the report at the Paris climate talks in 2016, but since then the gap between science and politics has widened, as some of the world's biggest source of historical emissions have started to back away from the accord. Despite such political challenges, the role of science is clear. The global plan for disaster reduction, the Sendai Framework, launched in 2015, duly recognises the importance of science and technology and calls for the enhancing of scientific and technical work on risk reduction and the coordination of existing networks and scientific research institutions at all levels and all regions. The plan, which replaced the Hyogo blueprint for disaster reduction, marked a fundamental shift in approach, with strong emphasis being placed on achieving evidence-based understanding of risk and its implications for disaster prevention, mitigation and response.

When we first started the *International Conference on Building Resilience* series in 2008, the theme was around physical reconstruction, in particular learning lessons from recovery after the 2004 Indian Ocean Tsunami, which had devastated parts of the host country, Sri Lanka. Since then, the conference has moved around the world, from the United Kingdom, to Australia, New Zealand and Thailand. In keeping with the Sendai Framework, the conference themes have also shifted to provide a platform for sharing international, multi-hazard, multi- and inter-disciplinary research that addresses the full spectrum of disaster prevention, mitigation and response. Since its inception and at the heart of the conference has also been the desire to strengthen the relationship between science, policy and action. The number of participants from non-academic stakeholders has significantly increased over the past decade.

Ten years after its inception, our team at the University of Huddersfield in the United Kingdom are delighted to support the University of Lisbon and the University of Coimbra in Portugal, which are organizing and hosting the 2018 *International Conference on Building Resilience* in association with the United Nations Office for Disaster Risk Reduction (UNISDR). This eighth conference in the series will take place in the historic city of Lisbon in Portugal. The theme for the conference reflects this historic setting, with a strong emphasis on heritage, but also the importance of people, their vulnerabilities, the impacts of displacement, and the importance of local communities in Disaster Risk Reduction. We thank our hosts for taking on the responsibility for organizing this year's event. We are confident that it will continue the success of previous conferences and that its outcomes will support the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030.

Our best wishes to you all for fruitful discussions and a successful conference.

Prof. Dilanthi Amaratunga and *Prof. Richard Haigh*
Global Disaster Resilience Centre, University of Huddersfield
Chairs of the *International Conference on Building Resilience* series

Welcome Note

Dear *8th ICBR* participants,

On behalf of the Organizing Committee of the *8th ICBR* 2018, which I proudly preside over an extraordinary team featuring experienced scholars and young researchers brought together in a balanced way, it is my great pleasure to welcome you all to Lisbon.

Following seven previous successful editions of this leading conference series on risk and resilience, held in different regions of the globe, this 8th edition is taking place for the first time in Portugal, being organized by the University of Lisbon, in collaboration with the Universities of Coimbra and Huddersfield, and held in the premises of the Lisbon University Institute (ISCTE-IUL), between 14 and 16 November 2018.

We feel honoured for having this opportunity of organizing a conference that becomes a reference on the annual calendar of those interested in disaster-related sciences. By bridging the gap between designers, disaster managers, and humanitarian and development practitioners, the *ICBR* has been promoting a vast interdisciplinary network aimed at strengthening and disseminating a culture of risk and resilience.

We have embraced the theme "Risk and Resilience in Practice: Vulnerabilities, Displaced People, Local Communities and Heritages" for the *8th ICBR* with the goal of addressing some of the most challenging and pressing issues that concern academia, public administrations, the private sector, civil society and, last but not least, local populations, whom our individual and shared efforts are meant to impact in a positive way. In the light of the more than 600 quality submissions (papers and posters) that were received from more than 50 countries, this choice seems to have been particularly inspiring. Indeed, the upcoming Conference is putting together excellent pieces of research and amazing projects focusing on Disaster Risk Reduction, disaster preparedness, post-disaster rebuilding and recovery, and resilience in general.

The *ICBR* is already one of the landmark international forums on risk and resilience for cross-disciplinary ideas, policy guidance and social meeting. Both academics and practitioners will have the opportunity to question the most challenging and pressing resilience issues, exploring and learning about past, present and future collaborative paths.

As a novelty, this *8th ICBR* edition introduces two special prizes: the *Building 4Humanity Design Competition* and the *Marielle Franco Community-Design Award*. As can be read further on in a dedicated section of this book, both prizes were successfully set up, with the help of committed partners and Jury members, and received valuable proposals from all continents. Furthermore, a mobile App was made available so that the delegates can easily access the information about the Conference, find out what is going on, consult the updates, see the Conference's photos, view and download submitted posters, respond to the survey on the Conference's sustainability features, and cast their votes for the selection of the best scientific posters and the best proposals submitted to the *Building 4Humanity Design Competition*.

Beyond the four special sessions focusing on the Conference's motto, the *8th ICBR* is enriched by six additional keynote speakers who join the set of prominent scholars participating in the event. The *ICBR*'s traditional PhD school will bring together several dozens of students from all around the globe and will benefit from the contribution of many of the *8th ICBR*'s keynote speakers and Scientific Committee members. Finally, the Resilient Tours, to take place on Saturday 17 November, will invite the attendees to become a little bit more acquainted with our beautiful country, visiting World and National Heritage sites, outstanding landscapes, while getting to know disaster-prone areas and how the government, technicians and communities have coped with different types of hazards and recovered from disasters.

We would like to thank the keynote lecturers, the track chairs, with their substantial role since the drawing of the call for papers (promotion of authors' participation, review of submissions and moderation of sessions), the honourable members of the Scientific Committee, the sponsors, local partners, and all the delegates for sharing and presenting their research results.

We sincerely hope that you all enjoy the Conference, Lisbon and in a broad sense, your stay in Portugal.

With warm regards,

A. Nuno Martins,
8th ICBR Lisbon 2018 Chair

The *8th ICBR* Lisbon 2018 Organizing Committee
Chairs: *Nuno*, *José*, *Pedro*, *Isabel*, *Liliane* and *Adib*
Organizing team: *Silvia*, *Rosa*, *Carla*, *Sarah*, *Mittul*, *Nuha*, *Ali*, *Mayeda*, *Oshien*, *Omimah* and *Franciele*
Digital designer: *Dominika Gorecka*

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Liliane Hobeica (Co-Chair) | University of Coimbra, Portugal

Adib Hobeica (Co-Chair) | Independent consultant, Portugal

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Richard Haigh | Global Disaster Resilience Centre, University of Huddersfield, UK

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H.E. the Secretary-General of the United Nations, Eng. António Guterres

The President of the Lisbon Municipality, Dr. Fernando Medina Maciel Almeida Correia

The President of the Coordination and Development Commission of the Centre Region (CCDRC), Prof. Dr. Ana Abrunhosa

The President of the Research Centre for Architecture, Urbanism and Design (CIAUD) of the University of Lisbon, Prof. Dr. Fernando Moreira da Silva

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Sarah Tantely | University of Antananarivo, Madagascar

Keynote Speakers

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Camillo Boano | University College London, UK

Christian Werthmann | University of Hannover, Germany

Isabel Raposo | University of Lisbon, Portugal

Ortwin Renn | Sustainable Institute Potsdam, Germany

Hsieh Ying-Chun | Atelier-3, Taiwan

Keynote Speakers | Special Sessions

Special Session on Architectural Heritage

Paulo B. Lourenço | University of Minho, Portugal

Special Session on Gender and Resilience

Maureen Fordham | University College London, UK

Special Session on Wildfire Risk

Fantina Tedim | University of Oporto, Portugal

Alan March | University of Melbourne, Australia

Special Session on Humanitarian Architecture and Incremental Housing

Carmen Mendoza Arroyo | Universitat Internacional de Catalunya, Spain

Chen-Yu Chiu | Bilkent University, Turkey

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Tiago Miguel Ferreira | University of Minho, Portugal
Tomás B. Ramos | NOVA University, Portugal
Virginia Murray | Imperial College and King's College, UK
Xavier Romão | University of Oporto, Portugal
Zeynep Gul Unal | Yıldız Technical University, Turkey

Programme Overview

Tuesday 13 November 2018	**Wednesday 14 November 2018**	**Thursday 15 November 2018**	**Friday 16 November 2018**	**Saturday 17 November 2018**
	8: 45 | **Opening Ceremony** 9: 15 | **Keynote Lectures**	9: 00 | **Keynote Lectures**	9:00 | **Keynote Lectures**	4 suggested **Technical Tours**: # 1: Areas recovering from wildfires near Coimbra # 2: Areas prone to flooding in the Tagus River Valley # 3: Remains of the 1755 earthquake in Lisbon # 4: Areas affected by extreme weather conditions (heat and drought) - Alentejo *Note: the tours include visits along the road, site entrances, lunch, coffee break and refreshments.*
	10:45 | Coffee break	*10:30 | Coffee break*	*10:30 | Coffee break*	
	11:00 | Special Session*: **Architectural Heritage** | **Track Sessions** | **Doctoral School** (1)	11:00 | Special Session*: **Humanitarian Architecture and Incremental Housing** | **Track Sessions**	11:00 | Special Session*: **Gender and Resilience** | **Track Sessions**	
	12:45 | Lunch	*12:45 | Lunch*	*12:45 | Lunch*	
	14:00 | **Track Sessions** | **Doctoral School** (2) | ***Marielle Award* Jury Meeting** (1)	14:00 | Special Session*: **Wildfire Risk** | **Track Sessions**	14:00 | **Track Sessions** | Workshop: ***Disaster Risk Reduction is Child's Play*** | ***B4H-DC* Jury Meeting** (1)	
	15:45 | Coffee break	*15:45 | Coffee break*	*15:45 | Coffee break*	
17:30 – 19:30 | Registration desk opens	16:00 | **Track Sessions** | **Doctoral School** (3) | ***Marielle Award* Jury Meeting** (2)	16:00 | **Track Sessions**	16:00 | **Track Sessions** | ***Marielle Franco Community-Design Award* Jury Meeting** (2)	
	18:00 | *Building 4Humanity Design Competition* (*B4H-DC*) – **Opening of the Shortlisted Proposals' Exhibition**	17:45 | **Poster Session**	17:00 | **Closing Ceremony** | Announcements of the different award results, and presentation on the 2019 *ICBR* edition by the next organizers	
	19:15 | **Welcome Reception**	20:00 | **Conference Dinner**	18:00 | **Traditional *Magusto*** (roasted chestnuts and sweet wine)	

* The Special Sessions feature keynote speakers and accept submissions of abstracts and papers in limited number; they are planned to have as outputs Special Issues of top journals.

Awards

The *International Journal of Disaster Resilience in the Built Environment* (published by Emerald) sponsored the following awards granted to the *8th ICBR* participants:

The Best Paper Award – Disasters and Built Environment.
Winners: *Elizabeth English*, *Michelle Li* and *Rebecca Zarins*, with the paper entitled
"The economic argument for amphibious retrofit construction".

The Best Paper Written by a Postgraduate Researcher Award.
Winners: *Finn Laurien*, *Stefan Hochrainer-Stigler* and *Adriana Keating*, with the paper entitled
"Community flood resilience across the globe: empirical analysis of measurement and dynamics".

The *8th ICBR* also featured a special recognition to the Best Poster.

The Best Poster Award.
Winners: *Jean You* and *Manuela Powidayko*, with the poster entitled
"New York City's Flood Resilience Zoning Outreach Process: from community awareness to community empowerment".

The Best Poster prepared by a Postgraduate Researcher Award.
Winners: *Ali Jamshed* and *Irfan Ahmad Rana*, with the poster entitled
"Assessing the role of post-disaster resettlement in building resilience: the case of the 2010 floods in Pakistan".

Publications

Besides this book of abstracts, the *8th ICBR* also features an e-book of proceedings with some of the papers submitted to the Conference. Furthermore, a selection of around 50 papers will take part in very special thematic books, published by Elsevier. Each of these four books will focus on one of Sendai's four priorities for action: (1) Understanding disaster risk; (2) Strengthening disaster risk governance to manage disaster risk; (3) Investing in disaster reduction for resilience; and (4) Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction. Finally, 14 papers will be selected to be part of a Springer book focusing on Humanitarian Architecture, Incremental Housing and Risk and Resilience.

Moreover, additional sets of high-quality papers will be selected for publication in one of the journals associated to the *8th ICBR*:

International Journal of Disaster Resilience in the Built Environment

The IJDRBE is the only journal to promote research and scholarly activity that examines the role of building and construction to anticipate and respond to unexpected events that damage or destroy the built environment.
Editors: Prof. Dilanthi Amaratunga | Global Disaster Resilience Centre, University of Huddersfield, UK
Prof. Richard Haigh | Global Disaster Resilience Centre, University of Huddersfield, UK

International Journal of Architectural Heritage

The IJAH provides a multidisciplinary scientific overview of existing resources and modern technologies useful for the study and repair of historical buildings and other structures.
Editors: Prof. Paulo B. Lourenço | Universidade do Minho, Portugal
Prof. Pere Roca | Universitat Politècnica de Catalunya, Spain

International Journal of Disaster Risk Reduction

The IJDRR publishes fundamental and applied research, critical reviews, policy papers and case studies focusing on multidisciplinary research aiming to reduce the impact of natural and technological disasters. The IJDRR stimulates exchange of ideas and knowledge transfer on disaster research, mitigation, adaptation, prevention and risk reduction at all geographical scales: local, national and international.
Editor in chief: Prof. David Alexander | University College London, UK

The *Building 4Humanity Design Competition*

Following the trail of the *7th ICBR*, which promoted the *Student Media Arts Competition*, the *8th ICBR* and the Portuguese NGO Building 4Humanity have jointly organized as a side event the *Building 4Humanity Design Competition* (*B4H-DC*). The Competition is aligned with the general aim of the *Sendai Framework for Disaster Risk Reduction* to achieve in 2030 "the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries" (UNISDR, 2015). Targeted at both professional and student interdisciplinary teams, the *B4H-DC* has an open programme, covering design for resilience in any stage of the disaster risk management cycle: that is, focusing on either mitigation ("building better from the start") or recovery ("building back better"). Each team was expected to present its own design programme, identifying a disaster-prone area (any hazard type) and proposing alternatives on how resilient buildings and settlements could support the building of communities' resilience. The Competition comprised three different categories:
Category 1: Professional teams / built projects;
Category 2: Professional teams / unbuilt projects; and
Category 3: Student teams / unbuilt projects.

The *B4H-DC* successfully received in its first edition 60 architectural design proposals, tackling hazards such as floods, volcanoes, earthquakes and hurricanes, and also including slum-upgrading and refugee-related interventions. The participating teams and team members originated from all five continents, while the architecture schools from the following two universities were particularly active: Dar Al Uloom University (Saudi Arabia), with six student teams who focused on extreme weather conditions, and Universidad Rafael Landívar (Guatemala), with five student teams who delved into volcano-eruption risks.

Location of the participating teams and focus of their architectural design proposals

The submitted proposals were in a first stage evaluated and shortlisted by an international jury composed of more than 50 academics and practitioners, and presided by Carmen Mendoza Arroyo (Universitat Internacional de Catalunya, Spain), Christian Werthmann (Leibniz Universität Hannover, Germany), and Carlos Alejandro Echeverri (Universidad EAFIT, Colombia).

The evaluation of the proposals was guided by the following criteria:
A) The quality of design, with particular emphasis on: (1) the robustness of the preliminary risk assessment as described in each team's *Design Programme*; and (2) the ensuing resilience strategies and solutions proposed, and the answers to the programme;
B) The quality of the overall framing and bonding of the design solution within the site/settlement, considering the utilization of local human and material resources, as well as the cultural, symbolic and spiritual endowments;
C) The evidence and adequacy of design strategies for community engagement and residents' involvement in the building, rebuilding or resettlement processes;

D) The value of the construction features, namely feasibility, cost-effectiveness, sustainability and, in particular, adaptability: to what extent the building/settlement can be delivered in a timely manner (the timeframe of the construction process), is extendable (scalable, expandable), flexible (versatile and convertible), recyclable (reusable).

In accordance with the final meeting of the second-stage evaluation Jury, held on 16 November 2018 during the *8th ICBR* in Lisbon, the winners of the first edition of the *Building 4Humanity Design Competition* are:

Category 1 (Professional teams / built projects):
– 1st prize: B4H-DC1152 (focus: resilience hub, France)
Members of the design team: *Constantin Petcou*, *Doina Petrescu* and *Anne Querrien*.

– 2nd prize: B4H-DC1108 (focus: floods, Peru)
Members of the design team: *Belen Desmaison*, *Kleber Espinoza*, *Urphy Vásquez* and *Fernando Carpio*.

– 3rd prize: B4H-DC1158 (focus: floods, Vietnam)
Members of the design team: *Elizabeth English*, *Pham Duy Tien*, *Nguyen Van Truoc*, *Teresa Tran* and *Thanh Tran*.

Category 2 (Professional teams / unbuilt projects):
– 1st prize: B4H-DC2137 (focus: hurricanes, USA)
Members of the design team: *Anita Berrizbeitia*, *Angel Rodriguez-Colon*, *Eduardo Llinás-Meseguer* and *Judith Rodriguez Portiele*s.

– 2nd prize: B4H-DC2102 (focus: wildfires, Australia)
Members of the design team: *Liz Brogden*, *Alexandra Illuk*, *Markos Hughes*, *Clare Kennedy* and *Nicholas McCarthy*.

– 3rd prize: B4H-DC2107 (focus: earthquakes, Japan)
Members of the design team: *Tadashi Saito*, *Hidenori Izumi*, *Yoshiro Namba*, *Kouji Mabuchi* and *Masakazu Terai*.

Category 3 (Student teams / unbuilt projects):
– 1st prize: B4H-DC3104 (focus: slum upgrading, Brazil) – students from the Federal University of Rio de Janeiro (UFRJ, Brazil)
Members of the design team: *Pérola Barbosa*, *Ana Dresler*, *Raquel Penna*, *Patrícia Monteiro Santoro dos Santos* and *Pablo Benetti* (supervisor).

– 2nd prize: B4H-DC3117 (focus: volcanos, Guatemala) – students from Rafael Landívar University (Guatemala)
Members of the design team: *Lily Reina Chen Rosales*, *Valerio SenLin Lee Pacheco*, *María Alejandra Lima Morales*, *Jorge Mario Pérez Sosa*, *Gerardo Andres Rodas Valladares* and *Eduardo Antonio Andrade Abularach* (supervisor).

– 3rd prize: B4H-DC3142 (focus: floods and cyclones, Bangladesh) – students from the School of Planning and Architecture, Bhopal (India)
Members of the design team: *Vishal Kumar*, *Akhilesh Shisodia*, *Mohit Arya*, *Reva Saksena* and *Sanjeev Singh* (supervisor).

A. Nuno Martins, Director (Chair of the *8th ICBR*)
Liliane Hobeica and *Adib Hobeica*, Executive Managers (Co-Chairs of the *8th ICBR*)

The first edition of the *Building 4Humanity Design Competition* was sponsored by:

The first edition of the *Building 4Humanity Design Competition* was supported by the following associate partners:

The *Marielle Franco Community-Design Award*

In association with the Portuguese NGO Building 4Humanity, the *8th ICBR* has organized a very special prize, in parallel to the *Building 4Humanity Design Competition*: the *Marielle Franco Community-Design Award*. This award pays a tribute to Marielle Franco, sociologist and social activist cruelly murdered in Rio de Janeiro (Brazil) in March 2018, who was working towards the legitimation of architecture as a public service in her home city. The *Marielle Award* intends to recognize the activities of architects in interdisciplinary teams working within deprived areas, such as slums and other informal settlements threatened or affected by disasters, extreme poverty, armed conflicts, forced displacements, eviction or urban violence. Therefore, the purpose of the award is to acknowledge architects' creativity but also their intellectual integrity and moral strength in seeking to improve the lives of underprivileged families, emphasizing both the results and the participatory process behind physical interventions that have contributed to the improvement of the living conditions locally, the reduction of risks and the strengthening of resilience.

The aim of the *Marielle Award* is not to recognize projects in isolation but the overall work of architects who have been having concrete impacts in the lives of underserved communities. It intends to give visibility to the outstanding performance of architects playing an intermediary role in dweller-based processes of building new homes, incremental housing, and community indoor- and outdoor-space improvements. The main focuses of the *Marielle Award* are indeed the professionals and their work processes, besides the interventions per se, which are taken as resepresentatives of their achievements. With a monetary value of 10,000 euros, the award is meant to be an incentive for the continuity of successful interventions, their scaling up or their replication elsewhere. The *Marielle Award* is supported by the Rio de Janeiro chapter of the Brazilian Council of Architects and Urbanists (Conselho de Arquitetos e Urbanistas do Brasil – CAU-RJ) and the Portuguese Order of Architects (Ordem dos Arquitectos Portugueses – OA), among others.

The *Marielle Award* received in its first edition 17 outstanding nominations from all around the world, of architecture practitioners, groups of professionals and organizations with a long-standing experience and substantial achievements in co-working with families and neighbourhood associations. The nominees' works have truly impressed the eminent members of the Jury, presided by Prof. Anna Tibaijuka (former Executive Director of UN-Habitat) and Mr. Abhilash Panda (Deputy Chief of the UNISDR Regional Office for Europe and Central Asia).

Indeed, the materials produced and submitted by the nominators vividly highlighted the engagement and commitment of the candidates, the high quality of the spaces designed and built in a shared manner, as well as the impacts that architecture can have not only in the physical materiality of deprived contexts, but also as a promoter of empowerment processes.

Location of the nominees and of the interventions showcased to represent their work

Another key aspect of the first edition of the *Marielle Award* was the fact that the great majority of the nominees are women or women-led groups and organizations, which was also reflected in the results of the first selection stage. The seven shortlisted candidates were (in alphabetical order):

– Afroza Ahmed (Bangladesh);

– Arquitetas Sem Fronteiras – ASF Brasil (Brazil);

– Carin Smuts (South Africa);

– Comunal: Taller de Arquitectura (Mexico);

– Mariana Estevão de Souza (Brazil);

– Office of Displaced Designers (Greece); and

– TAO-Pilipinas (Philippines).

In accordance with the final meeting of the second-stage evaluation Jury, held on 14 November 2018 during the *8th ICBR* in Lisbon, the recipient of the first edition of the *Marielle Award* is the NGO Arquitetas Sem Fronteiras – ASF Brasil, represented by the project "Arquitetura na Periferia" (Architecture in the Periphery), located in Belo Horizonte (Minas Gerais, Brazil).

The NGO ASF Brasil was founded in 2003, inspired by Architects without Borders International, with the mission to identify, create and articulate socio-environmental processes and projects in territories occupied by marginalized populations, in order to contribute to the empowerment of local populations and the social production of fairer and more balanced cities. The processes and projects being developed seek to value resources and local potentials, favouring cooperation between different governmental levels and activating processes of negotiation between public and private initiatives. The carried out activities involve technical counselling in the fields of design and planning, legal advising, construction and urban environmental recovery, through social processes that favour collective autonomy and self-government capacity. A number of strategic plans, project proposals and works have been developed in such fields as the improvement of the quality of life and work of homeless people, the recovery of environmentally degraded areas, or the rehabilitation of African-American religious traditional houses (*terreiros de candomblé*).

The main objective of the Architecture in the Periphery social project (AnP) is to improve housing conditions for families living precariously in high-vulnerability areas through the encouragement of women's autonomy and emancipation. Instead of simply offering a product – the design plans –, ASF Brasil shares knowledge, through a process of technical assistance targeted at women, using a methodology through which they learn basic practices

and techniques of project design, planning, budgeting and construction, and also receive an interest-free micro-credit so that they can carry out their constructions autonomously and with no wastage. This entire learning and planning process ends up promoting not only the improvement of the houses, but also an increase in self-esteem and self-confidence of the involved women, as they realize that they are capable of doing things they never imagined before. The methodology used by ASF Brasil was originally developed during the Master in Architecture and Urbanism (2013/2014) of AnP's current coordinator. The interventions already implemented through the AnP project have benefited 135 family members and range from the construction of previously inexistent bathrooms to the improvement of circulation, ventilation or natural lighting, to the installation of finishes and flooring that enhance house comfort. The AnP project has been providing a basis for women to strengthen their community bonds, to develop their critical and combative capacity in relation to current injustices, and to become the voices that will inspire other women living in similar contexts.

A. Nuno Martins, Director (Chair of the *8th ICBR*)
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The first edition of the *Marielle Award* was supported by:

Doctoral School

In keeping with the tradition of the *Building Resilience* conference series, the executive and scientific committees are delighted to present the Doctoral School as a special feature of the *8th ICBR* in Lisbon. This is organized to celebrate the contribution of our doctoral students to the research community. Within this dedicated forum, doctoral students get an invaluable chance to discuss their research work with the wider researcher community and receive constructive feedback.

Some of the activities that will take place within the Doctoral School include:

– A series of lectures by experienced scholars: Prof. Nuno Martins, Prof. Kaushal Keraminiyage, Prof. José Manuel Mendes and Prof. José Luís Zêzere, scientific directors of the doctoral school;

– A series of case studies presented by industry practitioners: Travis Bunt (One Architecture, USA), and Dave Hampton and Anya Brickman (RE:GROUND LLC Resiliency Strategies, USA);

– Interactive *PechaKucha* sessions in which doctoral students present their work to a panel of experts.

Workshop: *Disaster Risk Reduction is a Child's Play*

This fully interactive event, proposed by Ksenia Chmutina and Loïc Le Dé, takes the form of a game session facilitated by a range of academics and practitioners who use Disaster Risk Reduction games in their research, community engagement, outreach and other activities. The activities are followed by an interactive debrief allowing participants to reflect on their experiences with alternative approaches to appreciating the role of DRR through inquiry-based, active and experiential learning adopting the use of modular construction toys, board and card games, and video games, and discuss how the creative use of well-known toys and games helps exploring a real-world problem and test the solution.

Resilient Tours

The main idea of the Resilient Tours is to offer participants guided technical visits to one of four Portuguese sites that are particularly relevant from the risk and resilience points of view:

– Resilient Tour # 1: Areas recovering from wildfires near Coimbra (in the municipalities of Castanheira de Pera and Figueiró dos Vinhos).
– Resilient Tour # 2: Areas prone to flooding in the Tagus River Valley (in the municipalities of Vila Franca de Xira, Salvaterra de Magos and Santarém).
– Resilient Tour # 3: Remains of the 1755 earthquake and archaeological sites of Lisbon Downtown area.
– Resilient Tour # 4: Areas affected by extreme weather conditions (heat and drought), in the Alentejo region (municipalities of Évora and Mourão, namely the Alqueva Dam and the resettlement village of Aldeia da Luz).

The four Tours have a similar structure, comprising a cultural component in the morning, lunch, a scientific component in the afternoon, followed by a traditional *Magusto*. The one-day field trip will also be an informal occasion for further interactions between the *8th ICBR* delegates.

8th ICBR Papers

Communicating risks: factors influencing Filipinos living in high-risk areas to follow preemptive evacuation procedures

Jimwel Balunday [a,*]

[a] Ateneo de Manila University, Philippines

Abstract

With recent mega disasters, risk communication has become one of the important areas in disaster risk reduction. Pre-emptive evacuation has been a practice in the Philippines to lessen the number of casualties. Risk perception as part of the risk communication process was explored using the three predictors of the Theory of Planned Behavior. The researcher surveyed 1,200 respondents from the provinces of Aurora, Eastern Samar, and Davao Oriental of the Philippines regarding factors that influenced the participants to follow pre-emptive evacuation orders. Results were scored based on the recommendation of Francis and colleagues (2004) and other statistical models. Overall, socio-demographic and economic determinants were significant in following pre-emptive evacuation procedures, with subjective Norms having the strongest positive impact on the desired behavior. Results emphasized the interaction between important players in risk communication process, specifically giving pre-emptive evacuation procedures, rather than specific control of one player over the other. Aggregated results revealed that the three predictors were found to have positive impact to the intention and showed strong behavioral intention to follow pre-emptive evacuation procedures. This revealed that the respondents still experienced social pressure and motivation from external referents. Risk communication strategies should be designed context specific.

Keywords: Pre-emptive; Evacuation; Risk Communication

1. Introduction

Natural hazards events cause disasters with unique impacts on populations, economy, and the environment. The Philippines ranks 3rd in the World Risk Index as most prone to all hazards, including those that are human induced (Garschagen et al., 2015). Risk communication, as an integral factor in disaster risk reduction (DRR), forms part of the perception of risk and influences action in terms of disaster preparedness and emergency response (Shaw, Takeuchi, & Matsuura, 2011). Risk communication, as a practice, is an interactive process of exchange of information and opinion on risk among all stakeholders, specifically among risk assessors and risk managers according to the World Health Organization.

The concept of pre-emptive evacuation is part of both disaster prevention and mitigation and disaster preparedness in the Philippines. Surveillance agencies provide risk assessments, and these need to be turned into action by the local chief executive, who needs to advise residents living in low-lying and coastal areas to follow pre-emptive evacuation (Pama, 2014). The risk assessment allows the local government to enforce pre-emptive evacuation procedures if a tropical cyclone is forecasted to hit their area of responsibility.

1.1 Research questions

This research measured risk perception and its attributes relative to pre-emptive evacuation and answered the following questions:

1. How can NDRRMC most effectively communicate to the target recipients the call for evacuation?
2. What is the strongest factor that influences the intentions of Filipinos to follow pre-emptive evacuation procedures?
3. What are the implications of the factors in following pre-emptive evacuation procedures in developing disaster risk communication plans that are unique to the needs and profile of each location?

2. Conceptual framework

This study explains the discernment on the amount of risk (Inouye, 2014) vis-à-vis the three predictors of the Theory of Planned Behavior (Ajzen, 1985). The factors affecting the intentions of the target populations

* Corresponding author. E-mail address: jimwel08@gmail.com

encompass risk perception since the three predictors of the Theory of Planned Behavior evaluates the amount of risk that the population perceived. The risk appraisal, wherein the objectives are based on scientific facts, perceived risk, and source analyses (Smillie & Blissett, 2010), will form part of the intention to follow or not to follow pre-emptive evacuation procedures. The target behavior of followed pre-emptive evacuation procedures means an effective risk communication process since the actual behavior was performed.

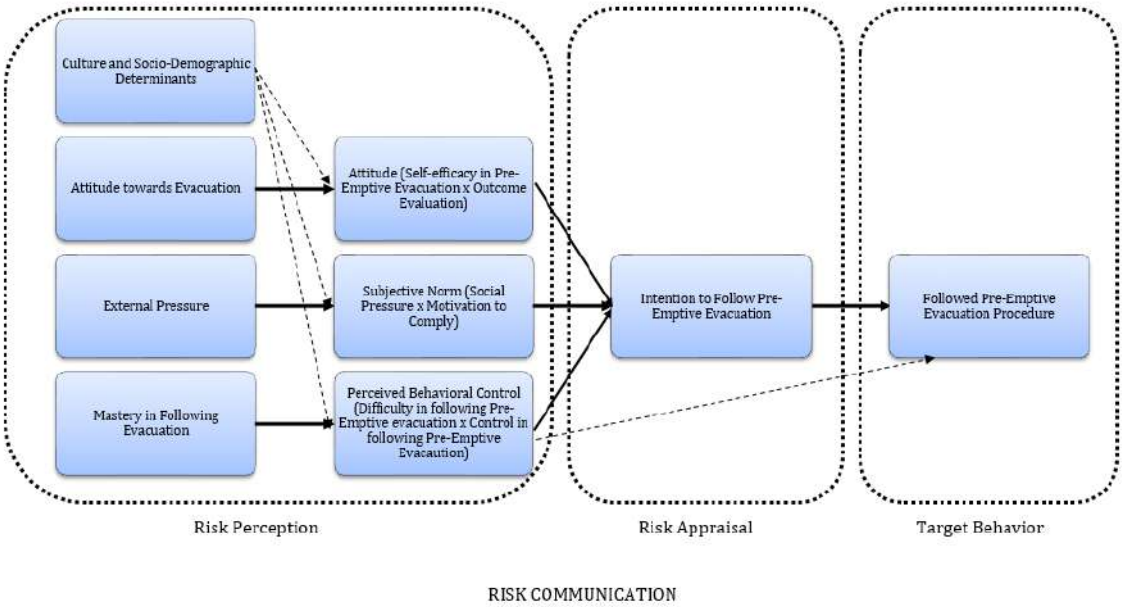

Figure 1: The theory of planned behaviour and risk communication process.

3. Methodology

Francis and colleagues (2004) developed a manual for health services researchers in constructing questionnaires based on the Theory of Planned Behavior. This study adapted some of the concepts of the manual that fit with behaviors during disasters and the scoring method.

To further analyze and interpret the results of the data and information gathered, the researcher used some statistical treatments, particularly regression analysis, in order to interpret the relationships among variables. Multiple regressions were used in analyzing the impact of the independent variables. The researcher used ANOVA regression to minimize the sum of square deviations to determine the relationship of dependent and independent variables.

4. Results and discussion

The purpose of this study is to investigate the intention of Filipinos living in high-risk areas to follow pre-emptive evacuation procedures. This study used the Theory of Planned Behavior (1988) as framework in predicting the occurrence of behavioral intentions, which is the intention to follow pre-emptive evacuation procedures. In addition, risk communication, as a process, was used following the risk perception (Inouye, 2014), risk appraisal (Smillie & Blissett, 2010), and a target behavior of following pre-emptive evacuation procedures as an indicator in the risk communication process.

Table 1 compares the socio-demographic and economic profile of all three provinces using eight variables: sex, civil status, age, average monthly income, house ownership, living arrangements, living companions, and educational attainment.

Table 1: Distribution of Respondents According to Socio-demographic and Economic Profile: Aggregated Result.

Variables	N=1,200	%	Variables	N=1,200	%
Sex			**House Ownership**		

Table 1: Distribution of Respondents According to Socio-demographic and Economic Profile: Aggregated Result.

Variables	N=1,200	%	Variables	N=1,200	%
Male	478	39.8%	House Owner	576	48.0%
Female	547	45.6%	Sharer	127	10.6%
Civil Status			Renter	94	7.8%
Single	214	17.8%	Caretaker	38	3.2%
Married	697	58.1%	I own my house but not the lot.	325	27.1%
Others	91	7.6%	I own the lot but not my house.	6	0.5%
Age			I do not own the house I am living.	22	1.8%
Below 20	10	0.8%	**Living Arrangements**		
20-29	129	10.8%	Alone	43	3.6%
30-39	264	22.0%	With my friends	53	4.4%
40-49	320	26.7%	With my family	983	81.9%
50-59	201	16.8%	With my extended family	103	8.6%
60 and Above	131	10.9%	**Living Companions**		
Average Monthly Income in Pesos			With someone below 18	657	54.8%
None	104	8.6%	With senior citizen (60 years old and above	2	0.5%
Less than 1,000	208	17.3%	With animals/pets	1	0.2%
1,001 to 5,000	587	48.9%	**Educational Attainment**		
5,001 to 10,000	234	19.5%	Less than Elementary	47	3.9%
10,001 to 50,000	30	2.5%	Elementary	251	20.9%
50,001 to 100,000	3	0.3%	High School	442	36.8%
More than 100,000	4	0.3%	College	342	28.5%
			Post-Grad	108	9.0%

Table 2 shows the overall score index on Attitude, Subjective Norms, and Perceived Behavioral Control of all the provinces. Subjective Norms showed the strongest factor (mean = 68, range = 105) on building the intention to follow pre-emptive evacuation procedure compared to Attitude (mean = 36, range = ± 84) and Perceived Behavioral Control (mean = 19, range = ± 84).

Table 2: Overall score index on attitude, subjective norms and perceived behavioral control: Aggregated result

Scale	Attitude		Subjective Norms		Perceived Behavioral Control	
Highly Strong (-)	253	0.21	74	0.06	199	0.17
Strong (-)	0	0.00	0	0.00	0	0.00
Moderate (-)	0	0.00	0	0.00	0	0.00
Weak (-)	0	0.00	0	0.00	0	0.00
Highly Weak (-)	0	0.00	0	0.00	0	0.00
Neutral	0	0.00	0	0.00	0	0.00
Highly Weak (+)	165	0.14	93	0.08	387	0.32
Weak (+)	144	0.12	140	0.12	384	0.32
Moderate (+)	192	0.16	224	0.19	126	0.11
Strong (+)	136	0.11	179	0.15	53	0.04
Highly Strong (+)	310	0.26	490	0.41	51	0.04
Grand Total	1,200	1.00	1,200	1.00	1,200	1.00
Index Score	**35.5**	**Moderate Positive**	**67.6**	**Strong Positive**	**19.4**	**Weak Positive**

Subjective Norms showed the strongest factor in building the intention to follow pre-emptive evacuation procedure in the over-all score of the three provinces. The strong social structures showed the powerful influence of government, friends, and experts and announcement from television and radio on people's opinion about risk (Fei et al. 2011).

These results revealed the focus on risk communication strategies of every province. Risk communication strategies for Eastern Samar should focus on improving their attitude towards evacuation facilities, while for Aurora and Davao Oriental on increasing their control towards evacuation and more motivation to the participants.

Table 3 shows information as regards media usage and evacuation experience. Majority of the participants used television (77%) and radio (67%) as sources of information before and during emergencies. These results concur with the findings of Ahmad (2011) which described the vital role of media in providing early warning and dissemination of information.

Table 3: Overall scores: attitude, subjective norms and perceived behavioral control, by locality.

Dimensions	Scores Index			
	Aurora	Eastern Samar	Davao Oriental	Grand Total
Attitude	53.10	22.90	30.01	35.54
Subjective Norm	72.31	60.71	69.84	67.63
Perceived Behavioral Control	10.48	23.09	25.02	19.39
Overall Scores	**45.31**	**35.56**	**41.61**	**40.85**

Majority of the respondents (83%) experienced evacuation and majority experienced evacuating during actual tropical storm (85%), and experienced evacuating once or more than once (82%). Previous studies (Leonard et al., 2012; Nyathi, 2013) acknowledged the importance of past experiences in building intention.

An overwhelming majority of participants (88%) was willing to follow evacuation. This matches previous studies of Eisenman and colleagues (2007) and RØd and colleagues (2012b) that claimed that the lack of

experience might impede the decision to evacuate or those who already experienced disasters are willing to follow the instructions to evacuate.

Table 4: Frequency distribution of the respondents on information as regards media usage and evacuation experience: Aggregated result.

Variables	N=1200	%	Variables	N=1200	%
Media Usage			**Experience about Evacuation**		
Internet	223	18.6%	Yes	993	82.8%
Television	921	76.8%	No	160	13.3%
Radio	803	66.9%	**Circumstances of Evacuation**		
Announcement from Local Government	673	56.1%	Evacuation Drill	102	8.5%
Word-of-Mouth from Neighbors	119	9.9%	Tropical Cyclone	909	75.8%
Newspaper	152	12.7%	Tsunami	274	22.8%
Others	24	2.0%	Others	47	3.9%
No. of Times Experienced			**Willingness to follow**		
One	321	26.8%	Yes	1060	88.3%
Two	313	26.1%	No	6	0.5%
Three	160	13.3%			
More than 3	190	15.8%			

4.1.Exploratory factor analysis of the study constructs

There are two primary reasons why the respondents prioritize evacuation related to Attidute- factor 1, “Positive Attitude” and factor 2, “Desirability in Evacuation center”. There are three primary reasons why the respondents follow pre-emptive evacuation related to Subjective Norms; Factor 1, “Confidence in Sources of Information relative to pre-emptive evacuation”, Factor 2 is the influence of Radio and Television, and Factor 3, which is the influence of friends. In terms of Perceived Behavioral Control, the results revealed that there are two primary motives why the respondents follow preemptive evacuation - factor 1, “Encouragement Expectations”; and factor 2, “Encouragement as Enabler”.

The estimates are summarized into three models that isolate the effects of each of the Socio-Demographic Determinants. The model, for example, indicates that:

1. Risk communication strategies should be age specific.
2. Risk communication strategies should be gender specific.
3. Individual response efficacy is affected by family.
4. Families with high income tend to be more resilient compared to low-income household and are normally not displaced; thus, they are not directly affected by evacuation.
5. There is a need to mainstream disaster risk reduction into the education system.
6. Risk communication strategies should focus more on personal safety and security rather than material things.
7. Importance of activities in building positive perception towards pre-emptive evacuation of the whole members of the family to improve risk communication.

Results provide the regressions’ aggregate result for Behavioral Intentions attributes (Difficulty in making a decision to follow and Willingness to follow) as the dependent variables and the relation to other variables. The model indicates that:

1. The estimates suggest that increase in the attitude scores of the participants reflects more difficulty in making decisions but more willingness to follow evacuation orders.
2. The estimates suggest that the increase in the normative scores of the participants reflects less difficulty in making decisions but less willingness to follow evacuation orders.
3. The estimates suggest that the increase in Perceived Behavioral Control score reflects more difficulty in making decision but more willingness to follow evacuation orders.
4. The estimates suggest that the increase in the number of times respondents experienced evacuation reflects more difficulty in making decisions but more willingness to follow evacuation orders.

4.2.Cultural determinants

Family as an indicator in living arrangement and also an external referent affects the intention to follow evacuation procedures. The family, which is considered the center of social structure, also affects the difficulty of the respondents to follow pre-emptive evacuation as subjective norm. Respondents also agreed to have more perceived control because of faith. This matches the findings of Güss and Panga (2004) describing the "bahala na" (accepting a given situation) attitude of the respondents. The acknowledgement of the respondents to accept their fate showed faith as an indicator in forming the behavior to follow evacuation. The results stress the need to also put focus in the advantages of having faith in designing risk communication strategies.

4.3.Implications for risk communication

All provinces showed positive intention to follow pre-emptive evacuation procedures; however, there are factors affecting the intentions and difficulty of the target populations to evacuate. The difficulty, at varying level, of the respondents to follow pre-emptive evacuation procedures affects the risk perception. In all provinces including the aggregated results, Subjective Norms showed the strongest factor in building the intention to follow pre-emptive evacuation procedure.

The results all participants appeared to have less perceived control over the desired behavior. However, closer examination of data shows differences: for those in Aurora and Davao Oriental, perceived behavioral control showed the least effect on participants' intention to follow evacuation procedures; for those in Eastern Samar, on the other hand, attitude towards evacuation showed the least effect to their intention to follow evacuation procedures. These findings show nuances on the three predictors of the Theory of Planned Behavior unique to locations in the Philippines; these nuances could be lost had the data been treated as a whole.

The results revealed that Subjective Norms showed the strongest factor in building the intention and risk perception to follow pre-emptive evacuation procedures. This revealed that there is already an established trust and relations of local officials, friends and media including television and radio across all the provinces. However, risk communication strategies should be context specific due to the differences in the significance of socio-demographic determinants to the three predictors of the Theory of Planned Behavior.

5. Conclusion

The purpose of this study is to analyze variables affecting the intention of Filipinos living in high-risk areas to follow pre-emptive evacuation procedures using the Theory of Planned Behavior and Risk Communication process to be able to provide recommendations to the NDRRMC such as ways to communicate evacuation orders effectively.

Results revealed the three predictors of Theory of Planned Behavior that form part of risk perception were found to have positive impact to the intention of the respondents and showed strong behavioral intention to follow pre-emptive evacuation procedures. Subjective Norms have the strongest positive impact on the desired behavior. This shows that the respondents experienced strong social pressure and motivation from external referents. Socio-demographic determinants have a direct relationship to the three predictors of the Theory of Planned Behavior.

1. How can NDRRMC most effectively communicate to the target recipients the call for evacuation?

   Results emphasized the interaction between important players in risk communication process, specifically giving pre-emptive evacuation procedures, rather than specific control of one player over the other. The dependency of the Local Government Units to the National Government Agencies that affects

the risk decision-making process stresses the importance of streamlining the communication flow of the NDRRMC.

2. What is the strongest factor that influences the intentions of Filipinos to follow pre-emptive evacuation procedures?

   Aggregated results revealed that the three predictors were found to have positive impact to the intention and showed strong behavioral intention to follow pre-emptive evacuation procedures. Subjective Norms have the strongest positive impact to the desired behavior. This revealed that the respondents still experienced social pressure and motivation from external referents.

3. What are the implications of the factors in following pre-emptive evacuation procedures in developing disaster risk communication plans that are unique to the needs and profile of each location?

   This study represents significant findings on the importance of the three predictors and socio-demographic profiles of the population in following pre-emptive evacuation procedures. The results revealed that while this study identified Subjective Norm as the highest predictor in the intention to follow pre-emptive evacuation procedures, this study suggests distinctions of each province and the overall results. These distinctions may be used in creating disaster communication plans that are unique in every study area. For example, the importance of either television or radio as source of disaster information must be considered in the communication process. This also stresses the importance of the roles of socio-demographic determinants in the risk perception.

An important implication of this study came from the results of exploring the individual resiliency or individual's assessment of resiliency. Some of the factors were not significant due to the developed individual resilience of the respondents. Accordingly, Perceived Behavioral Control may be considered in individual resiliency; however, even without perceived control an individual can change his/her behavior.

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Assessing urban resilience to extreme weather events based on human mobility perturbation

Zaishang Li [a,*], Fucheng Zhang [a], Nan Li [a], Dongping Fang [a]

[a] Tsinghua University, China

Abstract

The occurrence of extreme weather events such as rainstorms and consequent floods has posed serious threats to cities. There is substantial need to enhance the resilience of cities to the impacts of extreme weather events, for which quantifying resilience is of fundamental importance, as it sets the benchmark for assessing the effectiveness of possible resilience enhancement measures. Human mobility, which represents the characteristics of people's displacements in an urban space, is subject to perturbation when extreme weather events happen. Perturbed human mobility represents a reflection of the impacts that extreme events exert on cities and their populations. In this study, an approach is proposed for assessing urban resilience, by quantifying the human mobility perturbation over the entire lifecycle of extreme weather events. The efficacy of the proposed approach is validated in a case study, using taxi trajectories data in a Chinese city over a heavy rainstorm event.

Keywords: urban resilience; human mobility; indicator; rainstorm; taxi trajectory

1. Introduction

Extreme weather events have posed serious threats to urban people's lives and property. With this context, urban resilience, which can be defined as the ability of a city to maintain the necessary functions during a disturbance, rapidly recover in the aftermath of the disturbance, and adapt to uncertainties in the future (Meerow et al., 2016), has attracted tremendous attention. In order to improve the resilience of cities, quantifying urban resilience is of fundamental importance, as it sets the benchmark for assessing the effectiveness of possible resilience enhancement measures. However, cities are extremely complex systems, which are not only collections of buildings and infrastructures but also concatenations of social and cultural elements (Campanella, 2006), making it highly challenging to quantify urban resilience appropriately.

Human mobility, which represents the characteristics of people's displacements, has strong correlation with both physical and social elements of cities. On one hand, people rely heavily on various types of physical transport infrastructures including roads, bridges and so forth to travel in urban space. Malfunction of these infrastructures will apparently affect human mobility and even leave people cut off from the outside world in extreme situations (Hannam et al., 2006). On the other hand, the implication of human mobility is more than physical movement. Human mobility has been proved to be correlated with social ties and social networks (Wang et al., 2011). Prior studies have demonstrated that human mobility is subject to perturbation when cities suffer extreme weather events (Wang and Taylor, 2016). Under extreme weather events, roads may be paralyzed and buildings may be forced to close, hindering people from traveling smoothly as usual, while conditions of urban mobility will recover to normal once the extreme weather events end. Such a relationship between extreme weather events and perturbation of human mobility indicates that perturbed human mobility can represent a reflection of the impacts that extreme events exert on cities.

In this article, we propose a quantitative approach for assessing urban resilience based on human mobility perturbation. The following section describes the methodological design of the approach, which is then tested using a case study conducted in the Chinese City of Nanjing. The validity and performance of the approach is discussed in detail. The significance of the findings as well the limitations of this research are discussed in the last section.

* Corresponding author. E-mail address: lizs15@mails.tsinghua.edu.cn

2. Methodology

2.1. Assessment of urban resilience

The resilience of a system depends on its functionality ($Q(t)$), which varies within the range between 0% and 100% (see Figure 1). One hundred percentage means the system is fully functional and provides full service whereas 0% means the system malfunctions and no service is available. The functionality will drop down when the system encounters disruptions (the moment of occurrence of disruption is denoted as t_0), and will bounce back to the normal level after recovery measures take effect (the moment of full recovery is denoted as t_1). Mathematically, the level of resilience can be calculated by integrating the functionality over the period from t_0 to t_1, as shown in Eq. (1) below (Bruneau et al., 2003, Cimellaro et al., 2010):

$$R = \int_{t_0}^{t_1} \frac{Q(\mathrm{t})}{t_1 - t_0} dt \tag{1}$$

From Eq. (1), it is obvious that only by quantifying the functionality of the system ($Q(t)$) can the level of resilience (R) be calculated. However, a city is a very complex system composed of various types of sub-systems, and there still lacks an indicator to comprehensively depict urban functionality. Most prior quantitative studies of urban resilience only focus on the physical aspect of cities, such as buildings or infrastructures (Cimellaro et al., 2016, Tian et al., 2016). However, the social aspect is also important in the composition of cities, which should be accounted for in the assessment of urban functionality. Human mobility, which is correlated with both physical and social elements of cities as aforementioned, has good potential to serve as an indicator of urban functionality that reflects both physical and social aspects of cities.

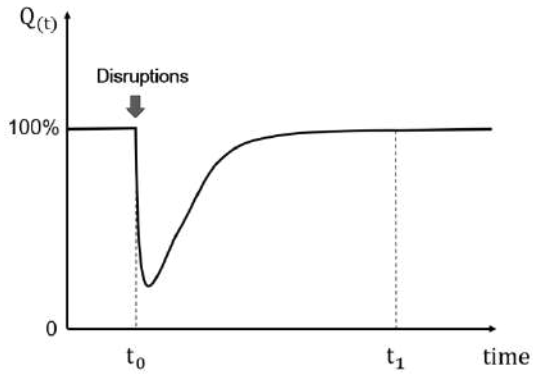

Figure 1: Resilience curve (adapted from Bruneau et al. (2003)).

2.2. Quantification of human mobility

Human mobility has been a research focus for years. A number of studies have focused on quantitative analysis of human mobility patterns, among which two metrics are widely used, including displacements and radius of gyration (González et al., 2008, Wang and Taylor, 2016, Oliveira et al., 2016).

Displacement (d) is the distance over two consecutive points from an individual. It can be calculated as follows (Wang and Taylor, 2016):

$$d = 2r \times \sin^{-1}\left(\sqrt{\sin^2(\frac{\theta_2 - \theta_1}{2}) + \cos\theta_1 \cos\theta_2 \sin^2(\frac{\varphi_2 - \varphi_1}{2})}\right) \tag{2}$$

where r denotes the radius of the earth, θ denotes the latitude in radians, and φ denotes the longitude in radians.

Radius of gyration (r_g) is a measure of how far the mass of movements is from its center (Yan et al., 2010). It can be calculated as follows: (Wang and Taylor, 2016):

$$r_g = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left[2r \times \sin^{-1}\left(\sqrt{\sin^2(\frac{\theta_t - \theta_c}{2}) + \cos\theta_c \cos\theta_t \sin^2(\frac{\varphi_t - \varphi_c}{2})}\right)\right]^2} \tag{3}$$

where n denotes the number of places an individual visits, t denotes each location, θ denotes the latitude in radians, φ denotes the longitude in radians, and c denotes the center of mass of movements.

The variations of these two metrics caused by natural disasters, such as extreme weather events, is a reflection of the perturbation of human mobility patterns (Wang and Taylor, 2016). Therefore, it is possible to use these metrics to construct an appropriate indicator of urban functionality ($Q(t)$) for the purpose of measuring urban resilience (R).

It needs to be noted that, according to Eq. (1), $Q(t)$ is supposed to decrease following the occurrence of disasters, and eventually bounce back over time. Any indicator of $Q(t)$ constructed based on human mobility should have similar trends of variations. One indicator that satisfies this criterion is travel distance (TD). During extreme weather events such as rainstorms, people usually avert traveling outdoor or move slowly due to poor commuting conditions. This will result in a decrease in TD, which will gradually return to its normal level once the influence of extreme weather events fades. TD can be calculated by accumulating a series of consecutive displacements, as shown in Eq. (4):

$$TD = \sum_{i=1}^{n-1} d_i \tag{4}$$

where n is the number of places an individual visits during a time span and d_i is the i-th displacement in the trajectory. Then, TD can be normalized and used as $Q(t)$ to obtain the resilience level of an urban system to extreme weather events based on Eq. (1).

3. Case study

To assess the efficacy of the proposed urban resilience assessment approach, a case study was conducted, based on the City of Nanjing, the capital of east China's Jiangsu Province. On June 10, 2017, there was a torrential rainstorm in Nanjing, with the daily precipitation reaching over 200 millimeters (see Figure 2), setting a new record of the city in 66 years (China Daily, 2017). The rainstorm imposed significant impacts on the city, leaving many roads in the city waterlogged and even paralyzed.

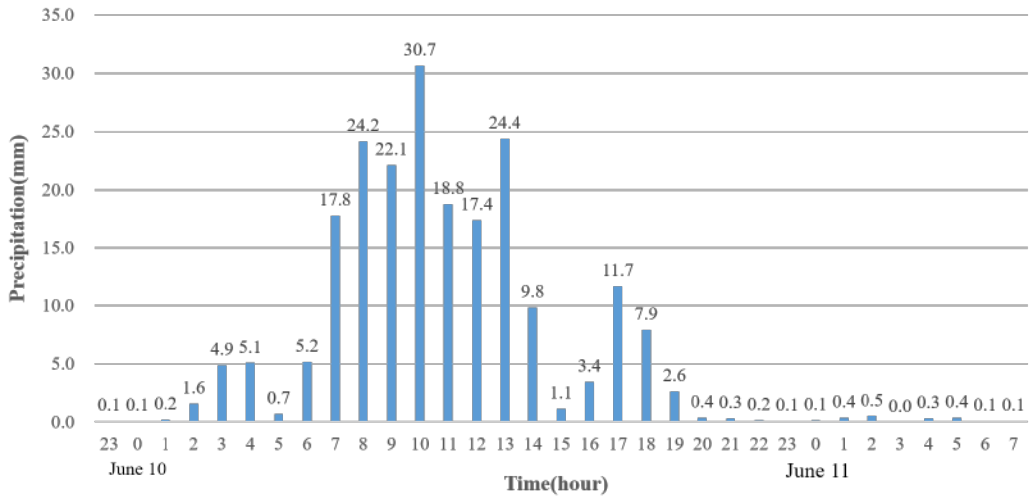

Figure 2: Hourly precipitation during the rainstorm event in Nanjing.
(Data source: Jiangsu Meteorological Bureau)

3.1.Data description

The trajectories of all taxis in Nanjing, which collectively provided a reflection of the overall human mobility in the city, during the rainstorm were collected and analyzed to assess the city's resilience to this extreme weather event. As regulated, every taxi in Nanjing is equipped with a sensor, which is configured to report to a central server every 10 seconds while the taxi is in operation. Data reported by the sensor contains several fields including taxi license plate number, timestamp, longitude, and latitude. Table 1 presents a few examples of the data entries. The data were collected over two weeks, including one week before the rainstorm and one week

after the rainstorm, namely from June 3 to June 17. A portion of the taxis that were not operating every day during this period were excluded in the dataset to avoid possible noise caused by irregularity of their work schedules. A total of 7,100 taxis and over 250 million data entries were included. All data were processed and computed using Python.

Table 1: Examples of the data entries.

Taxi license plate number	Time	Longitude	Latitude
A75***	170610080206	118.78802	31.99578
A75***	170610080213	118.78894	31.99518
AB3***	170606001202	118.80776	32.03721
AB3***	170606001214	118.80761	32.03780

3.2.Data pre-processing

As explained above, the normalized TD can be used as an indicator of urban functionality for the purpose of assessing urban resilience to extreme weather events. In this case study, the normalized TD was calculated as the ratio of average travel distance (RATD) of the 7,100 taxis in the city during the extreme weather event to its normal level, which was used as $Q(t)$ in Eq. (1). The RATD was calculated in two different time granularities, namely per hour and per 15 min, in order to assess possible impact of time granularity on the performance of the proposed resilience assessment approach.

In order to calculate RATD, the average travel distance (ATD) of all taxis was calculated first. Within any given unit of time (1 hour, or 15min), the trajectory of taxi j was extracted from the dataset and contained in a Python List *[Taxi license plate number, [longitude_1, latitude_1], [longitude_2, latitude_2], ..., [longitude_n, latitude_n]],* in which all n locations the taxi traversed were listed in time order. Based on Eq. (2), the TD of each taxi a unit of time was calculated.

A screening rule was applied to exclude a few anomalies which might have resulted from sensor malfunctions. Namely, any TD value that was over 160 km per hour or 40 km per 15 min was abandoned. Then, the ATDs of all taxis in every time unit over the two weeks were calculated in both time granularities based on Eq. (5), and stored in two datasets named as Dataset_hour and Dataset_15min, respectively:

$$ATD = \frac{1}{N}\sum_{j=1}^{N} TD_j \tag{5}$$

where TD_j denoted the travel distance of taxi j and N denoted the number of taxis that were in operation within the given unit of time.

3.3.Ratio of Average Travel Distance (RATD)

To examine the impact of the extreme weather condition on the ATD, two confounding variables were identified and their impacts on the ATD were excluded. Firstly, daily and weekly periodicity was observed in the taxi trajectories, e.g. peak hours in early mornings and late afternoons and different patterns between weekdays and weekends. Secondly, major events, such as the Chinese College Entrance Examination held on June 7-9, were deemed to have potential impacts on taxi trajectories.

In order to assess and exclude the influence caused by the above two confounding variables, Multiple Linear Regression (MLR), a method to model the relationship between two or more independent variables and a dependent variable by fitting a linear equation, was used. Hereinto, the dependent variable was ATD and the independent variables included the time (dummy, every hour or every 15min), the weekdays (dummy, from Monday to Sunday), the examination (dummy, whether it was within the period between two hours before the first exam and two hours after the last exam of each exam day) and weather condition (dummy, whether it was raining or not). The software Stata/MP 13.1 was used and the significance level for removal of variables from the model was set as 5%. The ATD was then adjusted by subtracting corresponding coefficients of the arguments

except "rain" so that the adjusted ATD ($ATD_{adjusted}$) was supposed to be dependent on the weather condition variable only. Based on the $ATD_{adjusted}$, a baseline for normalizing ATD was defined as the average $ATD_{adjusted}$ in non-rainy days (denoted as $ATD_{baseline}$). Then, the RATDs in both datasets were calculated based on Eq. (6):

$$RATD = \frac{ATD_{adjusted}}{ATD_{baseline}} \times 100\% \tag{6}$$

3.4. Urban resilience assessment

To compute the value of resilience (R) according to Eq. (1), the next step is to determine the values of parameters t_0 and t_1. In this case study, the starting point of the rainstorm event (t_0) was set as 23:00 on June 9 based on hourly precipitation data (Figure 2). The urban functionality was considered to have recovered to its normal level when the RATD became stable after the recovery process. In this case, the RATD dataset was organized in time order and could be considered as a time series. To identify the moment when RATD achieved full recovery (t_1), the Augmented Dickey-Fuller test (ADF test) was applied. The ADF test is a method to identify whether a time series is stationary, namely its mean, variance and covariance do not change over time (Stadnytska, 2010). In this case study, the ADF test was applied to identify the moment when the RATD time series became stationary. To ensure such stationarity is stable over time, t_1 was set to be the first time point that satisfied the condition that itself and its following nine time points were all significant by ADF test. By setting the time window for testing at 24 hours and the significance level at 5%, the ADT test reported that the urban functionality returned to its normal level at 3:00 and 2:15 on June 13, under one-hour and 15-min granularities, respectively.

Once $Q(t)$, t_0 and $t_1$were all determined, then the value of R could be computed based on Eq. (1). The results were reported in the following section.

4. Results and Discussions

Figure 3 and Figure 4 illustrated the RATD of all taxis in Nanjing over the two weeks in both time granularities. The grey areas were defined by $Q(t)$, t_0 and t_1 and laid the basis for computing the value of R. It could be seen in the figures that there was an apparent pattern of "decreasing first, staying low for a while and then recovering" between June 10 and June 11. Such pattern indicated that the rainstorm indeed had an impact on the human mobility of Nanjing, which lasted after the rainstorm stopped for a period even longer than the duration of the rainstorm. In addition, by comparing the $Q(t)$ curves in Figure 3 and Figure 4, it was observed that the two curves were mostly similar in their overall trends, although the curve in Figure 4 had more oscillations owing to its higher granularity.

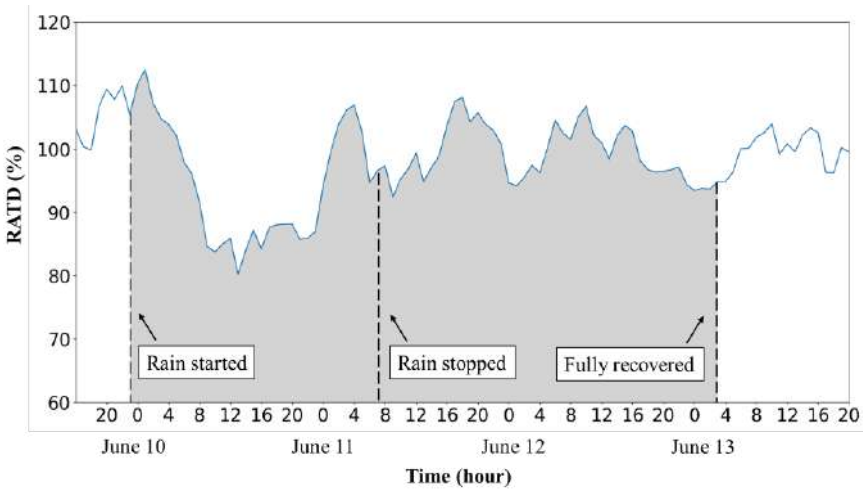

Figure 3: Resilience curve based on Dataset_hour.

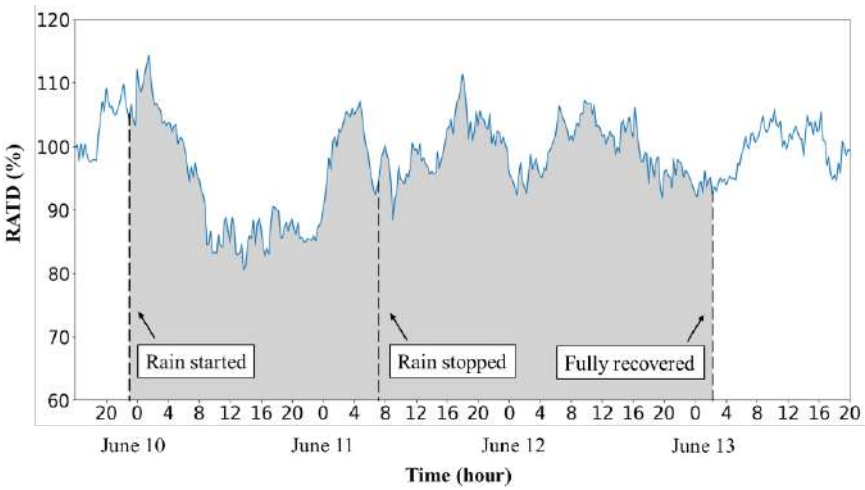

Figure 4: Resilience curve based on Dataset_15min.

The $Q(t)$ curves in Figure 3 and Figure 4 were closely correlated with the evolution of the rainstorm event. The rain started soon before the midnight of June 10 according to Figure 2, while the RATD started decreasing significantly right after the midnight of June 10. The rainstorm became much heavier around 7:00 through 20:00 on June 10, while the RATD reached its bottom around 9:00, and started oscillating around the value of 85% until 22:00 on June 10. The trend of RATD was highly coupled with the trend of the precipitation with about two hours' delay, which might be because of the time it took for floods to form and dissipate. Yet, it needs to be pointed out that the fully recovery of the RATD took almost two extra days after the rainstorm stopped, which showed lasting impact of the rainstorm event on the city, due to possible reasons such as urban waterlogging and failed storm water drainage system.

Table 2 presented the resilience assessment results of the case study. The resilience values under two time granularities were 0.960 and 0.969, respectively, which were generally consistent with each other. These results indicated that, although the rainstorm was a record-setting event, the city was highly resilient against its impact. The reason was probably because the rainstorm did not last long enough to cause sever and widespread flooding in the city, as was underscored by several local residents and witnesses of the rainstorm who were interviewed in the case study. Nevertheless, the case study served to demonstrate the efficacy of using the proposed approach to quantitatively assess the resilience of a city against extreme weather events, based on analytics of human trajectory data and human mobility patterns.

Table 2: Parameter values and resilience assessment results.

Parameter	Time granularity	
	Hour	15 min
t_0	23:00, June 9	23:00, June 9
t_1	3:00, June 13	2:15, June 13
R	0.960	0.969

5. Conclusions

Cities worldwide are constantly faced with serious threats by extreme weather events, which calls for improvement of urban resilience against their impacts. However, there lacks an approach which can quantitatively assess the resilience of a city by factoring in both its physical and social aspects. This study contributes to the existing body of knowledge by proposing a new approach for quantitative assessment of urban resilience. An indicator based on human mobility was constructed to represent the urban functionality and its variation, and, in turn, to assess the urban resilience based on urban functionality curve. The feasibility and effectiveness of the approach were validated using a case study.

There are several limitations in this study that should be acknowledged and addressed in future research. First, there were noticeable fluctuations in the RATD curves that were not accounted for by variables included in the MLR analysis, which may not necessarily be random and could introduce bias into the results. Second, the case study only examined taxi trajectories. Other modes of transport, such as buses, metro and private cars, were not included. The proposed approach could be easily modified and applied to other types of trajectories should data become available, and the results would further enrich the understanding of the resilience of a city to extreme weather events.

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Measuring the unquantifiable?

Elisabeth Marlow [a,*], Ksenia Chmutina [a], Andrew Dainty [a]

[a] Loughborough University, UK

Abstract

By 2050, 66% of the global population will live in urban areas; 98% of cities are experiencing the effects of a changing socio-ecological environment and increasing risks associated with natural hazards and human-induced threats. Defining strategies and metrics for resilience has led to a generation of measurement frameworks. Measurement frameworks often represent the outcome of risk governance; in a recent Overseas Development Institute's (ODI 2016) report, 39 resilience frameworks were reviewed, yet only two of those specifically considered cities. This paper analyses five recent frameworks aimed at measuring 'resilience' of a city using a thematic analysis to compare and contrast whether and how they quantify resilience. The five frameworks discussed are: IIED's Tracking Adaptation and Measuring Development, BRE's 12 cities assessment, Rockefeller's City Resilience Index, UNISDR's Making my City Resilient Campaign, and the Ecological Sequestration Trust's 'Resilience.io'. From reviewing the frameworks' characteristics, this paper has established that a version of a city's resilience has become quantifiable through indicators, but it leading to transformative adaptive capacity of our cities is still debatable. The frameworks or those that use them, still need to address further resilience and sustainability of design and planning in cities.

Keywords: Measurement Frameworks; Risk; City; Resilience indicators; Comparative analysis.

1. Introduction

Many seek to qualify the meaning of resilience (Carpenter et al. 2001; Folke et al. 2010; Chmutina, Lizarralde, et al. 2016) and the United Nations (2016, p.22) has defined resilience as *"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management*". If resilience is becoming qualified through this definition, or any other, it asks: can it be quantified? Or should it? Ayyub (2014) and Michel-Kerjan et al. (2013) suggest there is a need for quantification of resilience to reduce disaster risk and subsequent cost of recovery; LLoyd's (2015) City Index also seek to quantify risk and rate cities for these costs.

Folke et al. (2002) and Carpenter et al. (2001, p.767) discuss resilience's systematic relationship with sustainability and its measurement "*by the magnitude of disturbance the system can tolerate and still persist*" and considers this as transformative adaptive capacity. 39 frameworks and approaches were analyzed in (ODI 2016), when 'capacity' was reviewed only three frameworks operated at an 'urban' scale, of which only one considered 'capacity'.

Considering that the Sendai Framework and Sustainable Development Goal 11 are reciprocating one another on urban development (Peters et al. 2016) and when *"Cities consume over two-thirds of the world's energy and account for more than 70% of global CO2 emissions. And with 90 percent of the world's urban areas situated on coastlines, cities are at high risk from some of the devastating impacts of climate change, such as rising sea levels and powerful coastal storms"* (Cities, 2018), why are cities not better represented, or are city frameworks only measuring cost of disaster risk resilience?

Descending the measurement scale to buildings in their urban context needs more thought, it is imperative that future risks are not being generated through what is being quantified or inheritably informs city regulation. An example of this: in 2017, Grenfell Tower Fire (London, UK) occurred illustrating a catastrophic failure of building regulations in one building. Consequently, the inquest has led to the Hackitt Report (2018) which calls for a Principled approach and a risk based approach to change the way of the planning and design of 10 storey (or more) buildings. Structural Engineers who are custodians to building safety, state that "*The Hackitt Report sets out a vision for a cultural change in the way that certain buildings are designed, constructed, regulated and*

* Corresponding author. E-mail address: e.marlow@lboro.ac.uk

maintained. It recommends a model of risk ownership with clear responsibilities for the client, designer, contractor and owner to demonstrate the delivery and maintenance of safe buildings, overseen and held to account by a new Joint Competence Authority" (Institution of Structural Engineers, 2018). It is argued here that all the inferred stakeholders have an increased responsibility with regards to resilience, because they are able to provide a city-wide context and that every-day capacity to withstand hazards through sustainable development and better building regulation is important. This paper aims to identify more frameworks targeting cities to consider their characteristics and identify potential gaps for risk and sustainable development and to consider if there should be a unified approach and how it could be implemented.

1.1.Opening remarks on sustainability and risk

Sustainability has a place in cities because it supports the management of the long term shocks and stresses of urban development (Folke et al. 2002; Meerow et al. 2016; Vale 2017). Sustainable development is a building block for a resilient urban environment, but has it become the foundation of resilience without recognition?

Risk has many aspects to it, but for simplicity this paper accepts that an assessment of risk could use Wisner's reasoning and mnemonic equation of: R ≈ [H x (V/C) – M] *: "Where R stands for disaster risk, H for the specific hazard probability, V for vulnerability, C for localized and individual capacity for self-protection and recovery, and M stands for social protection provided by the state, ideally complementing and supplementing C and never blocking or diluting it"* (Wisner 2018, p.2). But what version of risk is being recognised in the frameworks?

1.2.Resilience measurement frameworks

A desire for quantification of resilience is illustrated by the sheer number of them; there are 39 frameworks in the ODI report (2016). 'What' is being measured could have significant consequences for risk and sustainability in the urban context of a city, particularly for city planning and building design. Five identified frameworks have been developed within 2010-2018 that explicitly aim to measure resilience at a city level. One key document representing each of the framework is reviewed and evaluated in this paper (Table 1).

Table 1: Document titles for each framework.

Framework	Document Title	Brief description
TAMD	An operational framework for Tracking Adaptation and Measuring Development (Brooks et al. 2013)	Uses scorecards with 9 indicators which have associated credentials. The score is achieved through a 'yes', partial or no response.
BRE	BRE 12 Cities Assessment Report (BRE 2016)	Results in a resilience rating that supports a cost and benefit analysis compared to the cost of inaction.
City	City Resilience Framework (The Rockefeller Foundation & ARUP 2015)	Identifies 52 indicators which are categorised into 12 goals and 4 sectors, these qualities distinguish one resilient city from another.
MMCRC	How to make my cities more resilient campaign: a handbook for local government leaders (UNISDR 2010)	A 10-point checklist to support local government.
Resilience.io	Resilience.io A revolution in planning (Passmore & Schmidt 2018)	An integrated systems open source platform 'tool' to enter in data to understand a system's 'performance' and how to make better decisions regarding resilience and sustainability.

2. Methodology

Given that the frameworks represent the available explanation of quantification of resilience in cities, there is no empirical data (yet) to support their use; this forces this process to be an abductive argument (Bryman & Bell 2015, p.27) assessing the available frameworks to find a best interpretation. A thematic analysis method was used to evaluate key themes described below and coding terms were categorised into themes (listed in Table 2).

Limitations exist as each framework is unique and the interpretation of meaning is subjective to the researcher. The themes for analysis:

- Theme 1 responds to 'how has resilience been interpreted and measured' and seeks to categorise the approach taken.
- Theme 2 responds to identifying and categorising the secondary characteristics/indicators of resilience to see common trends.
- Theme 3 considers how sustainability and risk are managed.
- Theme 4 considers who is involved as stakeholders.
- Theme 5 discusses whether the outcome is measurable, and reduces risk.

3. Results and thematic discussion

Refer to Table 2 which shows a simplistic representation of framework content by either a 'yes' or 'no' response or a number to facilitate the thematic analysis discussion.

Theme 1 – definitions and operational gaps:

From a cursory view of the results, explicit aims, a measurement process and a set of indicators or checklist (although without an explicit unit for any particular quantification of resilience) are provided by all the frameworks. Approaches to measurement divide into: Type 1 – conceptual and Type 2 – prescriptive approaches. Type 1 frameworks support how to make better decisions by providing actions. A checklist structure then provides a way to 'measure' resilience. Type 2 seeks to measure through indicators of how resilient a city is, comparing cities on a scale of resilience and locating what gaps exist that need action. Type 2 leads to an index of how resilient cities are around the world. But, what is the purpose of quantification of resilience? Is it to compare cities for risk and index them, or to capacity build over time for a particular city? Arguably, it is both, to establish a baseline through indicators and risk response, then build capacity to disaster and hazards through the checklists and work with built environment stakeholders (Bosher 2007; Chmutina, Jigyasu, et al. 2016). If the purpose is to compare cities then a universal unit of resilience could be particularly useful, perhaps 'capacity'? (Béné 2013)

Each framework defines its own version of resilience, reflecting that it is interpreted in many ways (UNISDR 2015, p.8). Only the MMCRC recognises the UNISDR version. City (2016, p.3) adopts "*City resilience describes the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter*". The definition of terms, then translates to working terms and differences occur between meaning and reality. Arup and Buro Happold are globally experienced engineering consultants with specialist knowledge that represent an operational perspective compared with a policy-led organisation of UNISDR. Resilience policy is mostly understood as Sendai Framework but not necessarily quantified in how the framework supports its progress. By considering this position of definitions and policy, a gap is exposed because each document yields a different 'working' version of its own interpretation of resilience.

Theme 2 – what is being measured?

The five frameworks collate 90 indicators. When compared, key themes occur between governance, society, ecosystems, 'design and planning' actions. What becomes noticeable is that 'sense of place' i.e. a specific exposure and vulnerability is buried into hazard mitigation, if a place is to become more resilient, this needs to become a part of the indicators to promote a bespoke response which if better positioned could promote decision making to pre-empt disasters (Bosher 2007).

Table 2: Thematic results table

Theme	Code	Search description	TAMD	BRE	City	MMCRC	Resilience.io
1	Framework Aim	What is the framework setting out to do? what does it want to achieve?	Yes	Yes	Yes	Yes	Yes
1	Resilience definition	What is the theoretical definition of resilience- is it defined?	No	Yes	Yes	Yes	No
1	Resilience working terms	What actions are undertaken under the word 'resilience'- is there a working definition?	No	Yes	Yes	Yes	Yes
1	Resilience policy	Sendai or other named documentation	Yes	Yes	No	Yes	No
1	Framework characteristics	Conceptual (Type1) or Prescriptive (type 2)	1	2	2	1	1
2	Measurement Indicator	What is the process being outlined?	9	5	12	10	5
2	Measurement Process	Do indicators use measurement indicators?	Yes	Yes	Yes	Yes	Yes
2	Measurement Unit	Is sense of place recognized as a term?	No	No	No	No	No
2	Sense of Place	Is it reflected in risk characteristics?	No	Yes	No	No	No
3	Risk	How is risk being managed?	No	Yes	No	Yes	No
3	Risk Management	Is sustainability defined? If so how?	No	Yes	No	Yes	No
3	Sustainability definition	Is there a working definition? and associated words with sustainability?	No	No	No	No	No
3	Sustainability working terms	SDG or other named documentation	No	No	No	Yes	No
3	Sustainability policy	Are stakeholders mentioned?	Yes	No	No	Yes	Yes
4	Governance Ownership	Are stakeholders identified explicitly?	No	No	No	Yes	No
4	Stakeholder management	Who has responsibility for the decision?	Yes	Yes	No	Yes	No
4	Stakeholder who?	Who?	No	Yes	Yes	Yes	Yes
5	Measurable Outcome?		1	4	1	1	No

Theme 3 – risk and sustainability:

This investigation does not seek to evaluate risk, but instead understand how it is conveyed. Risk is directly discussed in the BRE and MMCRC frameworks: MMCRC relates risk to hazards, vulnerabilities, exposure and coping strategy; BRE relates its framework as a risk management tool to reduce inactive financial decision making rather than directly to hazards and vulnerability. Can this interpretation of risk address Wisner's 2018 definition? The remaining three address 'risk management', which does not portray much meaning more that it is interwoven into a 'process' or has indirect actions such as hazard scenario planning. As an example, City's indicator 1 "Minimal human vulnerability Indicated by the extent to which everyone's basic needs are met" is very ambiguous and not explicit enough to assess the framework's approach to risk or assess its quantification method (Carpenter et al. 2001; Levine 2014).

Recognizing exposure, vulnerability and hazards is something that needs to managed from the outset and can be reduced through sustainable development with more collaborative approaches in the built environment. (Folke 2002; Davoudi 2012; Quinlan 2016; Kohler 2017)

Four out of five frameworks encompass the core components of sustainability such as 'environment, society, economy' as resilience characteristics but there is little recognition to how sustainability and resilience reinforce one another as concepts, which creates conflicts in decision making processes (Lizarralde 2015; Perelman 2017). Whereas Resilience.io sees the relationship as mutual and founds its measurement on delivering the Sustainability Development Goals (SDG).

Theme 4 – stakeholder responsibility?

Stakeholder participation is noted but rarely are they explicitly defined in all five frameworks, only the MMCRC directs this at local governance. The question remains about who is taking ownership of resilience in cities, apart from the loose terms of local governance and stakeholders; who is owning the risk? If cities become indexed for risk, what does it actually mean and where does it lead decision makers? Does it take a disaster to own it? (Goldstein et al. 2014). More explicit stakeholder participation is desired (particularly city planning departments within local government).

Theme 5 – outcomes:

The direction of travel is being able to rate cities in terms of risk and establishing baselines for a measurement process (LLoyd's 2015; UNISDR 2015). Is what is being quantified at juxtaposition with theoretical frameworks and operational ones (Desouza & Flanery 2013; Collier et al. 2014)?.

4. Final remarks

Identified frameworks in this paper, define a method to measure a version of a city's future resilience. The conceptual frameworks provide guidance in checklists, but this relies on stakeholders to move the position forward mostly in the governance and planning arena. The prescriptive approach has led to an index of what resilience means and can establish baselines. From a city's perspective, both approaches together support a better outcome. It may be desirable to quantify resilience in a bespoke manner that assesses a particular city's response to stressors and shocks at a network level. It could be that the Resilience.io systems network is best placed as a tool to support this thinking.

Creating more resilient cities should mean making better decisions for future generations. What is evident is that we need decision makers who understand the long, medium and short term risks to make progress, or no lessons will be learnt; "*the societal and economic impact of a short term approach to the problem could results in inflated problems for future generations*" (Champagne & Aktas 2016, p.381). This paper supports that sustainability has a mutual relationship with resilience, so when resilience indicators indirectly represent sustainability without truly reflecting how the concepts mutually support each other, it raises the point; has resilience encompassed sustainability principles but not its measurement indicators such as greenhouse gases emissions? Will quantification of resilience lead to these units- or be measured through 'building capacity'?

Embedding resilience into green building rating systems could lead to quantification of 'resilience' in design but planning decisions still need resilience becoming a part of the decision-making process. Already, the RELi framework being piloted in the LEED rating system with 3 resilience credits (Wilson, 2018) and Champagne & Aktas (2016; p.380) consider that "*It is imperative that new buildings, such as those to accommodate the expanding population, are designed to withstand stresses and loads that would be imposed by the future climate, rather than past conditions*".

Abductive reasoning highlights that there is concern that effective decision making of the resilience and sustainability of design and planning in cities is still 'at risk' and would benefit from more unification between operational and policy frameworks. This paper has established that a version of city's resilience has become quantifiable through indicators, but is it leading to transformative adaptive capacity in our cities?

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Climate-related disaster challenges for sustainable development: innovating a science and policy framework towards sustainable and climate-resilient Quezon City, Philippines

Tabassam Raza [a, b,*], Aldrin Cuña [c], Andrea Andres [d], Jun Castro [c], Vincent Vinarao [e], Thess Raza [d], Tariq Siddiqui [a]

[a] *Philippine School of Business Administration, Philippines*
[b] *U. P. Planning and Development Research Foundation, Inc. Quezon City, Philippines*
[c] *City Administrator Office, Quezon City Government, Philippines*
[d] *Environmental Protection and Solid Waste Management Department, Philippines*
[e] *University of the Philippines, Philippines*

Abstract

Urban cities have distorted the natural environment by haphazardly constructing roads, buildings, and other infrastructures. Such massive changes in the environment are altering the ecology, creating sustainable development challenges such as extreme weather events. Super Typhoon Haiyan devastated portions of Southeast Asia, particularly the Philippines, on November 8, 2013 that caused physical and psychological illnesses to the affected. To prevent these impacts and make cities sustainably-developed and Climate Change (CC) resilient, a Science and Policy Framework (SPF) piloting Quezon City Local Government (QCLG) was developed. It was done by operationalizing the 4th of eight Guideposts of an existing Risk-Sensitive Comprehensive Land Use and Development Planning Model. The application of the SPF produced physical and social vulnerability maps and determined the institutional and its personnel adaptive capacity and relative vulnerability levels. These findings allowed QCLG to prepare development sectoral-based Local Climate Change Action Plan (LCCAP) 2017-2027. The SPF and LCCAP are flexible and fashioned toward enhancing key development sectors to create sustainable and CC-resilient Cities, thus become globally effective tools in achieving Paris Agreement, Sustainable Development Goals, and targets of the Sendai Framework for Disaster Risk Reduction.

Keywords: Sustainable Development; Adaptive Capacity; Extreme Weather Event; Relative Vulnerability; Climate Resilient

1. Introduction

The extreme weather event Super Typhoon Haiyan devastated portions of Southeast Asia, particularly the Philippines, on November 8, 2013. It served as a wake-up call for urgent action by the Philippines to mainstream Climate Change Adaptation (CCA) interventions (ADB Blog, 2013). In addition, haphazardly constructing roads, buildings, and other infrastructures have distorted the natural environment, altering the ecology, creating Sustainable Development (SD) challenges such as local flooding. The bulk of this research is about scientists and policy-makers developing innovative bottom-up approach, building on increasing local CC challenges and how to prevent such concerns and make urban areas sustainably developed and CC-resilient. To achieve these objectives, the Quezon City Local Government (QCLG) took an initiative to craft a Science and Policy Framework (SPF) to formulate its Development Sectoral-based Local Climate Change Action Plan (LCCAP). The SPF, as an innovative risk assessment approach, was applied in generating primary data about hazards characterization, exposure to elements at risk, and relative vulnerabilities (QCG & UP PLANADES, 2017). Essentially, it allowed to assess impacts of CC-related events: Extreme Weather Events (EWE), Change in Precipitation Patterns (CPP), and Rise in Mean Temperature (RMT) in context of Quezon City; on seven CC-Priority Areas: Food Security, Water Sufficiency, Ecological Environmental Stability, Human Security, Climate-Smart Industries and Services, Sustainable Energy, and Knowledge and Capacity Development. These impacts become the drivers to formulate strategies and Programs, Projects, and Activities (PPAs) by five Development Sectors: social, economic, environmental, land use/infrastructure, and institutional. This information allowed the QCLG to prepare its Quezon City (QC) LCCAP 2017-2027 comprising of Development Sectoral-based PPAs.

* Corresponding author. E-mail address: tabassamr@psba.edu

The appropriate implementation of these PPAs, so called Action Plan (AP), will ensure the SD and CC-resilience of QC. The above SPF and AP are flexible and fashioned toward enhancing key Development Sectors to create sustainable and CC-resilient Cities; and to be considered as globally effective tools in achieving Paris Agreement, Sustainable Development Goals, and targets of the Sendai Framework for Disaster Risk Reduction by 2030.

2. Scope of Literature Review

2.1.Climate-related disaster challenges and sustainable development

The global increase in intense floods, storms, droughts, and heat waves has a likely and significant link to CC (Thomas and López, 2015). Furthermore, it is increasingly being recognized that CC and SD interact in a circular fashion (Downing, Munasinghe and Depledge, 2003). Sound growth policies have long been understood as those that expand investments in physical and human capital. But, unless we also invest in natural capital, all bets are off (UNISDR, 2015). The 17 Sustainable Development Goals (SDGs) acknowledge this strong link between human well-being and environmental and ecosystem services. The links between CC and SD are strong. Further, CC and DRR are significant challenges to achieving SD, and threaten to drag millions of people into grinding poverty. CC is not just a long-term issue; it is happening today, and it entails uncertainties for policy makers trying to shape the future (Kyte, 2014). Thus, SDG 13 is "Taking urgent action to combat climate change and its impacts". Specifically, the associated targets of SDG 13 focus on the integration of CC measures into national policies (UN-DESA, 2018). Further, the guiding principles of the Sendai Framework for Disaster Risk Reduction (DRR) state that "…DRR is essential to achieve sustainable development…" and "…addressing underlying disaster risk factors…contributes to sustainable development". Its Priority Areas 2 and 4 further highlights the significance of DRR for sustainable development (UNISDR, 2015a). So what needs to be done?

2.2.Climate change science and policy framework toward sustainable development

The following CC-SPF were considered: the United States Environmental Protection Agency (EPA)'s guidelines on how to develop State Climate Change Action Plan (US-EPA, 2018); the Local Government Unit (LGU) Guidebook on the Formulation of LCCAP by the Philippine Department of Local and Interior Government (DILG) in 2014; the United Nations Human Settlements Program studies in 2010 on Sorsogon City Climate Change Vulnerability Assessment (UN-HABITAT, 2010); Supplemental Guidelines on Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan (HLURB, UNDP, and Australian Aid, 2015); and other available literature for developing the SPF.

2.3.Institutional and its personnel adaptive capacity

There exists an important difference between coping and adaptive capacities. Coping is typically used to refer to *ex post* actions, while adaptation is normally associated with *ex ante* actions. Thus, adaptive capacity (AC) refers to the ability to anticipate and transform structures, functions, or organizations to better survive any hazards (Saldaña-Zorrilla, 2007). Improving AC, when used in the context of CCA, means to enhance the capability of the intuition and/or its personnel to achieve objectives under the seven CC-Priority Areas under the National Climate Change Action Plan 2011–2028 (CCC, 2011). It must be noted that the Local institutional and its personnel AC form the basis for assessment of climate resilience. Local institutions play a critical role in supporting adaptation. Thus, expanding the institutional and its personnel AC is the integral part in creating sustainably-developed and resilient societies.

2.4.Hazard threat level analysis

Threat Level Analysis serves as the summary of the exposure and sensitivity assessment. It is usually the numerical representation of the level of sensitivity of the exposed sector, people, and elements for each identified CC hazard (Kyte, 2014).

2.5.Relative vulnerability

This step summarizes the result of the Threat Level (exposure and sensitivity of the element at risk to CC-related Events) assessed by *Barangay's* (smallest LGU) personnel using questionnaire provided in section 4.2 versus the institutional and its personnel AC determined by gauging themselves against six AC Factors shown in Figure 3 found in the same section. The formula for computing relative vulnerability (RV) is (DILG, 2014):

$$Relative\ Vulnerability = \frac{Threat\ Level\ (Based\ on\ the\ Exposure\ and\ Sensitivity\ Analysis)}{Adaptive\ Capacity\ (Institutional\ or\ its\ Personnel)}$$

The output of RV ranges from 1-5 is interpreted using a scoring matrix adopted from LCCAP, Guide Process Book 1 (DILG, 2014) shown as in Figure 1.

Threat Level	Adaptive Capacity Score					Relative Vulnerability
	High (5)	Medium High (4)	Medium (3)	Medium Low (2)	Low (1)	
High (5)	1	1.25	1.66	2.5	5	High (4-5)
Medium High (4)	0.8	1	1.33	2	4	Medium High (2.1-3.9)
Medium (3)	0.6	0.75	1	1.5	3	Medium (1.5-2)
Medium Low (2)	0.4	0.5	0.66	1	2	Medium Low (1.1-1.49)
Low (1)	0.2	0.25	0.33	0.5	1	Low (>1)

Figure 1: Scoring matrix adopted from LCCAP, Guide Process Book 1 (DILG, 2014).

3. Objectives of the study

The main objective of this research is to develop SPF through innovative bottom-up approach, building on increasing local CC challenges and partially operationalizing the SFP components by applying it to develop its development sectoral-based LCCAP. The research aims to answer the following questions:

- What is a SPF and what components of the framework in gathering pertinent data in diagnosing climate-related challenges such as EWE, CPP, and RMT in context of Quezon City (QC)?
- What are the threat levels of CC-related events to CC-priority areas' elements at risk and their bearing on the five Development Sectors?
- What is CC Vulnerability/Sensitivity to understand the impact of CC events on elements at risk and what are the hotspots *Barangays* of QC?
- What is the institutional and personnel RV based on the current threat and corresponding institutional and personnel AC?
- What are the CC-Priority Areas and Development Sectors cross-cutting PPAs?

4. Research methodology

Intensive internal, external, and online desk researches were used as primary methodology to collect secondary data. Further, local CC guidelines, manuals, and programs made by the National Government Agencies and Non-Governmental Organizations were also considered in developing SPF.

4.1.Research locale

The selection of QC (Figure 2, left) as the pilot urban area was empirically done in a previous study by Raza in 2017. The specialized Logical Decision for Windows (LDW) software with built-in statistical tool was used to rank and select the top-ranked city as a pilot LGU (Figure 2, center and right) (Raza, 2015).

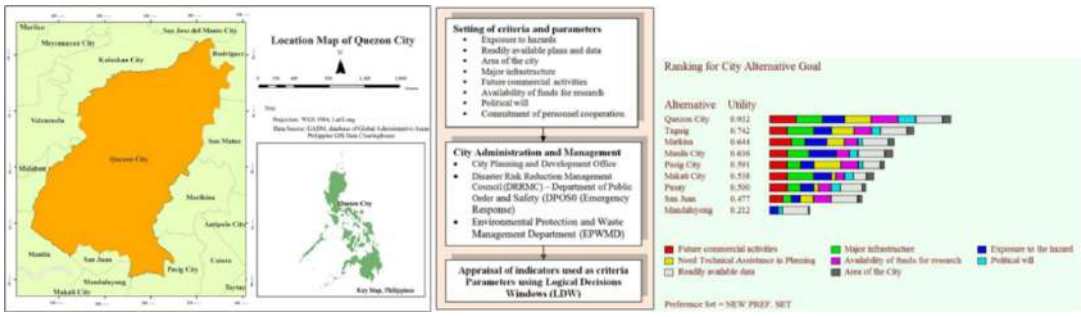

Figure 2: Location Map of QC (left), Framework to select Pilot City (center), and Ranking produced through LDW Software (right).

4.2.Research instruments

A questionnaire is also developed to assess QCLG institutional and personnel adaptive capacities against seven CC-Priority Areas. The questionnaire also includes readily-available fill-in-the-blank form for climate-related events impact identification and determining its threat level to CC-Priority Areas' elements at risk in context of QC (Figure 3). Further, the verbal interpretation is also provided in last column of Figure 3 to assess the threat level used after LCCAP, Guide Process Book 1 (DILG, 2014).

Climate Change (CC) Sensitivity or Climate Related Events / Phenomina / Incidents: • Extreme Weather Event (W) • Change in Precipitataion Patrren (P) • Rising in Mean Temprataure (T)	Please Indicate by putting abreviation of CC Event / Phenomina i.e. W, P, and/or T in front of each CC Priority Area below that may have tendency to be impacted by these CC climate related phenomena / incidents	Climate Change Priority Area / Sector / Hazrad Area (Seven Pillars of NCCAP): 1. Food Security, 2. Water Sufficiency, 3. Ecosystem & Environmental Stability, 4. Human Security, 5. Climate Smart Agencies and Services, 6. Sustainable Energy, and 7. Knowledge And Capacity Development	5 (High)			
			4 (Medium High)			
			3 (Medium)			
			2 (Medium - Low)			
			Indicate below the SCORE/THREAT LEVEL of W, P, and/or T in front of exposure elements using levels provided in above table.			Exposure Element (Who and What are exposed) – by sector-
			W	P	T	
Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) W Fill up the following Information, if applicable: When:_____ Where:_____ Change in Precipitation Pattern P Fill up the following Information if applicable: When:_____ Where:_____ Rising Mean Temperature T Fill up the following Information if applicable: When:_____ Where:_____		1. Food Security 1. Agriculture and Fisheries Production and Distribution System. 2. Agriculture and Fishing Communities				Availability
						Stability
						Accessibility
						Affordability of safe and healthy food
		2. Water Sufficiency				Sustainability of Water Resource
						Safe and Afferdable
						Salt Water Intrusion
						Groundwater Potential
						Equitable Access
						Water Shortage
						Water Quality and its Causes_____
		3. Ecosystem & Environmental Stability	Stability of Natural Systems (Urban Ecosystem)			
						a. Air Quality
						b. Land Use
		4. Human Security				Poor and vulnerable
						Health
						Housing
						Protection against Hazards Sudden Loss of Income
						Women
						Men
						Children
						Elderly
						Physically challenged/ Person with disability
						Capacity to manage risk
		5. Climate Smart Agencies and Services				Public Infrastructures
						Housing
						Toxic Packaging Materials
						Medium-to-high Density Integrated Land Use
						Transportation Plan
						Solid Waste Management
						Waste Disposal Facilities
						Green House Gases
		6. Sustainable Energy				Mode of Transportation System
						Energy and transport systems Infrastructures
		7. Knowledge And Capacity Development				Early warning System
						Institutional Adaptive Capacity

Figure 3: Fill-in-the-blank form to identify climate-related events and its threat level on the elements at risk.

To assess institutional and its personnel AC levels, this research used six AC factors after Local Government Academy (LGA) LCCAP, Guide Process Book 1 (DILG, 2014). The verbal interpretation corresponding to each factor is shown in Figure 4.

ADAPTIVE CAPACITY FACTOR	ADAPTIVE CAPACITY SCORE/LEVEL				
	5 (High)	4 (Medium High)	3 (Medium)	2 (Medium Low)	1 (Low)
ECONOMIC WEALTH	• Have adequate and available financial resources for assistance to all affected sector • The people in the affected areas have their own resources to respond to a hazard	• Have enough financial resources for assistance to some affected sectors • The people in the area have access to resources to respond to a hazard	• With limited financial resources for assistance for priority affected sectors • The people in the area have limited access to resources respond to a hazard	• Have very limited financial resources for assistance to affected sectors • Affected people have very limited access to resources to respond to a hazard	• No available financial resources for assistance to affected sector • Affected people don't have their own resources to respond to a hazard
INSTITUTIONS	• LGU and community leaders are aware and could effectively manage a quick response in the event of a hazard occurrence • There are existing processes and regulations to control the situation • Relevant legislations are in place to respond to a certain hazard	• LGU and community leaders are aware and can respond in the event of a hazard occurrence • There are processes and regulations but not yet fully implemented nor tested	• LGU and community leaders are aware but management set-up to respond to a hazard is non-existent • Relevant processes, procedures and legislations are passed but implementing guidelines still has to be formulated	• Few LGU officials and leaders are aware of the roles and functions during but quick response team to quickly respond during an occurrence of a hazard is yet to be formed • Draft process, procedures, and relevant legislations still has to be passed	• LGU officials are not fully aware of a hazard or disaster that may occur • There are no definite processes and regulations to control the situation and respond to a certain hazard
INFRASTRUCTURE	• There is more than adequate transport, water infrastructure, sanitation, energy supply and management, and medical services that can be used to respond to a hazard • These facilities and infrastructures are strong enough to withstand a projected hazard and located in safe areas	• There is enough transport, water infrastructure, energy supply, and medical service, etc. that can be used to respond to a hazard • Facilities and equipment are available but not enough	• There are some infrastructure, transport facilities and necessary equipment that can be used to respond to a hazard but not enough to accommodate a projected impact of a hazard • Infrastructure and facilities still has to be retrofitted to ensure its safety and strength during a hazard	• Infrastructures are available but there are no facilities that can be used to respond to a hazard • Transport services in some possibly affected areas are not available • Energy supply	• Necessary infrastructures and facilities necessary to respond to a hazard still has to be constructed • Existing infrastructures and facilities are not within standard to withstand a projected impact of a hazard

ADAPTIVE CAPACITY FACTOR	ADAPTIVE CAPACITY SCORE/LEVEL				
	5 (High)	4 (Medium High)	3 (Medium)	2 (Medium Low)	1 (Low)
TECHNOLOGY	• There are equipment available for use and facilities to communicate directly with the people/sector affected	• There are some equipment for use and facilities to communicate with the affected people /sector	• Limited equipment and facilities for assistance and communication	• Very limited equipment and facilities for assistance	• Very few facilities and equipment for use and communication with affected sector/people is difficult
INFORMATION	• LGU and stakeholders in the area/sector are well aware of the hazard and its potential impact to them • Communication facilities and procedures are in place to respond in the occurrence of a hazard • Early warning system in place and drills have been conducted	• LGU and some stakeholders are aware of the hazard and its potential impact to them • There is an early warning system in place	• Some degree of awareness of LGU and stakeholders •Communication facilities are in place, but procedures are not yet in place • Draft early warning system available	• Limited awareness of LGUs and stakeholders due to lack of IEC program	• LGU officials and affected communities are not yet fully aware of the hazards and its potential impact • No early warning system yet
SOCIAL CAPACITY	• There is political willingness to allocate resources to build adaptive capacity of the LGU • There are specific agencies, community groups and/or NGOs that have the mandate and skills to focus on the specific sector/area during occurrence of hazards • There are trained emergency response teams for this sector/area	• There is some degree of willingness of the leaders to allocate funds to build adaptive capacity of the LGU • Some agencies and NGOs are available and have skills to assist specific sectors during occurrence of hazard • There is a team with basic skills for emergency response	• LGU have political willingness but still has to be convinced to allocate resources to build adaptive capacity of LGUs • There are specific agencies and NGOs with mandate to assist affected communities but still lack skills to respond • Team has been organized for emergency response	• LGU officials still have to be convinced to allocate resources to build adaptive capacity of LGUs • There are limited number of agencies and NGOs with mandate and skills to assist in occurrence of hazards • Team for emergency response still has to be organized	• LGU officials still have to be oriented on adaptive capacity building • Specific agencies still has to have clear mandate and plans to assist affected communities • No NGOs with mandate and skills to help specific sector in times of climate hazards • No policies or orders yet for the creation of the team for emergency response

Figure 4: Verbal interpretations of AC factors' levels.

5. Findings

5.1.Science and policy framework

The SPF is developed considering the main related available literature mentioned in subsection 2.2. The SPF is a technically-oriented document that needs to be used by technical persons/experts assigned or involved in preparing the LCCAP in coordination with other LGU staff and relevant authorities in the country. The detailed procedure in operationalizing SPF is available as the 4th of eight guideposts developed by the primary author as part of a technical Risk-Sensitive Comprehensive Land Use and Development Planning (RSCLUDP) Model (Raza, 2015 and 2017). The brief description of SPF components' partial implementation on QC as pilot LGU is given below in Figure 5. Due to constraints, sub-component 4.2 and component 5 (shown as color blue in Figure 5) of the SPF application is not shown in this paper. However, it is included in crafting QC-LCCAP 2017-2027 (QCG and UP PLANADES, 2017). The application details of these components are available in said literature.

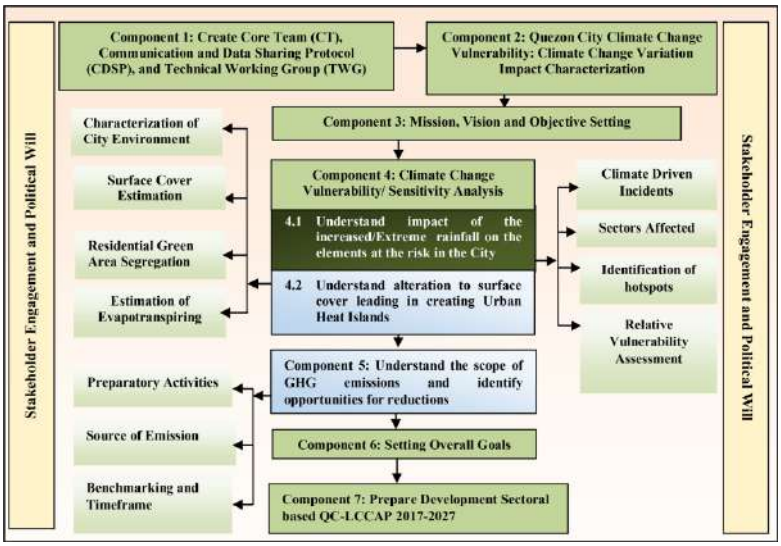

Figure 5: Interrelated components of Science Policy Framework (Modified after Raza, 2016).

Component 1: Create core team and technical working group

The unit-in-charge of developing the QC-LCCAP was able to create a Technical Working Group (TWG) and Core Team (CT) based on the right combination of elected and technical staff of the QCLG.

Component 2 & 3: Climate change event characterization, mission, vision, and objective setting

Strategic planning workshops were held by involving pertinent stakeholders to determine Strength, Weakness, Opportunities, and Threats (SWOT) of the QCLG Development Council members. The results allowed the TWG and CT to develop the LCCAP Mission, Vision, and Objectives. The fill-in-the-blank form shown in Figure 2 was also circulated during the workshop to collect the pertinent data. QCG & UP PLANADES provides the details in QC-LCCAP 2017-2027 (2017).

Component 4: Climate change vulnerability analysis

To depict Climate Change Vulnerability Analysis (CCVA), the existing data with QCLG was considered. The secondary data shows that QC is prone to EWE. Therefore, it is significant to understand impact of such EWEs.

Component 4.1: Understanding the impact of extreme weather events

To understand the impact of EWEs, the historical data regarding CC risk to Metro Manila, flood disaster situation related to CC, and flood context of QC were considered for CCVA. Most of the data regarding above activities and methodology for analyzing vulnerability is available in the Hazard, Vulnerability, and Risk Assessment (HVRA) report (QCG and EMI, 2013 and 2013a).

- *Climate-driven events*

The EWE scenario such as the Typhoon *Ondoy* was used for the entire HVRA in developing the LCCAP (QCG and EMI, 2013 and 2013a). It is therefore compatible and falls in with the CC event in terms of EWEs with increased frequency and severity (tropical cyclones, storm surges, riverine floods, and rainfall).

- *Affected development sectors*

Using Geographic Information System (GIS), the flood susceptibility map, observations from *Ondoy*-induced flood of 2009, value of capital stock and GDP in QC, and Japan International Cooperation Agency (JICA) outbreak model were used in estimating the projected casualties (Figure 6, left), population displaced (Figure 6, right), flood affected buildings (Figure 7, left), economic losses (Figure 7, right) and flood susceptibility with critical and high loss facilities (Figure 8, left). Raza (2015), QCG and EMI (2013 and 2013a) show the detailed understanding of the process used to produce risk assessment and corresponding flood affected sectors projections.

- *Identification of hotspots*

QCG and EMI (2013a) detail the procedure to identify the hotspots. The QC hotspots based on flood hazard and vulnerability are shown in Figure 8 (right).

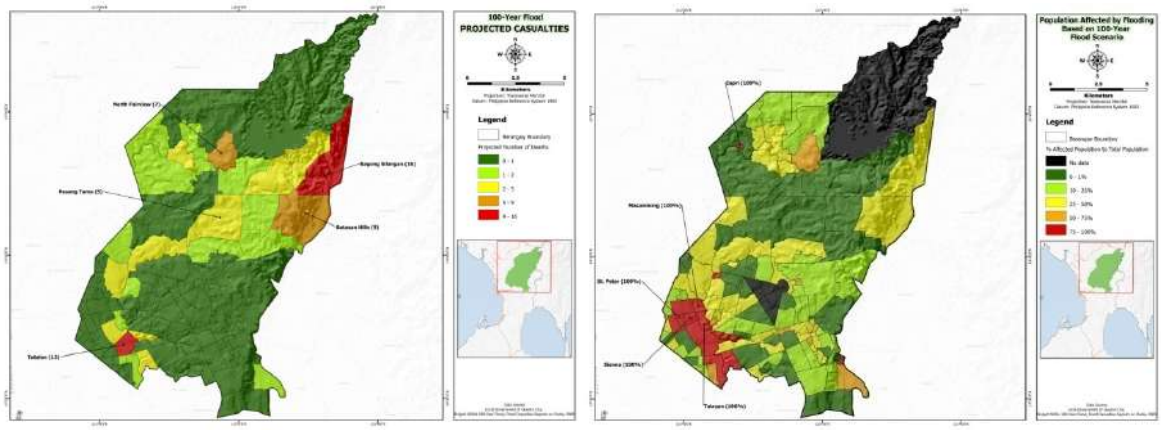

Figure 6: Projected causalities by 100-year flood scenario (left) and population affected by same flood (right).

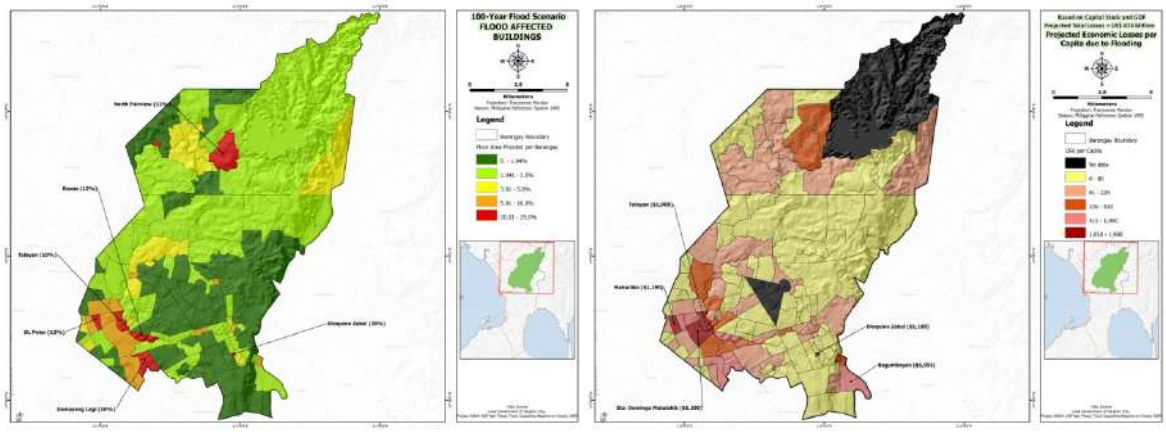

Figure 7: Affected buildingsby 100-year flood scenario (left) and projected economic losses per capita due to same flood (right).

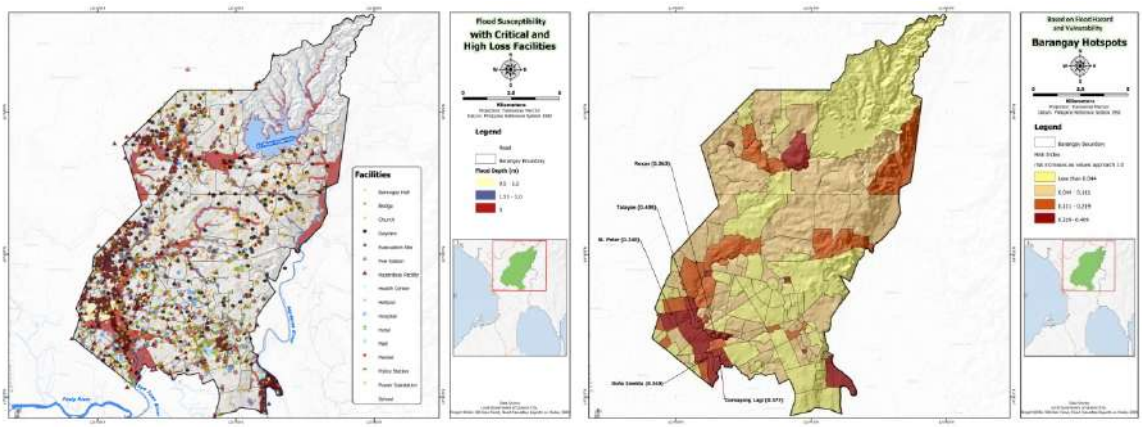

Figure 8: Flood susceptibility with critical and high loss facilities (left) and *Barangay* hotspots based on flood hazard and vulnerability (right).

- *Institutional and its personnel relative vulnerability*

QCG and UP PLANADES (2017) detail the procedure to calculate the QCLG's institutional and its personnel RV. Figure 9 shows the level of institutional and personnel adaptive capacities against seven strategic priority areas.

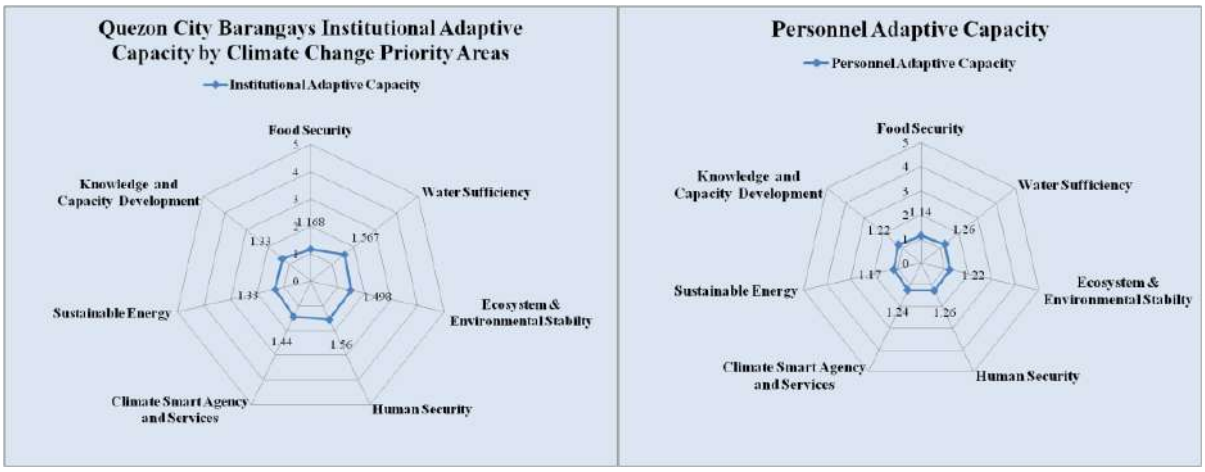

Figure 9: Institutional adaptive capacity (left) and its personnel adaptive capacity (right).

The threat levels of each CC-related event/hazard impact on seven CC-Priority Areas are shown on Figure 10. This revealed that CC event threat levels range from Medium High (4) to Medium Low (2).

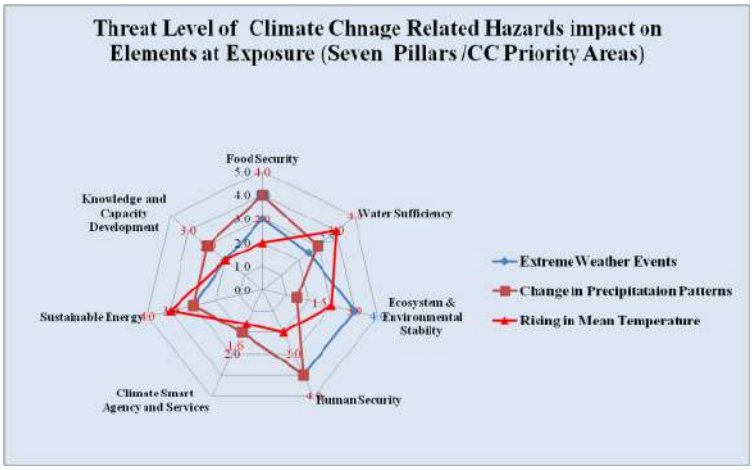

Figure 10: Threat levels of each CC-related event/hazard impact on seven CC-priority areas.

The institutional and its personnel RV to CC events against the seven CC-Priority Areas are shown in Figure 11, left and right respectively. The overall institutional RV values range from Medium Low (1.1) to Medium High (3.42) and its personnel RV range from Medium Low (1.63) to Medium (3.27).

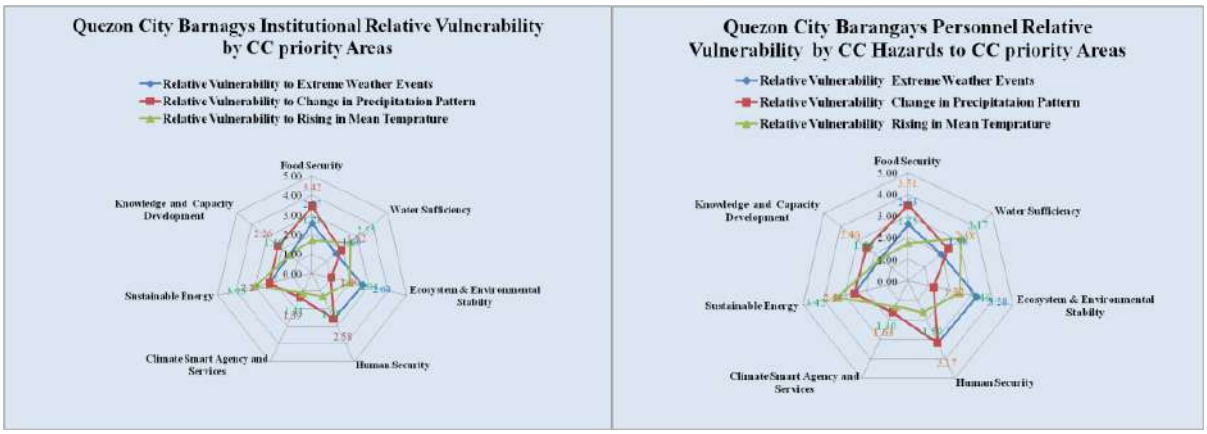

Figure 11: Institutional (left) and Personnel (right) RV to CC events against seven CC-Priority Areas.

Component 6: Setting overall goals

Figure 12 shows the CC events and corresponding objectives aligned with seven CC-Priority Areas. QCG and UP PLANADES (2017) can be consulted for the details.

CC EVENTS / PHENOMENA/ INCIDENTS	CLIMATE CHANGE PILLAR	GOAL/OBJECTIVES
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	CLIMATE CHANGE PILLAR 1: FOOD SECURITY	• To enhance City wide Food emergency storage campaign and knowledge regarding food security towards CC adaptation • To ensure availability, stability, accessibility and affordability of safe and healthy food
	CLIMATE CHANGE PILLAR 2: WATER SUFFICIENCY	• Provide sustainable, safe and affordable water to all QC Barangays • Evaluate City water governance towards a climate and gender responsive water sector • To improve sanitation infrastructure
	CLIMATE CHANGE PILLAR 3: ECOSYSTEM & ENVIRONMENTAL STABILITY	• To build adaptive capacity of local government and communities associated to each Barangays • To build institutional and personnel adaptive capacity towards healthy Urban living
	CLIMATE CHANGE PILLAR 4: HUMAN SECURITY	• To protect human from climate change risks such as health and social protection • To Promote development of CC adaptive human settlements and services • To build adaptive capacity of local government and communities associated to each Barangays
	CLIMATE CHANGE PILLAR 5: CLIMATE SMART INDUSTRIES AND SERVICES	• To promote climate-proof Infrastructures in the Quezon City • To Implement Ecological solid waste management towards Climate Change Mitigation and Adaptation • To Comply with scope of Green House Gases emission
	CLIMATE CHANGE PILLAR 6: SUSTAINABLE ENERGY	• To adopt Sustainable and renewable energy and ecologically-efficient technologies as major components of sustainable development • To rehabilitate and improve energy systems and Infrastructures through climate proofing • To promote and adopt climate proofed, rehabilitated and improved energy systems and Infrastructures
	CLIMATE CHANGE PILLAR 7: KNOWLEDGE AND CAPACITY DEVELOPMENT	• To enhance knowledge on the science of climate change • To enhance Capacity for CC adaptation, mitigation and disaster risk reduction at the local and community level • To establish Gender sensitive CC knowledge management system for Quezon City awareness raising and to establish Barangay CC network to share good practices and other resources

Figure 12: CC events and corresponding objectives aligned with the seven CC-Priority Areas.

5.2.Development sectoral-based QC LCCAP 2017-2027

The QC-LCCAP 2017-2018 (Figure 13, left) was developed by collecting and analyzing data from the strategic planning workshops and CCVA shown in Figures 6 to 11. These are used to formulate the strategies to resist impact on each CC-Priority Areas through defining Programs, Projects, and Activities (PPAs) categorized by City Development Sectors with corresponding personnel responsible, budget, and time frame. There are 35 tables, where each correspond to one of seven CC-Priority Areas cross-cutting one of five Development Sectors. Figures 14 to Figure 18 show the tables corresponding to the Social Development Sector of QCLG. The same tables are produced for the other four Development Sectors which can be found in the QC-LCCAP 2017-2018 (QCG and UP PLANADES, 2017).

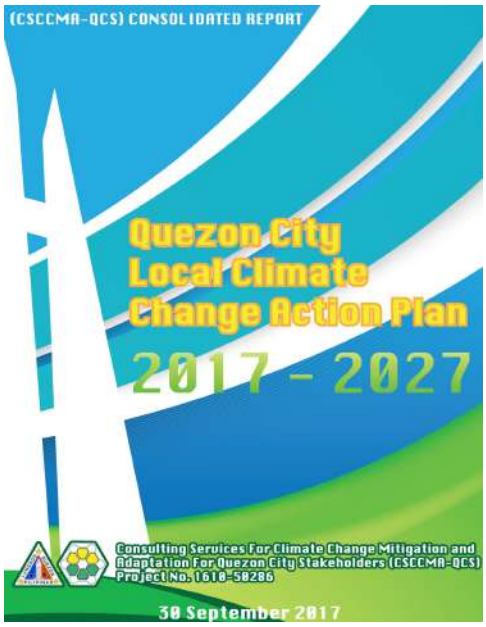

Figure 13: Cover of QC LCCAP 2017-2027.

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 1: FOOD SECURITY			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE/ DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Availability • Stability • Accessibility • Affordability of safe and healthy food	• To enhance City wide Food emergency storage campaign and knowledge regarding food security towards CC adaptation	Enhance City-wide Climate Change adaptive capacity building towards food security	1. Develop Communitybased awareness raising Program: Households and Business Establishment Food Security System.	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	P 1.50 M	**Immediate** Within 2-6 months
		• To ensure availability, stability, accessibility and affordability of safe and healthy food	Sustain City wide food distribution and storage to increase CC Adaptation capacity	2. Establishment of a Mobile smart App based on early food security warning system	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	P 0.5 M	**Immediate** Within 6 months to 1 year
				3. Barangay Common Food Storage Truck Program	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Short term** within 1 to 2 year
				4. City Canned Food Storage Warehouse Project	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Short term** within 1 to 3 year

Figure 14: CC event impact on food security with corresponding PPAs for the social development sector.

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 2: WATER SUFFICIENCY			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE/ DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Sustainability of Water Resource • Safe and Affordable • Groundwater Potential • Equitable Access • Water Shortage • Water Quality	Provide sustainable, safe and affordable water to all QC Barangays	Ensure safe, affordable, and sustainable water coverage in all the Barangays	1. Household based safe water storage awareness campaign covering 142 Barangays of the City	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Immediate** Within 6 months to one year
		Evaluate City water governance towards a climate and gender responsive water sector	Ensure Implementation of the Clean Water Act and City Septage and Sewerage Program.	2. Community awareness raising on climate gender sensitive water sufficiency governance and about protection from water contamination	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Immediate** Within 6 months to one year
		To improve sanitation infrastructure	Reduce the number of households without standard sanitation infrastructure by 33% per year	3. Household survey on the availability of sanitation infrastructure and water demand	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Immediate** Within 6 months to one year

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 3: ECOSYSTEM & ENVIRONMENTAL STABILITY			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVES	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE/ DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	Stability of Natural Systems • Urban Ecosystem: a. Air Quality, b. Land Use	To enhance citizen climate change urban resilience by protecting green spaces, reservoirs and biodiversity	Prevent City air, water, solid waste disposal, groundwater aquifer, rivers and creeks, and green environment from the Climate Change extreme weather phenomena	1. Integrated Management Plan of extreme weather prone open and green spaces, parks, groundwater aquifer, rivers and creeks of the City.	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Medium Term**
				2. Continue implementation of household Waste Segregation and Barangay clean air monitoring and incentive system	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Immediate**
		To build institutional and personnel adaptive capacity towards healthy urban living	Enhance Citizen adaptive capacity against adverse impacts of Climate Change	3. Stakeholders' Awareness Raising Program	EPWMD, CPDO, BD, GAD, SSDD	To be assessed	**Immediate**
				4. Adaptive Capacity Building of Households and Business owners towards livelihood and housing	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	**Immediate**
				5. Relocation of Informal Settler families (ISFs) living along danger areas (Waterways, Transmission lines, etc)	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD, LD	To be assessed	**Medium to Long Term**

Figure 15: CC event impact on water sufficiency (top) and ecosystem and environmental stability (bottom) with corresponding PPAs for the Social development sector.

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 4: HUMAN SECURITY			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE / DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Poor and vulnerable • Health • Housing • Protecting against Hazards Land Sudden Loss of Income (Livelihood / Economy) • Children • Elderly • Person with disability • Capacity to manage risk	To protect humans from climate change risks such as health and social protection	Reduced risks of men and women and other vulnerable groups (children, elderly and persons with disability, etc.) from climate and disasters.	1. Household- Based network building using mobile smart Apps for early warning and community-based monitoring and surveillance system for CC-sensitive diseases	EPWMD, CPDO, HACDRD, BPLO, BD, GAD, SSDD	To be assessed	Short Term
		To promote development of CC adaptive human settlements and services	Increase local and community capacities for CCA-DRRM	2. IEC Program on City gender sensitive climate induced disaster risks reduction	EPWMD, CPDO, BPLO, BD, GAD, SSDD	P0.5 M	Immediate
				3. Population management in case of resettlement and climate refugees	EPWMD, CPDO, HACDRD, BD, GAD, SSDD	To be assessed	Long Term
		To build adaptive capacity of local government and communities associated with each Barangays	Reduced Population congestion and exposure to CC related diseases spread and other risks	4. Periodic monitoring and evaluation of urban morphology types of Barangays	EPWMD, CPDO, BD,	To be assessed	Medium Term
				5. Local supplementary feeding program for children, elderly and people with disabilities during extreme weather impact	EPWMD, CPDO,OSCA, BD, GAD, SSDD	To be assessed	Immediate

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 5: CLIMATE SMART INDUSTRIES AND SERVICES			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE / DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Public Infrastructures • Housing • Toxic Packaging Material • Medium-to high Density • Integrated Land Use • Transportation Facilities • Solid Waste Management Waste Disposal Facilities • Green House Gases emissions	To promote climate-proof Infrastructures in the Quezon City	Promote development of sustainable Green Barangays and prevent creation of Urban Heat Islands Reduce solid waste reaching Payatas dumpsite	1. Enhance private public partnership for establishing policy and programs for new industry development and retrofitting for the old industry in smart Industry and services	EPWMD, CPDO, BPLO, BD, DPOS	To be assessed	Medium to Long Term
		To Implement Ecological solid waste management towards Climate Change Mitigation and Adaptation	Promote development of sustainable Green Barangays and prevent creation of Urban Heat Islands	2. Review and develop Innovative financing mechanisms to promote solid waste segregation at household level for sustainable livelihood	EPWMD, CPDO, HACDRD, BPLO, BD, DPOS	Cross Cutting	Short term
		To promote climate-proof Infrastructures in the Quezon City	Reduce solid waste reaching Payatas dumpsite and other landfill areas(?)	3. Private sector incentive program for eco-transportation and electrical retrofitting, in medium to high density Barangays	EPWMD, CPDO, BPLO, BD, DPOS	To be assessed	Short Term

Figure 16: CC event impact on human security (top) and climate smart industries and services (bottom) with corresponding PPAs for the social development sector.

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 6: SUSTAINABLE ENERGY			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL / OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE / DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Energy and transport systems Infrastructures • Mode of Transportation System and Gases emissions	To adopt sustainable and renewable energy and ecologically-efficient technologies as major components of sustainable development	Achieving low carbon and sustainable, renewable as major components of sustainable development.	1. Household based low carbon ecologically efficient technology awareness campaign covering 142 Barangays of the city	EPWMD, HACDRD, GAD,	P 3.00 M	Immediate Within 6 months to one year
		To rehabilitate and improve energy systems and Infrastructures through climate proofing	Increase local government and community capacities for ecologically – effective technologies towards sustainable energy	2. Develop Program on Private sector and community participation in energy efficiency, conservation and reduction of GHG emissions within the community level	EPWMD, HACDRD, BPLO, BD, GAD, SSDD	Cross Cutting	Short Term
		To promote and Adopt Climate proofed, rehabilitated and improved Energy systems and Infrastructures	Adopt socially Equitable mode of transportation system from Barangay to City roads.	3. Energy and transport Systems infrastructures Assessment for CC-risk vulnerability	EPWMD, CPDO, GAD, SSDD, DPOS	Cross Cutting	Medium Term

CC PHENOMENA / INCIDENTS	CLIMATE CHANGE PILLAR 7: KNOWLEDGE AND CAPACITY DEVELOPMENT			SECTORAL PROGRAMS, PROJECTS AND ACTIVITIES (PPAs) OPTIONS			
	IMPACT	GOAL/OBJECTIVE	STRATEGY	SOCIAL DEVELOPMENT SECTOR	OFFICE / DEPARTMENT RESPONSIBLE	INDICATIVE BUDGET	TIME FRAME
• Extreme Weather Events with increased frequency and severity (tropical cyclones, storm surges, riverine floods and rainfall) • Change in Precipitation Patterns • Rising Mean Temperature	• Public Infrastructures • Housing • Toxic Packaging • Material • Medium-to high Density • Integrated Land Use • Transportation Facilities • Solid Waste Management • Waste Disposal Facilities • GHG emissions	To enhance knowledge on the science of climate change	Enhance CC adaptation, mitigation and disaster risk reduction capacities from Barangay to City level	1. Develop Mobile-based application for early warning system and awareness campaign covering 142 Barangays of the city	EPWMD, IT	Cross Cutting	Immediate
		To enhance capacity for CC adaptation, mitigation and disaster risk reduction at the local and community level	Enhance knowledge and capacity of women and men to address climate change impacts	2. Continue existing DRRMC/DepEd/Partners campaigns on community capacity building and promoting Resiliency	EPWMD, CPDO, SSDD,	To be assessed	Short Term
		To enhance capacity for CC adaptation, mitigation and disaster risk reduction at the local and community level	Promote development of sustainable Green Barangays and prevent creation of Urban Heat Islands	3. Develop and implement a capacity building program for community representatives on CC.	EPWMD, CPDO	Cross Cutting	Immediate

Figure 17: CC event impact on sustainable energy (top) and knowledge and capacity development (bottom) with corresponding PPAs for the social development sector.

6. Conclusions

The output of the SPF is a Development Sectoral-based QC-LCCAP 2017-2027. The key towards urban sustainability, climate resiliency, and promoting liveable communities is through understanding the impact of CC events on seven CC-Priority Areas and their action as driving forces to sustain five Development Sectors in the

Philippines' context. In fact, the QC-LCCAP defined 125 PPAs segregated to: 60 on immediate-term (to be implemented in less than one year); 32 on short-term (to be implemented from 1-3 years); 17 on medium-term (to be done in 4-6 years); and 16 on long-term (need to be executed in 7 years) basis. Immediate- to short-term PPAs usually cater the CC Adaptation options whereas the medium-and long-term PPAs are meant to cover the execution of CC Mitigation measures. The Development Sectoral-based PPAs are easy to mainstream in City Comprehensive Development PPAs. The appropriate application of the QC-LCCAP will ensure the Sustainable Development and CC-resilience of QC.

7. Recommendations

- The immediate-term PPAs should be implemented as soon as possible. Upon implementation, the QCLG should determine each PPA's contribution in reducing the CC event impacts in terms of indicators such as number of causalities, displacement of population, susceptibility of critical structures, etc., based on local development goals, policies, and priorities.
- There is need to integrate these Development Sectoral-based PPAs into the QC Disaster Risk Reduction and Management Plan (DRRMP) 2014-2020 PPAs to develop an Integrated Action Plan (IAP). However, the DRRMP PPAs need to be updated and be geared toward Development Sectoral-based PPAs.
- Once developed, the IAP should be mainstreamed in Comprehensive Development Sectoral PPAs and Comprehensive Land Use Planning.
- The SPF and AP can also be considered as globally-effective tools for achieving the Paris Agreement, Sustainable Development Goals, and targets of the Sendai Framework for Disaster Risk Reduction.

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Humans play a crucial role in coproducing regulating ecosystem services: the case of forest fires in the Carmel-Haifa Region

Yaella Depietri [a,*], Daniel Orenstein [a]

[a] Technion, Israel Institute of Technology, Israel

Abstract

In the Mediterranean region, the number of forest fires and the total area burnt has increased since the 1960s. To counter this trend, large resources are generally invested to combat and suppress forest fires, though much less is done to adapt to fires using ecosystem-based approaches. We define ecosystem services and disservices related to the regulation of the frequency and intensity of forest fires. We then analyse historical, pre- and post-fire forest management practices in the Haifa-Mount Carmel region (Israel), as reflected in reports, scientific articles and policy documents. We also gather expert opinions to identify the criticalities of the social-ecological system with respect to fire risk. We derive that intensive afforestation, interspersed with managerial neglect, has introduced ecosystem disservices, and inadvertently generated and increased the risk of forest fires on the Haifa-Mount Carmel region. We explore opportunities for ecosystem-based approaches to fire risk reduction in the region. We conclude that ecosystem need to be sustainably managed to enhance fire regulating services, especially at the urban-wildland interface and in peri-urban parks, to render them less susceptible to large and catastrophic fire events. We suggest that human capital should become an integral part of the description and definition of fire regulating services and disservices if we want to reduce fire risk in the long term.

Keywords: forest fires; social-ecological systems; urban areas; ecosystem services and disservices; ecosystem-based disaster risk reduction.

1. Introduction

Fires are an integral part of the functioning of Mediterranean ecosystems, such that their structure and function can be considered fire dependent (Moritz et al., 2014; Naveh and Carmel, 2004). Here, fires have occurred for millennia and the vegetative composition and structure is adapted to them (Pausas et al., 2008). In recent decades, however, diverse human activities have increased the risk of catastrophic forest fires (Pausas and Fernández-Muñoz, 2012). The suppression of fires, the increase in the amount of young trees, habitat fragmentation, land abandonment (including the reduction of pastoral activities), rural depopulation, the homogenization of the landscape, changes in the vegetation composition, the introduction of highly inflammable invasive species (e.g. tall non-native grass invasion into woody ecosystems), large-scale afforestation, and the expansion of urban areas, have all increased the risk of catastrophic fires in the Mediterranean area (Badia et al., 2002; Bond and Keane, 2017; Fernandes et al., 2013; Pausas et al., 2008).

Traditionally, in the aftermath of a fire event, resources are channelled towards responding to fire damage through repair and restoration, or through the increase of resources for firefighting and preparedness, while little is done to adapt the social-ecological system to future potential risks. Ecosystem-based approaches for reducing fire risks, which encompass the sustainable management and restoration of ecosystems to reduce disaster risk (Estrella and Saalismaa, 2013), have too-often been overlooked, though they may contribute significantly to reducing the overwhelming scale of recent fires in the Mediterranean region. These approaches include: prescribed burning; the creation of firebreaks; fuel load reduction (through grazing or thinning); land use diversification; and restoration through planting of low biomass, fire-adapted and resilient native species (PEDRR, 2010). These approaches and others can intervene in the structure and functioning of ecosystems and, by extension, change the basket of ecosystem services related to fire risk reduction (just as the actions leading to increased fire frequency and intensity can be described as increasing ecosystem disservices).

* Corresponding author. E-mail address: yaella.d@technion.ac.il

In this paper, we develop a conceptual framework liking fire risk to ecosystem services and we outline different management systems that, through ecosystem change, increases or decreases fire regulating services and thus fire risk. To note is that when defining ecosystem services, the research community generally refers to those benefits that are provided by "nature" or by "natural ecosystems" (Boyd and Banzhaf, 2007; Daily, 1997; Fisher et al., 2009). Previous research has shown instead that ecosystem services are often socially constructed especially in and around urban areas (Depietri et al., 2016; Ernstson, 2013). Furthermore, Braat and de Groot (2012) contend, that while provisioning and cultural ecosystem services can be increased with investment of human energy (e.g. labour), regulating services are generally diminished by human intervention and their supply is greatest near pristine conditions. Using the case of forest fires in the Mount Carmel-Haifa region (Israel), we argue instead that to maximize regulating services associated to the reduction of fire risk, long term human investment and intervention is required. As such, regulating services too can be co-produced through human-nature interactions.

1.1.Fire regulating services and disservices

Most research concerning ecosystem services and fires focuses on the loss of services following fire events (Hurteau et al., 2014; Lee et al., 2015; Thom and Seidl, 2016). Other authors look at the ecosystem services provided by localized, intentionally set fires with the aim of increasing agricultural land, hunting opportunities, fodder and pasture, pest management, fuel wood, charcoal and cultural services (Schmerbeck et al., 2015). Little research is available on the characterization of ecosystem services that alleviate or contribute to fire risk (Parthum et al., 2017).

We define fire regulating services as those ecosystem' features that contribute to lowering fire risk and avoid catastrophic forest fires (see Table 1). Conversely, some other interventions in the system can introduce fire regulating disservices and raise the likelihood of the social-ecological system to experience catastrophic fires (see Table 1). Mediterranean autochthonous species are generally adapted to fires, are composed of less flammable biomass and possess a high capacity to withstand and recover from fires, providing fire regulating services. While, exotic tree species with abundant above-ground biomass (i.e. fuel) and horizontal or vertical continuity can increase fire intensity (Brooks et al., 2004; Nel et al., 2014). Changes in forest structure might indeed lead to catastrophic or megafires (Stephens et al., 2014). For instance, changes in the mix of vegetation, large amounts of young trees and homogenization of the landscape are fire disservices, as these increase the risk of catastrophic fires (Bond and Keane, 2017; Pausas et al., 2008).

Table 1: Regulating services and disservices relating to forest fire risk.

Ecosystem characteristics that increase fire regulation services	Ecosystem characteristics that increase fire regulation disservices
Autochthonous, fire adapted species	Highly flammable invasive species
Species with low biomass	High biomass species, high canopy density
Patchiness, mix or mosaic of land uses and vegetation	Homogenization of the landscape, land abandonment
Grazing	Large amounts of young trees

2. Case study and methodology

Mount Carmel is located on the Mediterranean Sea in the North of Israel (32° 48′ 43″ north, 34° 59′ 55″ east). The city of Haifa, which sits on the northwest slopes of the mountain has a population of about 277.000 inhabitants and it's the third largest city in Israel. It receives a yearly average rainfall of over 400 mm, while the mean annual temperature is 19 ºC (Brand et al., n.d.). The Carmel National Park, which covers an area of 10,000 hectares, is covered of *Pinus halepensis–Pistacia palestina–Cistus sp.* associations on south facing slopes and *Quarcus calliprinos–Pistacia palestina* association on north facing slopes (Wittenberg and Malkinson, 2009). Similar vegetation extends into the city of Haifa via a network of undeveloped wadis (dry river beds).

The topography of the region, the vegetation, the climate and the wind patterns all contribute to the high risk to fires (Naveh and Carmel, 2003). In the past 30 years, numerous fires, including three large fires (1989, 2010, 2016), affected the area. The 2010 fire resulted in 44 fatalities while the 2016 fire was almost exclusively in the urban environment, spreading throughout the city via the vegetated, dry river beds, it destroyed 527 apartments in 77 buildings, and leaving 1,600 people homeless.

We analysed policy and planning documents to explore pre- and post-fire management recommendations and practices to better understand the links between fire risk, ecosystem management and the supply of regulating services and disservices in the region. We integrate protocol of expert lectures regarding the topic of Mount Carmel fire management, and those from lecture series held in the immediate aftermath of the 2010 and 2016 fires. Finally we supplemented these sources with additional semi-structured interviews with government representatives, land use managers, and experts in the subject of wildfire response and management.

3. Results and discussion

3.1.Afforestation in the Carmel-Haifa region and the risk of fires

Mount Carmel has been managed, extensively and intensively, since pre-historic times (Naveh and Carmel, 2003). The typical vegetation composition which would dominate the area is characterized by *Quercus calliprinos*, *Pistacia palestina*, *Pistacia lentiscus typicum*, *Ceratonieto*, and *Olea europaea* (Danin, 1988; Naveh, 1973). These species are markedly scrub-like in Mediterranean ecosystems, with relatively low biomass for trees, and are adapted to fires. At the end of the 19th century, after a period of extensive overgrazing and deforestation, entire areas of Mount Carmel were afforested by the German Templers (Kaplan, 2011). This practice was then continued by the Keren Kayemeth LeIsrael (KKL), the Jewish National Fund. Most of the Aleppo pine (*Pinus halepensis*) forests on Mount Carmel and in Israel are the result these afforestation efforts (Ne'eman et al., 1997). The choice of this species was primarily due to the desire to reproduce European thick, dense forests (Kaplan, 2011) and it was thought to be particularly well-suited to the local climate, requiring minimal care (Stemple, 1998).

Pinus halepensis is, however, a very flammable species characterized by a strong ability to regenerate via seeds after fires (Ne'eman et al., 2004). This quality defines its invasive nature. Afforestation with pine plantations became a main source of risk in Israel producing "fire regulating disservices". Planted forests were uniform, dense, monocultured and even-aged, all characteristics which increase the risk of fire (Amir and Rechtman, 2006; Osem et al., 2008). The history of the afforestation of Israel and the Carmel Forest is thus one of introduction of highly flammable, largely allochthonous species driven mainly by a landscape aesthetic inspired from more mesic ecosystems in Europe (Osem et al., 2008). More recently enlarging scenic routes, footpaths and hiking trails, further exposed forests to human activities and thus to the risk of fires in the Carmel-Haifa region (Carmel et al., 2009). Nowadays, most fires in the area are then the result of these landscape changes and intended or unintended ignition.

3.2.Post-fire management practices

Despite these considerations, most of the discourse around the risk of fires in the Carmel and Haifa area does not clearly envisage the reduction of high biomass, high risk Aleppo pine forests. The 1995 Israeli National Master Plan for Forests and Afforestation (NOP 22), merely cites the issue of forest fires in a short paragraph with no mention about the need to improve the management of the afforested land to prevent forests fires. The general approach towards dealing with forest fires in the Carmel area, and in Israel in general, is to strengthen fire-fighting capacity, engaging in restoration and protecting lives and property, rather than adopting ecosystem-based approaches. Each commission of inquiry that followed the major forest fires events, instead, consistently advocated for the creation of fire breaks, natural regeneration (excluding pines), and the use of grazing to reduce fuel load (Pereira et al., 2017). Experts agree that more resources must be dedicated to ecosystem management, addressing fuel loads and landscape diversity. The scientific report prepared in the aftermath of the 2010 fire clearly states that the central problem concerning fires is the lack of the implementation of the recommendations concerning the management of forest and maquis shrubland (Perevolotsky, 2011), although government funding is repeatedly dedicated to post-fire research, preparedness and restoration. Some commentators suggested that the relatively large amount of government funding dedicated to fire restoration research is primarily due to the desire to compensate for the loss of human life, and not a reflection of the dedication to finding sustainable

solutions for fire policy in the Carmel. This contributes, according to experts, to the fact that since the establishment of the Carmel National Park in 1965, there have been no consistent forest management practices, which has led to the proliferation of invasive species trees, accumulation of organic matter and the growing risk of large fires.

By not intervening in the forest, and by focusing resources only on fire suppression, the risk of large and frequent fires on Mount Carmel is only perpetuated. The mere preservation of the present "natural" environment brings ecosystem disservices and risk. Management and human intervention to re-establish and enhance the regulating function of the ecosystem seem the only viable way to reduce risk in the area and in a lasting way. Ecosystem services for fire regulation are in fact not "out there", freely provided by "nature". Sustainable forest management and diversification of the landscape is a prerequisite of the supply of fire regulating services. Figure 1 shows the multiple relations between the different land use types which occurred in the area and associated trends in degree of human intervention, fire regulating services, disservices and the risk of forest fires.

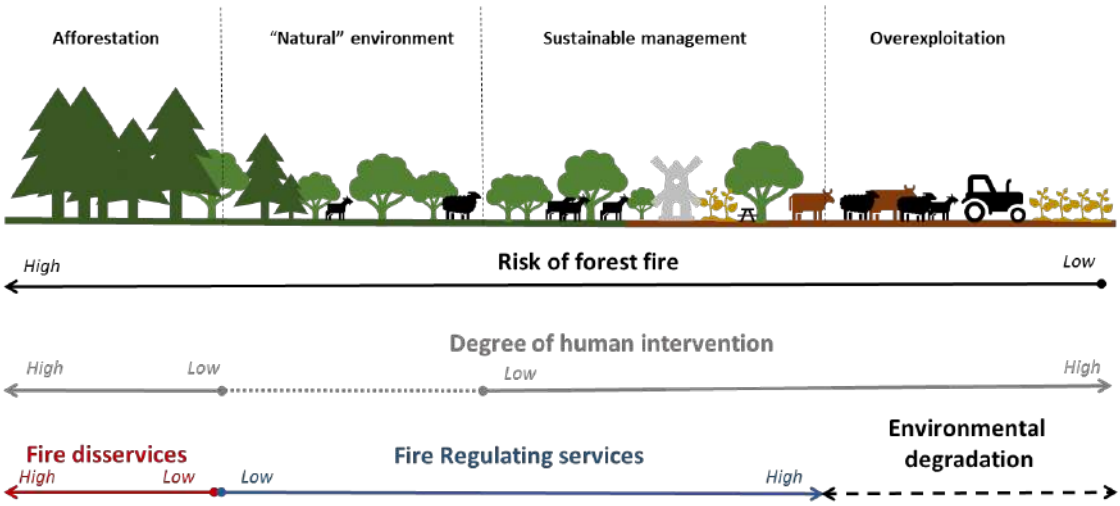

Figure 1: Diagram showing the links between the type of land use, the risk of forest fires, the degree of human intervention, the availability of regulating services and the creation of ecosystem disservices on Mount Carmel.

4. Conclusions

We defined fire regulating services and disservices. We then analysed historical, pre- and post-fire forest management practices in the Carmel-Haifa region as a case study, focusing specifically on how ecosystem management affects fire risk. We suggest that intensive afforestation, followed by managerial neglect, inadvertently increased the risk of forest fires by introducing ecosystem disservices. In contrast to this, managed ecosystems restoring local communities intertwined with sustainable degrees of human activities would provide regulating services to create a region less susceptible to large and catastrophic fire events.

From the experience of the fires on Mount Carmel we derive that risk reduction, via embellishing regulating services, necessitates active human management and restoration to more locally adapted and diversified social-ecological systems. Both high fire risk and the alleviation of that risk are, in fact, largely resulting from actual or potential human interventions in the ecosystem. We thus suggest that human capital should become an integral part of the description and definition of regulating ecosystem services and disservices, particularly regarding fire risk. Regulating function of ecosystems for fire risk reduction generally increase with sustainable management. Neglecting the importance of human capital in the production of ecosystem services and looking at ecosystems as something that is fixed, "out there" and little subject to human intervention, can be a source of risk. We stress that in the expanding field of ecosystem-based disaster risk reduction, we need to move from a description of services as "gifts of nature" to one requiring and integrated social-ecological-technological framework, if we aim to reduce risk, especially the urban setting.

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Wildfires in Portugal: where and why?

Adélia Nunes [a,*], Ana C. Meira Castro [a], Luciano Lourenço [a], Bruno Martins [a]

[a] University of Coimbra, Portugal

Abstract

Wildfires are not distributed uniformly throughout the Portuguese territory. The main aim of this paper is to investigate the incidence (and recurrence) of burnt area and to explore the relationship of those patterns with socio-economic variables, at municipal level. Simple Linear Regression and Geographically Weighted Regressions were applied in order to identify the most critical social and economic variables associated with the incidence of burnt areas. The multiple linear regression selected three variables as statistically significant (ageing index, per capita income and density of small livestock) with an adjusted R^2 value of 0.28. The explained variance increased to an adjusted R^2 of 0.76 when geographically weighted regression was applied. The mapping of the incidence of burnt and the most important socio-economic correlated variables can be a relevant tool for fire management in the prevention stage.

Keywords: Burnt area; socio-economic variables; spatial variability; Geographically Weighted Regression; Municipalities of Portugal.

1. Introduction

Fire has been a key apparatus utilized by humans since millennia as a competent management of fauna and flora. However, it has also been recorded, particularly in the Mediterranean countries, that forest fires also can cause considerable negative impact on the ecosystem and, consequently, on the socio-economic performance of a region (Miranda et al., 2008; Malkinson et al., 2011; Finlay et al., 2012; Novara et al., 2013).

Among all European countries, Portugal has the biggest relative value of burnt area in the period 1980-2015 (JRC, 2016), and 2017 was a very disastrous for Portuguese territory, with around 500 000 hectares burnt resulting in more than 120 deaths and thousands of injured people. According to several researchers wildfires are not only linked to the Portuguese weather/climate characteristics, that after a period of rain and lower temperatures in the autumn and winter, support the availability of fuel mass in the spring and summer when high temperatures and low relative air humidity tend to occur (Trigo et al., 2006; Carvalho et al., 2008) but also linked to the growing migratory movement of the rural population since the last century which led lands abandoned and prone to be covered by easy to grow and inflammable vegetation (Nunes, 2012; Moreira et al., 2011; Oliveira et al., 2012; Oliveira, 2014; Nunes et al., 2016). However, there is still a lack of information on the relationship between burnt area and socio-economical characteristics of the Portuguese' regions (Nunes & Lourenço, 2018).

In this context, the purpose of this paper is to investigate on the incidence (and recurrence) of burnt area spatial patterns at municipal level in Portugal mainland and to explore on the linkage of those patterns with socio-economic variables. In addition, by comparing the performance of classical linear regression and geographically weighted regression modelling, the most critical social and economic variables are identified and spatial variation maps are produced.

2. Materials and methods

2.1 Study area

Portugal mainland is located in the extreme west coast of Iberian Peninsula, in Europe and comprises 278 municipalities that cover an area of 89 015 km2. During the last five decades, Portugal experienced socio-economical alterations in the number of inhabitants. Since 1960 the population declined in 65% of the Portuguese municipalities, with figures varying from 71% to 0.2%, whilst 35% recorded an increase of 0.3% to 675%. The municipalities mostly affected by mass migration (abroad and to coastal areas within Portugal) were those of inland North and Centre, and of the South. In these regions, a considerable cultivated area of was then led to abandonment which potentiated the occurrence of wildfires (Moreira et al., 2011; Nunes, 2012; Nunes et al., 2016).

* Corresponding author. E-mail address: adelia.nunes@fl.uc.pt

Peripheral rural areas, especially in more remote regions, recorded the highest values of depopulation and ageing which contributed to an increase of vulnerabilities of resident population that become isolated and thus more prone to embrace poverty and social exclusion. On the contrary, the population in the coastal municipalities augmented during this period, making these municipalities experience higher per capita incomes due to the increase of younger and more qualified residents.

2.2 Data collection

A burnt area index was defined in order to support the comparison of the percentage of burnt area in each Portuguese municipality in relation to the total surface area of Portugal mainland, in the period of 1980-2017.The records of burnt area provided by the Instituto da Conservação da Natureza e das Florestas (Portuguese National Institute for Nature Conservation and Forestry) (ICNF), the Portuguese Government Forestry Service, were used to build the database for this study. The selection process of the socio-economic variables to include in the vulnerability assessment was preceded by an extensive literature review. Data was obtained from Census, provided by Statistics Portugal.

In order to examine the existence (or not) of spatial autocorrelation of the geographic distribution of burnt area, the global Moran's I test was used. The Moran's I test measures the degree to which burnt area pattern is clustered, dispersed, or randomly distributed across the municipalities by computing the deviation from the mean for each tract (Anselin et al., 2006). Moran's I coefficient between 0-1 indicate positive spatial autocorrelation or clustering, negative coefficients between 0-1 indicate dispersion or dissimilar neighbouring values, and those near 0 indicate weak or absent spatial autocorrelation (Fortin & Dale, 2005).

For check the existence (or not) of collinearity among the variables, the Pearson correlation coefficient was used. A correlation coefficient threshold between predictor variables of $|r| > 0.7$ ($p < 0.05$) was classified a suitable indicator for the point where collinearity begins to severely distort model estimation and subsequent prediction (Dormann et al., 2012). As a result, seven variables were considered for the statistical analysis of socio-economic vulnerability at a municipal level (Table 1).

Table 1: Variables used in the "burnt area index" definition and in the socio-economic vulnerability assessment

Variable	Description	Unit
% of burnt area per municipality,1980/2017	Relationship between total burnt area and the total surface of the municipality, in %	%
Density of population, Average1981/91/01/2011	Ratio between (total) population and surface (land) area	People/km^2
Ageing index, Average1981/91/01/2011	Ratio between people aged 65 and over to the number of young people (from 0 to 14)	%
Unemployment rate, Average1981/91/01/2011	Represents the unemployed people as a percentage of the civilian labour force	%
Per capita income, Average1981/91/01/2011	Average income earned per person in a given area and specified year.	Euros
Primary sector, Average 1989/1999/2009	Portion of the population employed in the agriculture and forestry sector	%
Density of small livestock, Average 1989/1999/2009	Relationship between the total number of sheep and goat and the total surface of the municipality	Nº of heads/km^2

As the variables were measured on different units, it was necessary to standardise each as index value. The formula used was:

$$\text{Norm (var 0-1)} = \text{var (value)} - \text{min(var)} / \text{max(var)-min(var)}$$

Where:

Norm (var 0-1), normalized value in the scale 0 to 1;
var (value), the value of the variable obtained for selected unit (municipality);
min (var), the minimum value of that variable registered at national level;
max (var), the maximum value of that variable registered at national level.

2.3 Data processing

In order to analyse the most significant association between the social and economic vulnerability and the percentage of burnt area in relation to the municipality's area, Simple Linear Regression (SLR) and Geographically Weighted Regressions (GWR) were carried out.

Formerly, an analysis of the linear relationship between wildfire incidence and each variable selected for socio-economic vulnerability was conducted using SLR, which assumes *a priori* that the studied relationship is stationary, i.e. the estimated parameters do not vary. Then GWR was used to estimate local parameter values according to the following equation (Fotheringham et al., 2002):

$$y_i = \beta_0(u_i, v_i) + \sum_{j=1}^{k} \beta_j(u_i, v_i) x_{ij} + \varepsilon_i$$

Where y_i is the value of the outcome variable at the coordinate location i where $(u_i\ ,\ v_i)$ represents the coordinates of i, β_0 and β_j denotes the local estimated intercept and effect of variable j for location i, respectively.

Several measures of goodness-of-fit can be used in GWR modelling, such as R^2 and the adjusted R^2, that measure the variation ratio in the dependent variable which is responsible for the variation in the model. The last should be considered once adjustments related to the number of variables in the model are needed (Fotheringham et al., 2002). Besides these, Akaike Information Criterion (AIC) and Corrected Akaike Information Criterion (AICc) can also be used as measures of the model's goodness-of-fit. However, the main difference between R^2 and AIC is due to the fact that AIC is not an absolute measure. Thus, being a relative measure, it can be used to compare different models that possess the same independent variable. The result obtained for AIC can be seen as the 'relative distance' between the model that has been fitted and the unknown 'true' model that generate a data set. Values of R^2 and the adjusted R^2 near 1 and the lowest value of AICc, suggest that the model is able to produce good predictions (Desktop, ArcGIS, 10.2, ESRI).

In this study, several regression models were carried out and AICc results were compared to assess the goodness-of-fit for each model. Based on the AICc scores, 10 was the number of neighbours selected. *ArcGIS* software *(10.2, ESRI)* was used to compute the results for the global and municipal regression models and Moran's I statistics.

3. Results

3.1. Burned area per municipality, 1980-2017

The burnt area layout in Portugal mainland is heterogenic and asymmetries in some municipalities are noticeable. In fact, for the period 1980-2017, although the average percentage of burnt area per municipality was 44.5%, the spatial variability ranges between a minimum of 0.1% and a maximum of 181%, with a standard of deviation of 40.6%. In relation to the spatial distribution of burnt area, the municipalities of central and northern and inland Portugal, covering the vast majority of the highland territories, show the largest % of burnt areas. In these municipalities, the average annual burnt area raises more than 100% of the total municipality surface (Figure 1).

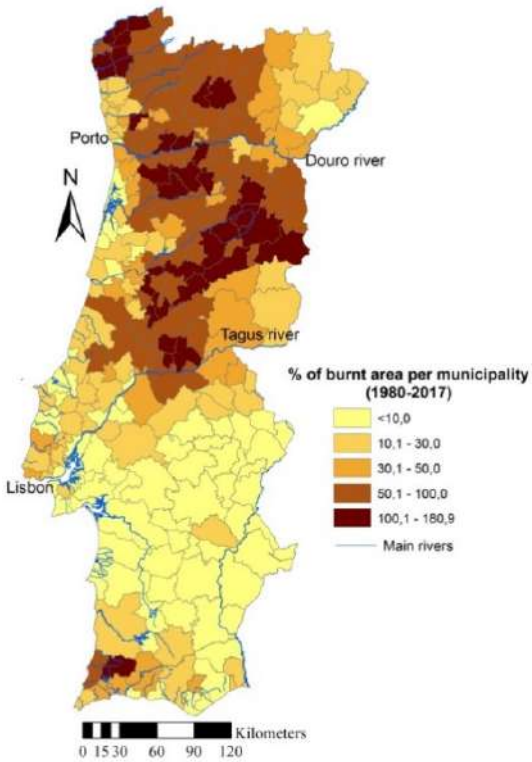

Figure 1: Magnitude of total burnt area in relation to the total surface area of the municipality (in %) between 1980/2017.

The municipalities that were more affected by fire are located in the southern Portugal (Monchique and Tavira) and the ones that were less affected are located in the coastal areas and in the Alentejo region. A clustered patterns are confirmed by the results of the global Moran's Index, indicating the presence of a statistically significant positive spatial autocorrelation in mainland municipalities (Moran's I = 0.558; Z-score: 19.44; p-value 0.000).

3.2 Relationship between burnt area and socio-economic variables

The relationship between the percentage of burnt area and 6 variables selected for socio-economic vulnerability variables at municipal level (Population density, Ageing index, Unemployment rate, Per capita income, Primary sector and Small Livestock) are presented in the Table 2.

Table 2: Coefficients of correlation resulting from the application of SLR and GWR between % of burnt area, per municipality, and the 6 variables used in the socio-economic vulnerability

Annual average (*n=278)*	Population density	Ageing index	Unemployment rate	Per capita income	Primary sector	Small Livestock
SLR adjusted R^2	(-) 0.02***	(+) 0.02**	(-) 0.01ns	(-) 0.11**	(-) 0.01**	(-) 0.01***
AICc	-42,89	-42,78	-38,16	-67,74	-38,22	63.58
GWR adjusted R^2	0.73	0.73	0.71	0.71	0.76	0.75
AICc	-190.51	-174,59	-159,76	-147.59	-225,81	-218,29
Residual Squares	1.71	1.64	1.72	1.71	1.48	1.57

Model variable significance **=0.05; ***=0.01; ns=not significant; (+) positive and (-) negative correlation

Table 3: Adjusted R^2 resulting from the application of multiple linear regression (MLR) and GWR between burnt area percentage and three socio-economic variables: Ageing index, per capita income and Small Livestock density

MLR adjusted R^2 : 0.29	GWMR adjusted R^2 : 0. 76
(+) Ageing index **	Ageing index
(-) Per capita income ***	Per capita income
(-) Small Livestock density***	Small Livestock density
AICc: - 127.63	AICc: 330.00
	Residual Squares: 0.57
	Moran's I: 0.21
	z-score: 7.63
	p-value: 0.00

Model variable significance ***=0.01; **=0.05; (+) positive and (-) negative correlation

The computation of SLR model has produced significant statistical correlations (p-value <0.05) but a very week values for *adjusted* R^2, range from 0.01 to 0.11. Model output shows a positive correlation (R^2: 0.02) for the ageing index and very low negative associations for the other variables.

Conversely, the computation of GWR model has produced a better degree of association between socio-economic variables and burnt area, presenting overall R^2 augmented values ranging from 0.71 to 0.76, which denotes a high predictive potential for socio-economic burnt area incidence. In relation to the GWR model residuals for spatial autocorrelation, Moran's I statistic was used and produced a value of 0.21, a z-score of 7.63 and a p-value of 0.00, suggesting a tendency toward a clustering in the spatial pattern.

Significant differences were observed, for each municipality, in the proportion of variance explained by GWR model (Figure 2). In this output, the proportion of municipalities that were included in the former classes present a coefficient of variability explained lower than 30%. Once the performance of the model is very low, these results indicate that the spatial incidence of burnt area depends on the combination of more than one variable, i.e., it is necessary to combine or include different variables for a better explanation of the extent of wildfires.

In fact, when considering all variables together (multivariate models), MLR selected three variables as statistically significant, increasing the predictive power to an adjusted R^2 of 0.29. In relation to ageing index, output reveals a positive relation of this variable with burnt area variable, while per capita income and density of small livestock variables show negative correlations. The combination of these variables in GWR model show an increase in explained variance, recording an adjusted R^2 of 0.76 (Table 3).

According to Figure 2, a considerable improvements in GWR R^2 is observed and these 3 predictive variables, in combination with each other are able to explain the large degree of variance in the of burnt area observed during the period of 1980/2017, once almost 2/3 of the municipalities were included in the final classes, where the explained variance is over 50%.

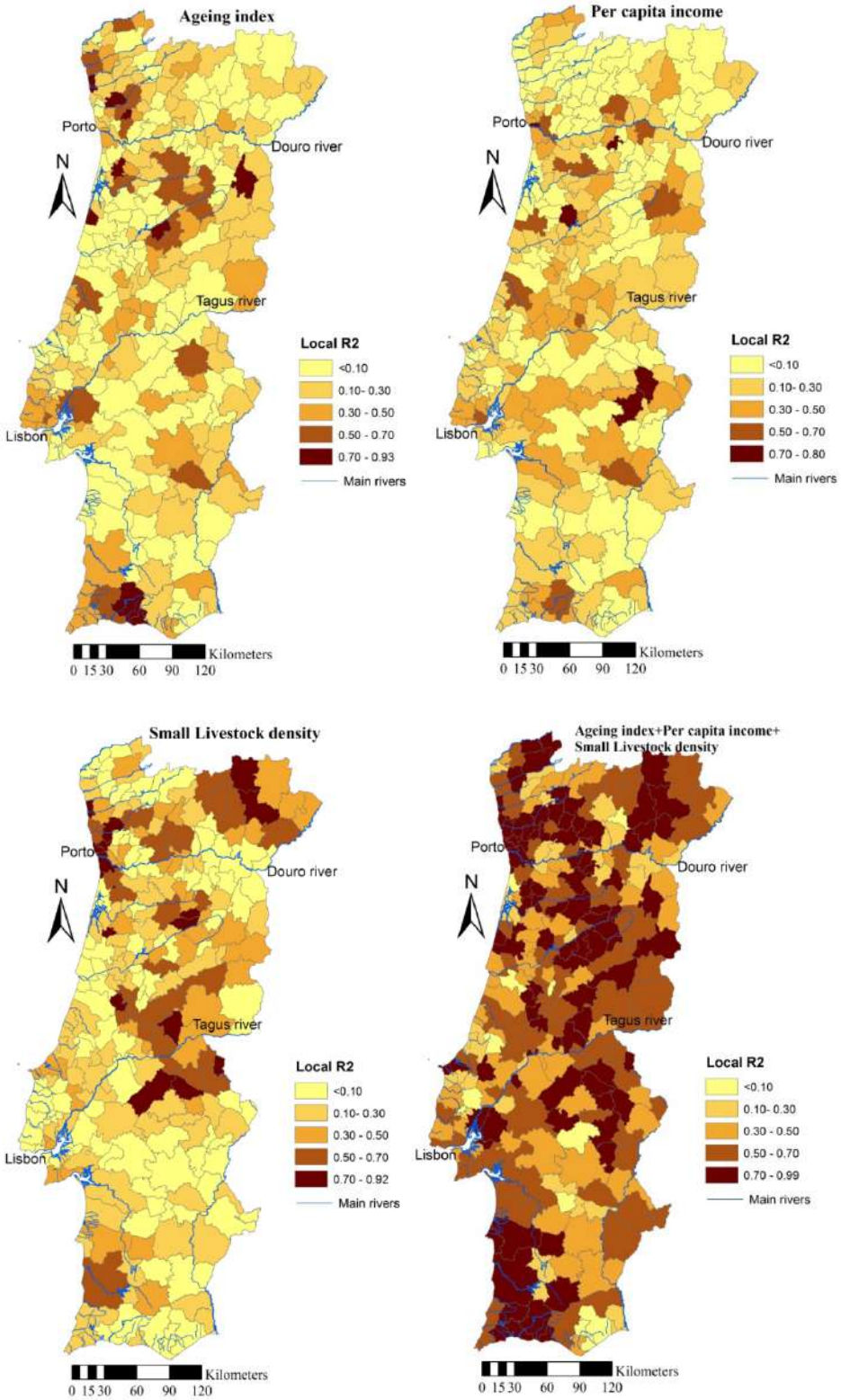

Figure 2: Spatial distribution of local R^2 results from the application of GWR between burnt area percentage and three socio-economic variables: Ageing index, income per capita and small livestock density.

4. Discussion

According to the results obtained, a strong spatial association between the incidence of burnt areas and some socio-economic variables is responsible for the wildfire vulnerability in mainland Portugal. The municipalities with high burnt areas are the ones with higher social and economic vulnerability due to the higher value of Ageing index. With the same trend, the burnt extension is negatively influenced by the high values of income populations and the prevalence of higher livestock densities.

The fact that ageing population becomes more vulnerable to disasters and more prone to face the absence of adequate economic resources was reported in other countries (Cutter et al., 2000; Birkmann et al., 2013; Bodstein et al., 2014). In Portugal, aging is strongly associated with illiteracy levels (r= 0.77) and illiterate population is less capable to obtaining information about environmental protection. Being uninformed, the population are more exposed to accidents and less able to recover from the effects of disasters. At a municipal level, grazing activity seems to have a negative effect in burnt area (Nunes et al., 2016), suggesting that the endurance of traditional Mediterranean silvopasture activities reduces the vulnerability and impact to wildfires and increase the resilience of landscape as to fire. The overlap between socio-economic vulnerability, in terms of low socio-economic status of residents, and wildfire incidence in Portuguese territory suggests a need to evaluate wildfire management policies with regard to social and economic conditions. However, socially vulnerable communities are generally less engaged in wildfire mitigation programs (Gaither et al., 2011) even when they are exposed to high levels of wildfire risk (Ojerio et al. 2011).

In Portugal, forest fires management policies have focused, unfortunately, the fire extinction instead of fire prevention (Mourão & Martinho, 2016), the individual education instead of more comprehensive sustainable development planning (Gaither et al. 2011; Ojerio et al. 2011; Poudyal et al. 2012). However, the usage of information regarding the economic and social susceptibilities is essential for a holistic vulnerability assessment (Tate et al., 2011) and the distribution of wildfire prevention and mitigation resources should be a priority in socio-environmental vulnerable areas (Collins 2008; Gaither et al. 2011; Ojerio et al. 2011; Poudyal et al. 2012).

The importance of designing effective strategies to reduce fire risk, involving all the stakeholders, was reported by Carreiras et al. (2014), that defend that only integrated solutions will produce effective results.

5. Conclusion

Even though this study can be understood a starting point to promote a better knowledge of the complex socio-economic vulnerability interactions, the obtained results could be useful to support a more adequate fire management for the prevention phase and an important tool to communicate complex issues from science to policymakers or to the general public. The development of a strategy based on territorial characteristics and social and economic objectives should improve the participatory process and involve the local communities in land management. An effective forest resources management and planning for hazard mitigation and adaptation should include an active and collaborative stakeholder participation in order to be consistent with local perceptions, values, needs and expectations.

It is essential, therefore, to establish a framework in order to meet the needs and the interests of local stakeholders and involve them in the community participation and implementation of strategies for an effective forest resources management. In fact, stakeholder participation is a key-issue and also a key-*challenge* in planning, implementation and monitoring of *wildfire management,* since primary stakeholders participation in forest resources management is affected by social and economic factors, such as age, gender, education or resident status.

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Building up resilience in the agriculture sector: minimizing the impact of nitrogen fertilizer on water bodies through Grey Water Footprint approach on paddy cultivation in intermediate zone, Sri Lanka

M. P. G. N. M. Palliyaguru [a,*], C. M. Navaratne [b], D. D. Wickramasinghe [c], C. M. Nanayakkara [c]

[a] Sri Lanka Standards Institution, Sri Lanka
[b] Faculty of Agriculture, University of Ruhuna, Sri Lanka
[c] Faculty of Science, University of Colombo, Sri Lanka

Abstract

Paddy is the major crop that uses a large amount of fresh water and fertilizer resulting elevated levels of nutrients as a non-point source in water resources which lead to increased health risks and negative effects on aquatic ecosystems. This study was designed to quantify the Grey Water Footprint (GWF): the volume of fresh water needs to assimilate polluted water of paddy field, which can be used as a decision making tool in achieving agricultural resilience. A field experiment was carried out in 2015 and 2016, for four consecutive cropping seasons in the same plots, same rice variety (BG 358) with similar treatments in intermediate zone, Sri Lanka. Lysimeters were arranged to collect leached water which were subjected to analyse for NO_3-N content. The average loss of NO_3-N through leaching accounted for 8.71 ± 1.74 kg/ha (8.4%). Fertilizer-induce leaching GWF of one tonne of paddy at the research site was calculated by different methods, resulting184 ± 14 ,187 ± 33, 153 ± 27 and 219 ± 39 m^3/t. It was revealed that growing season, year or calculation method did not significantly impact ($P>0.05$) on GWF in the selected site. The loss of nitrogen from paddy cultivation negatively impacted on water bodies indicating considerable amount of GWF thereby causing water pollution. Nitrogen pollution could be reduced by practicing sustainable fertilization technologies and with increased monitoring to ensure minimized impacts on ecosystems and promote resilience in agricultural sector.

Keywords: Grey water footprint, Paddy, Nitrate leaching

1. Introduction

Rice (*Oryza sativa* L.) is one of the major crop feeding the world population and represents a staple food for over half of the world's population, making it the most important food crop (Hassen, et al., 2017, p.1) and which consumes the highest amount of water and N based fertilizers. Urea ($CO(NH_2)_2$) (46% N) is one of the commercially available, fast-release nitrogen-based straight fertilizer, which is the popular source of nitrogen use in paddy cultivation in Sri Lanka. Urea dissolves in water within 48 hours after addition of sufficient amount of water (Wijesinghe and Weerasinghe, 2015, p. 28) and will be lost by ammonia volatilization, de-nitrification, run-off and leaching rather than absorbed by plants (Choudhury and Kennedy, 2005, p. 1). Nutrients leaching from agricultural fields are a main cause of non-point source pollution (Mekonnen and Hoekstra, 2010, p.10). In the case of use of fertilizers or pesticides, only a fraction seeps into the groundwater or runs off over the surface to a surface water stream, wetlands, rivers and lakes, and finally to oceans (Ongley,1996, p.7) without an obvious point of entry into receiving water resources. Therefore, the catchments of the tanks and river basins dense with paddy have threats of loading N- based nutrients into the water bodies and rivers driving them towards nutrient pollution (Piyasiri, 2009, p. 25). Contamination of drinking water by nitrate will increase possible health risks during consumption of water and negatively affect the biodiversity, commercial fisheries, tourism and aesthetic value of such whole aquatic ecosystems (Liu et al., 2012, p. 42).

Grey Water Footprint (GWF), which is an indicator of the degree of freshwater pollution, typically associates with substances emitted to water that quantifies the potential environmental impact related to water (ISO 14046, 2017, p.18). It is defined as the volume of fresh water required to assimilate the load of pollutants, given existing ambient water quality standards (Hoekstra et al., 2011, p. 30). GWF is a good arithmetic method to quantify and understand the potential environmental impact and disastrous way of the freshwater pollution of non-point

* Corresponding author. E-mail address: nilu.palliyaguru@gmail.com

source pollution by paddy cultivation which difficult is to measure and control directly (Hoekstra et al., 2011, p. 37).

2. Materials and Methods

The study was conducted in an experimantal field at Rice Research and Development Institute situated in North Western Province, Sri Lanka (7.53 N, 80.44 E, 115 m) from 2015 to 2016 during two cropping seasons per year: Yala season, the South-West monsoonal period of May to September and Maha season, the North-East monsoonal period from December to February in which cultivation is done by complimentary irrigation. The area belongs to Low country Intermediate Zone with an average annual temperature of 26.5-28.5^{0}C, annual average relative humidity of 70-90% and annual rainfall of 1750-2500 mm (Mapa et al., 2005, p.6 and 13).The soil type is a loam, clasified as Kurunegala Series and reaction of the soil is slightly acid (pH, 5.0 to 6.0), cation exchange capacity is lower than 10 cmol/kg (Mapa et al., 2005, p. 205).

The research field maintains the standing water during the entire growth period of paddy. Urea (46% N), nitrogen-based straight fertilizer, applied in four split applications which established total nitrogen availabilities of 103.5 kg/ha per a cropping season. Irrigated Water carried the minimum amount of nutrient of run-off from other nearby plots.

The lechate from the study plots were collected using non-weighable lysimeter. Following the preparation of the land, lysimeters were laid out in randomized block design in triplicates in upper and lower ends of the research plot having dimensions of 10 m x 10 m. Rice seedlings were transplanted in the field and as well as in each lysimeter and normal agronomic practices were followed. Water level in the field was managed as appropriate and runoff losses were prevented. Leached water was collected from each lysmeter at 7 to 14 day intervals during the whole cultivation period. Water samples were collected from irrigated and runoff flows at lower end of the field. All samples were subjected to analyze Nitrogen (NO_3-N) by ultraviolet spectrophotometric screening method: APHA 4500-NO_3^- - B (APHA, 2000, p.4-122 and 123). Total amount of leached nitrogen was calculated based on the test results.The experiment was conducted in the same plot, with the same variety and same treatments for four consecutive cropping seasons: Yala and Maha in 2015 and 2016.

2.1.Estimation of leaching run-off fraction (α)

As explain in the supporting guidelines of grey water footprint accounting (Franke et. al., 2013), the leaching-runoff of nitrogen to the combined ground-surface water system was estimated based on a rough estimate of the leaching-runoff fraction α; (Equation 1) within the range of leaching run-off fraction minimum (α_{min}), leaching run-off fraction maximum (α_{max}), estimated nitrogen leaching-runoff potential and N-application rate. Site specific information of environmental factors and agricultural practices are considered as weighting factors (w_i) and a four class score (s_i) with values of 0, 0.33, 0.67 and 1. (Table 1). Leaching run-off fraction (α) was calculated as:

$$\alpha = \alpha_{min} + \frac{[\sum s_i w_i]}{\sum w_i} \times (a_{min} - a_{max}) \qquad (1)$$

α	- Leaching-runoff fraction
α_{max}	- Maximum leaching-runoff fraction
α_{min}	- Minimum leaching-runoff fraction
s_i	- Class score
w_i	- Weighting factor

Table 1:Factors influencing the leaching-runoff potential of nitrogen

			Nitrogen				
Category	Factor		Leaching-runoff potential	Very low	Low	High	Very high
			Score (s)	0	0.33	0.67	1
			Weight (w) **α**				
Environmental factors	Atmospheric input	N-deposition	10	<0.5	>0.5	<1.5	>1.5
		Texture(relevant for leaching)	15	Clay	Silt	Loam	Sand
		Natural drainage (relevant for leaching)	10	Poorly to very poorly drained	Moderately to imperfectly drained	Well drained	Excessively to extremely drained
	Climate	Precipitation (mm)	15	0-600	600-1200	1200-1800	>1800
Agricultural practice	N-fixation (kg/ha)		10	0	>0	<60	>60
	Application rate		10	Very low	Low	High	Very high
	Plant uptake (Crop yield)		5	Very high	High	Low	Very low
	Management practices		10	Best	Good	Average	Worst

Source: Extracted from the GWF accounting supporting guidelines (Franke et. al., 2013, p. 20)

2.2.N leaching related grey water footprint for paddy

GWP is accounted for only the most critical pollutant, Nitrate-N, where above calculation yields the highest water volume. Therefore, GWF was calculated for N in current situation (Chapagain and Hoekstra, 2010, p.14).

2.2.1 Leaching run-off fraction (α) and related GWF

Calculation for Leaching run-off fraction (α) related GWF was based on two assumptions. For a continuous flooding rice cultivation system, ammonia loss to the atmosphere is 20% of application, the denitrification loss is 10% (Chapagain and Hoekstra, 2010, p.14). In the study site, urea (46% N) was applied as the nitrogenous (N) fertilizer in four split application, which totals up to 225 kg/ha. Therefore, in the current study, the total N application rate was 103.5 kg/ha. Out of total amount, 30% was lost by volatization and denitrification and N fertilizer fraction thus available was 72.45 kg/ha. Based on those assumptions GWF was calculated to the plot area of 0.01 ha. According to Hoekstra et al. (2011, p. 41), the grey component in the water footprint of growing a crop per unit harvested product ($WF_{Proc.grey} m^3 ton^{-1}$) was calculated (Equation 2).

$$WF_{Proc.grey} = \frac{\alpha \,.\, AR(kg/ha)/(C_{max} - C_{nat})\left(kg/m^3\right)}{Y\,(ton/ha)}\left(m^3 ton^{-1}\right)$$

(2)

α - Leaching- runoff fraction
AR - Chemical application rate (kg/ha)
C_{max} - Maximum acceptable concentration (kg/m³)

C_{nat} - Natural background concentration (kg/m³)
Y - Yield (ton/ha)

For the current study site, GWF for growing paddy was computed using the calculated leaching run-off fraction (α_{cal}) by equation (1), and average leaching run-off fraction (α_{avg}) of 0.1 (Franke et al., 2013, p. 17) for both Yala and Maha seasons in 2015 and 2016 separately.

2.2.2 Fertilizer-induced N leaching and related Grey Water Footprint

The total amount of NO_3-N leached to groundwater during whole cultivation period was calculated using above experimantal values. Run-off was managed in the experimantal site. Therefore, leached NO_3-N amount was taken as the pollutant load (L) which reached ground water or surface water body. The GWF was calculated by (Equation 3) (Hoekstra, et. al., 2011, p. 37)

$$GWF = \frac{L}{(C_{max} - C_{nat})}\left[\frac{volume}{time}\right] \qquad (3)$$

L - Pollutant load entering to a water body (mass/time)
C_{max} -Maximum acceptable concentration (kg/m³)
C_{nat} - Natural background concentration (kg/m³)

2.2.3 Constant leaching run-off approach related Grey Water Footprint

In the frame of GWF accounting, the constant leaching run-off approach (10% of applied fertilizer N) (Mekonnen and Hoekstra, 2010, p.11) was applied (Equation 3).

2.3 Statistical analysis

A two-way Analysis of Variance (ANOVA) was applied to investigate the effect of cropping seasons (Yala and Maha) and effect of year (2015 and 2016) on N leaching related GWF for paddy for experimental site which was calculated using different methods.

Two sample t-test was carried out to explain the effect of calculation method on GWF of paddy at research site. Statistical analysis done by using Minitab 17 statistical software.

3. Results and discussion

3.1.Leaching of nitrate-N

Amount of Nitrate-N in leached water which were collected from each lysimeter was expressed in Figure 1 for Yala and Maha seasons for 2015 and 2016 separatly.

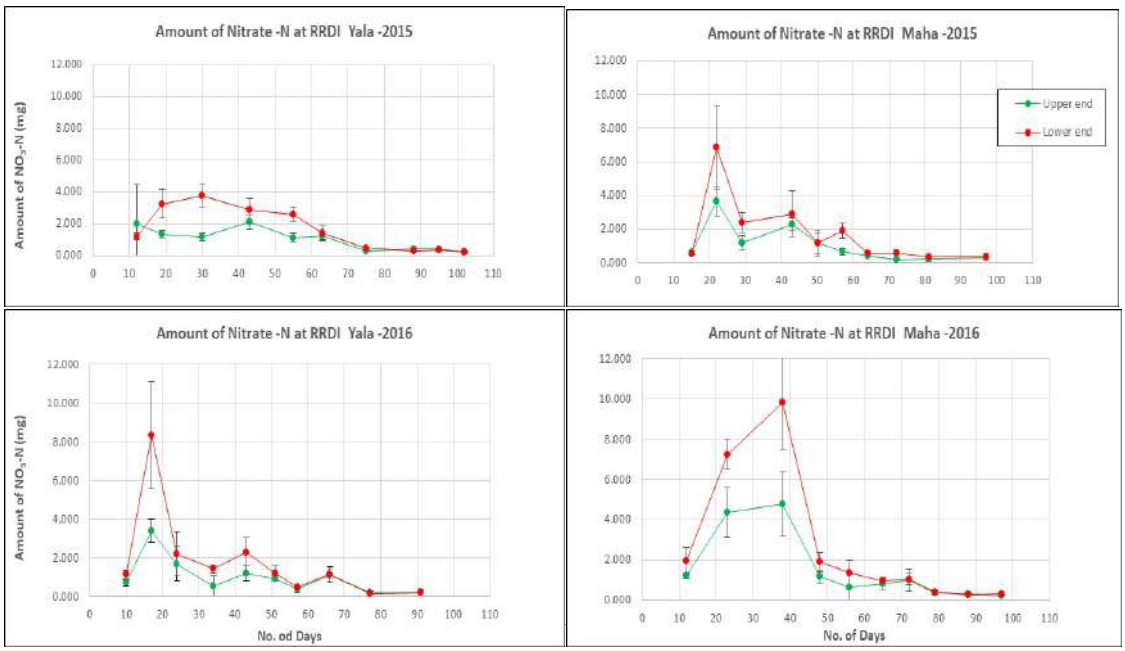

Figure 1: Relationship between leaching amount of NO_3-N and influence of gradient (upper end and lower end) of the experimental site.

The Figure 1 ilustrates the stready increasment of NO_3-N amount after application of urea and high values NO_3-N amounts were observed in lower end with compare the upper end upto 60 days.The average leached amount of NO_3-N was 8.71 ± 1.74 kg/ha (8.4% of applied N fertilizer) for the study site (Table 2).

Table 2: Total amount of leached NO_3-N throughout each growing period

Growing season	Amount of leached NO_3-N (kg ha^{-1})
Yala 2015	7.47
Maha 2015	7.95
Yala 2016	8.16
Maha 2016	11.28
Average	**8.71 ± 1.74**
Average (Yala)	7.81 ± 0.48
Average (Maha)	9.62 ± 2.36

3.2.Estimation of leaching run-off fraction (α)

Based on the GWF accounting supporting guidelines by Franke et al., (2013, p.17), the N leaching run-off fraction has a minimum (α_{min}) and maximum (α_{max}) value of 0.01 and 0.25 and the study site consists of loam soil having the score of 0.67. Further it is located in an area of high N deposition (score: 0.67) (Franke et al., 2013, p. 46). The site was poorly drained and score for natural drainage relevant for leaching is zero. Since the study was focused on leaching and not on run-off a score of zero was considered for both texture and natural drainage relevant for run-off. The score for annual rainfall in the study site is reported as "very high" (score: 1). It is also considered as N_2 fixation was low with the score of 0.33 (Watanabe et al., 1987, p. 246), application rate was high with the score of 0.67 (Iqbal, 2011, p.102), the score for plant N uptake was 0.33 and the score for good management practices was 0.33 (Franke et al., 2013, p.55)..

Table 3: Factors influencing the leaching run-off potential of Nitrogen for the research site.

Category	Factor		s (score)	w (weight)	s x w
	Atmospheric input	N-deposition	0.67	10	6.7
		Texture(relevant for leaching)	0.67	15	10.05
Environmental	Soil	Texture (relevant for run-off)	0	10	0
factors		Natural drainage(relevant for leaching)	0	10	0
		Natural drainage (relevant for run-off)	0	5	0
	Climate	Precipitation	1	15	15
Agricultural	N-fixation		0.33	10	3.3
practice	Application rate		0.67	10	6.7
	Plant uptake (Crop yield)		0.33	5	1.65
	Management practices		0.33	10	3.3
			Total	**100**	**46.7**

Note: The state of the factor determines the leaching run-off potential, expressed as a score between 0 and 1. A weight per factor shows the importance of each factor (Franke et al.,2013, p. 20).

In the study site, α was estimated to be 0.12208, a value close to the average leaching run-off fraction (α_{avg}) of 0.1 as reported in Franke et al. (2013, p. 17).

3.3.N leaching related grey water footprint for paddy

Nitrogen leaching related GWF of one tonne of paddy produced at the research site was calculated applying four metods expalined in the methodology. The results are shown in the Table 4. The highest GWP value is shown by the method of estimation based on the constant leaching approach (10% of applied fertilizer N).

Table 4: Calculated GWF for NO_3-N for the research site based on actual leached amount of NO_3-N, estimated α for N, average α for N and constant leaching approach (10%).

Cropping seasons	Actual leached amount GWF (m^3/t)	Estimated α (α = 0.12208) GWF (m^3/t)	Averageα (α =0.1) GWF (m^3/t)	Constant leaching (10%) GWF (m^3/t)
2015 yala	166.76	197.43	161.72	231.03
2015 maha	191.73	213.43	174.83	249.76
2016 yala	198.43	215.18	176.26	251.80
2016 maha	183.20	143.58	117.61	168.02
Average	**184 ± 14**	**187 ± 33**	**153 ± 27**	**219 ± 39**
Yala (average)	181 ± 22	206 ± 13	169 ± 10	241 ± 15
Maha(average)	187 ± 6	172 ± 49	141 ± 40	201 ± 58

The Figure 2 illustrated the GWF which calculated for the actual leaching amount for the site. The variation of the GWF for the four cropping seasons was observed depending on the yield and leaching amount of N-NO_3.

The increment of GWF was observed from 2015 Yala to 2015 Maha due to high N leaching during Maha. The decline of GWF is shown in Maha due to the high yield gained in the season though increment of N leaching was observed in that season.

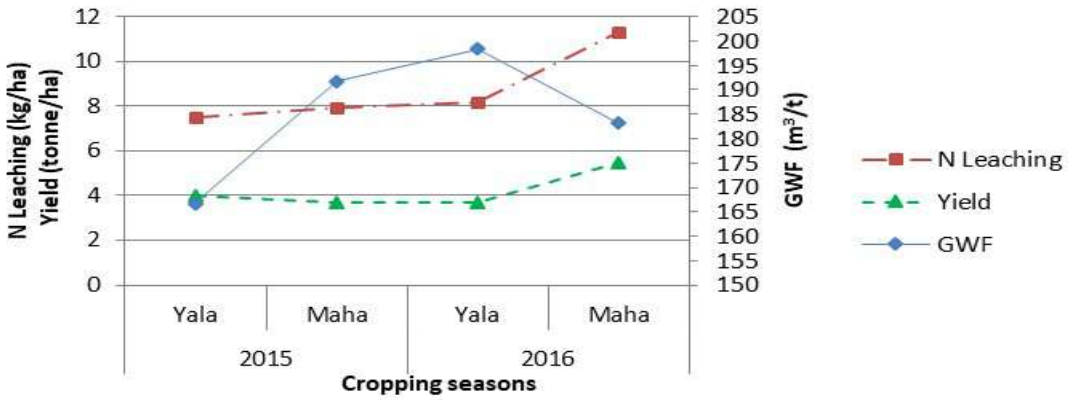

Figure 2: Relationship between leaching amount of NO_3-N, GWF and yield at research site for the period of 2015 – 2016 for four consecutive cropping seasons.

Based on the 2-way analysis of variance, both seasons and years have not been significantly impacted (P>0.05) on GWF for paddy at experimental site. Two sample t-test was shown that there were no significant differences (P>0.05) of GWF calculated using different methods except GWF for (average α) vs. GWF (constant leaching) (P=0.037).

3.4.Discussion

The use of commercial fertilizers has increased steadily in last 50 years, rising almost 20 fold to the current rate of 100 million tons of nitrogen per year (Anthony, 2003, p. 453). About 10% of total nitrogen fertilizers used globally is applied to rice (Bhat, 1998, p. 123). Only the fraction of the nitrogen-based fertilizers is absorbed by plants. The excessive use of nitrogen fertilizers is particularly damaging, as much of the nitrogen that is not taken up by plants is transformed into nitrate which is highly water soluble and easily leached, leading to increased runoff into surface water as well as leaching into groundwater, thereby causing surface water and groundwater pollution (Iqbal, 2011, p.102). In this study, the GWF was quantified above said pollutions using different methods.

The calculations were based on several assumptions: ammonia loss to the atmosphere is 20%, denitrification loss is 10% (Chapagain, and Hoekstra, 2010, p.14). According to Wijesinghe and Weerasinghe (2015, p.28), added urea on the soil surface will loss 50-90% of its initial amount of nitrogen within few hours of addition rather than being absorbed by plants. The differences of that amount are directly impacted to the variation of calculated values of GWF. In the other frame of GWF accounting, the constant leaching run-off approach is used where 10% of applied nitrogen fertilizer is lost through leaching.(Mekonnen and Hoekstra, 2010, p.11). The measured average leaching losses of the research site is 8.4% which was close to the estimated percentage of 10%. Percolation losses are not measured under the study and run-off losses is assumed as zero for the calculation. These assumptions also impacted to the variation of calculated GWF. The differences of leaching run off fraction (α) effect to variation of calculated values of GWF.

Irrespective of the calculation methods, it is proved the environmental impact of paddy cultivation through water pollution by the concept of GWF. Careful fertilization technologies are important since excess nutrients can be detrimental (Wijesinghe and Weerasinghe, 2015, p. 28). The increased fertilizer utilization efficiency and use of controlled release fertilizers are some of the sustainable methods to be practiced (Wijesinghe and Weerasinghe, 2015, p.28). Slowly converted N by controlled release fertilizers increases the N uptake by plants. Nitrification inhibitors (nitrogen stabilizers) suppress the conversion of ammonia into nitrate. In these ways polluting effects could be limited (Choudhury and Kennedy, 2005, p. 1633). Unfortunately, most developing countries like Sri Lanka apply urea, a straight fertilizer as N base, exceeding the recommended limits leading to

nitrate pollution of surface as well as ground water (Iqbal, 2011, p.101). That situation should be managed properly to conserve freely available valuable water resources in Sri Lanka for present and future generation.

4. Conclusions

This study revealed that a considerable amount of nitrogen leaching losses could occur through paddy cultivation as such elevated GWF values are apparent indicating considerable threats of water contamination. This situation warrants attention of all stakeholders including farmers, agricultural and other government officers and finally the policy makers. Even though the present study focusses on the intermediate zone, similar situations may have aroused in other parts of the country. The results of the present study highlight the need of more scientific investigations on nitrate pollution which could result in degradation of ground and surface water quality and ultimately the health impacts of the consumers. Therefore, the key message from the present study could be highlighted as the essential need of curbing nitrate pollution form the paddy cultivations in order to build resilience in the agricultural sector.

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Post-disaster recovery as socio-ecological and socio-political construction: responses to the 2010 Merapi eruption as a case study

M. Bobby Rahman [a, b,*], Pieter Van den Broeck [a], Constanza Parra [a]

[a] University of Leuven, Belgium
[b] Institut Teknologi Sumatera, Indonesia

Abstract

To understand the complex and dynamic situation after the 2010 Merapi mega-eruption in Indonesia, this paper examines the concept of disaster as a socio-ecological and socio-political construct, produced in the sometimes contradictory and even conflicted interactions between different stakeholders and the ecological systems involved. The paper re-embraces the idea that the concept of disaster risk is relying on who interprets it. It combines a socio-ecological approach seeing man and nature as mutually constitutive, with a socio-political perspective going beyond a bounce-forward understanding of resilience, and a social constructivist understanding of disaster and risk. The Cangkringan sub-district in Sleman region, the most severely impacted area in 2010, is taken as a case study area, for which the data were collected through literature review, observation, and semi-structured in-depth interviews with government officials, local activists, local NGOs, academics, political-cultural-religious leaders, and members of the local community. The research shows how the Merapi eruption is defined in various ways by various groups, shifting through time and according to various driving factors.

Keywords: disaster; risk; Merapi; social construction; governance.

1. Introduction

The 2010 eruption of the Merapi volcano in Indonesia, which is the most prominent one in the last hundred years, recently generated a new debate regarding nature-society interactions. In the complex post-disaster situation, discrepancies in the definition of risk corresponding with volcanic eruptions, have become a source of disagreement between the government and the inhabitants (Lavigne et al., 2008). Whereas government sees the Merapi eruptions as a natural hazard event that could threaten the people, local people accept the Merapi eruptions as a part of their daily life (Sulistiyanto, 2014).

This shows that the Merapi disaster and its responses are often still narrowly seen and grasped from a mere natural hazard approach. For example, the permanent eviction of some of the local people after the 2010 Merapi eruption was triggered solely by hazard-related considerations on areas impacted by the eruption. In contrast to this, research over the last decades on the Merapi volcano has been rapidly and profoundly growing and receiving widespread attention from a vast array of research fields (Lavigne et al., 2008; Surono et al., 2012). Oliver-Smith (1994) for example, explains how both the proponents of community relocation and its opposition are initiating political action, which involves power relations.

Tying in with Slovic (1999, p. 699), stating that "Whoever controls the definition of risk, controls the rational solution to the problem at hand", this research attempts to understand the complex and dynamic situation after the 2010 Merapi mega-eruption. The discussion of socio-ecological systems, resilience, and socio-political construction of disaster are mobilized to formulate a conceptual framework and to enable a better understanding of the way catastrophe was socio-ecologically and socio-politically defined after the 2010 Merapi eruption. In other words, events such as relocations are not mere natural hazard considerations but instead indicate complex interactions between nature and society.

This research takes the Cangkringan Sub-District (kecamatan) as a case study, focussing especially on three villages (desa), namely Umbulharjo, Kepuharjo, and Glagaharjo, which were the most severely affected villages by the Merapi mega-eruption in 2010 (see Figure 1). Data collection, conducted in November 2011 and December 2017 - May 2018, was done through literature review, observation and semi-structured in-depth interviews with government officials, local activists, local NGOs, academics, political-cultural-religious leaders and members of the local community.

* Corresponding author. E-mail address: bobby.rahman@kuleuven.be

2. Uncovering the socio-ecological and socio-political construction of disaster and its responses

Pelling (2001) argued that critical and political thinking on vulnerability have been largely conducted for pre-disaster events and focused less on vulnerability issues in post-disaster situations. The idea to see disaster risk as more than merely hazards came from O'Keefe, Westgate, and Wisner (1976) who argued that disaster is a construction including social, ecological, and political aspects.This notion has been further elaborated by Wisner et al (2004) who questioned the "naturalness" of natural disaster and explored the term of vulnerability further. This school of thought became an actively balancing counter-idea as opposed to the hazard-oriented and merely physical approaches. In their understanding, the disaster is (the result of) a social construction, which means that disaster events are not just caused by mere hazards but are fabricated due to the limitations in the access to economic, social, and political resources. A few decades later, Smith (2006) emphasized those ideas firmly by mentioning that 'there is no such thing as a natural disaster'. In the same vein, Paidakaki and Moulaert move beyond the idea of a "bounce back" and even "bounce forward" resilience, by examining how the initial political position of the disaster-affected people influences society's resilience. As such, resilience should be no longer approached as a singular character, a sequential way and a one-dimensional aim (Paidakaki & Moulaert, 2017). Therefore, moving toward a resilient environment cannot be exiled from political considerations.

The political dimension is also one of the main driving factors of defining risk. Slovic (1999) for example, has highlighted that each actor controlling the definition of risk can likewise compose rational breakthroughs. In addition, intimate interaction between society and ecology produces a sturdily socio-cultural belief that is deeply embedded in the inhabitants' minds (Parra & Moulaert, 2016). Consequently, how people interpret disaster risk as well as decision-making (respond/behaviour) is affected by such mutual robust connections. In the context of criticizing climate change discussions, Swyngedouw (2013) revealed that the ecological problem, e.g. climate change, is often depoliticized and identified as if it is a neutral matter, to hide and protect more substantial interests and cover the need to question the nature of political decision-making. In the same vain, Kelman (2003) affirmed that the risk interpretation depends on who defines it.

3. Reactions of the agents after the Merapi 2010 eruption

3.1.Ecological change and political reactions

Merapi's morphological change after the collapse of the old lava dome Geger Boyo in 2006 encouraged the discussion to control the spatial organisation in the southern region of Merapi. Since then, i.e. before the huge 2010 eruption, discussions had been growing as well as warnings to start rigidly controlling the spatial arrangement, particularly in the south-southeast slope of Merapi, due to the opening of a lava dome toward those regions. Geger Boyo was formed in 1910 (Lavigne et al., 2008), protecting the south-southeast part of Merapi since 1931 (Wilson et al., 2007). Although the 2006 eruption was not the first one to occur towards the South since the 1900s, at that time the discussion on controlling the spatial organisation in the South slope of Merapi was starting to become louder. Merapi's pyroclastic flows began to flow directly to the South since 1994, when an eruption was heading to the village of Turgo (South flank of Merapi), after Merapi had for decades erupted consistently heading to the West. Before 1994, the last time the pyroclastic flow had headed to the south was during the eruptions in the year 1904, 1939, 1942, and 1961 (Thouret & Lavigne, 2005).

Attempts to move out the inhabitants of the potential hazard-prone area met a momentum, when the 2010 Merapi mega eruption was heading to the South flank. The eruption was followed by a renewal of hazard-prone area maps I, II, and III (KRB), underlying spatial planning of the South Merapi region (see Figure 1). The KRB map was conducted and launched by the Merapi Observatory and Technology Center (BPPTK). Then, the KRB map became the basis of the Presidential Regulation (Perpres) No. 70 year 2014 on spatial planning of the Mount Merapi National Park (TNGM), leading to the eviction of more than 2,000 households, who lived in KRB III, and had to be permanently relocated to a safer location to avoid the potential hazard. Moreover, a series of regulatory-practical tools were issued as a basis for relocating the community. Before the Merapi 2010 eruption, the authorities had acknowledged that relocation of the inhabitants out of the hazard-prone area and resettlement to safer-permanent places was a mission impossible when no hazard was apparent.

Literally, the historically made KRB map repeated the same approach that had been conducted since the colonial era to evict people to deal with ecological issues (Handojo, 1985; Voight et al., 2000; Triyoga, 2010). The post-Merapi 2010 eruption KRB map, including Perpres No. 70 year 2014, is not strictly aimed at the South region of Merapi, but also at several regions bordering Merapi including Boyolali, Magelang and Klaten districts

in Central Java province (see again figs.1). However, the relocation was more predominantly and proactively carried out in the province of Yogyakarta.

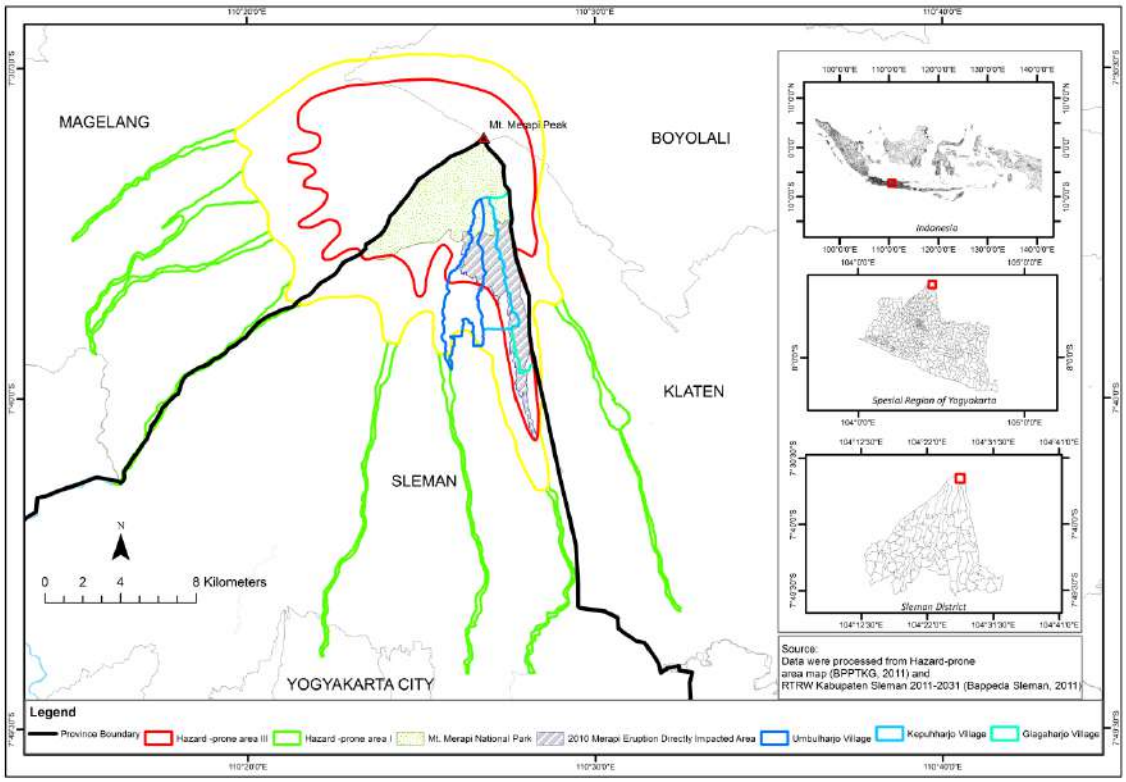

Figure 1: A map of the research focus location.

KRB III, located on the area directly affected by the eruption of Merapi 2010, has many physically developing limitations for the inhabitants. In a way, relying on the KRB III map to relocate people has been criticized by Thouret and Lavigne (2005) as an insufficient method to constitute the risk analysis, as it underestimates the potential hazard that can be greater than predicted; and by Lavigne et al. (2008), mentioning that it often constitutes an insufficient warning system and evacuation plan. Moreover, since it is a mere hazard mapping, the KRB map had not considered the socio-economical aspect that has a dominant role in the volcanic mountain society. As such, a comprehensive risk map should more completely consider the socio-economic vulnerability aspects in supporting the decision making (Lavigne, 1999). At this point, Slovic (1999) asserts that hazard is a real matter, while risk is socially constructed.

Other interests and agents, indirectly related with the Merapi disaster, benefit from the relocation of the directly affected communities to new locations. An example is the repetitive and ongoing conflict over the determination of the Merapi upstream area as Merapi Mountain National Park (TNGM). Behind the designation of TNGM, the primary motive is protecting water reserves and keeping the water supply of downstream communities, which are located in the Yogyakarta urban area (Handojo, 1985). The relocation of the society from KRB III to a safer location, although it was seen as based on convincing natural considerations (potential danger), it is also indirectly supported by an interest in avoiding disruption of the function of TNGM. It has become common knowledge that TNGM was established to maintain the condition of the forest in the upstream neighbourhood to safeguard the water catchment area. In this sense, as a topographic position, Merapi is an upper area of Yogyakarta urban area functioning to protect a large number of people and the Sultan (king) in the downstream. In the past, logging trees and taking grasses in the protected forests (now TNGM) were considered as potentially causing erosion and flooding of urban areas (Handojo, 1985).

Another example in differently defining a potential risk can be seen in the case of the development of New Yogyakarta International Airport (NYIA). In the midst of support for the efforts to relocate the Merapi community and to move it out from KRB III, which has been conducted since 2011, the Yogyakarta provincial government also supported the development of NYIA located in the southern province of Yogyakarta, Kulon Progo, which is explicitly situated in the earthquake and tsunami hazard-prone area (LIPI, 2017). The development of this airport is aimed to strengthen Yogyakarta's profile as a global tourist destination, thus

enhancing Yogyakarta as one of the leading destinations of cultural tourism in Indonesia (Bridger, 2017). This contradiction can reflect that the political support for a disaster risk reduction policy may differ and could be influenced by economic interests.

3.2. People's reactions to political-ecological change

Although the potential hazard is increasingly assessed as very high from the perspective of the government, more than 600 families in Desa Glagaharjo preferred to stay in KRB III. In fact, communities were found moving back to their original land not only in Desa Glagaharjo, on a small scale, but also in other areas in the Merapi area. Such stories are not unique for the Merapi case but happen in many volcanic hazard areas around the world. To understand the community decision contradicting the government policy as a reaction to the political-ecological changes after the Merapi 2010 eruption, the cultural-economic background needs to be elaborated.

For people living around Merapi, especially those who depend on the land and the resources generated from it, Merapi is not only a natural physical phenomenon per se. Merapi is believed to be a blessing that is a source of life for the people. Previous research has indicated that the community considers Merapi as more of a blessing rather than a disaster (Adisty, 2017; Dove, 2008; Ikhsan et al., 2010; Prasojo, MNB, 2015), and as a simultaneous blessing-calamity (Rahman, Nurhasanah, & Nugroho, 2016). The local society believes that what has been given to them by Merapi as an embodiment of an abundance of economic potency beyond the mega eruption is an inevitability. It can be clarified by the Javanese tradition, which is institutionalized in most of the Javanese people, *narima ing pandum*, which means resignation to God's scenario (Endraswara, 2015). Although, this belief, at times, is wrongly grasped, such that people lose their optimism to continue their life due to this faith. Contrarily, this paradigm helps them to live in balance and control the intractable human ambition (Endraswara, 2015) without losing their optimism in continuing their life eventually. In the Merapi context, this paradigm also helps to explain the apparent expression of belief produced in a socio-ecological nexus that "the more significant the impact, the higher the benefits it brings", which makes them bounce back from the negative impacts greater than their capacity. So the Merapi people's position is that Merapi is a hazard and blessing simultaneously (either as a producer of tangible or intangible beneficial materials). It was sympathetically described by the religious figure accompanying the survivors in the temporary-emergency settlement right after the Merapi 2010 eruption:

> …at the beginning, most of the people were feeling frustrated because of the loss of their properties, family members and their daily livelihood. As time goes by, they tried to adapt to the current situation and surrender themself to the God's scenario. Eventually, nowadays, the people have looked at the future optimistically… (Maulana, 2018).

People who rejected the eviction from their previous land feel their economy is running better than those who chose to live in new permanent residences. Suparlan (2017) and Adisty (2017) argue that, in general, the people staying in KRB III are socially and economically better off than the society who prefers moving to new permanent settlement (huntap). By returning to their previous location, communities could continue their cultural livestock activities, sand mining, and farming within a shorter distance or on their land. Although the people living in the new settlement also have the opportunity to mine sand either individually or communally, they have not succeeded structurally in raising the value of their economy. In addition to living in the new dwellings, relocation has limited the opportunity to conduct various economic activities (which used to be important), and also limited married and adult children of community members to own their property. People living in the new settlement have difficulties in accessing the new land and property surrounding their new vicinity, since the price is too high and their land in the KRB III cannot be used to build permanent housing. Although the people living in the settlement, for instance, those from the Desa Kepuharjo, receive communal grants from the management of the sand from the community, the income is insufficient to provide new access to land tenure for their married family members.

4. Conclusion

This research shows that the rehabilitation and reconstruction after the 2010 Merapi eruption are the domain of the mutual connection of social, political and ecological complex contestations, triggering different approaches to seeing risk that are led by more than a single interest. It confirms the fact that the discussion on

defining risk and its impacts is at times influenced by a narrow environmental understanding, and that there is a need of a broader ecological, social and political consideration of the primary and collateral functions of the Merapi territory. The complexity of Merapi-related issues will be higher and higher, in-line with the increasing Merapi-related interests, and the fact that Merapi is unevenly benefitting multiple actors and actants.

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Community resilience to natural hazards: a theoretical foundation for developing measurement tool and variable indicators

Osamuede Odiase [a,*], Andreas Neef [b], Suzanne Wilkinson [a]

[a] Department of Civil and Environmental Engineering, Centre for Disaster Recovery, Resilience and Reconstruction (CDRRR), University of Auckland, New Zealand
[b] Development Studies Programme, University of Auckland, New Zealand

Abstract

Resilience has become a cornerstone for reorganisation to potential damage from natural hazards. Some of the problems of theoretical development of resilience are multiple conceptualisations by different scholars and the progression from conceptual to a universally accepted measurement framework irrespective of temporal and spatial scales. Based on the secondary data source, this paper provides a theoretical foundation for measurement tools and indicators selection. To achieve the aim of this study, an integrated framework of disaster management principle, resilience and community resource was developed to guide indicators' selection; and in addition to this, an investigation into community resilience index (CRI) tool was conducted to ascertain the level compliance and practical implementation of criteria relating to tool development. Findings indicate that social, economic and physical capacities of an individual are more predictive of resilience than other dimensions and limited compliance regarding tool criteria and implementation. The result also shows the difficulty in complying with tool criteria as most assessments are interested in benchmarking and baseline condition of the community. The result suggests a more participatory approach and the need for assessment to account for the ecological and scalar relationship if the assessment is to reflect the resilience status of a community genuinely.

Keywords: Resilience; measurement; indicators; resources; hazards.

1. Introduction

The Government commitment to "Resilience to nature's challenges" in New Zealand underscores the growing concern for a disaster and the need to face up to the challenges. The concern is likely to become more worrisome as a result of the expected impact of climate change and the increasing rate of urbanisation in Auckland. Globally, the disquiet surrounding climate change has underpinned policy statement from different international fora on the need to be resilient to natural forces.

Since Holling conceptualisation of resilience in 1973, the concept of resilience has progressed as an attribute of a biophysical system (Holling 1973), an attribute of a social system (Adger 2000), a social-ecological attribute (Folke et al. 2005) and recently, as an attribute of a place (Cutter et al. 2008). Also, confounding issues relating to sustainability (Tobin 1999), adaptation (Adger 2006), the relationship between vulnerability and resilience (Beatley 2014) have emerged. Other issues relate to resilience as a process of social learning or as an outcome of an event (Handmer 1996). Aside from the epistemological debate, the concept encompasses the ability of a community to cope and adapt to environmental challenges. A significant consequence of the conceptual development of resilience is lack of consensus on how resilience can be measured and operationalised beyond conceptual and framework development (Cutter et al. 2008). Despite the conceptual debate, the need for measuring resilience has become imperative for policy planning and assessing interventions to mitigate disasters.

The primary purpose of this paper is to provide a theoretical foundation for measurement tool and indicators' selection. This study used secondary information as the primary source of data. The following steps were taken to achieve the aim of this study. Firstly, a conceptual development resilience measurement tool. Secondly, an integrated framework of disaster principle, resilience and community resource indicators. Thirdly, a cluster and reduction process of domain selection. Fourthly, a case study of CRI tool and compliance; and lastly, the study's conclusion.

* Corresponding author. E-mail address: edeodiase@yahoo.com

2. The context of the study

The epistemological variance in resilience study is not limited to conceptual development and definition of the concept. It also underpins the divergence in resilience tools and assessment methods. The National Academy of Sciences (2015) identified 17 assessment tools in the 2012 Disaster Resilience Report. In 2016, the number of tools increased to 27 (Cutter 2016) and shortly afterwards to 36 (Sharifi 2016). Tyler et al. (2014) attributed the increase to the financial commitment to resilience by the government, and also; at the behest of development agencies regarding interventions (Schipper et al. 2015).

Although hazard management scholars have emphasised the importance of resilience in managing disasters, few works have been done to investigate the relevance of existing tools to community resilience (Sharifi 2016). A few of the existing tools are difficult to operationalise and lack of contextual relevance (Irajifar et al. 2013). While Monaghan and others highlight the essential features of toolkits under their preview, their work was silence on the principles of resilience. Pfefferbaum et al. (2014) endeavour was an improvement on Monaghan et al. (2014). Beyond highlighting the essential features of each tool, they explored areas of convergence and divergence regarding tool criteria. Criteria relating to a spatial context, button-up approach, assets and need; and resilience skill were well-thought-out in their assessment. Cutter (2016) expands the scope of assessment criteria and the numbers of tools more than the earlier assessment. She identified common strands in assessment tools and suggested proper conceptualisation of resilience to improve assessment. Cutter's assessment was interested in the purpose of assessment and criteria relating to domains, spatial scale and method of data collection. Although Cutter's analysis identified common dimensions across all tools, there was a divergence on what to measure and the appropriate indicators.

Further to Cutter's, Sharifi (2016) used six criteria to analyse tools' compliance with the assessment criteria. Three of the criteria were similar to Cutters. In addition to that, Sharifi (2016) included criteria relating to temporal change, uncertainty and an action plan for resilience. Unlike other reviews, Sharifi (2016) assessment identified areas and levels of compliance and non-compliance among the existing tools. The highest level of compliance was related to addressing uncertainty through training and updating response capacities. The least criteria for compliance were related to spatial and temporals relationship. Although assessment tools such as index, toolkits, scoreboard and model exist in the resilience landscape, not many of the tool incorporated all the guidelines. Below is a table of guidelines identified in different studies which this study harmonised into all-encompassing guidelines.

Table 1: Table of assessment criteria

Stevenson et al. (2015)	Cutter (2016)	Sharifi (2016)	Harmonised *guidelines*
Conceptual framework	_____	_____	Conceptual framework
Operational definition	_____	_____	Operational definition
_____	Focus	_____	Focus
Drivers of resilience	Domain	Comprehensiveness	Dimensions of resilience
_____	Spatial scale	Cross scale relationship	Spatial linkage
_____	_____	Temporal dynamism	Temporal dynamism
_____	_____	Address uncertainties	Address uncertainties
Method Mixed data method	Method	Participatory approach	Data collection method
Desire outcome	_____	Action plan	Address findings

Despite the variance in the methodological tool, five themes have emerged from literature against which to assess resilience.

Table 2: Category of assessment.

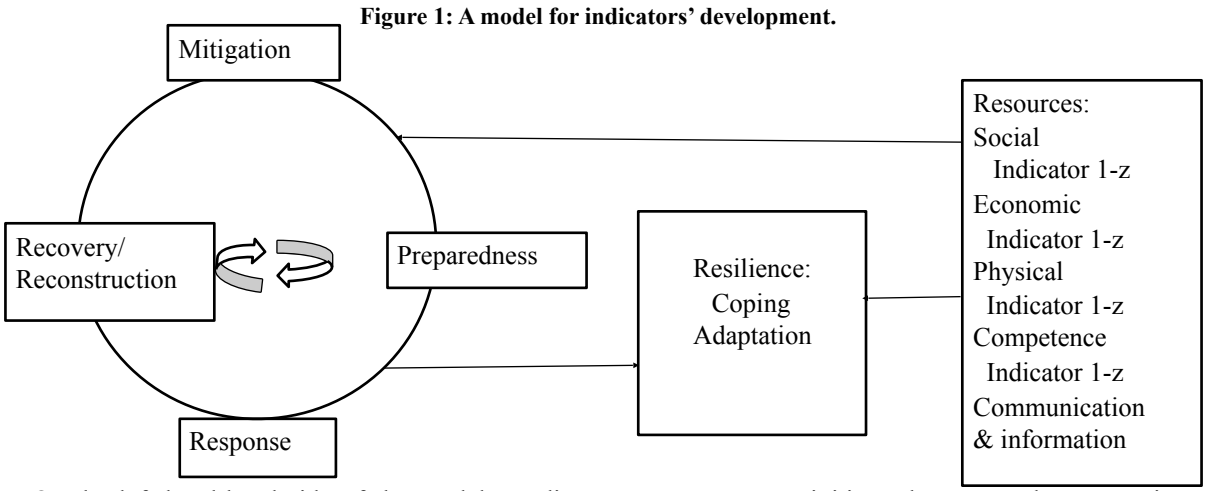
Assessment approach	Justification
Baseline condition	Information on the current state of resilience.
Intervention	Assesses progress of pre and post-disaster interventions.
Benchmarking	The state of resilience among other communities.
Good resilience	Holistic assessment of domains and updating disaster management capacities.
Speed of recovery	Investigates the duration for a community to recover after a hazard event.

Source: Cutter (2016); Cutter et al. (2008); Pringle (2011); Stevenson et al. (2015).

3. The development of variable indicators of community resilience

The development of variable indicators is a logical and sequential step in the construction of composite community index (Birkmann 2006). It ensures that measurable and practical indicators are selected (Freudenberg 2003). The relationship between resilience domains and indicators is that the latter determined the status of domains under consideration (Parsons et al. 2016). In developing resilience indicators, actions and activities regarding disaster management; and the resource capacities to achieve the activities are identified (Peacock et al. 2010). The model below explains the relationship.

Figure 1: A model for indicators' development.



On the left hand-hand side of the model are disaster management activities. The expected outcome is to enhance resilience. Resilience depends on the robustness of the variable indicator of community domains.

The resource section of the model excluded institution and natural domains for three reasons. Firstly, the focus of this paper is not about geography, but the existing capacity of a population. Secondly, the capacity for action is indicative of actual resilience capacity (Bormudoi et al. 2017), and thirdly, resilience is seen through the lens of human agency and the capacity for meaningful and intentional actions of individuals during challenges (Norris et al. 2008).

4. Community resource and variable indicators

This paper identified 16 related domains for assessing resilience to natural hazards. This paper adopts a process of clustering and reduction of the domain to enables merging similar domains under a general category because of the fluidity of indicators and to avoid duplication. Moreover, also, to eliminate domains not directly predictive of resilience at the individual level. Mainly, the dimensions of social, economic, physical, competence and communication and information are relevant in assessing the resilience capacity of an individual to natural hazard challenges.

In selecting the indicators of resilience, this study identified measurables attributes of the domains. In the social sphere, indicators of individuals' involvement in social groups, participation in communal affairs and community network (Putman 2000). Economic attributes encompass the financial means that support individuals during disaster challenges. At the level of an individual, the physical dimension can be measured by the possession of a house and personal car. Community competence has both social and disaster management components. Proxies such as risk, preparedness and response knowledge are relevant at the individual scale. Similarly, the means to receive and communicate information are relevant to individual resilience to unexpected challenges.

The proxies for assessing the resilience of domains can be identified from existing literature (Yoon et al. 2015) and through interactive data collection process (Forch 2012). The variables selection are considered against the background of consistency and objective of the study. Moreover, also, indicators' ability to influence disaster management activities (Peacock et al. 2010). In some cases, studies considered peer advice in the form of Delphi Process of indicator selection (Alsheri et al. 2015). The table below highlights the criteria for indicator's selection.

Table 3: Criteria for selecting resilience indicators.

Criteria for indicators selection
Predictive of resilience.
Data collection should be easy and inexpensive.
Ability to monitor changes at both spatial and temporal scales.
Measurable and easy to understand.

Source: Parsons et al. 2016; Birkman, 2013.

The selected indicators are arranged based on the underlining dimension (Parsons et al. 2016) which enables the creation of a dimensional index and the summation of dimensional indices to an index of community resilience.

5. Community resilience assessment criteria: compliance and discussion

This section examines index tool assessment of the resilience of a community to natural risks. Whereas the work of Sharifi (2016) analyses the design of different tools, this paper examines the implementation of a specific tool, the index tool in community resilience assessment. The studies main focus is on good resilience and benchmarking assessment. 60% per cent of the studies employs a mixed data while 40% relies only on qualitative data.

Table 4: Tool and assessment purpose.

Author	Tool	Data type	Baseline	Threshold	Good resilience	Benchmarking	Speed of recovery
Ainuddin et al. 2012.	CRI	QL&QT	✗	✗	✓	✓	✗
Kusumastuti et al. 2014.	CRI	QL	✗	✗	✓	✓	✗
Qasim et al. 2016.	CRI	QL&QT	✗	✗	✓	✓	✗
Yoon et al. 2015.	CDRI	QT	✗	✗	✓	✓	✗

Joerin et al. 2012.	CDCRF	QL&QT	✗	✗	✓	✓	✗

Key:
QL: qualitative; QT: quantitative; CRI: community resilience index; CDRI: community disaster resilience index; CDCRF: climate disaster community resilience framework; ✓: addressed; ✗: not addressed

Regarding the criteria in Table 1, Table 5 shows adherence to the conceptual development of resilience in all the studies. Conceptual development contextualise and harmonise competing views on resilience. Studies' conceptual development was on literature review rather than iterative development. Local input on what constitutes resilience did not reflect in all the studies. Contextual discourse improves understanding and implementation of resilience tool (Frankenberger et al. 2013).

Table 5: Tool application and criteria compliance.

Author/ Tool	Conceptual framework	Definition	Focus	Spatial linkage	Temporal dynamism	Address uncertainties	Participatory-data method	Address findings
Ainuddin et al. 2012. CRI.	✓	✓	✓	✗	✗	✓	✓	✓
Kusuma-stuti et al. 2014. CRI.	✓	✗	✓	✗	✗	✓	✓	✓
Qasim et al. 2016. CRI.	✓	✓	✓	✗	✗	✓	✓	✓
Yoon et al. 2015. CDRI.	✓	✓	✓	✗	✗	✓	✗	✗
Joerin et al. 2012. CDCRF.	✓	✗	✓	✗	✗	✓	✓	✗

Key
✓: addressed
✗: not addressed

Although 60% of the selected works have an operational definition of resilience, they closely aligned to a meta-definition rather than conceptual and contextual definition. A contextual and straightforward definition enhances the community consciousness on the need to manage risks. The studies are focused on the community as the unit of analysis. The importance of focus in resilience assessment is that it guides data collection and provides an answer to the question of the resilience of 'what and to what' (Carpenter et al. 2001). The importance of focusing on one level of analysis cannot be over emphasis. However, there is a concern that it undermines the scalar relationship in resilience assessment. The importance of addressing the scalar relationship is that vulnerability, resilience and interventions at one level are intricately linked to other hierarchies (Chelleri et al. 2015).

Following the process of clustering and reduction of domains, this study identified social, community capacity, economic, information and communication; and the physical dimensions of individual as predictive of resilience. In ascertaining how much the CRI tool accommodates the multi-faceted nature of resilience, this study constructed a matrix of resilience dimensions.

Table 6: The cope with assessment and compliance.

Author	Resilience dimension							
	Tool	Social	Economic	Physical	Info/ Comm	Community capacity	Institution	Natural
Ainuddin et al. 2012.	CRI	✓	✓	✓	✗	✗	✓	✗
Kusumastuti et al.2014.	CRI	✓	✓	✓	✗	✓	✓	✗
Qasim et al. 2016.	CRI	✓	✓	✓	✗	✗	✓	✗
Yoon et al. 2015.	CDRI	✓	✓	✓	✗	✗	✓	✓
Joerin et al. 2012.	CDCRF	✓	✓	✓	✗	✗	✗	✗

Key
✓: addressed
✗: not addressed

The social, economic and physical dimensions received more attention than other dimensions because of their importance in predicting individual resilience. The selected studies did not address the communication and information domain despite its importance in risk perception. Only 20% of the selected studies considered community capacity as a domain. The importance of personal competence in disaster management is that it enhances individual capacity to cope with a disaster. Although the institutional domain is not directly related to individual capacity, it is addressed by 80% of the selected works because of institutional linkage to other dimensions. The natural domain receives 20% attention despite the importance of sustainability in meeting the future challenge (Tobin 1999). The selected studies did not address the relationship between past, empirical and future resilience. All the studies focus on the current state of resilience rather than baseline conditions that enable the community to investigate the past to understand the present and make provision for future resilience (Schipper et al. 2015). Although the continuous iterative process and updating baseline are necessary to address disaster uncertainty (Pringle 2011), the selected studies did not fully account for these criteria. The issues relating to preparedness and response capacities were addressed at both institutional and competence domains. The level of inclusiveness in the implementation of the CRI tool varies. Participatory input from conceptual framework to the action plan indicates that inclusiveness in the CRI tools was limited to data collection in 80% of the study. All the studies identified weaknesses associated with capacities and indicators. However, only 60% of the studies specified actions that are necessary to enhance resilience.

6. Conclusion

The broad aim of this paper was to provide a theoretical foundation for resilience measurement tool and indicator selection. In achieving this aim, an integrated framework of disaster management principle, resilience and community resource was developed to guide indicators' selection; and also, an assessment of CRI tool was carried out to investigate compliance with resilience criteria. Finding from the selected studies suggest that the social, physical and economic dimensions of a community are more predictive of individual resilience than other dimensions. Regarding tool development and implementation, the selected case studies did not address issues of temporal change and spatial relationship. Conceptual framework and definition were products of literature review rather than an interactive process. The participatory requirement for a bottom-top approach was limited to data collection in most of the selected studies. Although the model of indicator selection can be useful in identifying indicators of resilience, the benefit of assessment can be enhanced if people have the opportunity to determine what constitutes their vulnerability and resilience during the assessment. Since most assessments focus benchmarking and good resilience, efforts are needed to accounts for environmental dynamic and scalar relationship in assessment.

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New multi-scale risk governance and management approach of natural, cultural and artistic preserved areas: the case studies of the Amalfi Coast and the Cilento National Park (Italy)

Luigi Petti [a,*], Domenico Greco [a], Angelo Mammone [a], Carmine Di Muro [a]

[a] University of Salerno, Italy

Abstract

The paper describes an innovative methodology for the governance and risk management of areas characterised by a high natural, cultural and landscape value. To this scope, the Cilento National Park and the Amalfi coast sites in Southern Italy, both inscribed in the UNESCO World Heritage List, are considered for the discussion. The paper, in accordance with the Addendum to the Strategy for the Reinforcement of UNESCO's Action for the Protection of Culture and the Promotion of Cultural Pluralism in the Event of Armed Conflict, concerning emergencies associated with disasters caused by natural and human-induced hazards, looks at the role of culture – in its broader definition – in strengthening resilience and fostering social cohesion for a sustainable recovery, aligned with the *Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR)*. The starting point for any management activity is the knowledge of territories, understood as a descriptive element of the tangible and intangible aspects, which mutually act as support for the preservation of Cultural Heritage. The complexity of analysis of the territories with a trans-disciplinary approach, finds in the available informatics tools (GIS) solid support, through the intersection of various levels of information and the overlapping of different representations, thanks to which a complex multidisciplinary and multilevel reading has been possible to obtain.

Keywords: Cilento National Park; Amalfi coast; Cultural Heritage; Risk Management; Transdisciplinary approach.

1. Introduction

"Cultural heritage tells the stories of the world's many peoples. The material part of that heritage, objects and sites, tells us of their activities, their perceptions, their skills, and their ideas. It is unique, irreplaceable and unfortunately, vulnerable. Our heritage institutions bear the solemn responsibilities not only of prolonging their survival but also of making them accessible so that we can know our past. In practical terms, we must plan how best to reduce the risks to the heritage in our care, and then act on those plans" (A Guide to Risk Management of Cultural Heritage, ICCROM, 2016).

The combination of Heritage Conservation - Risk Management and Mitigation is one of the main challenges recognised at the international level and placed at the attention of the peoples as priorities, both in the general resolutions (Res. 72/218, 2017. Disaster Risk Reduction) adopted by the United Nations and in the resolutions concerning Heritage.

In recent years, losses associated with natural and human-induced events have increased considerably. These trends are expected to become more pronounced as global population growth and rapid urbanisation in the developing world threaten to reverse hard-won development gains. By 2030, 325 million extremely poor people will be living in the 49 countries that are most prone to hazards (Shepherd et al. 2013, The geography of poverty disasters and climate extremes in 2030). In parallel, the world is also rapidly urbanising, with urban areas adding 1.4 million people per week (UN DESA 2014). Over 60 per cent of the land projected to be urban by 2030 has yet to be developed (UNISDR 2015, INVESTING IN URBAN RESILIENCE, World Bank Group, 2015).

In this context, the leading International Organisations have outlined strategies and ways for achieving the objectives set by the UN Sustainable Development Goals (SDGs) of the Agenda 2030, adopted by the UN General Assembly in 2015 in the definition of the action program for people, the planet and posterity. Among the documents produced, the document approved in Sendai (Sendai Framework for Disaster Risk Reduction

* Corresponding author. E-mail address: petti@unisa.it

2015-2030 - SFDRR), the addendum to the UNESCO Action Plan for the protection of culture and the promotion of cultural pluralism in the event of armed events and emergencies associated with disasters caused by natural phenomena or human actions (Res. 39C/57 UNESCO, 2017) and the ICOMOS action plan (ICOMOS Action Plan: Cultural Heritage and Localizing the UN Sustainable Development Goals, 2017) represent the references for the creation of tools aimed at analyzing, managing and mitigating risks.

In the case of complex territories, as for "Cilento National Park and Vallo di Diano, with the Archaeological Sites of Paestum, Velia and the Certosa of Padula" and "Amalfi coast", in which the identity of a people is based on the interconnection of nature, culture and people themselves, determining the living heritage (ICOMOS, Delhi *Declaration on Heritage and Democracy*, 2017), it is necessary to adopt transdisciplinary approaches capable to grasp the different degrees of reality, perception and knowledge that describe its complexity.

Inclusion, democracy, respect for the continuity, living heritage, moral education for heritage management, represent the fundamental concepts underlying the method and strategy to be pursued, as clearly emerges from the New Delhi Declaration "Heritage and Democracy" approved in 2018 on the occasion of the 19th ICOMOS General Assembly.

Within this approach, considering that the Mediterranean territory is a particularly complex case study, with several sites and regions with several institutional recognitions, it is necessary to apply an analysis model aimed at ensuring effective transdisciplinary management.

The aim of the paper is to connect the objectives (UN SDGs) of the Agenda 2030, using the OECD welfare indicators (*Better Life project*, *OECD,* 2011), to better analyse natural and cultural heritage that describes the landscape of the different areas in order to give relevant tools to management plans increasing the individual and collective wellbeing in time. Furthermore, it is evident that, despite the different recognitions present in a region or in a same area, as for example the Cilento National Park and the Amalfi Coast (southern Italy), there is a need for pecific management instruments. In this regard, the present work aligned a metodology to put these systems in a framework capable to coordinate all the ventures and the activities in order to do homogeneous politics of development, that could be opportune and/or necessary.

In this way, a process of regeneration of the economy based on the construction of relationships/bonds, which stimulates new chains of creation of value, increasing the density of relationships/ties and in a spiraling process over time tending to self-feed in virtuous way, should be done to build a desirable future. In other words, it should first regenerate the non-economic (i.e., immaterial) conditions of economic development (L. Fusco Girard, *Nuovo umanesimo e rigenerazione urbana: quali strumenti per una crescita economica inclusiva?*).

2. Conceptual Framework: UN SDGs – OCSE Better Life links and Site Risk Governance

The UN SDGs, also known as Global Goals, were built on the success of the Millennium Development Goals (MDGs) and aim to go further to end all forms of poverty. The new Goals are unique in that they call for action by all countries, poor, rich and middle-income to promote prosperity while protecting the planet. They recognise that ending poverty must go hand-in-hand with strategies that build economic growth and addresses a range of social needs including education, health, social protection, and job opportunities while tackling climate change and environmental protection. (UCLG, 2017. *Culture in the Sustainable Development Goals: A Guide for Local Action*; UN HABITAT, 2013. *Planning and Design for Sustainable Urban Mobility: Global Report on Human Settlements*)

To strengthen risk governance and management of complex sites, the combination of a simultaneous reading of the UN SDGs and the OCSE Better Life Index is relevant to analyse and implement a process used to improve the individual (and collective) wellbeing and the sustainability of wellness in time. As shown in Figure 1, all these outcomes converge to the proposed risk analysis approach.

Figure 1. Proposed risk analysis approach.

Table 1: Proposed Conceptual Framework: linking UN SDGs and OCSE Better Life Index.

OECD Better Life Index		OCSE Better Life Index for measuring well-being – (Italy's scores)		UN Sustainable Development Goals (SDGs)
Individual wellbeing	Dimension of well-being	Income and wealth	(**4.1**/10)	SDG 1 (Poverty)
				SDG 2 (Fame)
		Work and pay		SDG 8 (Good Employment and Growth)
		Housing conditions	**5.4**/10	SDG 11 (Sustainable Cities)
		Health conditions	**7.7**/10	SDG 3 (Health)
		Life-Work Balancing	**7.5**/10	SDG 8 (Good Employment and Growth)
		Education and skills	**4.5**/10	SDG 4 (Quality Education)
		Civic Commitment and Governance	**4.3**/10	SDG 16 (Peace and justice)
		Quality of the environment	**3.8**/10	SDG 6 (Clean water)
				SDG 11 (Sustainable Cities)
		Personal safety	**7.0**/10	SDG 16 (Peace and justice)
	Differences among groups			SDG 1 (Poverty)
				SDG 5 (Gender Equality)
				SDG 10 (Inequalities)
Sustainability of wellness in time		Natural Capital		SDG 13 (Climate change)
				SDG 14 (Flora and fauna)
				SDG 15 (Land and flora and fauna)
				SDG 12 (Sustainable Consumption)
		Economic Capital		SDG 7 (Renewable energy)
				SDG 8 (Good Employment and Growth economic)
				SDG 9 (Infrastructure)
				SDG 12 (Sustainable Consumption)
		Human capital		SDG 3 (Health)
				SDG 4 (Quality Education)
		Social capital		SDG 16 (Peace and justice)
OECD individual wellness dimensions not covered by SDGs		Subjective benevolence Social relations		
SDGs not covered by the conceptual framework OECD				SDG 17 (Partnership for Goals)

LEGEND

- Dominate tendencies to improving mostly on the right track to reach the target
- Trends show a non-homogeneous picture

Dominating the worsening tendencies is not on the right track to reach the target

Not available

The proposed framework permits to identify the links between the 17 UN SDGs and the OECD Better Life topics that contribute to the achievement of the individual and collective wellbeing. This allows understanding what the sustainable development goals that affect, positively or negatively, the various topics of the OECD Better Life Index (Table 1) are. In the same table, as example, the Italian indexes are shown.

Furthermore, to allow the implementation of the 2030 Agenda in Italy, the Ministry of the Environment, which coordinates the work of shared and participatory elaboration of the National Strategy for Sustainable Development, has necessarily developed as a starting point an evaluation of the "Positioning" of Italy compared to the 17 Objectives of the Agenda 2030. In addition to the qualitative definition based on the selected indicators of the "Positioning" of Italy with respect to the individual objectives and sub-objectives, the work allowed to identify the main strategies and policies in place at the level national for each target so as to subsequently guide the definition of the medium-long term vision of the Strategy (*Il posizionamento Italiano rispetto ai 17 Obiettivi per lo Sviluppo sostenibile delle Nazioni Unite*, 2017).

The satisfaction of the 17 UN SDGs is the key to achieve a social and economic status that guarantees a high level of well-being for all the populations of the world. For this reason, measuring well-being represents, however, a considerable challenge. First, because well-being is multidimensional, as living a good life depends on many factors. Secondly, because comparing well-being across countries requires defining common metrics for a set of dimensions, not an easy task given that culture and institutional contexts may influence these dimensions. Third, because a comparative assessment of well-being requires a large amount of comparable data in many domains and existing indicators are often far from ideal.

The linkage between UN SDGs and wellbeing, expressed by OCSE Indexes, permits to understand the opportunities and the weaknesses of a territory in order to pursue the goal of finding a developing target and a resilient capacity using own resources. This leads to get a close relation between wellbeing and site management and governance using a coherent and participated system.

As shown in Figure 2, the proposed process related to a disaster that can strike a site with a considerable quantity of cultural heritage depends from several factors, and it has several phases first, during and after the event. Also, there are four cornerstones of Disaster Risk Reduction, Governance and Management: public policy actions, safer construction and urban planning, community participation and a culture of prevention, that all converge to the risk reduction and better governance and management of the territories.

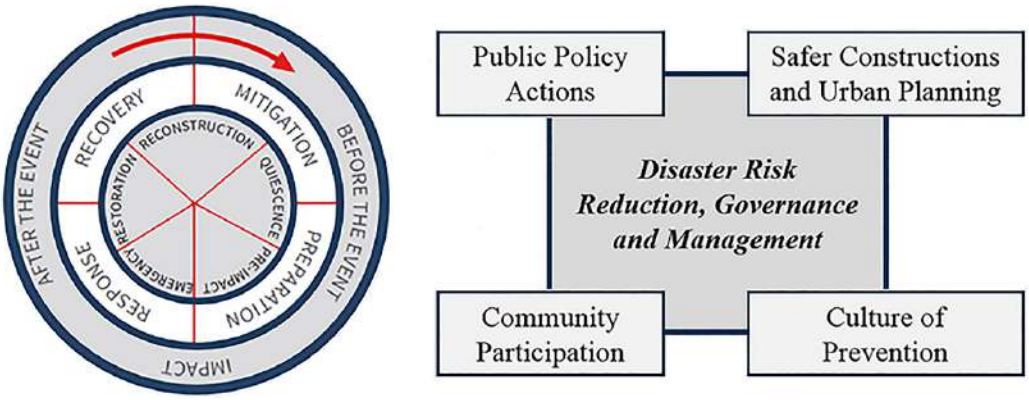


Figure 2. Disaster Risk Reduction, Governance and Management process and its principal cornerstones.

For this reason, the information of public and local communities about the risks to Cultural Heritage and the need for investment in management plans protecting heritage from natural disasters can create an active constituency to support preventive measures.

The proposal of this work is based on the creation of an integrated framework, which has as its primary objective specific training aimed at drilling and sensitising various stakeholders on the issues of multi-scale risk governance and management of multi-labels areas such as those of Cilento National Park and the Amalfi coast.

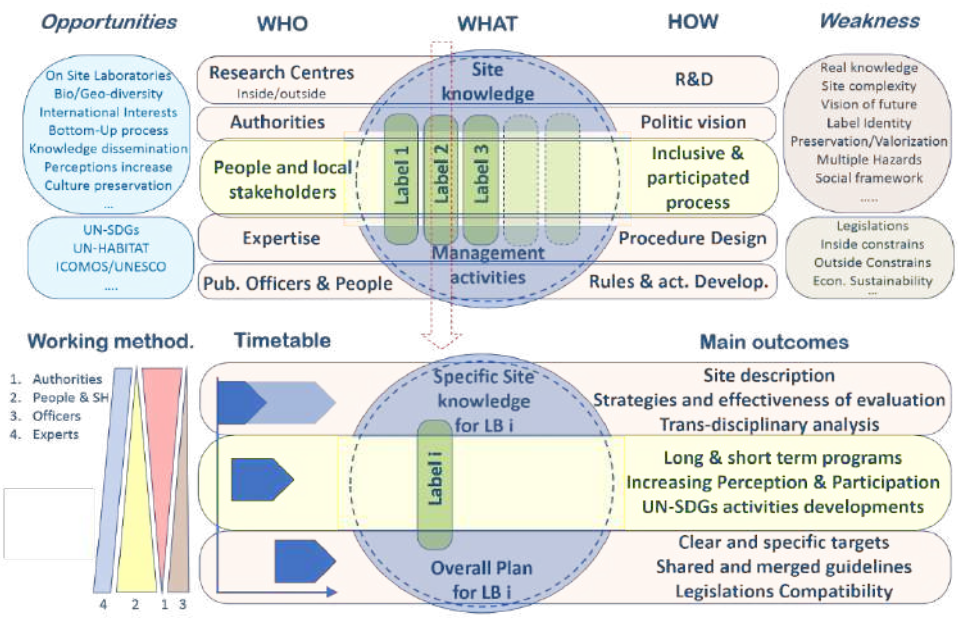
The approach sees the training of the employees of the autonomous bodies of the above-mentioned sites, of the employees of the technical and administrative offices of regional, provincial and municipal bodies, but at the same time also the local communities, through the creation of a web platform with which everyone can interact at any time. What we propose to achieve is, therefore, a real *digital agenda*, based on the connection between opportunities-weaknesses of a territory and wellbeing, which has the power to provide essential tools to the various stakeholders regarding the risk governance and management of the sites. In this way, a standardised and unique system would be created that would allow citizens a facilitated interaction with the body in charge of their needs, in a *smart city* system.

It also proposes the formation of a digital branch of the activities with which the autonomous bodies that manage sites with multi-labels of very complex areas can respond directly to the needs of citizens, for example on the feasibility of a project, a request of a building permit, an authorisation. The web platform is the core tool to ensure effective communication between local communities and stakeholders. It will provide all people and the broader audience (policymakers, experts, practitioners) with a valuable tool for knowledge building and sharing. The website will be highly interactive, functioning both as a medium for engagement with cultural heritage and risk management good practice and experience and tool for the downloading and uploading of documents and data. The website will function as a repository, where all reports and open access publications associated with the transparent activities of the public body can be downloaded.

In this way, the bureaucratic system that afflicts, not a little, the fluidity of governance and management of this territory, particularly about natural and man-induced risks that put the enormous quantity of goods at serious risk, could be significantly reduced.

In Figure 3 an innovative working model for integrated management plan of multi-labels sites, such as the two case studies presented in this work, is shown. It foresees the application of management guidelines at several levels, from the knowledge of the territory with an inclusive and participated process based on several factors (opportunities, weaknesses and wellbeing) to the training and involvement of several stakeholders.

Figure 3. Innovative working model for Integrated Management Plan for UNESCO multi label sites (L. Petti, LACE Lab 2018).



3. Application of the proposed procedure to two Italian case study sites.

As part of the present study, the territories of the Cilento National Park and the Amalfi Coast were analyzed, showing what are the resources, the urban planning and development patterns characteristic of the territory and, at the same time, an accurate analysis of the risks present in these areas of high historical, artistic, cultural and landscape value, highlighting the critical aspects.

The main critical issues, found in the territories included in the above-mentioned UNESCO sites, are closely related to the geomorphology that characterizes them and their subsequent anthropization, ranging from the saturation of urban surfaces and the problems inherent in erosion coastal areas, the stability of the terracing, the hydraulic hazard and risk, floods, landslide, forestal hazard and seismic risk.

After an analysis study conducted and deepened through the methodologies typical of large area studies, for the entire territory that embraces the sites under study, maps have been processed at different scale of detail, georeferenced in *GIS*, highlighting the many resources of the territories and, at the same time, the main problems encountered.

On the one hand, the Cilento National Park, being a vast territory rich in natural landscapes and cultural heritage, is a case study of particular interest as there are many hazards on the territory. Among the critical issues that emerged from the study carried out, there is mainly the hydrogeological risk, with points of high danger from landslides and floods, even near archaeological sites of tourist attraction. No less relevant are the forest risk (arson and negligent fires) mainly in the summer period, the receding of the coastal strip and erosion and, finally, the seismicity of the area falling into an area that is classified as medium-low seismicity (Figures 4 and 5).

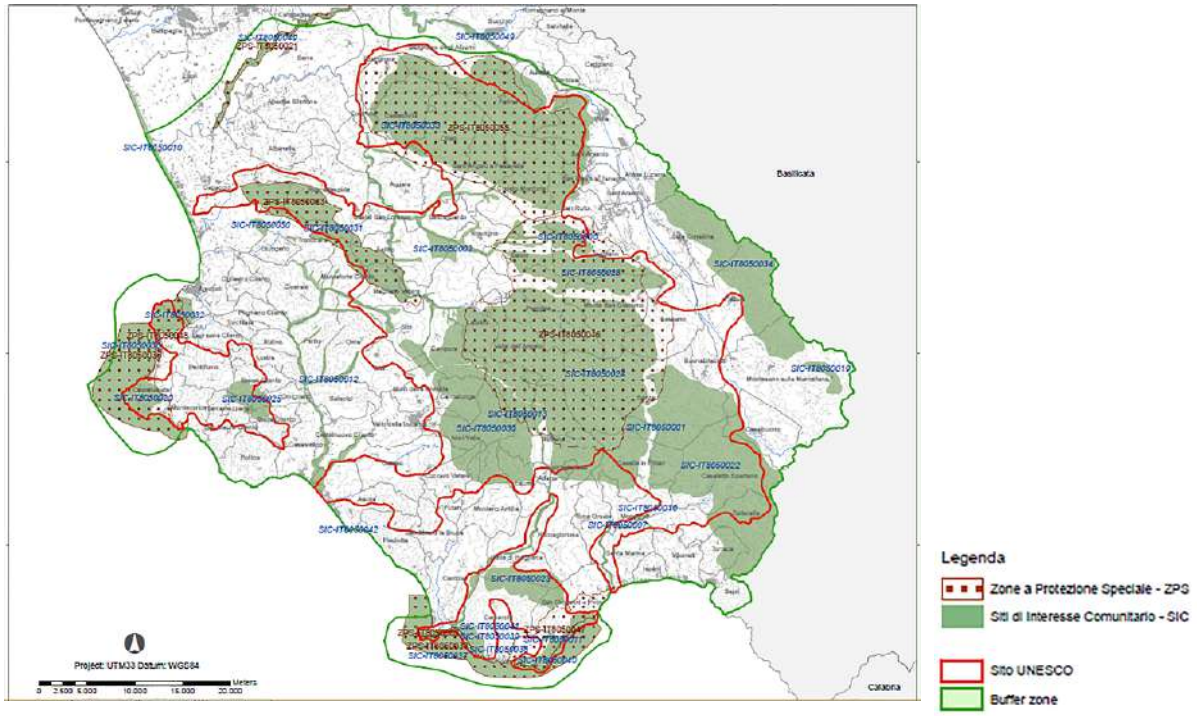


Figure 4. Cilento National Park, Natura 2000 network.

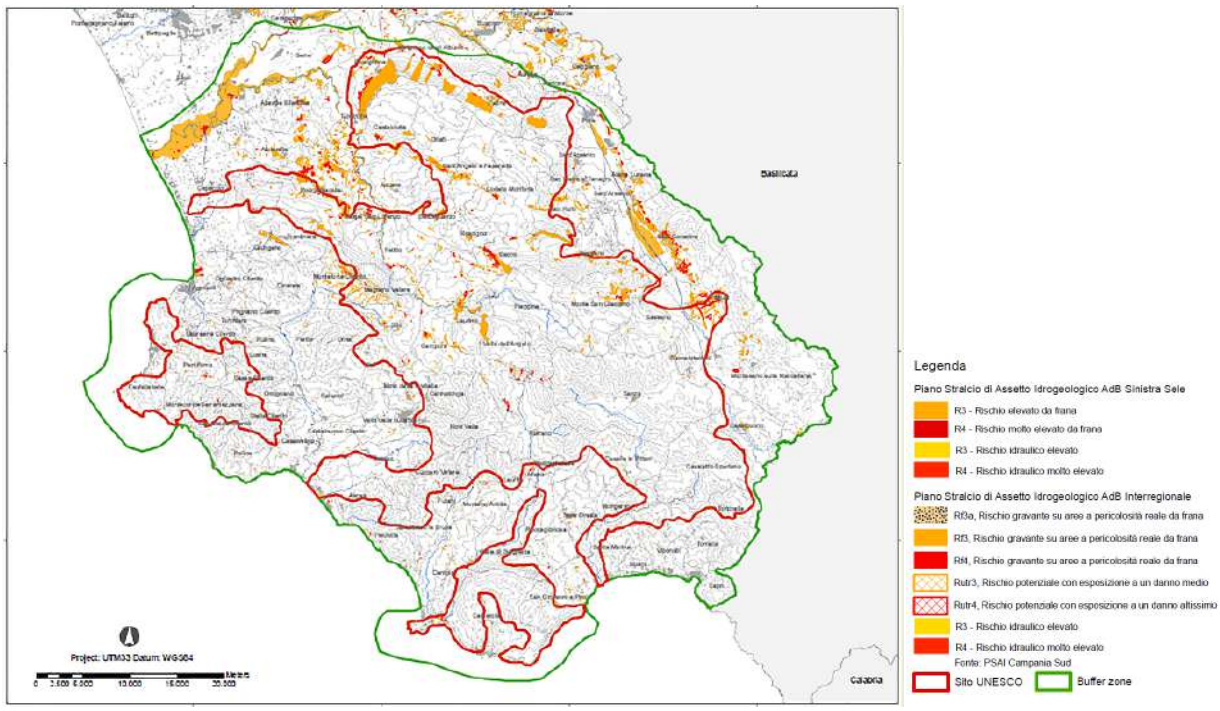


Figure 5. Cilento National Park, landslide and hydraulic risks.

On the other hand, the case study of the Amalfi Coast, the critical issues that have emerged mainly concern the saturation of the urbanized surface, particularly for the municipalities facing the sea such as those of Cetara, Maiori, Minori, Amalfi and Positano, the variation of the coastline with a shoreline recession due to the construction of port and floods that have constantly occurred over the years, the precarious stability of the terraces built to soften the steep slopes of the slopes, the landslide of the territory that manifests itself through rapid mudslides and collapses and, finally, the seismicity of the area, which, as for the area of the Cilento National Park, is classified as medium-low seismicity (Figures 6 and 7).

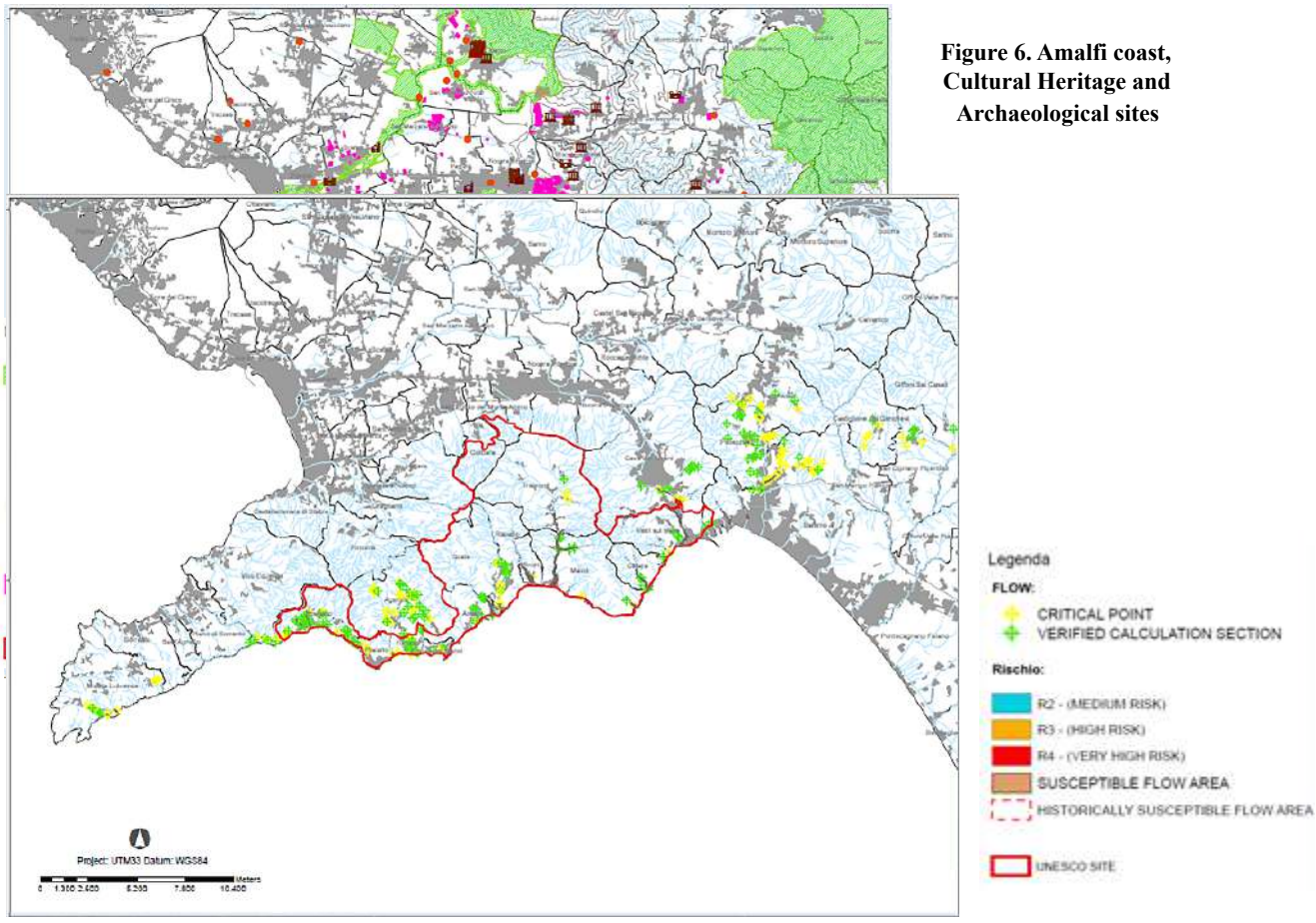


Figure 6. Amalfi coast, Cultural Heritage and Archaeological sites

Figure 7. Amalfi coast, debris flow risk.

Applying the reading of the sites evaluated above, an interpretation of the risks (natural or human-induced) is obtained, which is fundamental for improving and strengthening the risk governance and management of complex sites as the two case studies analysed in this work (Table 2).

To summarize, starting from the compared understanding of the UN SDGs and OCSE Better Life Index referring to cultural heritage complex sites such as the Cilento National Park and the Amalfi coast and then analyzing these territories using a georeferenced and multi-disciplinary approach, this work leads to better evaluate the core of the matter in term of governance and management of complex sites.

Table 2: Application of the proposed procedure to two Italian case study sites.

Analysis elements	Cilento National Park (Site 1) (2014 UNESCO periodic report)	Amalfi coast (Site 2) (2014 UNESCO periodic report)	Risk	
			Site 1	Site 2
Housing	3.1.1 - 3.7	3.11.2 / 3.11.3 3.11.6	HI	HI
Income	-	-	HI / N	HI / N
Jobs	3.2.1 / 3.2.3 / 3.3.4 3.5.1	-	HI / N	HI / N
Community	3.8.4 / 3.8.6	3.3.3	HI	HI
Education	-	-	HI	HI
Environment	3.10.2 / 3.10.6 / 3.11.4 3.11.5 / 3.11.6 / 3.12 3.12.5	3.3 / 3.10.2 3.11.2 / 3.11.3 3.11.6	N / HI	N / HI
Civic engagement	-	-	HI	HI
Health	3.4.5 / 3.8.4 / 3.8.6 3.10.2 / 3.10.6 / 3.11.4 3.11.6 / 3.12	3.10.2 / 3.11.2 3.11.3 / 3.11.6	N / HI	N / HI
Life satisfaction	3.3 / 3.3.1 / 3.3.4 3.6.4	3.3.3 / 3.9.1 / 3.10	HI / N	HI / N
Safety	-	3.9.1	HI	HI
Work-life balance	-	-	N / HI	N / HI

LEGEND

3.1.1 Housing
3.2 Transportation Infrastructure
3.3.1 Ground transport infrastructure
3.2.3 Marine transport infrastructure
3.3 Services Infrastructures
3.3.1 Water infrastructure
3.3.4 Localised utilities
3.4.5 Solid waste
3.5.1 Fishing/collecting aquatic resources
3.6.4 Water (extraction)
3.7 Local conditions affecting physical fabric
3.7.1 Wind
3.7.6 Water (rain/water table)
3.8.4 Changes in traditional ways of life and knowledge system
3.8.6 Impacts of tourism / visitor / recreation
3.9.1 Illegal activities
3.10.2 Flooding
3.10.6 Temperature change
3.11.2 Earthquake
3.11.4 Avalanche / landslide
3.11.5 Erosion and siltation / deposition
3.11.6 Fire (wildfires)
3.12 Invasive / alien species or hyper-abundant species
3.12.5 Hyper-abundant species

4. Conclusions

Reading a territory linking UN SDGs and wellbeing from OCSE Index could give important instruments for the management and the economy of a site, helping the understanding of present and future trends regarding complex sites as the case studies analyzed in the present paper.

The present work has shown how an innovative approach, to strength governance and management of complex and wide multi-hazards territories, can be developed, describing a new way of reading that complement

the UN SDGs and OCSE Better Life Index referring to cultural heritage complex sites such as the Cilento National Park and the Amalfi coast, both located in Southern Italy.

In conclusion, it could principally give an improvement of the knowledge of the hazards and train people to better estimate risks and then better reduce them, to govern and manage these areas for the better.

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Mapping the path to more resilient food supply chains: a novel approach to bespoke vulnerability identification

Jamie Stone [a,*], Shahin Rahimifard [a]

[a] Loughborough University, UK

Abstract

The highly international nature of many modern supply networks increases the number of links involved and thus increases exposure to disruption in increasingly volatile operating environments. Food supply networks face additional challenges due to the limited shelf life of food and the myriad factors that can influence the quality and quantity of agricultural yields. Resilience is therefore of paramount importance and a key first step in achieving this is the accurate identification of vulnerabilities. However, traditional risk management approaches typically rely upon historical likelihoods of occurrence and consequences of a disruption. This may not be accurate in today's more volatile operating environments where vulnerabilities are less likely to have been encountered previously. In response, this paper uses a thorough review of the literature to identify the metrics that are important in determining the exposure of companies within food supply networks. These are developed into a novel real-time food sector specific vulnerability mapping tool, which is then validated in two case studies with comparable food and drink manufacturers. Results emphasise the ability of the mapping procedure to identify vulnerabilities that are highly company specific and show that these are consistent when compared to companies in similar supply chain situations.

Keywords: Supply chain resilience, vulnerability, food security, supply chain management.

1. Introduction

It is increasingly accepted that supply chains in all forms face increasing volatility across a range of business parameters from energy cost, to competition for raw materials (Bellemare, 2015; Christopher and Holweg, 2017). Food Supply Chains not only share these general risks, but also face their own unique vulnerabilities due to the limited shelf life of food and the myriad factors that can influence the quality and quantity of agricultural yields. Clearly there is a need for food supply chains to become more resilient. This requires the accurate identification of specific vulnerabilities that make a given actor in a supply chain (i.e. a company) susceptible to disruption. Only then can mitigating capabilities be assigned in a way that is both adequate to deal with the threat faced and proportional in terms of any negative side effects associated with the resilience capability chosen. However, traditional risk management approaches typically rely upon historical likelihoods of occurrence and consequences of impact rather than real time mapping. This presents a challenge in contemporary volatile food supply chains where vulnerabilities are less likely to have been encountered previously.

In response, the aim of this paper is to present a novel, real-time mapping procedure that different actors within a food supply network can use to identify their bespoke vulnerabilities. This aim is facilitated by three objectives:

- To identify the indicators that a company would use in a mapping process to evaluate their supply chain.
- To identify under what circumstances the aforementioned indicators would suggest risk of a failure mode and to categorize what these failure modes are.
- To identify what causal underlying vulnerabilities may lead to each failure mode.

* Corresponding author. E-mail address: j.stone@lboro.ac.uk

2. Methodology

This research is based on a thorough review of the literature which is then used in the development of a novel conceptual mapping procedure for identifying bespoke supply network vulnerabilities. The review was performed in June 2018 and consisted of the search strings presented in Table 1 applied to the following databases: Google Scholar, Web of Science, Emerald and Scopus. Each primary phrase was applied in combination with each of the secondary phrases respectively. Only peer reviewed articles were included so as to maximise reliability. Articles were not restricted by date. Whilst not intended to be systematic, this approach was felt to be sufficiently broad and once non-English language articles and duplicates were excluded, the final review size equalled 36 articles. The mapping procedure developed based on the review findings is then evaluated and improved via two interview based empirical case studies in the chilled convenience food sector.

Table 1: Search strings used to identify key components involved in the identification of supply network vulnerability.

Primary Phrases	Secondary Phases
Food Supply Chain	Risk/Risk Management, OR Vulnerability, OR Volatility, OR Security, OR Business Continuity, OR Disruption, OR Resilience
Food Supply Network	
Food Value Chain	

3. Review Findings and Model Development

At its simplest, dictionary definition, vulnerability refers to the risk of something being 'lost' or damaged'(Christopher and Peck, 2004). In a supply chain context however, a number of variations on this basic definition can be found. Some focus on 'exposure' to disturbances (Svensson, 2002; Jüttner, 2005; Stecke and Kumar, 2009), others explore the 'consequences' of disturbances (for example, in terms of fluctuations in the values of key performance indicators) (Tang, 2006; Vlajic *et al.*, 2013) and others still the ability of a supply chain to collectively react to disturbances (Godfray *et al.*, 2010; Brandon−Jones *et al.*, 2014). In line with Palovita et al. (2016), the author of this paper considers all three aspects of vulnerability to be important in food supply chains where vulnerability can stem from multiple stressors including environmental and social sources (Paloviita *et al.*, 2016). This contrasts with the concept of risk, which concerns the likelihood of occurrence and mechanism of impact (Ritchie and Brindley, 2007; Soni and Kodali, 2013). This, in the authors opinion, makes vulnerability a much more appropriate target for food supply chain resilience strategies, given the conditions of volatility and uncertainty, where disruptions are less likely to have been previously observed and likelihood/ consequence pathways are therefore harder to accurately calculate (Christopher and Holweg, 2017).

As a result, any attempt to identify actual vulnerabilities must rely not on analysis of historical risk scenarios, but on actual exposure metrics that provide a snap shot of the current supply chain. The review identified that whilst it is common for food supply chains to be depicted as a linear series of value adding steps from primary production to customers, in reality, each step will have their own suppliers and dependencies for packaging, utilities, infrastructure and governance. To capture this complexity, a number of metrics were identified in the review, including the nature of the entities in the supply network (Christopher and Peck, 2004; Burch and Lawrence, 2005), the specifications of the materials in the supply network (Carvalho *et al.*, 2012), the way in which those materials move across a supply network (Aramyan and Kuiper, 2009; Greening and Rutherford, 2011), the movement of supporting information (Richey *et al.*, 2009; Jüttner and Maklan, 2011), and finally, the relations between the different entities in a supply network(Pettit, Croxton and Fiksel, 2013; Vlajic *et al.*, 2013). These are detailed in Table 2.

The exposure metrics displayed in Table 2 can be used to identify the situation in which a company's exposure to disruption is at its highest, something which this paper will now refer to as a 'high priority exposure metric'. For example, a raw material might be a high priority exposure metric if it showed a long production time (thus hindering a supplier's flexibility to ramp up production unexpectedly) or if it was highly restricted in where it could be grown (reducing ability to find alternative suppliers in the event of one going out of business). These 'high priority exposure metrics' are listed in Table 3 (Van Der Vorst, 2006; Vlajic, der Vorst and Hendrix, 2010; Greening and Rutherford, 2011; Wilding et al., 2012; Perera, Bell and Bliemer, 2015)

Table 2: Supply network vulnerability exposure metrics

Class	Object	Metrics for each object
Primary entities	Immediate Suppliers, Internal Assets and Immediate Customers.	a) Total number of each type. b) Geographic location(s). c) Number of sites for each. d) Level of auditing.
Secondary entities	Suppliers of suppliers, customers of customers, government, NGO's, 3rd party logistics, utilities	a) Numbers. b) Geographic location(s). c) Alternative entities that could match product specifications.
Input criticality	Raw material, energy, water	a) Location of origin. b) Growing constrictions (if applicable). c) Inbound lead time (if applicable). d) Value chain reserves (if applicable). e) Value chain alternatives (if applicable). e) Supplier capacity to alter supply volumes. f) Peak capacity of supplier.
Material flow	Inbound materials, internal movement of goods, outbound movement of goods	a) Transport type. b) Volume. c) Frequency. d) Transport route. e) Presence of alternative types of transport and routes.
Information flow	Supplier, utilities, logistics and customer communications	a) Information type. b) Information route. c) Information frequency.
Relational links	Horizontal, vertically integrated and supply network relationships	a) Level of adversity. b) Interdependence. c) Level of collaboration.

Table 3: Conditions under which the supply network exposure metrics become 'high priority'

Class	Metric	High Priority Exposure If:
Supply chain entity	Primary entity:	• **PE1**: Geographically clustered. • **PE2**: High number of long distance suppliers/customers. Amplified when volumes are low and /or complexity of product is high. • **PE3**: Limited alternative suppliers which could fit product specification. • **PE4**: Absence of sister sites which could take over production/supply /staff/ equipment in a disruption situation. • **PE5:** Inflexible production characteristics that limit ability to change production capacity at short notice.
	Secondary entity:	• **SE1:** Geographically restricted secondary suppliers. • **SE2:** Limited auditing of secondary suppliers. • **SE3:** Highly specific product with few alternative suppliers. • **SE4:** Limited/inflexible supplier peak capacity. • **SE5**: Political instability/inconsistency. • **SE6:** High levels of corruption.
Input criticality	Criticality of raw materials, energy, and water	• **IC1:** Long production timescale. • **IC2:** Tight geographic restrictions on supply.
Material flow	Inbound, internal and outbound flow of goods	• **MF1:** High frequency deliveries using singular transport mode and route with limited ability to switch. • **MF2:** Heavy reliance on network utility supplies with little private capacity (such as generators).
Information flow	Communication between a company and all of its supply chain entities	• **IF1**: Lack of communications integration/protocols between teams. • **IF2**: Communication routes susceptible to disruption (i.e. single phone line in region prone to strong weather).
Relational links	Relationships between a company and all of its supply chain entities	• **RL1**: Buying-selling relationship where interdependence is high and adversity is particularly high, or collaboration is particularly low. • **RL2:** Long term partnership where there is a strong power imbalance in favour of one party. • **RL3**: Vertical partners are closely integrated on product specifications yet supply each other under circumstances of high competition leading to the risk of monopolisation.

However, for each high priority exposure metric there may still be many causal 'vulnerabilities' which could result in a disruption. For example, for the high priority exposure metric of 'Limited alternative suppliers which could fit product specification', the vulnerabilities which could lead to a shortage in supply include anything from extreme weather to labour shortages or export restrictions. However, by selecting only the failure modes that are relevant to a given company, i.e. the major mechanisms that could halt company functionality, the list of significant vulnerabilities faced is reduced. Using the previous example, the restricted supply bases might be heavily automated with production occurring in controlled environments, thus the actual failure mode of a raw material shortage might be much lower than would be expected. Failure Modes facing the food and drink industry are suggested in Table 4 (Lambert, Cooper and Pagh, 1998; Brand and Jax, 2007; Moser, Raffaelli and Thilmany-McFadden, 2011; Baker and Morgan, 2012; Tassou Bsc *et al.*, 2014). Based on the excellent work of Carvalho et al. 2012 in addition to the authors own knowledge, the high priority exposure metrics can be provisionally linked to Failure Modes, as shown in the relational matrix in Table 5 (Carvalho *et al.*, 2012).

Table 4: Food-supply-network failure modes.

Failure Mode	Description/Characteristics
FM1: Raw Material Shortage	All manner of upstream disruptions which limit raw material availability to the company of interest.
FM2: Raw Material Sub-Standard Quality	All manner of upstream disruptions, which, whilst not necessarily halting raw material supply, significantly affect the quality of raw materials received (e.g. size and credence factors).
FM3: Unable to produce/ Scrap/Rework	Specific to food manufacturers, occurs when a product is unable to move beyond the production line, whether because production could not be attempted in the first place, because the final product needed to be reworked, or because the finished was only fit for scrappage.
FM4: Labour Shortage	Refers to any factor(s) which limit labour availability.
FM5: Loss of process economic viability	Factors leading to a particular process becoming commercially untenable for the company in question. Examples include raw materials not being profitable, wider market saturation or evolving consumer trends.
FM6: Loss of Site	Refers to any number of disruptions which either prevent or severely hinder operations at a particular site (e.g. farm, plant, depot, shop etc).
FM7: Unable to Deliver	Goods are finished to specification but are prevented from being sold by various internal or downstream disruptions that prevent packing, loading or delivery.
FM8: Legally enforced cessation of operations	Situations which could result in a regulatory body forcing certain supply chain activities to cease, likely in response to major legislative violations, for example, environmental breaches, significant health and safety concerns, or major incidents of food contamination.
FM9: Sub-Standard Product Quality	Any disruptions which, whilst not forcing a scrap/rework, do impact on the final quality and may result in concessionary rates or penalties being applied by the customer.
FM10: Product Recall	This failure mode refers to any disruption(s) which result in food either being rejected at the retailer depot, or food which has made it onto retailer shelves or consumers' homes, being recalled.

Table 5: Relational links between high priority exposure metrics and failure modes

High-priority exposure metric	Failure modes									
	FM1	FM2	FM3	FM4	FM5	FM6	FM7	FM8	FM9	FM10
PE1	X	X			X					
PE2	X	X			X					
PE3	X	X			X					
PE4			X		X	X			X	
PE5			X		X	X			X	
SE1	X	X			X					
SE2	X	X			X					X
SE3	X	X			X					
SE4			X		X			X	X	
SE5	X		X	X						
SE6	X				X					
IC1	X	X								
IC2	X	X			X					
MF1	X	X	X							
MF2		X	X			X			X	X
IF1	X	X	X	X			X		X	
IF2			X				X		X	X
RL1	X	X	X		X					
RL2					X					X
RL3					X					

Each Failure mode can then be linked to underlying causal vulnerabilities using literature observations and the authors own knowledge applied via Ishikawa diagrams (Peck, 2005; Elleuch *et al.*, 2016) (See Table 6). In summary, this mapping procedure allows a food company to identify priority exposure points in their unique supply network, establish likely failure modes and from there, deduce which causal vulnerability (s) they should focus resilience efforts on.

Table 6: Relationships between food supply network failure modes and underlying causal vulnerabilities

Failure mode	Potential causal vulnerabilities		
	Internal vulnerability	**Value chain vulnerability**	**Supply network vulnerability**
FM1: Raw Material Shortage	1. Challenges related to storing raw materials/finished inventory. 2. Inaccurate forecasting. 3. Breakdowns in internal information handling. 4. Absence of early warning detection systems.	1. Poor reliability of external logistics providers. 2. Lack of established, integrated information sharing infrastructure.	1. Variability in availability of raw materials. 2. Political instability. 3. Import/export restrictions. 4. Industrial actions. 5. Natural disasters. 6. Biological factors
FM2: Raw Material Sub-Standard Quality	1. Absence of early warning detection systems. 2. Challenges related to storing raw materials/finished inventory.	1. Deliberate withholding of information.	1. Variability in quality/heterogeneity of raw materials. 2. Natural disasters. 3. Biological factors.
FM3: Unable to produce/ Scrap/Rework	1. Challenges related to storing raw materials/finished inventory. 2. Inaccurate forecasting. 3. Breakdowns in information handling.	1. Lack of established, integrated information sharing infrastructure. 2. Deliberate withholding of information.	1. Changes in Public Food Policy. 2. Private Food Policy. 3. Disruption to transport infrastructure. 4. Disruption to water infrastructure. 5. Disruption to communications. 6. Workforce health. 7. Criminal acts.
FM4: Labour Shortage	1. Inaccurate forecasting. 2. Absence of early warning detection systems.	N/A.	1. Disruption to transport infrastructure. 2. Disruption to energy infrastructure. 3. Workforce health. 4. Industrial actions.
FM5: Loss of process economic viability	1. Poor protection of intellectual property.	1. Poor financial robustness of value chain partners. 2. High concentration in supply chains. 3. High levels of power imbalance between actors.	1. Market price fluctuation. 2. Market decline. 3. Competitor undercutting. 4. Changes in Public Food Policy. 5. Import/export restrictions. 6. Conflict, piracy and terrorism. 7. Changing consumer trends.
FM6: Loss of Site	1. Absence of, or ineffective Business Continuity Planning.	N/A.	1. Criminal acts. 2. Natural disasters.
FM7: Unable to Deliver	1. Breech in information/data security. 2. Breakdowns in internal information handling.	1. Poor reliability of external logistics providers.	1. Disruption to transport infrastructure. 2. Disruption to energy infrastructure 3. Disruption to communications. 4. Criminal acts.
FM8: Legally enforced cessation of specific operations	1. Product failure to comply with environmental legislation. 2. Product failure to comply with Health and Safety Legislation.	N/A	N/A
FM9: Sub-Standard Product Quality	1. Challenges related to storing raw materials/finished inventory. 2. Breakdowns in internal information handling.	1. Raw material and product related hazards. 2. Deliberate withholding of information.	1. Disruption to transport infrastructure. 2. Disruption to water infrastructure. 3. Conflict, piracy and terrorism. 4. Criminal acts. 5. Biological factors.
FM10: Product Recall	1. Challenges related to storing raw materials/finished inventory.	1. Deliberate withholding of information. 2. Lack of ability to trace food across the value chain.	1. Private Food Policy. 2. Criminal acts. 3. Biological factors.

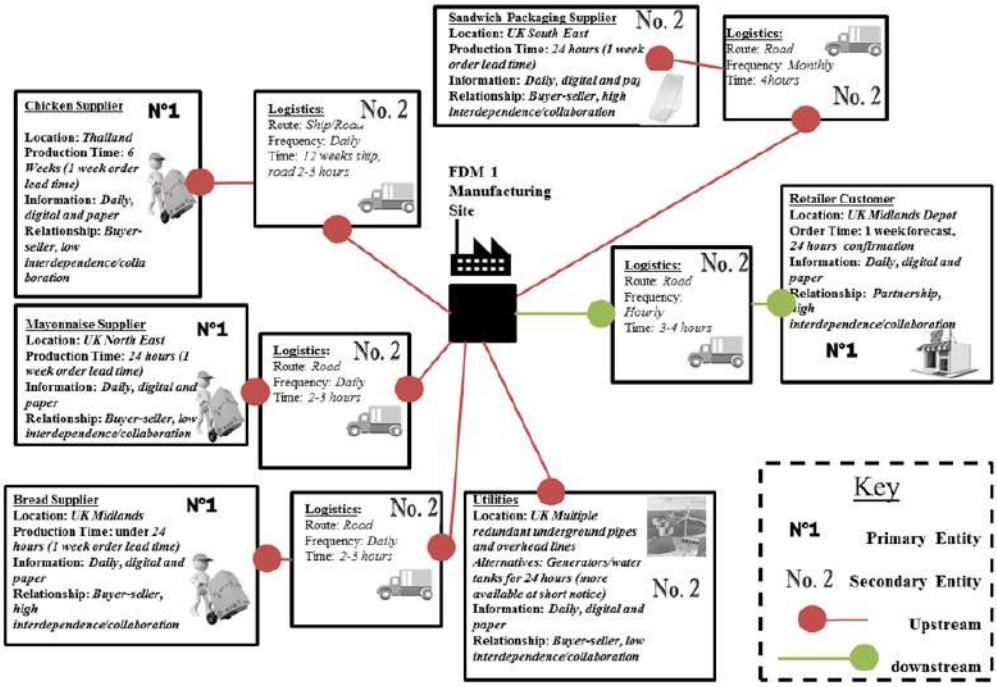
4. Case studies

Two relatively large manufacturers within the UK chilled prepared food sector were chosen to evaluate and enhance the previously described mapping process. They were selected for their direct comparable in some areas, thus enabling evaluation of the consistency of findings, and contrasts in others, thus enabling the mapping procedure to be tested in different contexts (See Table 7) (Yin, 2013). Due to the competitive nature of the sector, results had to be anonymised and the two manufacturers are referred to as FDM1 and FDM 2 respectively from now onwards.

4.1.FDM1 findings

In this case study, the exposure metrics in Table 2 were applied to the supply network of a chicken salad sandwich line supplied by FDM1 to five major retailers (see Figure 1).

Table 7: Comparison of case study companies.



Comparison criteria	FDM1	FDM2	Level of Comparability
Product type	Chilled sandwiches, prepared meals and snacks.	Chilled sandwiches, prepared meals and snacks.	High
Company size	Large with approximately 33000 staff.	Relatively large with approximately 1,500 staff.	High
Collaboration with retailer customer(s)	High.	High.	High
Number of retailer customer(s)	Multiple retailers and caterers.	One retailer.	Low
Supplier base	Large and international.	Large and international.	High
Range of products	High range of sandwiches, snacks, meals, sauces, salads and desserts.	Focus on sandwiches and meals with a much smaller range of snacks and desserts all for one private label.	Low
Production Process	High reliance on manual labour for sandwich assembly.	High reliance on manual labour for sandwich assembly.	High
Range of Production Sites	Multiple (over ten nationwide).	Two (geographically clustered).	Low

Figure 1: Map visualising relevant exposure metrics to FDM1.

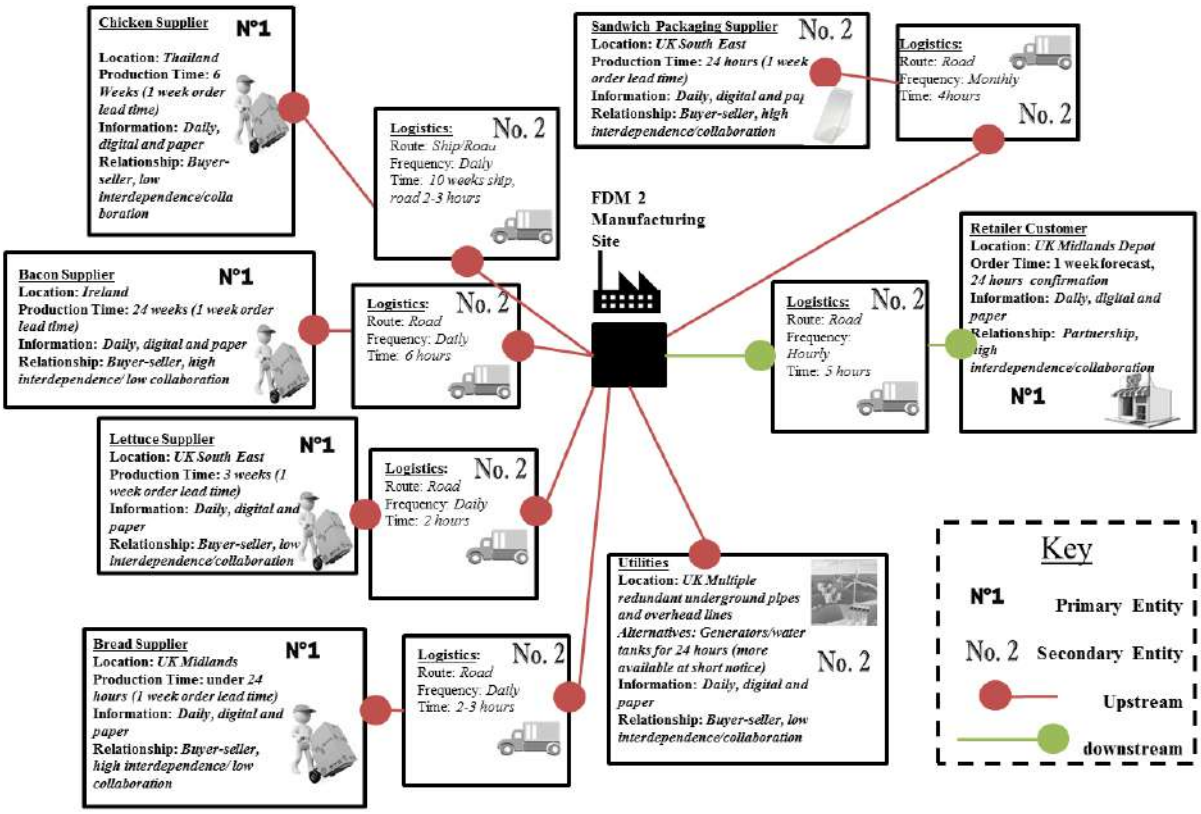
When cross referenced with the high priority exposure metrics in Table 3, five high priority exposure metrics were identified. The first concerned the primary supplier of chicken for FDM1 and the exposure metrics surrounding material flow. It was identified that the long distances involved and singular transport routes with limited alternatives, combined with the short lead time FDM1 faced in manufacturing the sandwich, made this a priority exposure point (PE2+3). This was compounded by the fact that, whilst alternate chicken suppliers meeting retailer specifications did exist, often the cooked chicken required specific flavouring which in practice, made switching supplier quickly challenging (PE5). FDM1's primary bread supplier was also identified as one of few in the UK geared up to make bread to FDM1s exact specifications and high quantities required (PE3). Equally FDM1 required incredibly frequent (hourly) deliveries which were entirely dependent on limited road routes for transport with no non- road-based alternatives (MF1).

Finally, the fact that interdependence (due to high volumes and very specific product specifications) between the bakery and FDM1 was high, but that collaboration was relatively low, meant that in the case of a major disruption, FDM1 would struggle to find alternatives (RL1). The next step was to use the identified priority exposures to highlight potential resulting failure modes via the relational matrix in Table 5. Six possible Failure Modes were identified, FM1, 2, 3, 5, 6, and 9 as shown in Table 8. For each, Table 6 in the proposed vulnerability mapping procedure provided a number of associated vulnerabilities, some of which were linked to more than one of the Failure Modes identified in the case study. As such, the vulnerabilities shown in Table 8 have been ranked according to how many of the identified Failure Modes they may lead to, with some, such as "Challenges related to storing raw materials/finished inventory" potentially leading to four different failure modes. These high ranking vulnerabilities are therefore priority targets for mitigation strategies. Using this rationale, FDM1's top vulnerabilities identified by the mapping process were "Challenges related to storing raw materials/finished inventory" and "Breakdowns in internal information handling" at an internal level and "Deliberate withholding of information" at a value-chain level.

Table 8: Failure modes linked to the identified priority exposure metrics and possible associated causal vulnerabilities.

Identified priority exposure metric	Associated failure mode	Linked casual vulnerabilities (ranked according to the number of failure modes they are attributed to)		
		Internal	**Value chain**	**Supply network**
PE2	FM1, FM2, FM5	4 Attributed Failure modes: • Challenges related to storing raw materials/ finished inventory. 3 Attributed Failure modes: • Breakdowns in internal information handling. 2 Attributed Failure modes: • Inaccurate forecasting. • Absence of early warning detection systems. 1 Attributed Failure modes: • Poor protection of intellectual property. • Absence of, or ineffective Business Continuity Planning.	3 Attributed Failure modes: • Deliberate withholding of information. 2 Attributed Failure modes: • Lack of established, integrated information sharing infrastructure. 1 Attributed Failure modes: • Poor reliability of external logistics providers. • Poor financial robustness of value chain partners. • High concentration in supply chains. • High levels of power imbalance between actors. • Raw material and product related hazards.	2 Attributed Failure modes: • Import/export restrictions. • Changes in Public Food Policy. • Conflict, piracy and terrorism. • Changing consumer trends. • Disruption to transport infrastructure. • Disruption to water infrastructure. • Criminal acts. 1 Attributed Failure modes: • Variability in availability of raw materials. • Political instability. • Industrial actions. • Natural disasters. • Biological factors. • Market price fluctuation. • Market decline. • Competitor undercutting. • Private Food Policy. • Disruption to communications. • Workforce health.
PE3	FM1, FM2, FM5			
PE5	FM3, FM5, FM6, FM9			
MF	FM1, FM2, FM3			
RL1	FM1, FM2, FM3, FM5			

4.2.FDM2 findings



In this second case study, the mapping procedure was again applied to the supply network of a specific sandwich line, but this time, a Chicken Bacon and Lettuce Sandwich which was supplied to just a single retailer.

The exposure metrics related to this sandwich line were mapped out in a similar way as for FDM1 with the results being displayed in Figure 2. When cross referenced with the high priority exposure metrics in Table 3, six high priority exposure metrics were identified. The first three high priority exposures were very similar to FDM1. For example, the very specific nature and high volumes required of the bread products to match FDM2's own specifications, meant that there were very few possible alternatives (PE3). Additionally, the multiple daily deliveries were highly susceptible to road disruption (MF1). Finally, the fact that interdependence (due to high volumes and very specific product specifications) with the supplier was high, but collaboration was relatively low, meant that in the case of a major disruption such as a major bakery fire, FDM2 would struggle to find alternatives (RL1). However, the slightly different ingredients involved in the sandwich also led to very different high priority exposures compared to FDM1. The presence of bacon in the sandwiches, which as a raw material takes approximately, 24 weeks to produce, means that it is difficult for the supplier to increase supply significantly at short notice (IC1). The lettuce suppliers were also a concern because of their tight geographic clustering, particularly in Spain where lettuce is grown in the open and as such is particularly susceptible to bad weather and/or pest infestations (PE1). The final high priority exposure was agency staff and their willingness to come to the UK with the anticipated British departure from the European Union (SE5).

The next step was to use the identified priority exposures to highlight potential resulting failure modes via the relational matrix in Table 5. Four possible Failure Modes were identified, FM1, 2, 3 and 5 as shown in Table 9. As before, vulnerabilities proposed by the vulnerability mapping procedure are ranked according to how many of the identified Failure Modes they may lead to. In this way, FDM2's top vulnerability identified by the mapping process were "Challenges related to storing raw materials/finished inventory" However, nine other vulnerabilities relating to internal information handling, forecasting and early warning, value-chain information sharing and deliberate withholding of information, and supply network import/export restrictions, public food policy, natural disasters and biological factors (such as pests and diseases) were all important.

Figure 2: Map visualising relevant exposure metrics to FDM2.

Table 9: Failure modes linked to the identified priority exposure metrics and possible associated causal vulnerabilities.

Identified priority exposure metric	Associated failure mode	Linked casual vulnerabilities (ranked according to the number of failure modes they are attributed to)		
		Internal	**Value chain**	**Supply network**
PE1	FM1, FM2, FM5	3 Attributed Failure modes: • Challenges related to storing raw materials/finished inventory. 2 Attributed Failure modes: • Breakdowns in internal information handling. • Inaccurate forecasting. • Absence of early warning detection systems. 1 Attributed Failure modes: • Poor protection of intellectual property.	2 Attributed Failure modes: • Lack of established, integrated information sharing infrastructure. • Deliberate withholding of information. 1 Attributed Failure modes: • Poor reliability of external logistics providers. • Poor financial robustness of value chain partners. • High concentration in supply chains. • High levels of power imbalance between actors.	2 Attributed Failure modes: • Import/export restrictions. • Changes in Public Food Policy • Natural disasters. • Biological factors. 1 Attributed Failure modes: • Conflict, piracy and terrorism. • Changing consumer trends. • Disruption to transport infrastructure. • Disruption to water infrastructure. • Criminal acts. • Variability in availability of raw materials. • Political instability. • Industrial actions. • Market price fluctuation. • Market decline. • Competitor undercutting. • Private Food Policy. • Disruption to communications. • Workforce health.
PE3	FM1, FM2, FM5			
SE5	FM1, FM2, FM3			
MF1	FM1, FM2, FM3			
IC1	FM1, FM2			
RL1	FM1, FM2, FM3, FM5			

5. Discussion and concluding remarks

In summary the mapping procedure described allows a company to pick relevant supply network markers (exposure metrics in Table 2), identify the circumstances under which each has the highest likelihood of resulting

in a failure mode (Table 3) and what this failure mode might be (Tables 4 and 5) and from there, identify a refined list of possible causal vulnerabilities (Table 6) thus achieving the papers initial objectives. Whilst not the goal of this paper, the identification of an accurate shortlist of likely vulnerabilities is a key requisite to the design of countering resilience strategies (Pettit, Fiksel and Croxton, 2010; Stone and Rahimifard, 2018). Empirical validation of the mapping procedure identified that similarities in the two company's operations such as transport routes and the short shelf life of ingredients, resulted in raw material storage challenges and breakdowns in internal information sharing being top internal vulnerabilities for both manufacturers. Similarly, the risk of breakdowns in value-chain information sharing, possibly deliberate, was a major concern given the cost of potential recalls and the damage that might be caused to retailer relations. However, differences in company characteristics, such as the much higher labor dependency at FM2, resulted in 'political instability' being a major vulnerability where this was not the case for FDM1. This indicates that the mapping procedure is not only consistent but adaptable to different contexts, suggesting that it could feasibly be expanded to cover different supply chain stages next (i.e. agriculture and retail). However, it must be stressed that the current case studies are too small in number to be truly representative of all different actors within a food supply network and the mapping procedure would benefit from further empirical validation to develop the taxonomies of exposure metrics, failure modes and vulnerabilities.

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Critical institutional capacities to strengthen downstream multi-hazard early-warning risk communication in rapid onset hydrometeorological and geophysical hazards: the case of the Philippines

Elirozz Carlie Labaria [a, b, *], Charlotte Kendra Gotangco [b, c], Jairus Carmela Josol [c]

[a] *Manila Observatory, Philippines*
[b] *Ateneo Institute for Sustainability, Philippines*
[c] *Ateneo de Manila University, Philippines*

Abstract

This case study on the Philippines investigates the critical institutional capacity needs of its downstream multi-hazard early-warning system, particularly on risk communication for hydro-meteorological and geophysical hazards. The legal and policy environment and coordination mechanism capacity dimensions were assessed. Among the most critical needs identified are: the completion of the National Prevention and Mitigation Plan to guide the establishment and operation of national and local early warning systems, and wider practice of 'organizational translation' of risk information to improve the coordination mechanism.

Keywords: early-warning systems; disaster risk governance; disaster risk communication.

1. Introduction

A country's institutional architecture significantly influences risk governance. Zuo et al (2017) presented empirical evidence that government effectiveness is the most powerful indicator for risk governance versus other dimensions, concluding that improving administrative effectiveness (both at the centralized/national and local levels) should be prioritized to improve efficiency of risk governance. Furthermore, "high-quality" institutions have been linked to fewer casualties from disasters triggered by natural hazards (Kahn, 2005). However, by what criteria can institutional capacities, whether national or local, be evaluated as "high quality" or "effective"? One factor identified in literature is the legal and policy environment, as major losses from disasters have been attributed to inappropriate policies. An IFRC and UNDP (2014) multi-country report demonstrates how law and regulation support disaster risk reduction by providing the country a strong institutional basis for implementation of its strategies. Pal et al. (2017) also observed that governments' machine bureaucracy for disaster management are usually standardized organizations (from central to local levels). Therefore, the effectiveness of the institution cannot be gleaned from just the structure but in another key factor, the coordinating mechanism. The government crisis management system should be adaptive and uphold its capacities in cognition, communication, coordination, and control (Pal et al., 2017).

The current study considers these factors – the legal and policy environment, and the coordinating mechanisms – towards strengthening institutional capacities by investigating the case of the Philippines, one of the most disaster-prone nations based on the World Risk Report 2014 (UNU-EHS, 2014), and thus among those compelled to quickly adapt in terms of risk governance. Specifically, the study analyses institutional capacities in the context of the Philippines' downstream multi-hazard early warning system (MHEWS). The risk communication pathway of the Philippines' MHEWS is designed to match the country's decentralized and devolved governance system as risk communication not only entails transmission and feedback of information, but also ultimately compels action and response from authorities to reduce the risk. Although this configuration in no way guarantees effective risk communication down to the communities in the 'last mile', it is presently the limiting element of the country's MHEWS and influences organizational routines, cultures, and resource mobilization. It is, therefore, strategic to treat the capacity of the DRRM institution as an object of inquiry.

* Corresponding author. E-mail address: carlielabs@gmail.com

2. Scope and objectives, methodology

2.1.Scope and objectives

This study investigates critical institutional capacities in the dimensions of legal & policy environment and coordination mechanism which need to be addressed to strengthen downstream risk communication in the Philippines. It discusses risk communication tools and practices, and organizational translation of risk information as capacity components of the coordination mechanism. It is limited to analyzing capacities within the multi-hazard early warning system for rapid onset hydro-meteorological and geophysical hazards.

2. Methodology

A combination of literature review, document analysis, and retrospective analysis were conducted to gather information for this study. Literature on early warning systems, good practices, and national assessments from the United Nations International Strategy for Disaster Reduction (UNISDR) and agencies like the World Meteorological Organization (WMO), as well as journal articles and case reports on disaster risk governance and risk communication, and published documents on the relevant laws, policies, plans, reports, and manuals from the Philippines government were reviewed. Retrospective analysis was applied by the authors by recalling and reflecting on information gathered from professional engagements in the DRRM sector in the Philippines, including involvements in intersectoral meetings, trainings, workshops, and interactions with government officials from various levels as well as at-risk local community members.

3. Framework

The paradigm shift from the 'disaster management' focus by the Hyogo Framework for Action (2005-2015) towards a more comprehensive 'disaster risk management' emphasized by the Sendai Framework (2015-2030) increased the attention on the aspects of preparedness and prevention rather than just response and rehabilitation. Early Warning Systems (EWS) took on prominence as a "critical live-saving tool" especially for hydrometeorological events like storms, floods, droughts (WMO, 2017). There is also a shift from hazard-specific EWS to a more efficient multi-hazard EWS (MHEWS) which allow preparedness and response for several hazards, including those that may cascade (UNISDR, 2017).

Golnaraghi (2012) makes a case for the greater integration of the operational components of EWS in planning at all levels of society in a compilation of national good practices from Bangladesh, China, Cuba, France, Germany, Japan, and the USA. From these seven good practices, ten guiding principles for successful MHEWS, regardless of political, social, and institutional factors in each country, were distilled and shown to concern the following: (1) political recognition, (2) common operational components, (3) role clarification, (4) resource allocation, (5) risk assessment, (6) appropriate warnings, (7) timely dissemination, (8) integration into response planning, (9) integration in relevant educational programmes, (10) feedback mechanisms.

This study draws its assessment framework from a selection and synthesis of the ten principles by Golnaraghi (2011). Table 1 presents the two dimensions of institutional capacity for risk communication within an EWS and corresponding indicators to serve as criteria to assess the status and identify the critical needs.

Table 1: Assessment Framework: Select Dimensions of Institutional Capacity for Risk Communication

Dimensions	Indicators
Legal & Policy Environment	Political Recognition Established Legislative & Policy Framework Development of National and Local Plans
Coordination Mechanism	Articulation of Risk Communication Chain Designation of Roles & Responsibilities Sound Risk Communication Tools and Practices

The legal & policy environment dimension looks at the following elements: (1) political recognition – the acknowledgement of the benefits of establishing EWS by the government and civil society; (2) legislative &

policy framework – the presence of body of laws and policies that mandate and support the establishment of an EWS; and (3) national & local plans – the development and implementation of plans that organize and operationalize the EWS in the different government levels. Coordination mechanism refers to the system established to align the different DRRM actors to effectively operate the EWS. In this dimension, the designation of roles and responsibilities of the different actors, and the efficiency overall risk communication chain of the government bureaucracy will be considered. Some risk communication tools and practices vital to the coordination mechanism will also be briefly examined. The discussions on these institutional capacities are in the context of downstream risk communication within the country's MHEWS. That is, what capacities does the DRRM institution need to ensure and enhance the way risk is communicated down to the last mile?

4. Discussions

4.1.Disaster Risk Reduction and management policies in the Philippines

Superseding Presidential Decree (PD) 1566 of 1978, which focused more on disaster response coordination, the Philippine DRRM Act of 2010 (Republic Act 10121) provides a "comprehensive, all-hazard, multisectoral, interagency, and community-based approach to DRRM" (Domingo & Olaguera, 2017). It established the National Disaster Risk Reduction and Management Council (NDRRMC), composed of government agencies and civil society members, housed by the Office of Civil Defense (OCD) under the Department of National Defense (DND). It mandated the crafting and implementation of the National Disaster Risk Management Framework (NDRRMF) and the National Disaster Risk Reduction Management Plan (NDRRMP) 2011-2018 which defines four thematic pillars of disaster work (preparedness, response, recovery, prevention and mitigation), and designated lead agencies for each. Along the policy evolution, DRRM implementation eventually conformed to the encompassing governance mandate of the Local Government Code (Republic Act 7160 of 1991) which espoused decentralization and promoted local autonomy, affording local government units (LGUs) more powers and resources. It is with such that the DRRM Act mandated the establishment of the DRRM offices in every province, city, and municipality, and a committee in the *barangay*, the lowest political unit. These lower offices are required to prepare localized DRRM plans. It is against this policy backdrop that we locate the institutional architecture which enables and limits the capacities for risk communication within the MHEWS.

4.2.Capacity needs: legal & policy environment

From 1970 to 2017, the Philippines experienced at least 554 occurrences of disasters, dominantly triggered by storm and flood hazards, resulting to more than 59,000 deaths and incurring damages of more than US$26 million (CRED, n.d.). The scale of historic and anticipated impacts has increasingly motivated government and civil society to urgently establish the necessary DRRM institution and systems. It was, in fact, the devastating flood impact in Metro Manila by Typhoon Ketsana in 2009 that pushed government to finally pass the new DRRM Act.

The DRRM Act indeed includes the development and operation of end-to-end MHEWS with the prescribed four key components. The local DRRM offices are mandated to operate their respective systems. The NDRRMF further specifies EWS as a component of local contingency plans under the 'preparedness' pillar. In the NDRRMP, under 'prevention and mitigation', the Department of Science and Technology (DOST) is tasked to oversee the establishment of a 'end-to-end monitoring system, forecasting, and early warnings'. Under 'preparedness', the OCD is tasked to lead the activities for risk assessments, including mapping, analysis, and monitoring. The Philippine Information Agency (PIA) is tasked to lead the development of IEC materials and campaigns. A whole thematic area covers response led by the Department of Social Welfare and Development.

The National Disaster Prevention & Mitigation Plan (NDPMP) is yet to be completed. It should ideally cover more detailed targets and guidance on the establishment of MHEWS, especially on the aspects of risk assessment and monitoring and warning services. The National Disaster Preparedness Plan (2015-2018), prepared by the Department of the Interior and Local Government (DILG), covers critical work on IEC, capacity building, risk assessment and plans, and preparedness for emergency and disaster response, among others. DILG further developed Operation *Listo* (translation: "ready") disaster preparedness manuals to guide LGUs, specifically their local chief executives, which come in a form of checklists for (1) minimum critical preparations for Mayors, (2) early preparation for Mayors, (3) MLGOOs, Chief of Police and Fire Marshall.

Meanwhile, there are separate National Disaster Response Plans for (1) Hydro-Meteorological Hazards, and (2) Earthquake and Tsunami.

Notably, the activation of key aspects of the preparedness and response plans are dependent on the 'early warning' to be issued by the detection and monitoring service agencies under DOST. The completion of the NDPMP is therefore critical to formally bridge the planning and protocol aspects across the plans. The Operation *Listo* manuals have been well-received by its users as they help local governments be on top of most operational aspects for preparedness and consequently improving the response capability. Where appropriate, more of such user-friendly manuals should be developed by the lead agencies in the respective areas of work.

Disaster preparedness audits in 2014 under the Seal of Good Local Governance (SGLG) of DILG revealed that the preparedness rate of the country is 73.9%, based on an assessment of 1,676 (98%) LGUs (DILG-LGA, 2015). Table 2 presents selected indicators of organization and operational readiness and presence of the different localized plans. The compliance is commendably high; however, note that the SGLG is a self-assessment system and that there is yet to be a systematic assessment of the quality of the local plans as well as the technical soundness of the local EWS established. Plans and systems should be evaluated soon after they are produced and that they should be updated at the prescribed interval.

Table 2: Organizational and operational readiness, and presence of plans in the LGUs (DILG-LGA, 2015)

Indicators	Number out of 1,676 Total LGUs	Percentage out of assessed LGUs
Organized local DRRM council	1,664	99%
Organized local DRRM offices	1,594	95%
Early-warning system in place	1,601	96%
Presence of DRRM plan and budget	1,538	92%
Presence of contingency plan	1,409	84%

Ensuring that LGUs have organized their DRRM councils and offices and have produced their respective plans is a step towards ensuring they appropriately set a budget for operations. The DRRM Act requires that 5% of the income of LGUs be allocated for DRRM; from which, 30% can be set aside as a Quick Response Fund, while 70% should be utilized for prevention, preparedness, and response expenses. The establishment of the local EWS can be taken from the latter portion. As this local budget is replenished yearly, the LGUs should seize the opportunity to purchase materials for and conduct IEC or capacity-building trainings for preparedness, to include any improvements for their local EWS.

4.3.Capacity needs: coordination mechanisms

The MHEWS of the Philippines is technically composed of separate systems for different hazards. More elaborate systems are designed for more frequently occurring hazards like storms, floods, and earthquakes (Josol et al., 2018). As there is oversight from a national command – the NDRRMC and its Operations Center - in all key EWS components and localized systems, it can be argued that its MHEWS is a system of systems.

Figure 1 depicts the country's risk communication and coordination chain, and the flow of information from the warning agencies, through the various levels of government, to the at-risk communities and the public. The detection and warning agency for hydro-meteorological hazards is DOST's Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), while the Philippine Institute of Volcanology and Seismology (PHIVOLCS) handles geophysical hazards. These agencies issue warning bulletins in pro forma technical text. The NDRRM Operations Center digests these warnings and packages them into technical advisories for use of regional to *barangay* DRRM councils or offices, disseminated through fax, e-mail, and phone calls. City and municipal LGUs usually disseminate the warnings and corresponding responses to the *barangay* households by means of door-to-door roving, text blasts, phone calls, and social media posts. Early warning sirens or horns may be sounded. Site reports are the main feedback mechanism from ground to central. The NDRRMC members and ultimately the President are apprised of the situation.

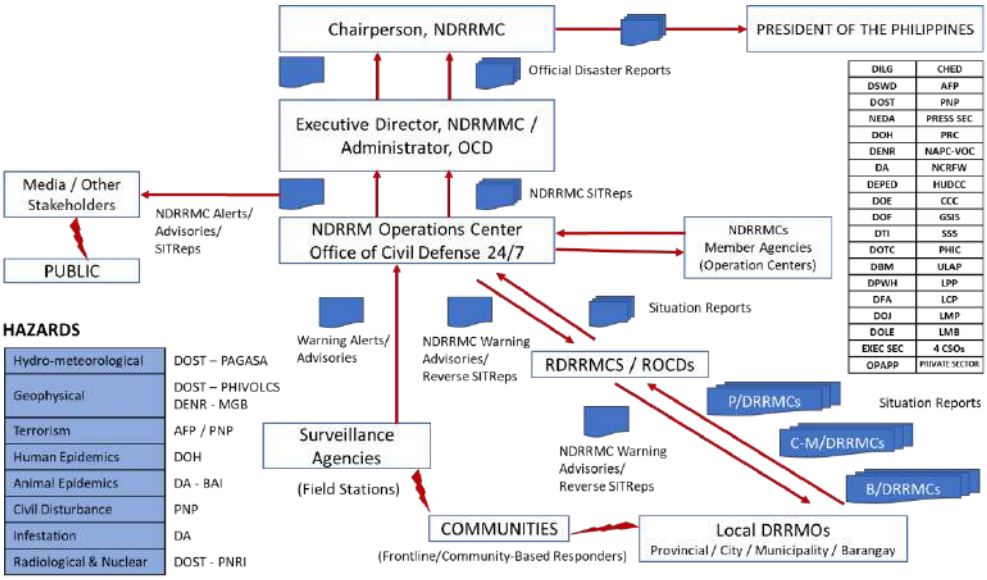

Figure 1: Risk communication and coordination chain, Philippines (NDRRMC, n.d.)

OCD's Public Affairs Office also processes advisories into shareable warning messages for the wider public, disseminating through traditional media (print, radio, TV) and through posting on official government websites (e.g. NDRRMC, DOST, PIA) and social media (e.g. Facebook, Twitter). A unified hashtag system for a hazard event is usually set to track, monitor, and respond to citizens. OCD has designed specialized information and communication tools like the 'Text Blast Systems', an organizational alert system which provide localized advisories and announcements for major weather and geophysical hazards to pools of mobile subscribers as well as disaster managers in the impact areas in the form of SMS. It has also developed the *Batingaw* mobile application which is a digital disaster preparedness kit that provides access to the latest advisories and safety tips. While the Text Blast System is increasingly gaining attention from the public, the crafting of warning messages need to be improved to incite proper response on an individual and household level. *Batingaw*, meanwhile, did not gain enough traction but remains replete with potential and should be redeveloped and marketed properly.

A study on the risk communication practices during the Typhoon Haiyan disaster recommends a 'more widespread practice of organizational translation' to better communicate risk and impact information. Organizational translation is defined as "the restatement, explanation, or embellishment of the technical information" so that recipients meaningfully understand it and are guided to act or respond accordingly (Lejano and Tan, 2016). As all levels of office are involved in some capacity in this organizational translation down the communications chain, it is critical that DRRM & even LGU officers receive the appropriate risk communication training. OCD's Capacity Building and Training Service has included risk communication and media management in the National DRRM and Civil Defense Training Plan for 2018-2020 for OCD employees, government workers in DRRM roles, local DRRMCs, and volunteers. It is recommended that this training become part of the standards of competency to hold office for those in the role of communications manager. Meanwhile, with the growing emphasis on localization in terms language, manner of expressing content, and modes of delivery, it may be beneficial for local DRRM offices to collaborate with local academic and research institutions to study effective risk communication methods tailored to their culture and demographics.

A recent innovation to the coordination mechanism involves DILG's Central Office Disaster Information Coordinating Center (CODIX) receiving advisories from the NDRRMC and cascading these to the LGUs through the DILG Regional and Field Offices to activate the progressive response actions in accordance to the protocols set in the Operation *Listo* manuals. This is a helpful development as it not only makes the risk communication down the line more robust but also ensures to an extent that the triggers for local response are insulated from political interferences as the organizational routines are rationalized.

The physical assets for communication and information exchange remain a great challenge because of the archipelagic nature of the Philippines. Strong typhoons have been experienced to damage telecommunication infrastructure, disrupting landline services and mobile signal in the areas of impact, most especially small islands. It is thus critical to purchase and install technologies that allow direct, seamless, and ideally redundant

communication channels between and among various levels of DRRM offices, LGUs, and their constituent communities. Satellite phones are eyed as ideal back-up devices by the national government but may be too expensive to require from local offices. Local DRRMOs should also design communication protocols within their area that allow them to reach far flung or isolated households that may not be within reach of mobile signal or early warning devices. Equally important is the need to properly design and activate feedback mechanism from the ground up. The prevailing formal and unidirectional approach of risk communication has restricted citizens from clarifying the warning information and from requesting additional guidance on response actions.

5. Final remarks

The MHEWS of the Philippines is a complex system of systems tied to a devolved style of governance. The country's case demonstrates how an enabling legal & policy environment, manifested in the abundance and quality of policies, frameworks, and plans, provides a strong foundation for implementing DRRM strategies in all levels. The study found that Philippines' hierarchical communication and coordination mechanism is not entirely efficient, but workable. Addressing efficiency does not need an overhaul of the downstream mechanism; the expansion of the pathway through DILG-CODIX to trigger local response greatly improved the system without reinventing the structure. It was also found that the risk communication tools and practices within the coordination mechanism are critical such that there should be more attention on how risk information is processed, translated, and delivered downstream. This necessitates appropriate training of DRRM officer in strategic risk communication. Finally, government should invest in sound and durable technologies, ensure that communications protocols reach the far and isolated households, and that a feedback mechanism is activated. The goal should not be a perfect MHEWS but one that is adaptive and continuously seek to strengthen its capacities.

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The National Plan for Disaster Management of Bangladesh: process, product and promulgation

Iftekhar Ahmed [a,*]

[a] University of Newcastle, Australia

Abstract

The National Plan for Disaster Management (NPDM 2016-2020) of Bangladesh was prepared by the author for the Ministry of Disaster Management and Relief (MoDMR), supported by the United Nations Development Programme (UNDP), and it is aligned with international frameworks including the Sendai Framework for Disaster Risk Reduction (SFDRR). The plan development process was inclusive, involving extensive consultations. While the planning and the product itself were significantly rigorous, its promulgation in terms of translating into implementation, institutional capacity building and uptake at different levels remains uncertain. Resourcing, both financial and human, is a key challenge, compounded by other contextual factors. On the other hand, Bangladesh has made significant socio-economic gains, with investments in disaster risk reduction decreasing disaster mortality. Thus, given such achievements, and the political will to engage in developing a comprehensive plan, it can be expected that many of the targets of NPDM 2016-2020 might be addressed over the long term.

Keywords: Bangladesh; Disaster management; National DM plan; Sendai Framework.

1. Introduction: disaster management planning

Disaster management (DM) planning is carried out in many countries that are vulnerable to natural and human-induced hazards. Such planning results in a policy document to guide the government's actions relating to disasters. The author was tasked as a consultant to edit and finalise the National Plan for Disaster Management (NPDM 2016-2020) of Bangladesh (MoDMR, 2017) by the United Nations Development Programme (UNDP) for the Government of Bangladesh (GoB). This paper reflects on the production of NPDM 2016-2020, the strategic approach and assumptions contained within it, and the barriers and opportunities for its promulgation for translation into implementation.

2. Context: changing nature of disaster risk in Bangladesh

Bangladesh is a highly disaster-prone country, so managing disasters and their impacts has been of major focus, with investments in DM decreasing disaster mortality, indicated by more than a 100-fold reduction of deaths in cyclones since the 1970s (Haque et al., 2012). The disaster risk context, however, is changing. Bangladesh is one of the most at-risk countries in the world to the negative impacts of climate change (Maplecroft, 2015). There is also the risk of earthquakes, and the rapidly growing cities are highly vulnerable (World Bank, 2012) (see Figure 1).

These emerging risks present key challenges, however, Bangladesh has made major socio-economic gains in recent years. With an average 6 per cent economic growth in the last decade, the country reached lower middle-income status in 2015 (World Bank, 2016) and also achieved significant progress in the Millennium Development Goals (Bangladesh Planning Commission, 2015a). However, the economy suffers from disasters and a large amount of gross domestic product (GDP) is lost each year (PreventionWeb, 2014).

* Corresponding author. E-mail address: ifte.ahmed@newcastle.edu.au

Figure 1: Rapid urbanisation in Bangladesh poses a serious risk to earthquakes.

3. NPDM (2016-2020)

The previous National Plan for Disaster Management (NPDM) 2010-2015 of Bangladesh (GoB, 2010) was the first policy document of its kind reflecting a paradigm shift from a focus on disaster relief and response to a comprehensive risk reduction culture, with emphasis on capacity strengthening. It led to establishing a legal basis for DM through the Disaster Management Act (2012) (GoB, 2012) and was drawn from regional and global frameworks including the SAARC Comprehensive Framework on Disaster Management (SAARC, 2006) and the Hyogo Framework of Action (UNISDR, 2007). It recognised the need for addressing emerging risks, thus setting the context for NPDM 2016-2020.

3.1.Overview

NPDM 2016-2020, prepared under the leadership of the Ministry of Disaster Management and Relief (MoDMR), is aligned with national, regional and international frameworks, particularly the Sendai Framework for Disaster Risk Reduction (SFDRR) (UNISDR, 2015). The plan places importance on emerging risks linked to urbanisation and climate change, and disaster risk reduction (DRR) for sustainable development, and recognises the changing nature of risks in Bangladesh.

NPDM 2016-2020 takes a 'whole-of-government' approach and has a set of strategic aims reflecting its alignment with the SFDRR, strategy guidance to relevant stakeholders, recognition of emerging risks and phased implementation of prioritised actions. A set of objectives allow operationalising the aims through identifying priority actions, providing a roadmap for implementation of at least 20 core investments, incorporating DM aspects in sectoral plans, exploring public-private investments, ensuring inclusivity, addressing emerging risks, promoting risk governance and illustrating how the work of various stakeholders can contribute to GoB's DM vision. With potential engagement of the private sector in mind, NPDM 2016-2020 promotes risk-informed planning and implementation of investment initiatives for business continuity in disasters.

3.2.Development process

The development of NPDM 2016-2020 was participatory and inclusive, involving consultations with a wide range of stakeholders including GoB agencies, non-governmental organisations (NGOs) and civil society organisations (CSOs). A set of regional workshops allowed drawing diverse insights, and a national consultation workshop (with plenary presided by the Honourable Minister of MoDMR) was conducted to gain feedback through a SFDRR-based framework. These workshop outputs were made available online for further feedback and subsequently with inter-ministerial approval, the draft plan was also made available online.

3.3.SFDRR and the plan product

NPDM 2016-2020 provides two main implementation guides: Broad policy direction in terms of national level action plans to guide DM in alignment with SFDRR in the national context of the SDGs; Action plans with indicative timeframes over the next 5 years and 34 core targets to be continued until 2030 (see Appendix 1). The

stakeholder and expert consultations focused on the SFDRR priorities and action plans were derived following an 'all-hazards' approach with hazard-specific activities linked to broader priority level action plans:

3.4.Promulgation for implementation

Given the significant effort in producing NPDM 2016-2020, its promulgation to make it known by open declaration, publishing and operationalising it is of high importance. This is also essential to translate the plan into implementation. The plan is built upon the participation of key stakeholders involved in the disaster management field; its promulgation would reciprocate such mostly voluntary participation and also resonate the participatory ethos embedded in it. Many of the action plans are expected to be undertaken in partnership with other ministries and agencies (see Appendix 1) and promulgation would provide a basis for such partnership.

The original scheme when the plan was drafted was to publish it as a GoB-badged publication available both as hard copy and online versions to have it in the public domain as part of the democratic processes of accountability and transparency. As human lives are involved, such accountability is of high importance. This is also a mechanism to receive constructive feedback on the implementation of the actions and monitor them.

Yet more than a year after NPDM 2016-2020 was produced and well into its planned timeline, it was only available online as a Word document on MoDMR's website (http://www.modmr.gov.bd/) without any governmental badging. There was no accompanying official declaration, and the document is available from a section on "Publications", yet it was not really published. On the other hand, the previous NPDM 2010-2015 is available as a fully badged and promulgated document in a section on "Policies". It is not clear why the two documents of similar nature and scope are treated differently in terms of promulgation. Thus, while the planning process and the product were significantly rigorous, promulgation in terms of translating into implementation, institutional capacity building and uptake at different levels remains uncertain.

4. Discussion: a critical review of NPDM 2016-2020

The discussion above on the limited promulgation of NPDM 2016-2020 sets the stage for a critical review of the plan. Below, the factors blocking promulgation, broad strengths and weaknesses of the plan and contextual barriers and opportunities are analysed.

4.1.Key factors impeding promulgation

The 34 core targets of the plan (see Appendix 1) at first sight may appear ambitious and perhaps intimidating, which may have deterred MoDMR from seriously embarking on their implementation. However, as stated in the plan, despite the plan timeline ending in 2020, there is provision to continue implementing the targets until 2030; additionally, the plan has provision to prioritise 20-25 key targets, which would reduce the scope. This was perhaps not clearly understood.

It was beyond the scope of the plan to identify funding and human resources to implement it. Ministerial expenditure is dependent on the national budget, and although there is strong national interest in disaster risk reduction as indicated in the 7th 5-Year Plan (Planning Commission, 2015b), it would be necessary to coordinate budgetary allocations with the plan's targets. Thus, the lack of a clearly articulated funding pathway for implementation of the plan is perhaps one of the key barriers to its promulgation.

Bengali is the national language of Bangladesh, but NPDM 2016-2020 was prepared in English. While this was necessary to be able to include inputs from various international stakeholders and experts, it limited its currency in the local context, perhaps even at the level of MoDMR. It was highly important to translate it to Bengali, but again, the possible funding source for this is uncertain.

4.2.Strengths and weaknesses of the plan

The strengths as identified by an independent review of NPDM 2016-2020 (Haque *et al*., 2017) include: (a) Footprints of transformation; (b) Emphasis on Incident Command System; (c) Whole-of-Government approach; (d) Use of statistical references; (e) Hazard-specific plan; (f) Lessons from the previous plan; (g) Reflection of urban issues; (h) Implications for partnership coordination; and (i) Implications for accountability.

While identifying the plan's strengths, its ambitious scope was also indicated. The plan certainly moves forward from the previous NPDM 2010-2015, and it does have a transformational approach to DM in line with

global frameworks including SFDRR. However, while some of the above issues such as partnership and accountability have been highlighted in the plan as essential for its effective implementation, whether the stakeholders involved would actually base their actions on these strengths of the plan is uncertain. Describing the plan as "hazard-specific" is not entirely accurate – although many of the consultation processes at different stages had focused on a hazard-based approach, the plan clearly states that it "… follows an 'all-hazards' or multi-hazard approach; hazard-specific activities where suggested are linked to broader priority level action plans." The "whole-of-government" approach is also problematic and perhaps idealised, even in the plan; on one hand, to implement such a plan inter-ministerial engagement and mainstreaming at all levels of government would be necessary, but quite often this presents a challenge where different ministries largely operate as silos and can even be territorial.

Other weaknesses identified by Haque *et al.* (2017) demand for a much stronger focus on urban disasters, although it is acknowledged that the plan reflects on the critical nature of urban issues; despite many DRR and developmental achievements in Bangladesh, rapid and largely unplanned urbanisation poses a serious risk, and perhaps the plan should have prioritised those targets that specifically relate to urban issues. One weakness mentioned in the review is based on a wrong assumption: it questions whether there is the "… capacity to develop homegrown policies with local experts", alluding that the plan was prepared by external experts. However, almost all the key persons involved in the plan's production were of Bangladeshi origin. Perhaps this assumption emerged because of the direct involvement and support of UNDP, which does point to a key weakness in MoDMR as noted, "Dependence on external agencies prevails." This is perhaps the crux of the problem – despite a well-developed plan, its implementation ultimately relies on access to external funding.

4.3.Contextual barriers and opportunities

Promulgation of a national plan, or any other such policy instrument, is essentially an accountability issue because its implementation would have impacts and implications for citizens of the country and hence they have the right to be informed. By at least making NPDM 2016-2020 available on the Internet is a step in this direction, but accountability extends beyond that by a sharing of responsibilities by relevant institutional stakeholders. This is reflected in the plan's accountability framework, expressed diagrammatically in Figure 2, consisting of eight key elements: (a) Focal points; (b) Coordination, communication and cooperation; (c) Policy and operations linkages; (d) Expanded planning scope; (e) Political consensus for allocation of resources; (f) Funding/Resource mobilisation; (g) Contingency/Preparedness planning; (h) Periodic review.

Figure 2: Accountability framework of NPDM 2016-2020.

Two key strands within the accountability framework serve as barriers related to the socio- politico-economic- context of Bangladesh. Firstly, the capacity of MoDMR as the main focal point to facilitate and achieve 'buy-in' from and coordination between a wide range of stakeholders from the national to local level in a context of disputatious bipartisan politics. Secondly, the difficulty of accessing budgetary allocations for implementation of the plan's targets, not only within MoDMR, but also within other ministries to implement DM as per their specific sectors.

However, there are also opportunities to address these barriers. There is an Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) for DM coordinated by MoDMR, providing scope to build on this existing institutional platform. Perhaps the MoDMR would be able to champion this cause given that DM is a national priority, and its ability to reduce disaster mortalities and strong participation in international DRR forums. Resource mobilisation is not only a matter of accessing external donor funding; Bangladesh has made significant economic achievements and there is increasing international investment and private sector growth. NPDM 2016-2020 therefore strongly advocates private sector engagement in its implementation. There is also an extensive and highly active NGO sector in Bangladesh and can be a valuable partner in the plan's implementation.

5. Conclusion: potential for change

Despite its recent economic improvement, Bangladesh remains a developing country with a high prevalence of poverty, and frequent and recurrent disasters being increasingly amplified by climate change. The challenges of implementing DM policies in such a context are severe. The other side of the coin of economic growth is widespread, rapid and unplanned urbanisation, not only in the main cities, but also in the smaller cities and peri-urban areas. DM has traditionally focused on rural areas in this predominantly rural agrarian country where the reduction of disaster impacts has been achieved, particularly of cyclones in the coastal areas (Haque *et al*., 2012); managing the emerging urban risks is less well-understood and hence strongly emphasised in the NPDM 2016-2020 targets. This will have to be the future direction of DRR in the country.

NPDM 2016-2020 is a landmark policy document and has great transformational potential for supporting resilience building in Bangladesh. It represents a significant initiative of the government and its partners, principally UNDP, as a continuum of the progress made over recent decades in reducing disaster risk and impacts. Despite the bottlenecks in the plan's promulgation discussed in the preceding sections, the consultative and participatory process of the plan's development and its comprehensive suite of targets are indicative of the potential for effective implementation of crucial elements of the plan's targets. Perhaps initiating the implementation process is the greatest hurdle, especially with a persistent barrage of disasters continuously distracting institutional attention. It is now a matter of time when the end date of the plan arrives, allowing a progress review and thereby the future course of action.

Acknowledgements

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Appendix 1

Action Plan: 2016

Priority 1		Priority 2		Priority 3		Priority 4	
Actions	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**
Awareness raising and data products on earthquakes. DM-related research and development activities on scientific and socio-economic issues. Strengthen regional and international DM networks. International and regional cooperation and knowledge/ information sharing.	Continuation and planned expansion of earthquake program. Signatory to ARPDRR and Delhi Declaration.	Inter-ministerial coordination to develop sectoral policies and capacity building.		Nationwide capacity building for resilience. Physical works and structural measures for resilience. Strengthen flood management. Strengthen cyclone management.		Sector wise and critical facilities preparedness and emergency response measures. Inclusive recovery and rehabilitation strategy.	

Action Plan: 2017-2018

Priority 1		Priority 2		Priority 3		Priority 4	
Actions	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**
Contemporary technologies and innovations for improved weather and climate monitoring, prediction and forecasting. Awareness raising and data products on earthquakes.	At least one innovation in forecasting of at least one hazard (e.g. drought, landslide).	Review and update the National Earthquake Contingency Plan. Strengthen the capacity of DMCs. activation of urban DMCs. Risk proof public investments and inclusion of Disaster Impact Assessment.	National Earthquake Contingency Plan reviewed and updated. At least five trainings of DMCs conducted with at least 100 DMC leaders in each training. Urban DMC activation strategy paper produced. Disaster Impact Assessment strategy paper produced.	To follow an 'all-hazards' approach.	At least two "all-hazards" risk reduction pilot projects initiated in prioritized multi-hazard regions (e.g. coastal, haor).	Sector wise and critical facilities preparedness and emergency response measures. Inclusive recovery and rehabilitation strategy.	Preparedness and emergency response guidelines produced for at least one prioritized sector. Concept paper produced for recovery and rehabilitation strategy.
***Continuing actions/* New core targets**							
Upgrade and strengthen national awareness. *DM-related research and development activities on scientific and socio-economic issues.* *Strengthen regional and international DM networks.*	Continuation and planned expansion of earthquake program (e.g. EPAC). At least two R&D projects initiated with balance between scientific and socio-economic.	*Inter-ministerial coordination to develop sectoral policies and capacity building.*	Inter-Ministerial Disaster Management Coordination Committee (IDMCC) to make provisions for periodic review of NPDM 2016-2020.	*Nationwide capacity building for resilience.* *Physical works and structural measures for resilience.* *Strengthen flood management.* *Strengthen cyclone management.*	National DM capacity building plan produced. Construction of fire stations initiated in all the district headquarters. At least one demonstrated improvement of flood and cyclone management each.	*Strengthen forecasting and early warning systems.* *Build capacity on emergency response.*	At least one demonstrated improvement in forecasting and/or early warning. Capacity raising program for CPP begun.

Action Plan: 2019-2020

Priority 1		Priority 2		Priority 3		Priority 4	
Actions	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**	**Actions**	**Core Targets**
DM-related research and development activities on scientific and socio-economic issues. Studies on other hazards (e.g. cold wave, lightning, fire, chemical hazards and oil spills).	At least two R&D projects (scientific and socio-economic) completed with directions for future research. Studies on resilience building for at least two human-induced hazards.	Strengthen formal institutional capacities and social protection institutions. Guidelines for private sector investment for resilience. Close gaps in institutional policies and programs on drought and cold wave hazards.	Social protection for disaster resilience agency established. Guidelines for risk-informed private sector investments produced. Drought and cold wave unit in MoDMR established.	DM financial options - private sector, insurance and funding for social protection. Resilience institutions - Research & Development Center, National Emergency Operations Center.	Concept paper on DM financial options produced. At least one institution (R&D Center or NEOC) initiated.	Financial instruments e.g. recovery compensation or loans. Business continuity. Emergency preparedness and response to human-induced disasters. Preparedness and response measures for slow-onset hazards.	Concept paper on finance for disaster recovery produced. Emergency preparedness and response plan produced of at least one human-induced and one slow-onset (e.g. drought) hazard.
Continuing actions							
Contemporary technologies and innovations for improved weather and climate monitoring, prediction and forecasting. *Awareness raising and data products on earthquakes. Upgrade and strengthen national awareness.* *DM-related research and development activities on scientific and socio-economic issues.* *Strengthen regional and international DM networks.* *International and regional cooperation and knowledge/ information sharing.*	At least one demonstrated innovation in forecasting of at least one hazard (e.g. drought, landslide) and another initiated.	*Inter-ministerial coordination to develop sectoral policies and capacity building.* Strengthen the capacity of DMCs.	Inter-Ministerial Disaster Management Coordination Committee (IDMCC) to make provisions for periodic review of NPDM 2016-2020. Urban DMCs activated.	*Nationwide capacity building for resilience.* *Physical works and structural measures for resilience.* *Strengthen flood management.* *Strengthen cyclone management.*	National DM capacity building plan pilot implementation. Construction of at least five fire stations completed in district headquarters and construction of further stations initiated. At least one improvement of flood and cyclone management each proposed and/or developed.	*Inclusive recovery and rehabilitation strategy.* *Upgrade and strengthen national awareness.* *Strengthen forecasting and early warning systems.* *Build capacity on emergency response.*	Preparedness and emergency response guidelines produced for at least one more prioritized sector. Pilot recovery and rehabilitation strategy program initiated. Capacity raising program for CPP demonstrated.

Development of ASEAN Urban Resilience Checklist

Masashi Inoue [a,*], Makine Kusano [b], Shinichi Fukasawa [c], Hitoshi Baba [d]

[a] Eight-Japan Engineering Consultants INC., Japan
[b] PACET Corporation, Japan
[c] Nippon Koei Co., Ltd., Japan
[d] Japan International Cooperation Agency (JICA), Japan

Abstract

After the Sendai Framework adopted in 2015, more and more attention is paid to Urban Resilience and disaster risk reduction (hereinafter referred as "DRR") activities. However, most of the persons in charge of DRR-related measure planning in the local governments and communities do not have enough experience and expertise to implement proper DRR-related activity from the comprehensive viewpoint, which leads to having a tendency to work with the easy and noticeable activities. Under this situation, the tool for logical and comprehensive DRR-related measure planning is strongly required. Based on the background, ASEAN Urban Resilience Checklist was developed to compose of two parts of "Checklist A for Disaster Risk Management" and "Checklist B for Resilient Urban Development". This paper introduces the process of developing the checklist and case study in Denpasar City which identified the current status of DRR and necessary future action item for enhancing their resilience. Through the case study, it was confirmed the effectiveness of the checklist and the process of identifying necessary action item using it.

Keywords: Resilience; Risk governance; Checklist; Disaster Risk Management; Action plan.

1. Introduction

After Sendai Framework for Disaster Risk Reduction (hereinafter referred as "SFDRR") adopted in 2015, more and more attention is paid to urban resilience and disaster risk reduction (hereinafter referred as "DRR") activities. Especially, SFDRR stated substantial increase of the number of countries with national and local disaster risk reduction strategies by 2020. However, most of the persons in charge of DRR planning in local governments do not have enough experience and expertise to make a proper DRR plan from the comprehensive viewpoint, which leads to a having a tendency to work with the easy and noticeable activities. In addition, another challenge in DRR is that urban planning confronts many of the generic challenges to mainstreaming risk reduction due to the marginal position of both fields (Christine, 2006). Under this situation, the tool for logical and comprehensive DRR planning which bridges gap between DRR and urban planning is strongly required.

Some checklists such as "Disaster Resilience Scorecard for Cities" and "Local Government Self-Assessment Tool" were already developed and implemented by international organizations. These checklists contribute as a common performance measurement tool for activities' assessment for disaster risk reduction applicable to all local governments in the world, but still, some issues can be found such as follows:

- Not quantitatively evaluated with certain criteria
- Questions are relatively general and its result does not provide concrete action to solve issues
- The result is not utilized to actual DRR planning and urban planning

Based on this background, ASEAN Urban Resilience Checklist is developed as a part of outputs of the project components for Concept Note 18 (CN18): Building Disaster and Climate Resilient Cities in ASEAN. CN18 was under the Strategy and Priorities for AADMER Work Programme Phase 2 (2013-2015) formulated by ASEAN Committee on Disaster Management (ACDM), and it was implemented through the assistance of Japan International Cooperation Agency (JICA). This paper presents the process of developing this checklist and the case study in Denpasar City, Indonesia.

* Corresponding author. E-mail address: inoue-ma@ej-hds.co.jp

2. Method for developing ASEAN Urban Resilience Checklist

2.1.Examination on the structure of the checklist

The checklist is composed of two parts of "Checklist A for Disaster Risk Management" and "Checklist B for Resilient Urban Development". This is because one of the issues on mainstreaming DRR into land use and urban development planning is observed by inefficient coordination and interaction of two key sectors of disaster risk management and urban sector including infrastructure in ASEAN. It is essential for the two parts of the checklist to enhance effective coordination and interaction among these two sectors in order to promote mainstreaming DRR in local governments.

In addition, the structure of checklist is based on the four priority actions of SFDRR since they are international common understanding on DRR nowadays. However, the order of elements of the four priority actions is adjusted by the ordinal planning process as a common order of activities such as "data collection – analysis – planning – implementation". Therefore the priority action 2 of "strengthening disaster risk governance to manage disaster risk" is adjusted in the last part of the checklist as illustrated in Figure 1.

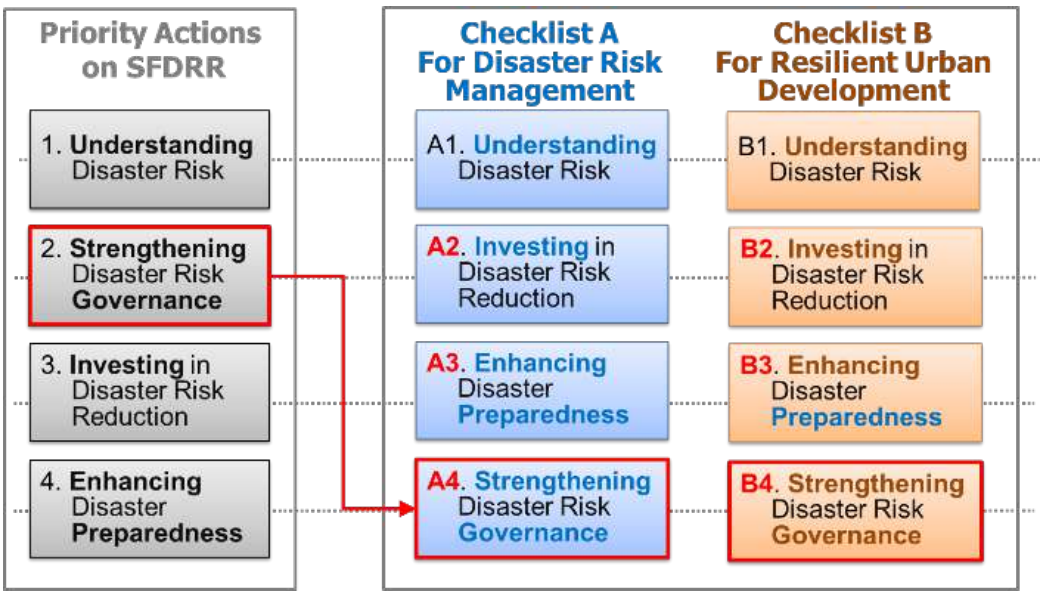


Figure 1: Framework of the checklist in accordance with four priority actions of SFDRR

2.2.Development of questions on the checklist

Each question on the checklist is prepared by making breakdown from four priority actions of SFDRR. Firstly, key actions are listed up for accomplishing each priority action. Afterward, questions are produced by listing up important activity necessary for key actions. Finally, scoring criteria for each question are prepared in order to get a quantitative and objective answer as much as possible. The result of question development is summarized as follows:

(1) Checklist A for disaster risk management

This Checklist A aims at assessing capacities of local governments in disaster risk management at prevention, mitigation and preparedness stages how their activities and measures are or have been achieved by DRR activities in line with the priority actions of SFDRR. Accordingly, these activities are covered by a broad range of activities to prepare actions from planning, human resource development, institutional arrangements to physical interventions.

As a result, total 125 questions were developed with considering comprehensive activities to encourage activities for DRR in local government. Table 1 shows the developed contents of the Checklist A for disaster risk management.

Table 1 Contents of checklist A for disaster risk management

Priority Actions (SFDRR)	Head title of key actions	No. of Questions
A1 Understanding Disaster Risks	A11. Identifying probable hazard that may affect the local society	18
	A12. Analysing local vulnerabilities	19
	A13. Assessing local disaster risks	13
	A14. Sharing hazard and risk information	3
A2 Investing in Disaster Risk Reduction	A21. Formulating strategies and plans for disaster risk reduction	7
	A22. Investment in DRR measures on key facilities	9
	A23. Back up or alternatives to key facilities	4
A3 Enhancing Disaster Preparedness	A31. Formulating effective disaster response system and administrative management	8
	A32. Formulating effective emergency relief and resilient medical care system	6
	A33. Formulating effective evacuation system	5
	A34. Formulating effective recovery plan and program in advance before a disaster event	7
	A35. Formulating effective reconstruction plan and program in advance before a disaster event	2
A4 Strengthening Disaster Risk Governance	A41. Overall mechanism of improving urban resilience	10
	A42. Enhancing the capacity of the local community for improving societal resilience	7
	A43. Participation of private sector in the local society for improving urban resilience	7
Total number of questions		125

(2) Checklist B for resilient urban development

The Checklist B aims at assessing capacities of local governments in land use and urban development planning how their planning activities and measures are or have been considered by DRR. The questions are considered how a plan is materialized by concrete measures such as development control, building regulations and physical interventions assured by certain budget programs as actions of prevention and mitigation of disaster risks. Table 2 shows the contents of the developed checklist by 116 questions for land use and urban development planning.

Table 2: Contents of checklist B for resilient urban development

Priority Actions (SFDRR)	Head title of key actions	No. of Questions
B1 Understanding Disaster Risks	B11. Basic Socio-economic data provision for probable exposure against hazards	16
	B12. Fundamentals of hazard and vulnerability analysis	15
B2 Investing in Disaster Risk Reduction	B21. Incorporating disaster risk reduction into land use strategies and framework	6
	B22. Land use planning reflecting the strategy and the development scenario	12
	B23. Implementing development control and land use regulations	11
	B24. Strengthening building regulation in combination with zoning system	5
	B25. Enhancing infrastructure investment reflecting the strategy and the development scenario	14
	B26. Enhancing public facilities investment reflecting the strategy and the development scenario	12
	B27. Improving vulnerable urban block / area	6
B3 Enhancing Disaster Preparedness	B31. Effective recovery and reconstruction mechanism in land use planning	5
B4 Strengthening Disaster Risk Governance	B41. Inclusive, transparent and collective management and activities for urban planning and development	6
	B42. Efficient administration of resilient urban planning and development	8
Total number of questions		116

2.3.Formulation of the checklist in MS Excel file

Questions prepared in the previous section are summarized into MS Excel file so that user(administrative official) can automatically get score and necessary action item list based on the answer in the following sequential steps:

(1) STEP1: Answering questions by scored criteria

According to the contents of each Checklist A and B described in Table 1 and Table 2, users are requested to select the most suitable answer to each question from the scroll list of a cell of Excel sheet. The answers in the scroll list are equivalent to scored criteria given by 0 ~ 4 points as illustrated in Figure 2.

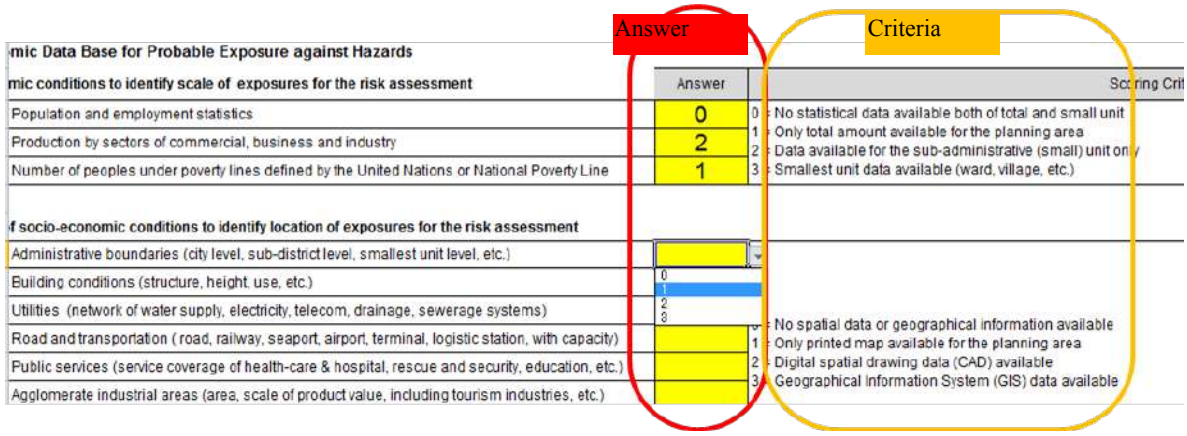


Figure 2: Scored criteria by 0-4 points in scroll list as answer to each question (Worksheet 1)

In addition, this checklist provides default responsible sector for answering each question as shown in Figure 3 so that user can get score by sector in the STEP2. If necessary, users can add and modify the sector in the scroll list of each cell by the main sector and sub-sector. Table4 shows abbreviation of relevant sector.

ancing Availability of Socio-economic Data Base for Probable Exposure against Hazards		Relevant Sector			
Available statistics of socio-economic conditions to identify scale of exposures for the risk assessment		Main	Sub		
11.1.1	Population and employment statistics	Statistics	Commerce	Industry	Agri/Fishery
11.1.2	Production by sectors of commercial, business and industry	Statistics	Commerce	Industry	Agri/Fishery
11.1.3	Number of peoples under poverty lines defined by the United Nations or National Poverty Line	Statistics			

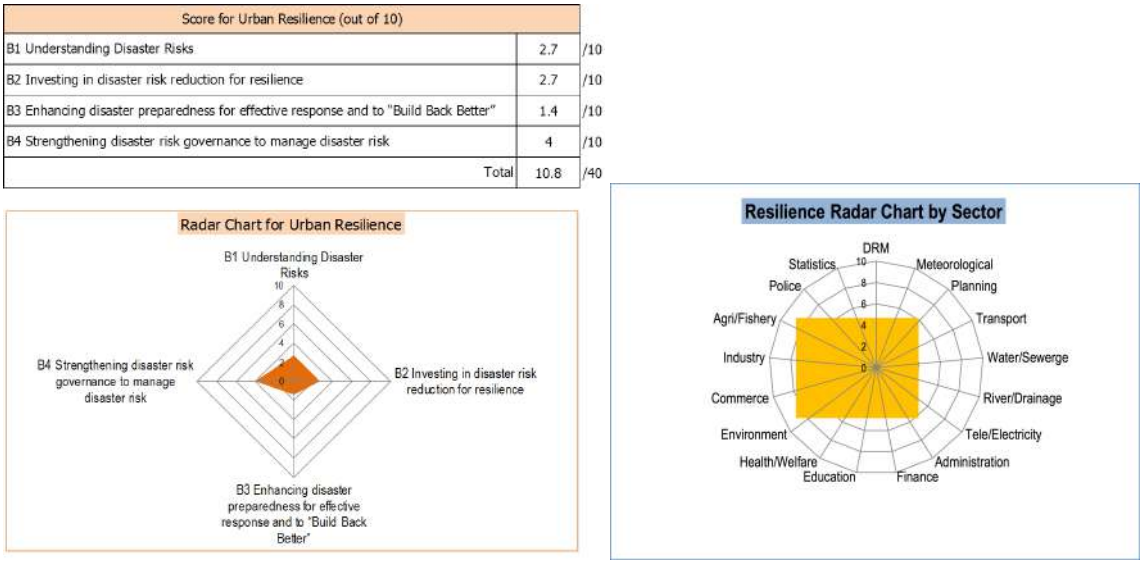
Figure 3: Excel cells for identifying relevant sector/s in scroll list responsible for each item of the questions

Table 4: Abbreviation of sector in the checklist

Abbreviation	Relevant Sector
DRM	Disaster Risk Management
Meteorological	Meteorological Office
Planning	Urban Planning & Housing
Transport	Road & Transportation
Water / Sewage	Water Supply & Sewage
River/Drainage	River & Drainage
Tele/Electricity	Telecom & Electricity
Administration	Administration, Institution
Finance	Economic Finance
Education	Education & Culture
Health/Welfare	Health Social Welfare
Environment	Environment

(2) STEP 2: Resilience Scores Chart as result of answers

After answering to all questions in the checklist, users will find two types of "Resilience Score Chart" in another worksheet of Excel file. One is the result of questions assessed and represented by a Radar Chart indicated by aggregated scores into the four Priority Actions of SFDRR. The other is that aggregated by sector. These radar charts notify users which priority action and which sector should be strengthened from the aspect of DRR, which enables users to understand their strength and weakness. Figure 4 shows the examples of outputs in case of Checklist B: Resilient Urban Development.



Score for Urban Resilience (out of 10)		
B1 Understanding Disaster Risks	2.7	/10
B2 Investing in disaster risk reduction for resilience	2.7	/10
B3 Enhancing disaster preparedness for effective response and to "Build Back Better"	1.4	/10
B4 Strengthening disaster risk governance to manage disaster risk	4	/10
Total	10.8	/40

Figure 4: Resilience score and its radar chart aggregated by four priority actions of SFDRR (on the left) and sectors (on the right)

(3) STEP 3: Prioritization from "Issues List"

In the next step, users will find "Issue List" where it is generated by the results of answers on the criteria by setting the lowest score (zero points). These criteria can be set by the user which appropriate or a preferable score of each answer would be equivalent to issues of activities to be improved or developed because of zero or lower achievement of them.

As the work in Step 3, users are requested to judge and determine prioritization of necessary actions by A, B, C (A is the highest priority) on each listed issues of urban resilience. Figure 5 shows an example output table as the issues list and input priority.

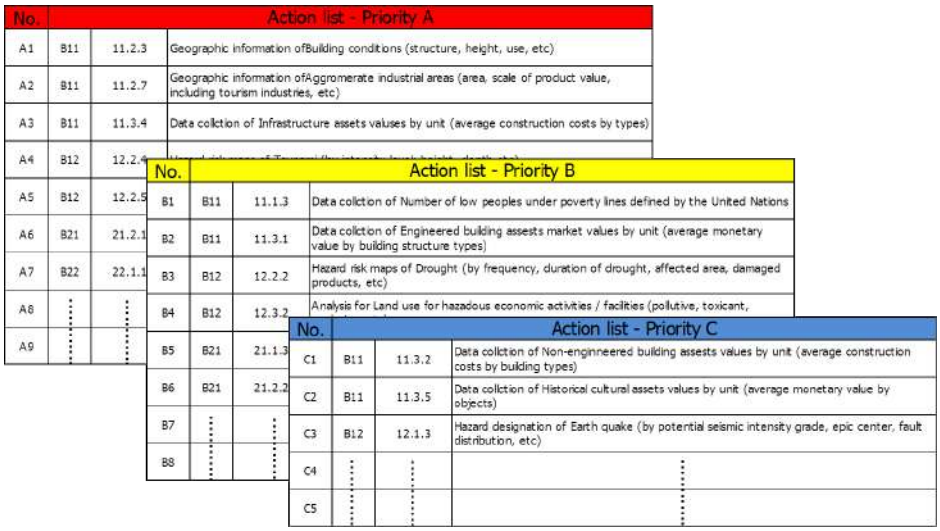
Please input priority with A,B,C ↓

No.	Issue list for Urban Resilience			Priority (A,B,C)
1	B11	11.1.3	Data collction of Number of low peoples under poverty lines defined by the United Nations	B
2	B11	11.2.3	Geographic information ofBuilding conditions (structure, height, use, etc)	A
3	B11	11.2.7	Geographic information ofAggromerate industrial areas (area, scale of product value, including tourism industries, etc)	A
4	B11	11.3.1	Data collction of Engineered building assests market values by unit (average monetary value by building structure types)	B
5	B11	11.3.2	Data collction of Non-enginneered building assests values by unit (average construction costs by building types)	C
6	B11	11.3.4	Data collction of Infrastructure assets valuses by unit (average construction costs by types)	A
7	B11	11.3.5	Data collction of Historical cultural assets values by unit (average monetary value by objects)	C
8	B12	12.1.3	Hazard designation of Earth quake (by potential seismic intensity grade, epic center, fault distribution, etc)	C
9	B12	12.2.2	Hazard risk maps of Drought (by frequency, duration of drought, affected area, damaged products, etc)	B
10	B12	12.2.4	Hazard risk maps of Tsunami (by intensity level: height, depth,etc)	A
11	B12	12.2.5	Hazard risk maps of Typhoon and/or Cyclone (wind, surge, including flood and other water hazards)	A
12	B12	12.3.2	Analysis for Land use for hazadous economic activities / facilities (pollutive, toxicant, explosive, etc)	B

Figure 5: Issues list identified by Worksheet 3 for urban resilience

(4) STEP 4: Formulating "Action Lists" by prioritized actions

As the final step of the checklist, "Action List" is generated based on the work results in Step 3. The actions would be sorted by priority as illustrated in Figure 6. These tables would be a useful reference for local governments to determine actual priority projects for urban resilience, taking account of other factors such as their feasibility, budget criteria, political will, etc.



No.	Action list - Priority A		
A1	B11	11.2.3	Geographic information ofBuilding conditions (structure, height, use, etc)
A2	B11	11.2.7	Geographic information ofAggromerate industrial areas (area, scale of product value, including tourism industries, etc)
A3	B11	11.3.4	Data collction of Infrastructure assets valuses by unit (average construction costs by types)
A4	B12	12.2.4	
A5	B12	12.2.5	
A6	B21	21.2.1	
A7	B22	22.1.1	
A8	⋮	⋮	
A9	⋮	⋮	

No.	Action list - Priority B		
B1	B11	11.1.3	Data collction of Number of low peoples under poverty lines defined by the United Nations
B2	B11	11.3.1	Data collction of Engineered building assests market values by unit (average monetary value by building structure types)
B3	B12	12.2.2	Hazard risk maps of Drought (by frequency, duration of drought, affected area, damaged products, etc)
B4	B12	12.3.2	Analysis for Land use for hazadous economic activities / facilities (pollutive, toxicant,
B5	B21	21.1.3	
B6	B21	21.2.2	
B7	⋮	⋮	
B8	⋮	⋮	

No.	Action list - Priority C		
C1	B11	11.3.2	Data collction of Non-enginneered building assests values by unit (average construction costs by building types)
C2	B11	11.3.5	Data collction of Historical cultural assets values by unit (average monetary value by objects)
C3	B12	12.1.3	Hazard designation of Earth quake (by potential seismic intensity grade, epic center, fault distribution, etc)
C4	⋮	⋮	⋮
C5	⋮	⋮	⋮

Figure 6: Example of action lists by priority to be referred to decision-making

3. Case study

3.1.Overview of case study

In order to verify the effectiveness of the checklist, a case study was conducted in two cities, namely Denpasar City in Indonesia and Luang Prabang Province in Lao PDR as part of the CN18 demonstration project. For the implementation of the checklists, collaborative works were carried out by Disaster Risk Management Department and Urban Planning Department at each city in cooperation with relevant organizations in the following procedure:

- Checklist workshop was held and the officials from relevant organizations of Denpasar City Government answered the questions in the checklist.

- Disaster Risk Management Department and Urban Planning Department collected and summarized the result.
- Quantitative result and identified issues were presented to relevant organizations at the workshop.

Figure 7: Checklists workshop with relevant organizations in Denpasar City

3.2.The result of the checklist

This paper explains mainly the result of Denpasar City due to space limitation. In Denpasar, this checklist is applied to identify future necessary action item for tsunami disaster.

Figure 8 shows the result of the checklist (A) for Disaster Risk Management in Denpasar City. The quantitative result indicated total score is 14.0 points out of 40 points. Looking into details of the scores by the groups of questions based on the SFDRR Priority Actions, it is assumed that "A4 Strengthening disaster risk governance to manage disaster risk" needs to be strengthened. On the other hand, looking into the score by departments, it is found that PU-BM(Public Works Office-Highway Division) implemented enough measures already against disaster risk, while low score department such as PLN(State Electricity Company) and Perdag(Industry and Trade Office) should improve their measures on disaster risk management.

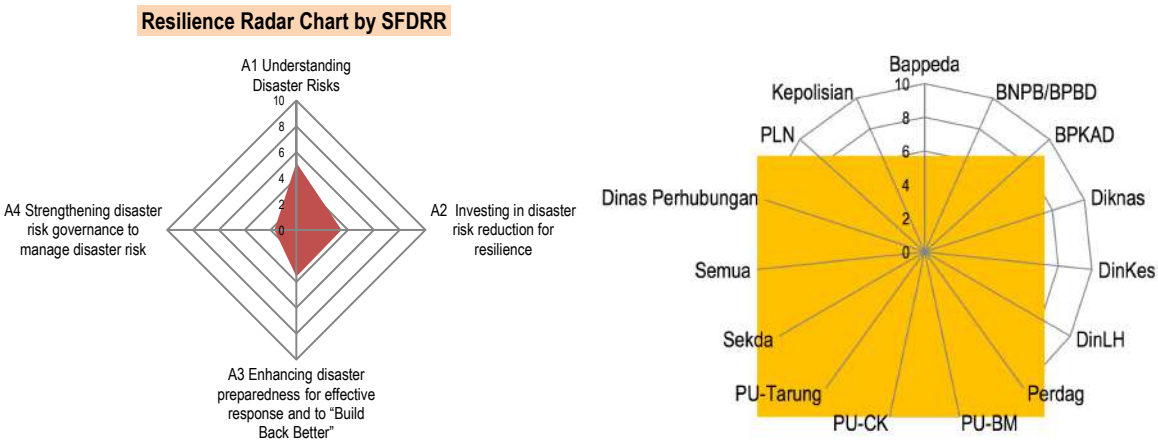


Figure 8: Result of the checklist (A) in Denpasar City

On the other hand, Figure 9 illustrates the result of the checklist (B) for Resilient Urban Development. The quantitative result indicated its higher scores than Checklist (A), of which the total score is 17.3 points out of 40 points. Looking into details of the scores by the groups of questions based on the SFDRR Priority Actions, it can be seen that measures related to " B1 Understanding the risk" and "B2 Investing in disaster risk reduction for resilience" should be strengthened. In case of respondents of the questions, it is found that BAPPEDA(Regional Development Planning Agency), BKPAD(Regional Finance and Asset Management Agency) and PU-SDA(Public Works Office-Water Resources Division) have a relatively high score, while other respondent institution has a low score and need to be improved.

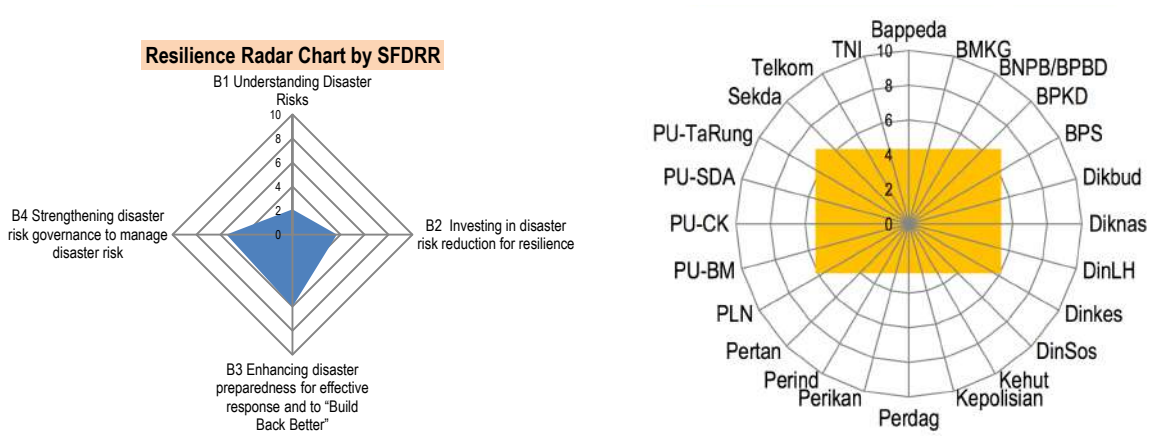


Figure 9: Result of the checklist (B) in Denpasar City

3.3.Action item list developed based on the checklist result

Based on the result of the checklist, issue list was identified by Denpasar City with low scored 26 questions which are related to the tsunami disaster, and those questions were categorized into four themes in Table 5.

Table 5: Themes of issue based on the result of the checklist

Themes	Number of relevant questions	
	Checklist (A)	Checklist (B)
Theme.1 How to make Disaster Resilient Government offices?	2	1
Theme.2 How to prepare for swift and effective disaster response?	4	7
Theme.3 How to prepare for a safe evacuation?	5	2
Theme.4 How to incorporate Disaster Risk Reduction into land use strategies?	0	5
Total number of relevant questions	11	15

Afterward, the Action Plan Workshop was conducted. Participants from relevant agencies both of Denpasar City and Bali Province discussed four themes above and wrote down their opinion about; A) Current Situation regarding the issue; B) What have been done about the issue; C) What kind of action is necessary for the issue. As a result, more than 150 opinions and suggestions were collected.

Figure 10: Action Plan Workshop

Finally, as a result, necessary action items for future urban resilience were identified by Denpasar City based on the result of action plan workshop as shown in Table 6.

Table 6: Action item list for future urban resilience identified through the case study (extract)

Category	Action item	Period		
		Short	Mid	Long
Priority 1. Understanding disaster risk				
Hazard map	Updating hazard map		○	
	Sharing hazard map		○	
Risk Assessment	Update risk assessment and evacuation analysis based on the updated hazard map		○	
Raising Awareness	Raising awareness through tsunami evacuation drill, workshop, and meeting.	○	○	
	Education and Raising awareness for agencies	○	○	
	Cooperation with universities including GIS training	○	○	
	Strengthen community awareness through community events, exhibitions, workshops, flyers, etc.	○	○	○
Priority 2. Strengthening disaster risk governance to manage disaster risk				
	Rearrangement of Masterplan Bencana and PRB		○	
	Regional action plan for all department based on close communication between all department		○	
	Improvement of Land use planning(RTRWK) considering hazard potential	○		
	Involve other sectors (e.g. private or community) in DRM and DRR		○	○
Priority 3. Investing in disaster risk reduction for resilience				
Prevention and Mitigation of critical facilities and infrastructure	Prevention measures on three strategic area(Sanur, Benoa port, and Serangan), such as an embankment for Benoa Port		○	
	Improvement (or Relocation) of government offices in the tsunami prone area			○
	Relocation and prevention measures on important infrastructure including power plant, disposal facility, and so on			○
Prevention of tsunami with structural measures	Examine of Road embankment on the bypass	○	○	
	Examine of installation of Mangrove forest		○	○
Building and land use control	Building regulation in tsunami-prone area		○	
	Land use planning(RTRWK) considering hazard potential	○		
Priority 4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation, and reconstruction				
Evacuation facility and route	Designation of temporary tsunami evacuation facility	○	○	
	Installing temporary tsunami evacuation facility(tower)			○
	Data collection of high building and survey for candidate evacuation building		○	
	Designation of tsunami evacuation route	○	○	
	Rearrangement of Tsunami evacuation signage	○		
Equipment for tsunami evacuation	Installing evacuation equipment at government offices	○		
	Installing Tsunami Early Warning System			

evacuation	Installation of additional tsunami siren(alarm) in the inland area			
Evacuation Planning	Evacuation zone regulation in Denpasar Land use planning	○	○	
	Designation of place on gathering facilities including hospital and school	○	○	
	Preparing for community-level tsunami evacuation map	○	○	
	Evacuation Drill on community, school, and hospital	○	○	
	Consideration of traffic jam during the tsunami evacuation	○	○	
	Examination of alerting and supporting for evacuation of tourists(cooperation with the hotel)	○	○	
	Encouragement for more hotels to renovate their facilities to add evacuation facilities to receive certification from BNPB Bali Province	○	○	○

4. Conclusion and discussion

This checklist aims to provide administrative officials with a simple tool to assess the existing capacities of a target DRR, keeping in mind the capacities that local governments actually need in order to achieve effective DRR. Through the case study, following advantages of the checklist were confirmed with Denpasar City.

- The Checklist could enable Denpasar City to understand the current status of DRR and clarify its strength and weakness with the quantitative result according to the four priority actions of SFDRR.
- Active discussion and cooperation regarding DRR among relevant organizations in Denpasar City were emerged through conducting the Checklist and Action plan workshop.
- The Checklist played in useful role in enabling them to identify necessary actions to enhance DRR and formulate an action plan.
- The plan-do-check-action (PDCA) cycle is one of the essential activities expected to secure and enhance DRR activities. This Checklist can be utilized for benchmarks and monitoring tool of DRR

On the country, the following discussions were presented through the discussion between the authors and Denpasar City.

- The checklist does not require submission of any evidence. For this reason, in some cases, answers do not seem to be given appropriately. In the future, measures should be taken so that respondents can sincerely participate in the checklist assessment by either submitting evidence documents or writing names of evidence documents in an answer sheet.
- The checklist provides the default respondent sector for answering each question as shown in Table 4. In addition to that, Denpasar city clarified respondents with the specific department name at Denpasar city, which enabled participants in the checklist workshop to answer smoothly. On the occasion of disseminating this checklist to other ASEAN member states, respondent sector should be interpreted with specific department name in their states.
- It was suggested that this kind of checklist should be conducted every year based on the evidence of relevant activities, assignments of responsible respondents with monitoring activities. Therefore, it is necessary for implementation scheme of the checklist in the local government, while national governments are also required to guide utilization or operation by the provision of its guideline and incentive.

Based on the advantages and issues found during case study, our team will consider further research including monitoring future trend of the resilience score at Denpasar city.

Acknowledgment

The authors are grateful to Denpasar City local government for helping and cooperating during a case study of the checklists. We would also like to thank the ASEAN Committee on Disaster Management (ACDM) Working Group on Prevention and Mitigation and JICA for their support and valuable input on developing the checklists.

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Development of resilience improvement programs for a large university system: the case study of the Instituto Politecnico Nacional after 2017 Mexico earthquakes

Norberto Dominguez [a,*], Luis Botello [a], Guillermo Guerrero [a]

[a] ESIA Zacatenco Instituto Politecnico Nacional of Mexico, Mexico

Abstract

The last disastrous earthquakes occurred in Mexico on September 2017 linked to the population's increasing fear induced by the recent earthquake of February 16, 2018, showed the urgent necessity of implementing specific resilience programs for different type of communities (large urban cities, rural villages or coastal settlements) to facilitate the recovering of the normal life in the shortest possible time, adapted to the local conditions of any community. The aim of this work is to present the application of the *Five-Fingers Resilience Improvement Program* (5FRIP) on a university campus (the largest Civil Engineering School of Mexico with more than 6000 students) as well as some of the original results obtained. The 5FRIP is a proposal for auto-organizing geographical-organizational-social delimited urban systems potentially affected by a combination of multiple hazards as earthquakes, hurricanes and/or flooding. The case study has a peculiarity that affected -and enriched- its application: the third "finger" was being applied when the two large earthquakes hit Central Mexico in September 7th and 19th, 2017. Due to this, it was possible to configure and create a Civil Engineering Committee for Structural Safety as an active decision taken on the framework of the 5FRIP "Finger Four: actions and decisions".

Keywords: Mexico earthquake 2017; Resilience Improvement Program; 5FRIP; University campus.

1. Introduction

"*Resilience*" has become a fashion-word and politically correct to use in all kind of forums; eventually, the term was borrowed by different disciplines (even for psychological studies) thanks to its core-meaning: "recovery after shock", and adapted to several situations, being highly revaluated by the studies concerning climate change. Nevertheless, the term finds its origins in *Structural Mechanics*, where **resilience** is understood as the total strain energy stored in a body, which allows to recover its initial configuration after being deformed by a set of temporary loadings. Depending on who is using the term, the definition of resilience might vary according to the corresponding needs, but in general, resilience refers to the capacity of a community to recover in the shortest possible time after a disastrous event occurs interrupting its ordinary activities, reducing and controlling any long-term stresses and uncertainties (Boroschek et al., 2014).

In the field of the Civil Engineering, structural engineers are misleading this term as a new version of the **Performance-Based Design**, focused in designing buildings and structures for a specific seismic performance. Nevertheless, resilience goes beyond this definition becoming much more complex, due to the importance of protecting not only the building but also its infrastructure to preserve the operability of the whole system. Unfortunately, the social and economic conception of resilience has been misunderstood; as a recent report of OECD (2014) noted: "*Some narrowly interpreted resilience as 'better' food security and livelihoods planning, or just another way to look at disaster risk reduction. Such cynicism and confusion reinforced a feeling that resilience was just another 'buzzword' or 'fad', devoid of real meaning for programming*". One of the greatest risks of this ambiguity and misinformation is the fast and wide implementation of governmental programs for protecting endangered communities, without a clear comprehension of the resilience's underlying ideas.

From the wide collection of resilience approaches developed around the world, two main tools have taken shape over time, becoming a central key to transform ordinary communities in resilient urban regions:

- The Resilience Improvement Programs (RIP)
- The Resilience-Based Design (RBD)

* Corresponding author. E-mail address: norberto_dominguez_mx@yahoo.com.mx

For a general definition, the aim of a **Resilience Improvement Program** for a specific community is to identify weaknesses and strengths related to the own social and technical organization, to provide basic criteria for decision making and to propose actions easily assimilated by the local population of the affected region, to be applied before, during and after one or multiple disasters. Concerning to the **Resilience-Based Design**, this is conceived as the safety evaluation of the structural integrity and stability of a critical resilient system (it means a central structural system connected to different vital components including infrastructure) which operability must be guaranteed before, during and after any hazard happens, to ensure the recovery of the affected region.

Based on the foregoing, the CONACYT's project 2015-1187: "*Development of a pilot plan for the improvement of resilience of a region vulnerable to earthquakes and/or floods, for large urban concentrations in the Mexican Republic*", seeks to develop a methodology for both items, RIP and RBD. In this work, we introduce a methodology to elaborate Resilience Improvement Programs (RIP) for any Mexican community, susceptible of suffering the effects of a catastrophe induced by multiple hazards, that we called the "*Five-Finger Resilience Improvement Program (5FRIP)*". This one is described in the second section of this paper; afterwards, we present the application of the 5FRIP proposal in a university campus placed in Mexico City in the third section, with the analysis of some partial results. Finally, some preliminary remarks and comments are appended in the conclusions.

2. The Five-Fingers Resilience Improvement Program (5FRIP)

The original objective of the 5FRIP (*Five-Fingers Resilience Improvement Program*) is to propose a primary methodology that will help to build a Resilience Program for any Mexican urban region -continental or coastal-, susceptible of suffering the effects of earthquakes and/or flooding. After the 2017 Mexico earthquakes, it was necessary to verify if this proposal could be applied for other kind of closed system, as it could be a large Institutional System (like the Instituto Politécnico Nacional of Mexico) or an Enterprise System (like a private Transportation or Communication System): this lead us to formulate a multi-layer model to complete the proposal, as it will be explained here.

2.1.Description of the 5FRIP

Two of the most important requirements that any Resilience Program ought to accomplish to be feasible of being adopted by a community, is simplicity and naturalness. Inspired on these ideas, we performed a methodology based on the five fingers of the human hand - indeed, for the resilience student team it was easier to remember the steps by using their own fingers. The *Five-Fingers Resilience Improvement Program* is composed by the following five steps (see Figure 1):

1) Nucleation;
2) Public Survey and RC-Detection;
3) Resilience-Based Design;
4) Actions and Decisions;
5) Implementation and Retrofitting.

Figure 1: The Five-Fingers Resilience Improvement Program.

Finger 1: Nucleation

We define nucleation as the creation of a cluster of three actors: a) proactive and well-known persons within community; b) local authorities -or a local representative-; and c) engineering experts, trained in the development of local RIP's, according to the 5FRIP's recommendations. This group will be identified as the ***Resilience-Seed-Group*** (RSG).

Finger 2: Public Survey and Resilient Core Detection

The main objective of this step is to involve the population in the necessity of building its own resilience plan, and mostly, to give it a central role in the development of the plan, taking account of its opinion and point of view about hazards and needs, even if these differ from the previsions of the local authorities or the RSG members. The detection of a potential Resilient Core (or Resilient Command Centre) is done through three parallel approaches: i) the **Technical** approach (based exclusively in technical criteria); ii) the **Social** approach (Public survey applied to the community); and iii) the **Strategic** approach (supervised by the local authorities depending on political or economic criteria).

Finger 3: Application of the Resilience-Based Design to the Critical Resilient System

Once identified the Resilient Core, the main idea is to revise it according to the Resilience-Based Design, using numerical nonlinear analysis as well as multi-risk methods (Ibrahimbegovic et al., 2014), to prevent any possibility of malfunction of the Resilient Critical System, beyond the requirements of the local construction codes. According to the 5FRIP, the RBD must be applied in two phases:

a) **First phase** for evaluation of the real state of the Resilient Core and its components, in case to be subjected to potential scenarios of combined extreme hazards.

b) **Second phase** for reinforcing and restructuring of the Resilient Critical System, based on higher security requirements, to guarantee the operability and functionality of the RCS.

Finger 4: Actions and Decisions

After evaluating the Resilient Core, according to the procedure of the RBD-phase A (finger 3), a technical report must be elaborated describing the structural real state of the resilient critical system and its response to catastrophic scenarios, covering the regulatory structural revision as well as a complex nonlinear analysis. This report must provide information about the economic and social consequences on the urban region of protecting or not the Resilient Critical System against any partial or total interruption, after the occurrence of any potential hazard. The analysis of these consequences must be done jointly by the RSG and the local authorities, who are the responsible of taking any legal decision about provisions, which can be classified in two categories:

- **Active actions**, referring to the potential reinforcement of the Resilient Core and its components, applying the engineering procedure of the RBD-phase B.
- **Passive actions**, corresponding to the minimal provisions to be executed by the community if the structural reinforcement of the Resilient Core is not possible, supervised by the local authorities.

Finger 5: Implementation and Retrofitting

Based on the actions and decisions taken on the step 4, the RSG will proceed to inform and make the community aware of the future actions about resilience to be applied on the urban region, foreseeing their assimilation in the population through its participation on the local plan.

2.2.A multi-layer dynamic model of seven levels

As mentioned before, the complex behaviour of any urban system during an extraordinary event and for the next 24-hours, can be simulated with a Multi-layer Dynamic Model, composed by seven layers; each layer gives

support to any specific subsystem. The layers may be temporally activated or deactivated according to the real situation in a period of 24-hours. The layers -from bottom to top- are classified as follows (see Figure 2):

Layer 1: Cell-community;

Layer 2: Building and infrastructure for community's resilient support;

Layer 3: Critical Resilient System (Resilient Core and its components);

Layer 4: Resilient Mobility interconnectivity;

Layer 5: Institutional Network;

Layer 6: Enterprise Network;

Layer 7: Federal / International /NGO Super-cover.

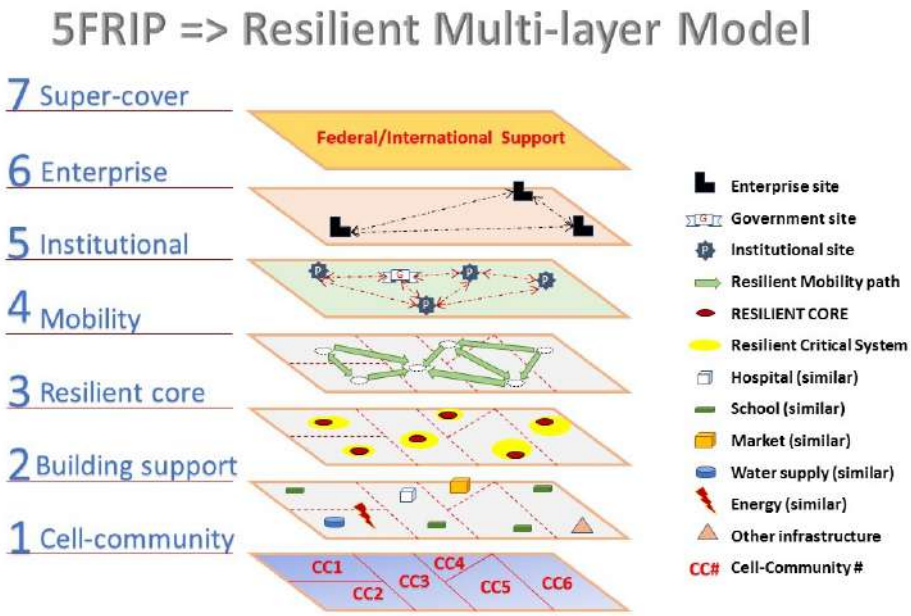

Figure 2: The Seven levels Multi-layer dynamic model.

3. The application of the 5FRIP in the Civil Engineering School of the Instituto Politecnico Nacional of Mexico

In this section, we describe how the Five steps of the 5FRIP were applied to our University region of study, namely the Campus Zacatenco of the Escuela Superior de Ingenieria y Arquitectura, which belongs to the Instituto Politecnico Nacional of Mexico. Originally, the main idea was to characterize a representative prototype of a urban region located on Mexico City vulnerable to earthquakes and floods; taking account of our initial resources, as well as the advantages (mainly, to have a high-educated population concerned to the risks) and disadvantages of studying the resilience of a civil engineering school, it was decided to test the proposal in a controlled community with more than 7000 members, integrated by students, teachers and the educative support staff. It must be highlighted that the occurrence of the earthquake on September 19, 2017, boosted the development of the "fingers" 4 and 5 of the pilot project into the School, as it will be explained further in the analysis of the preliminary results.

3.1.Finger 1: Nucleation of the ESIA's Resilient-Seed-Group

Constitution of the RSG

The **Resilient-Seed-Group** (RSG) was initially integrated in 2015 by three professors of postgraduate studies, 10 civil engineering undergraduate students and 3 civil engineering master students, focused in developing and testing some survey tools to make the consultation of the community. Afterwards, the RSG evolved in its resilience actions distributing the engineering activities among the members organized in commissions, which were working in different aspects related to the Resilient Core and its components.

Definition of the zone of study

The campus of the *Escuela Superior de Ingeniería y Arquitectura Unidad Zacatenco*, is located in the political delegation of Gustavo A. Madero, at the northern part of Mexico City (see Figure 3), very close to the "*Chiquihuite*" hill, a volcanic dome with an elevation of 2730 m above sea level. Placed within the lake zone in the Valley of Mexico, the soil of this region is characterized by clay being highly compressible.

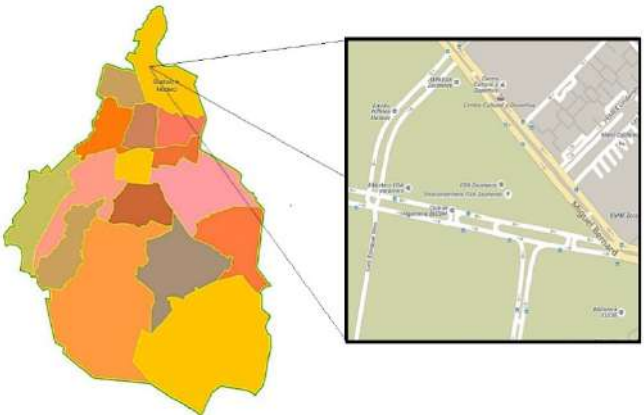

Figure 3: Location of the Campus of Zacatenco at the North of Mexico City.

3.2.Finger 2: Public survey and Resilient Core detection

Analysis of the social characteristics of the ESIA Zacatenco's community

Based on the estimated data provided by the direction of the Civil Engineering School, in 2017 the *Escuela Superior de Ingenieria y Arquitectura Unidad Zacatenco* had a population between 6500 and 7000 individuals. For our research, this population was classified according to the following groups:

- Undergraduate students (nearly 6000 individuals)
- Postgraduate students (nearly 350 individuals)
- Undergraduate lecturers (nearly 500 members)
- Postgraduate professors (nearly 50 members)
- School administrators (nearly 25 members)
- Administrative staff (nearly 125 manpower)
- Maintenance and cleaning staff (fluctuating number < 50 individuals)
- Security staff (3-5 officers)

Briefly, around 83.0% of the total population are undergraduate students, while 5.0% are postgraduate students. The whole set of lecturers and professors represents around 8.0%, while school administrators are just around 0.35% of the population. It can be deduced that almost the whole population has a higher education compared to a typical Mexican community.

Development and application of the public survey

The conception, development and application of the survey tools to evaluate the resilience perception of the community was responsibility of the RSG. For the survey, only a sample extracted of four social groups were consulted:

- Undergraduate students
- Postgraduate students
- Lecturers and professors
- School administrators

Afterwards, the sample was reclassified in two major sets:

- **Population**: a set of individuals integrated by undergraduate and postgraduate students, lecturers and professors
- **Government**: only school administrators.

The survey was composed by 12 questions that were applied using different consulting tools, including internet, emails, iPad interviews and paper questionnaires: some of the survey results are analysed in the next Section. From the analysis of the survey data, it was determined that most of the community considers the library building as the best candidate to become the **Resilient Core** of the potential *Resilient Critical System* for the civil engineering school (see Figure 4).

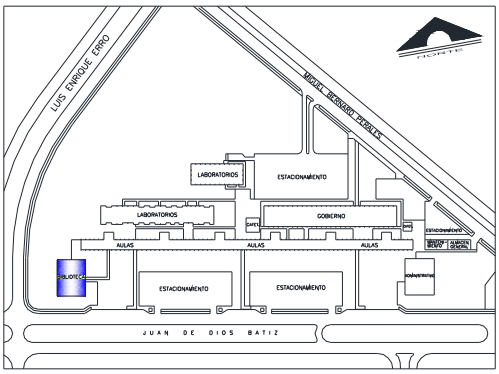

Figure 4: Location of the Resilient Core of the Civil Engineering School: the Library Building.

3.3.Finger 3: Applying the Resilience-Based Design to the whole Campus (multi-scale numerical strategy)

As a pilot project, we decided to proceed only with the Phase A of the Resilience-Based Design methodology that we are also proposing in the framework of the CONACYT-project 2015-1187. According to this numerical methodology, it is possible to adopt a multi-scale strategy based on finite elements, to simulate not only the seismic response of each building, but also the dynamical response of the whole campus at the Mega-scale. It should be recalled that the aim of the phase A is to determine numerically a realistic structural response of the main buildings, in case to be demanded by a strong earthquake.

The analysis and simulation of the ESIA Campus Zacatenco was done at two different scales: the mega-scale and the macro-scale. At the mega-scale, pseudo-buildings and some layers of soil are modelled using a 3D mesh of 8-node cubic elements, leaned on absorbing boundary conditions to eliminate the spurious reflections of the realistic earthquake waves that will be applied on the bottom surface of the model. The resulting displacements are transferred to the local macro-model of each building to reproduce its expected linear and nonlinear seismic response. The numerical modelling in both scales (Mega and Macro) was made in the Finite Element Program FEAP (Taylor, 2001). A fully description of these numerical simulations can be consulted in Botello and Dominguez (2017).

3.4.Finger 4: Actions and Decisions during and after the earthquake on September 19, 2017

According to the original RSG's schedule, it was planned to have a meeting with the administration of the Civil Engineering School at the end of September 2017, to show the survey's results as well as the proposal of reinforcement for the Library Building as the potential Resilient Core of the School. It should be said that the RSG was preparing a list of passive actions, but the occurrence of the earthquake on September 19, 2017 changed deeply the perception of the community and the authorities about the seismic events, as it is explained in the next section.

3.5.Finger 5: Implementation and retrofitting

Before the September 2017's earthquakes, the RSG was preparing some advertising posters for the members of the community, focused in explaining what resilience means. The main idea was to distribute and poste all these posters into the Campus facilities in some visible points, to inform the community about the survey's results and the importance of adopting resilience. After the earthquakes, there was a huge social pressure of the IPN's community (namely students and administrative worker unions) against the authorities concerning to the

structural safety of the different polytechnic buildings and facilities (three large schools of the Instituto Politécnico Nacional were seriously damaged). Due to this, it was necessary to promote informative engineering meetings using a technical language intended for different kind of people, in parallel with the construction works for building's reinforcement. Some of the positive findings of these meetings are explained in the next section.

4. Analysis of the preliminary results and the effects of the earthquake of September 19, 2017

In this section, we present some of the preliminary results associated to the 5FRIP applied on the Civil Engineering School. It is very important to mention that the Social Survey (Finger 2) as well as the multi-scale modelling of the Campus (Finger 3) were done before the occurrence of the earthquakes in September 2017, while the active actions were unexpectedly boosted after the seismic events, reaching the level of the whole Instituto Politécnico Nacional, with a national population of 178 000 students and 16 600 lecturers: as a result of this research, it will be created the Institutional Committee of Security and Resilience of the Instituto Politécnico Nacional.

4.1.Analysis of the Social Survey's results

For the public survey, a questionnaire of 12 interrogatives was elaborated and applied in different events (internal conferences, personal interviews, classroom visits) among the population. The whole set of responses obtained were analysed and treated separately, but in this paper, we will only discuss the results of three main questions.

Question 1: about possible contingencies

Mexico is a large country very vulnerable to different catastrophic natural hazards, but they affect mostly by regions, some with a major intensity depending the region´s location. Even if this question seems to be obvious, it is necessary to verify the community's perception about any possible contingency. In this case, we verified that for most of the community (more than 85% of the population), the earthquake is considered the most dangerous risk in the zone, followed by fire and explosions, as it can be seen in Figure 5.

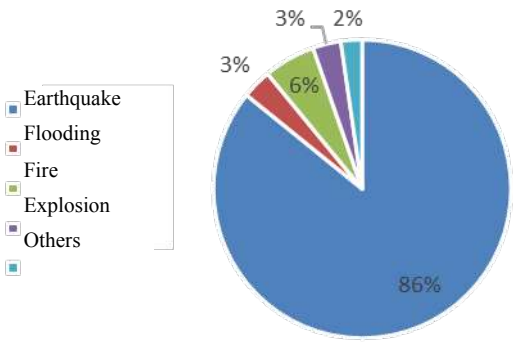

Figure 5: Perception about any possible contingency at the ESIA Zacatenco Campus

Question 2: about the safest building

In which concerns to the community perception about the safest building, it is important to highlight that this opinion is very influenced by the type of local contingency considered the riskiest. Consequently, people related this question to an earthquake event, giving the results shown in Figure 6. Most of the community members considered the open areas as the safest location inside the campus (without thinking in the case of floods), while the three large buildings that host all of the classrooms, were considered the less safe on the campus.

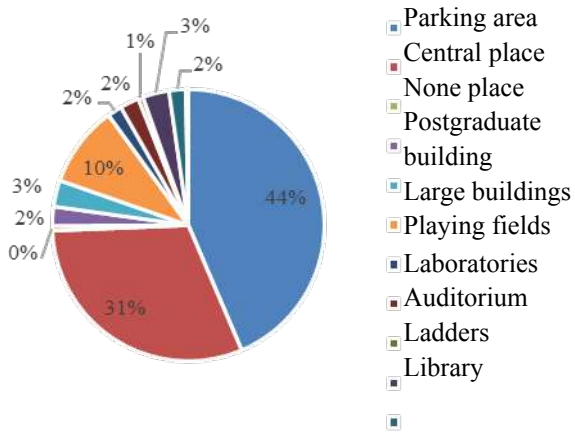

Figure 6: Perception about the safest place at the ESIA Zacatenco Campus

Question 3: about time of recovering

*After a major shock in any region, the members of the affected community might be suffering commotional effects, that can be expressed in such different ways. In all cases, the population expects a rapid response from the local authorities, even if the individual perception of "*how much time the community must wait*" varies considerably. In the case of the ESIA Zacatenco community, the results show a high exigence for the time of response, giving a time of 12 hours as a maximum (see Figure 7). We believe that these results are related to the fact that most of the members are very young (undergraduate students) and they expect a fast reaction which is not always possible.*

Choice of the Resilient Core

In general terms, the population expressed different opinions about the nine buildings presented in the survey, contrasting with the response of the school administrators, who considered only **four** of the nine signalled buildings as a possible candidate to become the **Resilient Core**. Finally, the Library Building is considered the best candidate for most of the population according to the public survey.

Figure 7: Perception about the recovering time after shock, according to the community of the ESIA Zacatenco

4.2.A preliminary evaluation of the numerical seismic response of the buildings

In which concerns to the application of the ***Resilience-Based Design*** (*finger 3*), the university urban region was analysed at the mega-scale, while the resilient core -the library building- was modelled and analysed at the macro-scale, based on the data derived from the mega-scale analysis. The mega-scale model was excited with an earthquake signal induced at the base of the soil -which was modelled with 3D solid elements-, and the

maximum displacements of each building were recorded in a file database. These numerical results show that the library building has an isolated response without any dynamic coupling with any other structure. Furthermore, the Mega-scale simulation allows to verify that there are no interferences between the different buildings lying on the campus. The corresponding displacements of the Library Building were introduced into the local model, to effectuate an incremental linear analysis, that will be followed by a nonlinear structural analysis -still in progress. At the same time, a structural revision of the Library Building was done according to the local regulatory construction code of Mexico City.

4.3. *A summary of the active actions adopted in the Instituto Politécnico Nacional of Mexico after the earthquakes of September 2017*

The Mexico's earthquakes of September 2017 allowed to prove the real efficacity of the Civil Protection protocols developed during the last 30 years over the country, as well as the readiness and responsiveness of authorities, engineers and collectives. In the case of the community of the Civil Engineering School at IPN, we witnessed two unexpected situations:

a) In one side, local population and authorities turn to seek the help of engineering experts in the following days after the event, through the support of societies, associations, schools or any other, even if these groups needed to deal, first at all, with their own problematic.

b) In the other side, the resilience project CONACYT 2015-1187 was boosted to the level of the whole Instituto Politécnico Nacional, where a set of actions will be adopted in the short term.

Based on this dramatic experience, the following initiatives were launched in the last six months:

- An internal plan for the Instituto Politécnico Nacional with a list of actions to be implemented at the short, medium and long-term.
- A 24-hours reaction protocol intended for the authorities of each Polytechnic school or office.
- The enhancement of the scopes of the resilience project, as well as the incorporation of new students and professors.
- The implication and conjunction of the three main Polytechnic schools related to structural safety of buildings, infrastructure and patrimony: The Civil Engineering school (Zacatenco campus), the Architectural school (Tecamachalco campus), and the Earth Sciences school (Ticoman campus).
- Based on the last actions, the Instituto Politécnico Nacional will be the first National Educational Institution in Mexico that will launch an Institutional Committee of Security and Resilience to deal with these issues.

5. Conclusions

The development of a new proposal called the "*Five-Fingers Resilience Improvement Program* (5FRIP)", and its application on a Mexico City's University Campus were presented in this work. The 5FRIP is integrated by five steps: i) Nucleation; ii) Public Survey and RC-Detection; iii) Resilience-Based Design; iv) Actions and Decisions; v) Implementation and Retrofitting. As a first approach, we applied the 5FRIP to the campus of the *Escuela Superior de Ingeniería y Arquitectura Unidad Zacatenco*, creating a **Resilient-Seed-Group** (RSG), who developed the survey tools and questionnaires used at this research. Based on these consulting results, it was detected that the Library Building is considered by most of the population, the **Resilient Core** of the Civil Engineering school. So, in parallel to the public survey, we proceed to simulate the seismic response of the campus of ESIA Zacatenco at the Mega-scale, obtaining reactions and displacements of each building located inside the campus, to transfer them to the local model of each concerned building. The Mexico City's earthquake of September 19, 2017 boosted the project CONACYT 2015-1187 to be implemented at the level of the whole Instituto Politécnico Nacional, being the first National Educational Institution in Mexico that will launch an Institutional Committee of Security and Resilience to deal with these issues.

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Regulatory mechanisms in intergovernmental relations and citizenship in risk governance in Portugal

Manuel Ribeiro [a,*]

[a] CERU – European Centre on Urban Risks, Portugal

Abstract

This paper discusses two specific types of risks and catastrophes, forest fires and earthquakes, highlighting their similarities and differences regarding risk-governance processes. About forest fires, it should be noted that the events of June and October 2017 have become a significant moment in the history of catastrophes in Portugal. Apart from the disastrous consequences of the high number of human victims, destroyed assets and burnt-out hectares, their effects have also spread across the political, social and economic dimensions that seem to reconfigure the existing risk governance processes, particularly on the exercise of an inclusive citizenship. In the same way, and assuming a significant weight around the mechanisms of risk governance, the debate has been centered on the seismic risk, due to the recovery and rehabilitation processes of part of the buildings in Lisbon, resulting, among other factors, from the current tourism development processes. Highlighting also intergovernmental relationship processes, namely in terms of production and legislative application, this situation has amassed a wide discussion over the role of professional groups and the population in general, in a communication process mainly centered on the domain of specialized protagonists, not always decoded for lay populations.

Keywords: Risk governance, intergovernmental relations, citizenship

1. Introduction

As social rupture processes, disasters derived from the articulation between society and the built environment. This assertion conducts the research of these phenomena for territories where various areas of approach are interfacing in their observation. One of these areas resides in the political and institutional relations between central and local administration, being a critical area of civil protection policies and actions. In this context, it is discussed the assignments, competencies and responsibilities to be taken in the light of disasters, namely regarding the whole cycle of catastrophes.

Another domain, also with significant representativeness in the analytical framework of civil protection, concerns the type of involvement of the populations in the activities of this system. The discussion on what kind of participation citizens should have in the policies and actions of civil protection is a recurring issue in disasters, taking relevance in the periods of relief and emergency, and immediately after them. The narratives and practises confronted here not always, or even rarely, are consensual between institutional actors, stakeholders, experts, and lay people.

A reflection will be carried in this paper on the implications arising from two types of risks and disasters which, while presenting distinct readings, and even different interpretations in the perceptions and representations of the population, have a fundamental importance in safety public policies in Portugal, either by action or by omission.

These are the situations associated with forest fires and earthquakes which, and above all in the former, record high levels of concern and discussion in the Portuguese society. It will be discussed both the social causalities and the practical and symbolic consequences that have been behind the emergence of new attitudes and behaviours. On the one hand, they have reformulated intergovernmental relations between central and local administration and, on the other hand, they have contributed for the change and (re)construction of relationship processes between the State and the populations, until then virtually non-existent or merely residual.

* Corresponding author. E-mail address: manueljmribeiro@gmail.com

2. A hierarchical model of risk governance

The assertion that Portugal can be characterised by a hierarchical model of risk governance must necessarily be supported explanatorily, identifying which domains lead to this finding.

Synthetically, five operational dimensions stand out – politics, citizenship, public engagement, concept of disaster, and operational management models – where, upon analysing their most individual components, its integrative articulation in an explanatory reading is promoted. It is in the result of this integration that the four ideal typical models of risk governance are obtained, namely directive, hierarchical, decentralised and cooperative, which are shown in Figure 1.

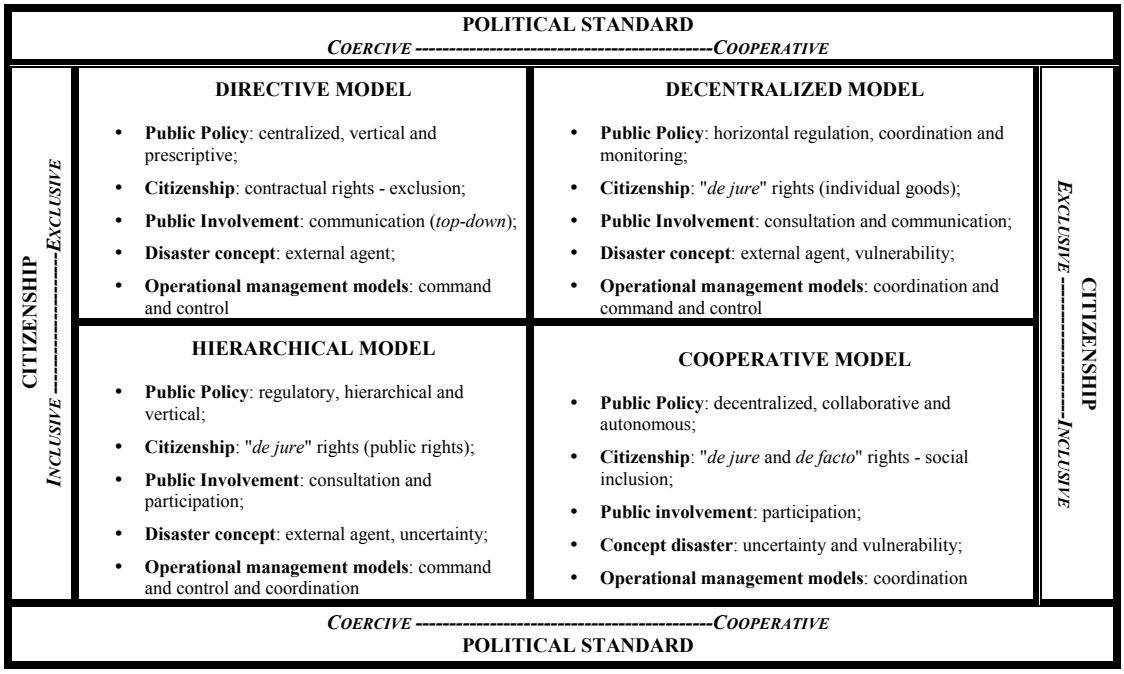

Figure 1: Risk governance models (Ribeiro, 2018)

The Portuguese system is characterised, generically, by a hierarchical typological model, with the following particularities:

- A vertical political standard, in which the central administration determines and prescribes the policies and guidelines of civil protection, seeing local authorities as regulatory agents;
- Citizenship rights are considered constitutionally as public goods, but presented as *de jure*, and not as *de facto*;
- Public involvement is based on communication flows of consultation, although there are examples of participation, notably in some participatory budgeting processes;
- Disasters still have a prevalence as external agents, although they are emerging, mainly through specialists, the shifting of this conceptualisation to vulnerability and uncertainty processes;

In operational management models, it prevails a Command and Control logic, which has been accentuating by the arriving of new protagonists. In any case, there are also processes of Coordination, mainly located in the field of decision and strategic management, albeit with less reflection in tactical actions and operational manoeuvring.

This interpretation of the risk governance that characterises the Portuguese system will be operationalised, based on the analysis of the situation of forest fires and the seismic risk, which will be further addressed.

3. 2017 forest fires as reconfigured processes of risk governance in Portugal

The forest fires of June and October 2017 are associated with some of the worst disasters ever recorded in Portugal. The consequences from these events resonated in various areas of national life, leading to strong media reactions and pressure from public opinion.

The high number of fatalities, destruction of property and of rural and forest heritage caused a political and symbolic earthquake in the State's governance structures. The shockwaves propagated across political, social and economic dimensions that even overflowed the national scope by escalating into international contours.

The State is confronted with its failures – constitutionally, the State must ensure the safety of the populations –, being forced to focus its interventions reactively and casuistically, to tin line with the pressures/social unrest, in purpose to minimize and reduce the impacts of their institutional vulnerabilities. As Mendes (2017) highlights: *"The resumption of the initiative by the State has materialised in a series of legislative initiatives, the constitution of commissions and mission units, (...) that emphasize the ad-hoc and unstructured character of the presence of the State, always within the logic of its perpetuation and (its) regulatory role".*

Two of those initiatives were the creation of the Independent Technical Commission (CTI) and the Council for the Compensation of Fire Victims (CIVI). The former with competences to promoting an assessment of the fires, and also to proposing recommendations for change and improvement in the civil protection and defence systems against forest fires, and the latter with the aim of defining the minimum values to be paid to the victims, and their relatives, as compensations. The consequences were also felt within intergovernmental relations, which contribute to explain some of the main vulnerabilities of the national civil protection system.

Portugal is characterised by presenting high regional asymmetries which are reflected in an unbalanced development of the country. An analysis centred on the genealogy of fires cannot neglect these processes and their consequences. It is in this context that we can interpret the public policies of risk governance, identifying actions and omissions which contribute for not betting or implementing development projects in certain regions, translating into failures in territorial planning with the consequences of abandonment and, therefore, the increase in risk of forest and rural fires.

Despite the diagnoses, strategies and plans that, reactively, always arise to (short)cut through the problems identified, the reality is that this set of intentions seldom finds correspondence with the realisation of the measures advocated.

For example, it should be noted that, after the 2003 forest fires, where about 426 000 hectares were burnt and up to 20 fatalities were registered, the Ministry of Internal Affairs (MAI) produced a *White Paper of Forest Fires* (MAI, 2003). In this document, it is mentioned the importance of not repeating similar situations, for which the government would develop a set of actions to avoid them. The results achieved were not the intended ones. Similar events occurred two years later, in 2005, having caused 17 fatalities and destroyed about 340,000 hectares. Once again, these events came to be the source of new legislative reforms, introduced both in the civil protection and defence systems against forest fires.

It is approved in 2016, by Resolution 65/2006, the National Forest Fire Defence Plan (PNDFCI). This diploma defined the strategy and guidance of public policies towards forest land. In the same year, Decree-Law (DL) 124/2006 of 28 June defined the roles, both in relation to structural prevention and to the competencies and responsibilities for action.

This legislative sequence will promote a first amendment to DL 124/2006, with the publication of DL 17/2009, of 14 January, where it is referred: *"The obligation for municipalities to have a Municipal Forest Fire Defence Plan (PMDFCI), defining (...) their criteria, and reinforcing the importance of the Municipal Forest Fire Defence Commissions (CMDFCI) constitution, in all the country's municipalities"* (Ribeiro, 2018, p. 273).

It was added in article 10 (4) of the same diploma, *"The elaboration, implementation and updating of the PMDFCI is mandatory, and the municipal council should devote its implementation in the context of the annual activity report",* and in paragraph 7 of the same article, *"(...) shall only be entitled to subsidies or benefits provided by the State the municipalities that have PMDFCI approved*".

The directive and hierarchy logic is evidence in intergovernmental relations. DL 124/2006 confirms that assignments, competencies and responsibilities are located at the level of the central government entities and services. One example is the impositions of the methodologies to be followed upon the elaboration of these instruments, not distinguishing between rural and urban municipalities, with results that, naturally, distort the reality. The change produced with DL 17/2009 is also mandatory to local administrations. They should have PMDFCI and CMDFCI, with the caveat that, without these instruments, there will be no subsidies or benefits from the State.

In short, two problems emerge here: some municipalities simply fail to comply with central determinations; others, despite complying, they do it as a formal obligation and not as a preventive practise of risk management. Because of that, they didn't produce any kind of effect or the results fell short of expectations.

Analytically, a twofold dimension problem arises in intergovernmental relations, as one of the explanatory factors of the social and institutional causes of forest fires.

On the one hand, within central government, a prescriptive attitude, strongly hierarchical and vertically regulatory, of the guidelines and measures to be implemented by the local levels, to which there is imposition of penalties, in case of non-compliance. In centralist logic, two readings should be had: one, the assumption manifested that their obligations and responsibilities were resolved with the legislation; other, the latent confirmation that civil protection is not a fundamental area of government activity.

On the other hand, and with regard to local authorities, there are also several implications, which help to explain these behaviours:

- Firstly, a lack of political culture that depicts some local leaders. Responsible for the management of their territories in emergency situations, they would have a structure to deal with these disasters. The local level is the first answer to emergency situations. However, some perceptions still consider forest fires with low probabilities, not justifying the organisation of a local system of safety and, in some cases, they don't have any dispositive;
- Secondly, the consideration that investing in prevention and emergency response seems to divert resources that would be more useful in other types of interventions, that have a more emblematic and visible nature to the municipality;
- A third explanation can be found in the deficit of pressure that the populations and communities themselves exert before the institutional powers, in relation to safety issues. These pressures, as studied, only emerge when citizens are, directly or indirectly, affected on their safety;
- Finally, a principle that is strongly rooted in social perceptions and representations, in which it is considered, as constitutionally defined, that the citizens safety is a competence of the State, bridging the shortcomings of other governmental levels.

The analyses of intergovernmental relations within political and institutional domains is, thus, an important contribute to the explanation of social causalities of forest fires. The main discussion here concerns about the role of the two levels of administration, central e local. In Portugal, this hierarchical model of risk governance accentuates the presence of a prescriptive regulation, where local levels are considered as regulatory agents and not as regulatory administrators.

Centred on the involvement and participation of the populations, the fires of 2017 also demonstrate the change of existing paradigms in the relationship between civil society and State.

As Mendes (2017) refers in an opinion article, in an allusion to what he defines as "*institutional accountability and standardization of deviation*", *"Extreme situations reveal how institutions work and they should be analysed as indicators of the type of state, social contract and existing civil society, and the ability to mobilise people, social groups and communities*".

The response of civil society is unequivocal here, assuming an active role in much of the subsequent post-catastrophe processes. Concerning the disaster of June 2017, the Association of the Fire Victims of Pedrógão Grande (AVIPG) was created, and it was constituted as a stakeholder in the negotiation with the State about the subsequent policies for the affected victims and burnt areas. This assumption, close to the right to have rights principle, is understood as a requirement of an inclusive citizenship exercised by the populations of the affected areas.

In any case, the State continues/will continue, in a hierarchical logic, to exercise its institutional prerogatives. Thus, and despite the inclusion of an AVIPG element in the aforementioned CIVI, the responsibility of fixing the final value of compensation lies only with the Ombudsman, without including the AVIPG. According to Mendes (2017), "*placing the final decision on distant entities of the victims (...) and their families*, ends up being a wasted opportunity for *"the State and civil society to constitute, outside of a logic of acting Ad hoc and case-by-case, conventional and institutional mechanisms to meet the victims of extreme events or disasters*".

The unequivocal translation into/as to risk governance processes, in its political and citizenship assertions, finds explanatory translation in Mendes (2017), when he states that, "*The biggest consequence of the major fires of June and October in Portugal was the confirmation of all its vulnerability before extreme events, in a country guided by bureaucratic logics of planning and civil protection, and fully based on the projections of experts and without direct participation of interested parties*".

4. Seismic risk: perceptions and social representations in risk governance

The interpretations around the seismic risk, characterised by their alienation to metaphysical, natural or unknown territories, which generally reflect an exemption of responsibilities in implementing public policies of prevention and social organization. Understood as unavoidable and uncontrollable fatalities, they also explain the few attitudes and behaviours claimed to the State by civil society. However, these processes have recorded significant changes, and there are new references that acknowledge the transformation in these perceptions and representations, among certain social protagonists, namely technicians and researchers from various scientific areas.

In this respect, one of the discussions that has been most felt is related to the rehabilitation processes of buildings in Lisbon, and in other Portuguese cities, emphasizing the risks associated with these operations, by the circumstance that the law does not oblige the structural reinforcement of seismic resistance in the existing buildings. Inextricably linked to one of the most striking disasters in universal history, the 1755 Earthquake, Lisbon is located in a region of moderate seismic hazard, being expected to be affected sooner or later by the consequences of an analogous event. Thus, the importance of taking into account and reducing the buildings seismic vulnerability of the buildings is a subject area of paramount attention, making the difference between the eventual decrease, or increase, of the number of victims by the occurrence of an earthquake.

The city of Lisbon, as well as Portugal, has been a very sought-after tourist destination in recent years. A significant number of tourists have been acquiring buildings or apartments in the city for their habitation. Therefore, a huge increase in rehabilitation works were registered, namely in degraded buildings without seismic resistance.

To address this increase in rehabilitative interventions, the State legislated, exceptionally, on the subject, having published DL 53/2014 on April 8, with the aim of facilitating and simplifying the constructive processes. This diploma regulates the urban rehabilitation sector. Article 9 points out that "*interventions in existing buildings may not diminish the safety and health conditions of the building or the structural and seismic safety of the construction*".

However, although it is said that it is not allowed to diminish safety conditions, much of the intervention is done in ancient buildings, which, in their original construction, never contemplated seismic resistance measures. A lot of buildings are from the '30s, '40s and '50s, marked by the absence of mandatory seismic resistance legislation. Because of that, and with the contribution of other factors, namely the introduction of dissonant elements and the bastardization of the buildings themselves, all contribute to the increase on the physical vulnerabilities of the building stock.

This problem manifests itself in risk governance processes. In intergovernmental relations, it is noted a divided attribution of responsibilities, with a greater burden on central government given its national responsibility legislative. The municipality critics the government but, at the same time, takes advantage of this legislation so as not to inspect, in loco, the rehabilitation works. Thus, it allows restoring many degraded buildings, although this restoration is mainly at the level of the facades, not considering the essence of its seismic resistance, with the subsequent safety issues.

This lack of harmony, as mentioned regarding forest fires, has a reading in the type of existing governance model. Once again, the hierarchical and vertical modelling of the regulatory mechanisms is present and, while recognizing in its official narratives the importance of its change, the situation is dragging without any modification.

In an article published in the newspaper "*Diário de Notícias*" of January 5, 2017, it was attributed to the Secretary of State for the Environment that "*The Government wants to review the legislation of urban rehabilitation to compel the rehabilitation of buildings to be preceded by evaluations to their seismic resistance (...)*". As it turns out, after more than a year, the situation remains the same without any evolution, accentuating the existing risks as an effect of interventions only carried out in facade works, without structural consistency. As known, the earthquakes are not foreseeable.

In the field of an active citizenship, there are two types of consequences and effects. On the one hand, and reflecting a more participatory attitude, it is, above all, in the field of technical and scientific stakeholders, empowered as specialists to take a position about risk and safety, but not always or rarely, having the indispensable capacity to pressure the State to reformulate its action. Once again, the constitutional principle, that it is a State responsibility to ensure public safety, must be present.

On the other hand, the parameters defined by Somers (2008) related to the concept of market fundamentalism are found in a more passive manner. In the absence of control and monitoring by the State, both at local and central levels, it remains up to the citizens to acquire their security and pay it in terms of markets.

5. Final remark

The analytical evidence of risk governance models constitutes an important aid for the explanation of the regulatory factors mechanisms between State and civil society, both in the field of intergovernmental relations, between central and local administration central, and in the processes of involvement and public participation of citizenship.

The confrontation with public policies finds relevance during extreme disasters that affect territories and populations. This evidence is demonstrated by the comparative exposure between the processes arising from forest fires and those resulting from representations and perceptions of seismic risk. In relation to the former, there is a reaction by the State in the resumption of its regulatory logic but including concessions as an effect of public and media pressures. In the case of seismic risk, both due to the effect of depersonalization of this hazard and to its impersonal symbology, it can be found to be non-integrated given its non-problematic status in the immediate risk governance options.

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A modified needs assessment method in post-disaster recovery processes

Anshul Puriya [a,*], Arindam Biswas [a]

[a] IIT Roorkee, India

Abstract

The paper proposes a new method of needs assessment in which the skills and abilities of the affected individuals are used in the recovery process thereby enhancing community resilience. The method involved studying the current assessment strategies and suggest inputs in the assessment process based on the literature study. The literature review advocates the use of skills of the affected community in the recovery process. A better cooperation among all stakeholders working towards enhancing the disaster resilience of communities can only be achieved if the expectations or the needs of each stakeholder are understood. This study would help the Post Disaster Needs Assessment (PDNA) coordination team involved in the disaster recovery to become aware of the specific abilities and skills of the communities affected by disasters and use them for the purpose of developing their resilience to future disasters. The findings from the study would be useful for governments, NGO's and related organizations working in the field of disaster recovery to create the recovery plan as per specific skills and competencies of the affected community.

Keywords: Post-disaster recovery process; Needs assessment; Community resilience

1. Introduction

When a disaster strikes it brings with it the danger of death or physical injury. There is also loss of property, possessions and community. But the effects of the former are more detrimental because it hampers the regular development the individual or the community was achieving through time. The loss of physical assets can be refilled sooner or later with the help of an external assistance but the non-structural system cannot reach the same normal state as it was there before the disaster.

The community affected requires immediate help to survive, resources, and efforts to recover in a short time. Thereafter the assessment of damage is done to initiate the recovery process. The ultimate product of the recovery assessment is a complete schedule of recovery and reconstruction that directs all activities after the disaster. In the medium term and long term recovery, this assessment is used to estimate the financial requirements and needs to achieve overall recovery and reconstruction.

The current assessment methodology measures the total impact of the disaster through determining the damage and loss in different sectors. These sectors calculate the destruction to housing, health, education, tourism, infrastructure jobs etc. and bring the total impact of the disaster in the region.

Non-structural areas requiring a damage assessment may prove difficult to calculate, and may require experts (Phillips 2009). Economic damage can be calculated in a variety of ways. Building damage is certainly one way to view the impact. However, measuring the physiological and mental damage on individual is a challenging task (Phillips 2009). Some individual may show signs of mental damage at the early stage while many show this in the long run. This is certain if the individual is unable to reach the same economic and social condition which was prior to the disaster.

Nakagawa and Shaw (2004) highlighted the importance of social capital in the recovery process. They emphasized that the post-disaster recovery processes are an opportunities for development, which boosts the local economy, generates livelihoods opportunities and enhances the living conditions of the affected people (Nakagawa & Shaw 2004). Including the capable people from the affected community in the post-disaster recovery and reconstruction process can be one such solution to revitalize the local economy through generating livelihood opportunity from the reconstruction activities required for recovery. The Sendai framework for Disaster risk reduction in its priority for action also envisions to 'Build Back Better (BBB)' in recovery,

* Corresponding author. E-mail address: anshulpuriya@gmail.com

rehabilitation and reconstruction. If somehow the local people can be involved in 'BBB' process, it will enable the enhancement of skill and abilities of the people. If needed these people can further be useful in future such programs in the same region affected again by the disaster or any other neighbouring region affected by disaster needing similar recovery interventions. The Sendai framework (UNISDR 2015) evolved from the Hyogo Framework for Action 2005-2015 (UN 2005) which previously had already called upon the need for all stakeholders' contribution in building disaster resilience.

This paper identifies the need for involvement of people the affected community in post disaster recovery processes which will include the people in need of income generating activities by external interventions. The objective of this paper is to modify the current needs assessment process in which the skills and abilities of the affected individuals are used and thus improving the recovery process to develop the resilience of the community.

2. Literature Review

The scope of assessments for disaster effects and impact and for estimation of post-disaster recovery and reconstruction financial requirements has been agreed as a result an agreement between the heads of the European Commission (EC), the World Bank and the United Nations' Development Group (UNDG), within the Hyogo Framework for Action. While this is an agreement between major international organizations, many countries are following such lead and have accepted its contents in recent years (GFDRR 2013).

The PDNA is comprised of a 'Damage and Loss Assessment' (DALA), a 'Human Recovery Needs Assessment' (HRNA) and a 'Recovery Framework. In prior PDNAs, the World Bank and IFIs have focused on the damage and loss assessment, the UN agencies on the identification of human impact and needs. Together, the analyses of damages, losses and needs are used to develop the Recovery Framework (GFDRR 2010).

The HRNA focuses on the social impact of disasters, analysing how disasters affect local patterns of life, social structures and institutions. A HNRA includes analysis of primary data from household or other units of analysis and provides insight into the recovery and reconstruction from the viewpoint of the affected community (GFDRR 2013).

The section below describes the DALA methodology in brief and elaborately discusses PDNA methodology since it includes the components of DALA. It reviews the PDNA in terms of involvement of the affected community. It brings out the insufficiency of community participation in the PDNA assisted recovery process and discusses the sectors and activities in the methodology where the affected population can be involved in the process.

2.1. Damage and Loss Assessment (DaLA Methodology)

The Damage and Loss Assessment (DaLA) Methodology was initially developed by the UN Economic Commission for Latin America and the Caribbean (UN-ECLAC) in 1972. It has since been developed through close cooperation of World Health Organization (WHO), Pan American Health Organization (PAHO), World Bank, Inter-American Development Bank, UNESCO to estimate damage and losses due to disaster events in economic terms. It is a tool that gives the flexibility to be adapted to specific disaster types and different kinds of government ownership requirements. The DaLA Methodology assesses impact on the overall economy of the affected region or country. It uses the data available from national accounts and different statistics organizations of the country government as baseline data to measure damage and loss.

The methodology first estimates the value of the destruction of assets (damages) and of the changes (or losses) in the flows of the economy as a result of the disaster. This is done for each sector of the economy and then the aggregation of such damage and losses provides an estimation of overall effects of the disaster on the affected region and economy. This further facilitates the assessment of disaster impact on sectors and various levels, including the potential and temporary disruption on the growth of the national economy, the external sector and the fiscal balances. This also facilitates to measure the impact on the decline in income and livelihoods of households and community (GFDRR 2010). Once an initial features of the overall strategy for recovery and reconstruction is available, the methodology assists a comprehensive calculation of financial requirements (or needs) for post-disaster short term and long term activities (GFDRR 2010).

2.2.Post-disaster Needs Assessment (PDNA) Methodology

The PDNA is used by the World Bank and the United Nations to assist the affected country in disaster recovery. The PDNA guidelines by Global facility for Disaster reduction and Recovery (GFDRR 2013) outlines main goal of conducting a PDNA is to support governments to measure the full magnitude of a disaster's impact on the country and the region and based on these findings it produces a Recovery Strategy for organizing financial and technical resources. And, also if necessary it can demand further external cooperation and support to implement the recovery strategy based on the financial and technical capabilities affected region.

The objective of conducting a PDNA is to evaluate the disaster effect on various sectors like infrastructure, services etc. and then estimate the damage and loss occurred in the economic flow of the region to identify the reconstruction and recovery needs by developing a recovery strategy. It is achieved by involving various external agencies already working in the related field to go and access the situation in the region (GFDRR 2013).

The PDNA Guide includes the main elements of the Damage and Loss Assessment (DaLA) method and the Human Recovery Needs Assessment (HRNA) approach and process for a comprehensive assessment of damages, losses and needs, which would lead to the development of a Recovery Strategy.(GFDRR 2013) Since the assessment and Recovery Strategy developed during the PDNA is completed in a relatively short period, it requires more comprehensive recovery planning, particularly in the case of large scale disasters (GFDRR 2013).

The PDNA includes various activities which starts with collection of pre-disaster data of the region which is gathered from the government mostly. Then collecting primary data in the affected region through questionnaires and conducting surveys among the affected population and interviewing the agencies involved in the relief and recovery. Based on these data a pre-disaster and post-disaster scenario is compared and a recovery strategy is developed which has clear objectives and priority areas to focus on first.

This method is described with the help of a flowchart in the Figure 1. Only sub-sections which are important for this paper are used to describe the process.

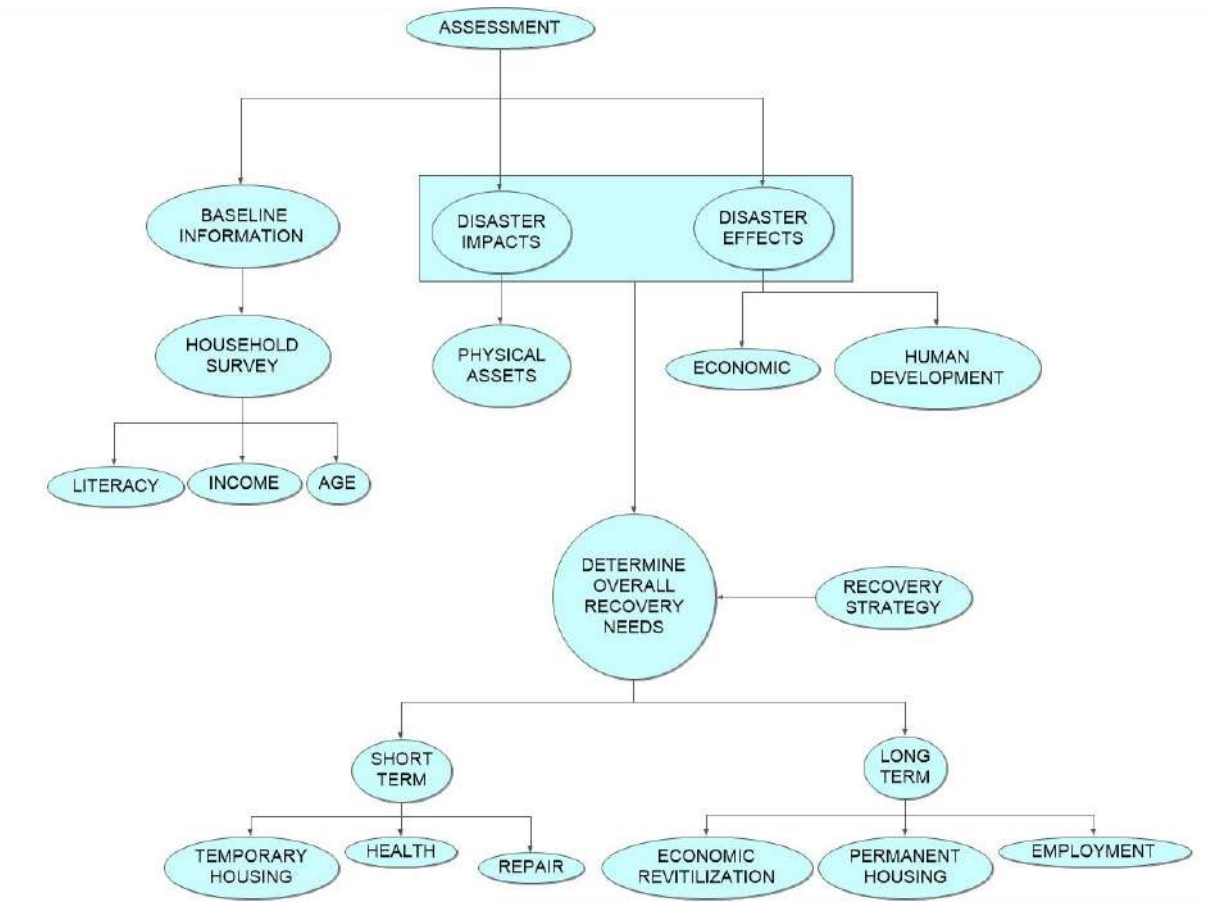

Figure 1: The current process of needs assessment

Pre-disaster condition is studied through baseline data available in Census, local surveys and various other reports. The baseline data collected is important to analyse the total impact of the disaster on various sectors. The assessment produces an integrated sector-by-sector report of the damages, losses and needs that is then summarized into a Recovery Strategy. The Strategy identifies recovery priorities, a cost structure, stakeholders, and suggests a timeframe for recovery. The Recovery Strategy would need to be followed through with a detailed recovery framework which comprises information on the policy and institutional arrangements, financial mechanisms, monitoring and evaluation systems for recovery.

The most important objective of recovery is to enable the affected community to improve their overall wellbeing by reconstruction of physical assets, generation of livelihoods opportunities, and enhancement of sociocultural and economic status. The recovery strategy has cross-cutting sectors and themes like Employment and Livelihoods, Disaster Risk Reduction (DRR) etc. It is here the community involvement can be given priority and included in most of the components in the recovery strategy.

This recovery process has very little involvement of the local people which are capable of participating in the redevelopment. The affected population is helpless for some time after the disaster occurs but it can revive to normal settings once enough relief measures are provided in time. This revived number of population who are capable of contributing and leading in some activities of recovery are not given proper attention. They are considered helpless as the rest of the population and external aid and support is provided to them. This free help only makes them wanting for more.

3. Development of a modified needs assessment process

The participation of the people from the affected community and the involvement of the local resources has a positive effect on the psychological functioning of the community. It also boosts economic activities by improving local business activities and provides a reason for the industries to recover as soon as possible (Sullivan 2003).

The Figure 2 explains the new modified needs assessment process. The new process emphasizes surveying and collecting data on the type of employment the people were engaged in before the disaster. This information would be included in the household survey forms. Based on this information the population which is in good health and capable of contributing can be included and given preference to participate and conduct the recovery and reconstruction work.

The skills of the communities can be utilized in different sectors as described in the PDNA guidelines. People can help in social sectors in rebuilding and repairing houses. In providing education to the displaced children or where the school building is damaged. People skilled in health and nutrition sector can help in the immediate recovery by providing their services. The reconstruction of infrastructure is time and money consuming. This can be fastened up by involving the people and resources from the local community. The ACARP (Aceh Community Assistance Research Project) report of 2007, recognised the importance of local knowledge and institutions and concluded that the one-way transfer of knowledge, skills and technology from benefactor to beneficiary is not a complete solution. Rather the engagement of local ways of knowing and doing, and the institutional forms and networks that already exist in communities can help in crafting alternative solutions that are appropriate to local norms, conditions, constraints and capacities.

Survey should be conducted for – in what activity the people from the affected area can support and earn a living in return. This will be very helpful to the affected people from the informal sector as they are the prime victim of a disaster. There earning opportunity is lost in disaster. A study from the survey about what is the highest number of people engaged in a particular employment activity should be done. Future development and construction work should have their interest.

It should be noted that every member of a particular community is not equally intelligent, efficient and experienced. Therefore, it may not be possible for each and every member of the affected community to contribute in disaster management program equally. On the other hand, each and every member of a particular community is not equally affected. Hossain (2013) has given a solution to this by using social workers to assess who are mostly affected, with whom the program will be operated and who will contribute more to implement.

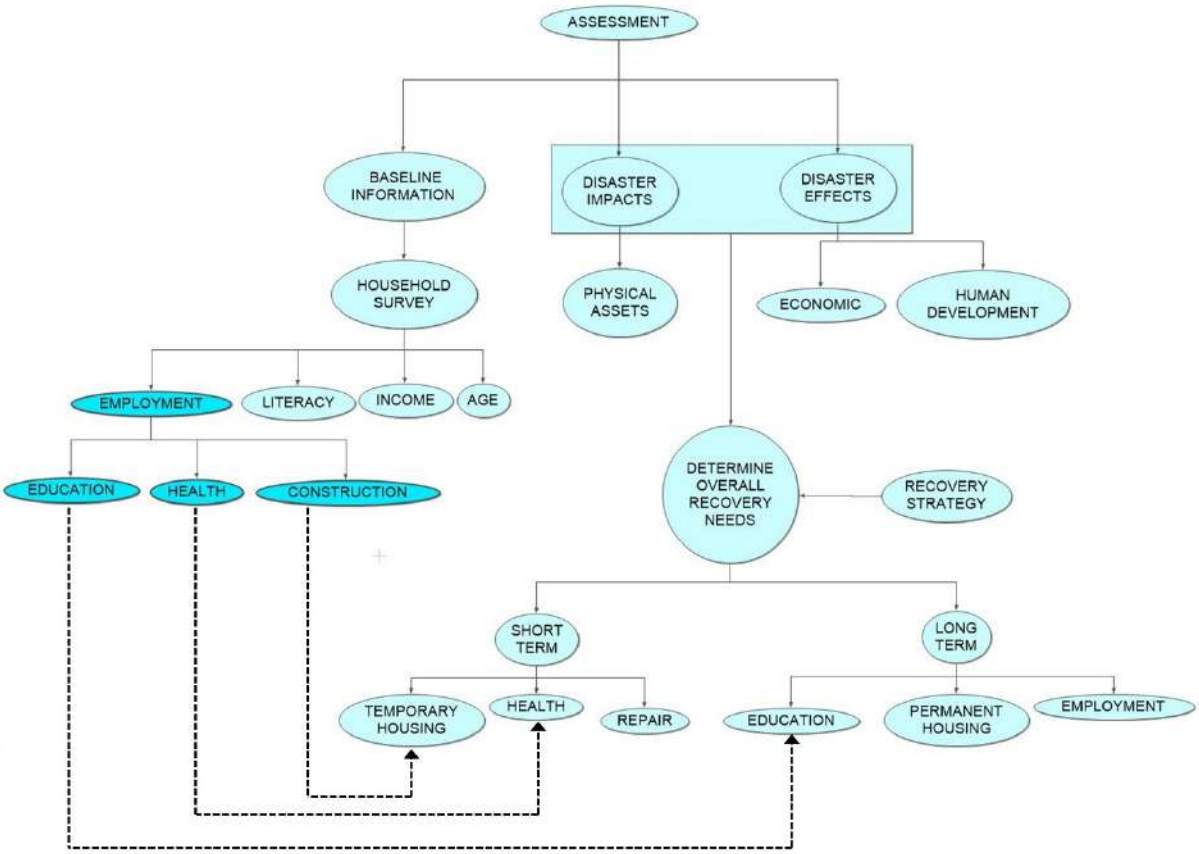

Figure 2: The modified needs assessment process

4. Discussion

While immediate relief through external aid is important in the immediate aftermath of a natural disaster, it should be replaced shortly with efforts to encourage ownership and participation by the local people. More local involvement and contributions to the reconstruction process could reduce social tensions and lead to more sustainable development efforts. Nakagawa and Shaw (2004) also found that the affected community after the Kobe earthquake in Japan made a successful and speedy recovery because the affected people actively participated in the recovery process. The majority of reconstruction activities should be done by the affected population to develop resilience to future disaster activities. Suppose if another similar disaster strikes the same region after some years, the population will now be ready to cope with it expertly and recover on its own with very little or perhaps no external interventions.

The process for disaster recovery also offers an opportunity for improvement through community development activities, which should be a feature of all recovery processes (Sullivan, 2003). Furthermore, a reliance on external resources hinders recovery by diminishing the use (and hence recovery) of local markets, thus prolonging recovery, as economic recovery is a key requirement for community recovery (Hass et al., 1977; as cited in Sullivan, 2003).

Gharaati (2006) in his review of the reconstruction program after the Earthquake of Bam, Iraq concluded that the knowledge and expertise of the new techniques used during the reconstruction were not transferred to the community. The buildings later on developed problems in bonding the traditional and new material which the inhabitant were not capable of solving on their own. Bilau et al. (2015) suggested three general phases in the housing reconstruction process and the importance of community led reconstruction in the third phase where according to them the actual reconstruction works are undertaken. They recognised post-disaster context as a situation where community engagement might be useful to establish post-disaster reconstruction practices to improve current normal construction practice.

Petal et al. (2015) studied five case studies and reported achievements in community-based construction for disaster risk reduction. The projects they studied demonstrated power of local ownership and participation,

building relationship and building capacity. They recognized the long-term success of reconstruction activities by directly involving building occupants.

Lawther (2009) studied community involvement in post-disaster housing reconstruction and analysed methods in which communities were involved in the process of housing reconstruction and evaluated the success and deficiencies of this involvement. (Lawther 2009) found the involvement to be more productive and more empowering. The local community involvement helps in restoring confidence in those traumatized by the disaster and provides capacity building and employment to the affected people.

Joerin et al. (2018) in their study in recovery process found out that the community not involved in the recovery process took longer to recover from the disaster. Moreover the interaction between communities and authorities are necessary for effective and timely recovery (Joerin et al., 2018). This interaction can also be improved by including the people from the affected community in the recovery process.

The engagement in recovery work will help the individual to deal with sorrow and forget about what is lost. Helping others will bring them happiness and develop a sense of responsibility in them. This will also motivate them to live with the new normal.

5. Conclusions

The need assessment covers the entire area affected by the disaster and also the sectors of economic activities that may have sustained negative or positive disaster effects. On the basis of this needs assessment, the estimation of future needs of the population is done. This practice does not involve assessment of any skills or competencies of the victims which may be further useful for their development.

The current needs assessment method is helpful in estimating the money required for the recovery and releasing the funds as per the assessment output. Just by a small input of getting to know the skills of the community can be an effective way in bringing the situation back to the normal. Only giving what is needed is going to make the population helpless and wanting. In the unforeseen event of a similar disaster again in the region, the population will be again at demanding external help. Instead if the people are taught to recover themselves and come up to the normal level, with a very minimal external input. This is where the population will said to have achieved resilience.

This new method of assessment can help the organisations involved in disaster resilience to become aware of the specific abilities and skills of the communities affected by disasters and use them for the purpose of developing their resilience to future disasters.

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Responding to change: adaptive re-use in Medina of Fez

Meltem Vatan [a,*], Mohammed Belcadi [a]

[a] Bahcesehir University, Turkey

Abstract

The aim of this study is to examine the current state of heritage buildings in Medina (old city) of Fez and to discuss adaptive re-use approach for safeguarding cultural heritage. Adaptive re-use is chosen as a main strategy for preserving historic house buildings in Medina of Fez because of their existing condition. Most of the examples are abandoned and few are restored or converted into restaurants, guest houses, exhibition galleries and the like, intended for foreign visitors located in the city as a symbol of an ancient civilization. Therefore, The Medina of Fez responds to the change of life by adapting its historic heritage values to the new functions as tourism needs. In this study, Fez, a city of Morocco inscribed in UNESCO's world heritage list, is selected to be explored in order to examine adaptive re-use approach as an investment in tourism sector to enhance the economic, social and cultural resilience of communities and to preserve heritage values as well. Expected result of this study is to discuss adaptive re-use approach in cultural heritage preservation.

Keywords: Adaptive re-use; Preservation; Cultural Heritage; Morocco – Fez; Tourism

1. Introduction

Witness to a subtle and refined civilization reflects architectural heritage and identity. Intangible values of cultural heritage give life and spirit to the tangible ones within their existing environment and context. This aspect promotes cultural heritage as a living expression and certifies its irreplaceable role to being a source of identity for communities and individuals to being protected and consigned to posterity. Indeed, its protection includes public authorities' and individuals' works in terms of existing safeguarding strategies and conservation approaches. Therefore, preservation actions are based on development of new strategies to protect cultural heritage, considering both tangible and intangible as responding to change.

1.1.Objectives

The aim of this study is to examine the current state of Medina of Fez and to discuss adaptive re-use approach as responding to change for safeguarding cultural heritage. Nowadays, Medina of Fez is facing backflows of historic house owners to use their properties as investment in tourism by converting existing functions to the new ones. On one hand, this adaptive re-use approach helps to preserve heritage buildings instead of being abandoned, but on the other hand increase of tourism brings new problems such as infrastructure, population etc. that need to be controlled.

1.2.Methodology

In this study, adaptive re-use is explored as an investment to enhance the economic, social and cultural resilience of communities and as responding to change for safeguarding heritage as well. A face to face survey with the inhabitants has been made in order to understand the present condition and the restoration works at the site as well as the demands of its community. 160 inhabitant from different generations were surveyed by 31 questions in order to investigate their interpretation and perception of responding to change of Medina of Fez. Additionally, to observe their behaviour either individually or as a group. This survey was based on closed-ended questions which were followed by response options. In-depth interviews with representatives from institutional, individual and academic level has been executed alongside with the survey. The objective of in-depth interviews were understanding the strategies of preservation of the Cultural heritage of Medina of Fez, and the legislation applied by the government to ensure the heritage preservation, understanding the way of intervention, and challenges faced during conversion works. These interviews were based on open-ended questions to explore the

* Corresponding author. E-mail address: meltemvatan@gmail.com

answers of respondents. Consequently, this study raises the fact of the importance of integration between decision makers and practitioners to build resilience (New Uses for Heritage Places, 2008, pp.17-18).

2. Adaptive re-use approach: potentials and limits

Protection of heritage buildings is a challenging topic in terms of ensuring continuity of the life and meeting modern demands (Powell, 1999, p.9; Schittich, 2003, p.9). Intervening a building by alteration is called 'adaptive re-use' (Brooker, G. & Stone, 2004). Although adaptive re-use approach seems as quite recent topic in the field of preservation of heritage buildings, it can be traced in Viollet-le-Duc statement: "*the best way to preserve a building is to find a use for it, and then to satisfy so well the needs dictated by that use that there will never be any further need to make any further changes in the building*" (Brebbia & L. Binda, 2011, p.156). Adaptive re-use approach advocates sustainability in terms of saving energy and preservation of cultural heritage (Conejos & Langston, 2010). Alteration for giving new function to the buildings which face the risk of becoming obsolete is the way of re-use. Adaptation of an existing building to its new function includes many challenges. Finding the most appropriate function within the context is crucial in order to preserve the cultural significance of a heritage building.

Cities as living phenomena are constantly changing under the pressure of technological innovations, changes in social practices, life style, and globalization as well. Protecting the built heritage and preserving cultural identity are challenges which enthusiastically are taken up by decision makers, developers, professionals and communities etc. (Kerr, 2004, p.1; New Uses for Heritage Places, 2008, pp.11-14). Therefore, responding to change is inevitable fact of safeguarding heritage.

Adaptive re-use is considered as part of resilience to sustain the use of historic buildings in order to preserve cultural heritage. Aytac et all defines adaptive resilience as "self-organizing behaviour and adaptive capacity". Also, associates it with Holling's adaptive cycle which is formed as infinity symbol. Cities change continuously in terms of economic, social, political and planning point of view and do not hold on their current state (Aytaç et all, 2016). To conclude, adaptive re-use has a good potential to preserve heritage buildings however it needs to be limited with conservation theories and consideration of additional new loads.

3. Case study: Medina of Fez

A study of Medina of Fez, listed on the World Heritage List is conducted as a case study in order to explore re-use approach to a historic site by discussing challenges due to the context and existing circumstances. Medina of Fez (Figure 1) is located in Morocco, which has nine inscribed properties and seven intangible values listed on the World Heritage List.

Figure 1: Medina of Fez (whc.unesco.org)

3.1.Particularities of Medina of Fez

The word 'Medina' refers to the old part of a town or a city. It is typical traditional settlement including narrow streets, fountains, palaces and mosques. The case of this study, former capital city, Medina of Fez, is dating back to the 9th century. It includes rich cultural assets such as madrasas, fondouks, palaces, residences, mosques and fountains as tangible part, and Tan-tan festival, Mediterranean diet, argan tree, and cultural spaces etc. as intangible values. Since 1912, the capital city was transferred to Rabat, however, Fez kept its statues of being cultural and spiritual centre with its largest Medina (whc.unesco.org). Medina of Fez is considered as one of the largest and best preserved historical cities in the Arab-Muslim world. It is surrounded by the city walls dating back to the different periods and spread over an estimated length of 25 km (Fez Tourist Guide, 2016, pp. 6-8, pp. 52-55).

At the end of the fifties, the Medina of Fez underwent changes at various levels that effected its traditional fabric. The traditional houses have been abandoned by their owners to move towards economic activity clusters or the new cities that represent the image of modernity with their new habitats, better infrastructure, better services and modern standards. As a result, the city has been left to low-income population. Hence deterioration of the traditional street pattern and buildings were inevitable. Consequently, the site faces serious risk of loss of traditional fabric and heritage values. However, in the last few years, there has been a new movement, which is reflected by the return of the national investors to the old houses with essentially touristic intention. Some strategies are applied to safeguard Medina of Fez in governmental level, among which adaptation and giving new functions to the individual buildings being one of the mainly used actions. Another action that has been undertaken with the practical aim from the governmental level is establishing an agency titled "ADER" in order to coordinate and to scrutinize restoration works of Medina of Fez. ADER is the Agency Of Development And Rehabilitation of the Medina of Fez founded in 1989 (Bennani, 2016).

3.2.Site Survey

In order to better understand the dynamics of the Medina of Fez, and to have information about the site and its culture, a face to face survey with the inhabitants of Medina of Fez was conducted. The aim of this survey was to bring out the reality of the current condition in Medina of Fez and to discuss how adaptive re-use plays an important role in the development of the tourism. Alongside the survey, three interviews with local stakeholders such as representatives of institutional, individual and academic level were executed.

Survey

The survey was aiming to explore interpretation of the users regarding their connection with Medina of Fez, economic condition and building quality of the site. The questionnaire was divided into four parts according to the scope of the questions such as personal information, house status, and opinions about restoration strategies, and options that can be suitable for the inhabitants. 160 respondents from different ages and social statues were selected without any specific criteria.

The significant outcomes of the survey are summarized below:

- The largest part of the people surveyed (70%) comprises of the locals living more than 20 years in the Medina of Fez who own their own properties (56%).
- The size of the houses is mostly between 70 – 100m^2 (36%).
- The reason of living in the Medina of Fez is more or less equal in terms of having family there (40%) and working as a craftsman (30%).
- Education level of the locals is basically limited to the primary (40%) and high school (30%) with the 20% of the locals is being uneducated.
- 50% of the locals are employed and 49% among them are unskilled employees.
- The large part of the buildings is over 20 years old (68%).
- Most of the population have the intention and demand to alter their houses (53%) and most of them have not made it yet due to the lack of finances (45%).
- The thought about re-use is mostly related to giving new function in the form of accommodation for tourists (27%) and the profit that can be gained (27%).

As a result of the survey it can be said that most of the inhabitants have the intention and desire to convert their houses and re-use for tourism purposes, however, could not effort the expenses. In general the locals support adaptive re-use strategy and believe that it will have a positive effect on the revitalization of their neighbourhood. This approach will bring reputation to the owner in the society while offering new jobs for unemployed locals.

Interviews

The interviews including open-ended questions was aiming to get information from decision makers, professionals and experts about policies and practises in restoration works in Medina of Fez.

The main aim of the interviews is to get the point of view of the actors in the field of restoration works. The president of ADER Fez agency, Fouad Serrhini, gave information about the procedure of acceptance of restoration projects in Medina of Fez. He stated that the decision of the acceptance is dependent on the different authorities based on the funding of the project such as the prefecture, the Ministry of Culture, Habitat Ministry, Craft Ministry, community and ADER Fez Agency. The role of ADER Fez is to steer and oversee the works in terms of their legal status. He also remarked the importance of the World Heritage Convention (WHC), ratified by Morocco, which establishes a system of identification and registration to the heritage list and definition of the outstanding value as well. "Although recently Medina of Fez does not get international financial support no one can deny the 80s and 90s projects funded by FADES and World Bank" said Mr. Serrhini.

During the interview undertaken with the architect Mr. Kabbaj as a representative of professionals who owns the guest house restored by himself, the intervention works and the challenges faced during an adaptive re-use project were explained. The necessity of alteration to old houses as the evidences of the culture and identity of Morocco and the link between the past, present and the future was pointed out. He explained in detail the restoration and conversion process and works on his own house. He stressed the importance of structural problems and provision of solutions, and the difficulty of finding skilled craftsmanship to restore traditional ceramics and the plaster.

The last interview was undertaken with the representative of scientific side, Prof. Dr. Bennani, the Director of International University of Rabat and an expert in the field of Moroccan heritage. She has studied the case of Medina of Fez and is the author of a book (2016) discussing the disastrous state of the Moroccan heritage. She stated her support to the idea of adaptive re-use strategy to preserve the cultural heritage versus ignorance or leaving the buildings to their destiny towards demolition by neglect.

To conclude the interview results, it is possible to say that the points of views of the three different levels of heritage preservation actors are coming together in support of adaptive re-use approach for the case of Medina of Fez when its particular condition wis taken into consideration.

3.3.Adaptive re-use approach: responding to change in Medina of Fez

One of the main drivers of adaptive re-use in Median of Fez is the potential for tourism in a site or an individual building which will bring income to the locals. However, the use of tourism as a tool of preservation may be critical for the heritage site itself. Control in the increasing number of the site's population has a vital role for infrastructure and capacity problems. Therefore, planning of adaptive re-use with all its positive and negative effects is crucial.

Adaptive re-use strategy in Medina of Fez is framed as setting criteria for evaluating the existing building as an integrated approach and its relationship with the stakeholders. Each criteria given in the Table 1 needs to be documented for each individual case in order to adequately evaluate and compare the existing condition with the proposed new use. Particular attention needs to be paid on to the new number of the users to see the potential impact to the infrastructure. This evaluation has a critical role in estimating the level of the impact of the adaptive re-use work in order to ensure preservation of the individual building and its heritage context.

Table 1: Criteria for evaluating the existing buildings

Criteria		Existing	New proposed
Budget	Personal		
	National support		
	International support		
Function	Residential		
	Guest house		
	Public		
Context	Residential neighbourhood		
	Commercial neighbourhood		
	Mixed		
Comfort level	Traditional life style		
	Modern life style requirements		
	Universal design criteria		
	Water management		
	Energy consumption		
Impact to the infrastructure	Electrical energy		
	City sewage system		
	Communication system		
	Other technologies		
Number of the users			
Stake holders	Owner		
	Decision maker		
	Professional		
	Expert		

The decision and evaluation need to be taken by integrated design approach and with an interdisciplinary team (Figures 2 and 3).

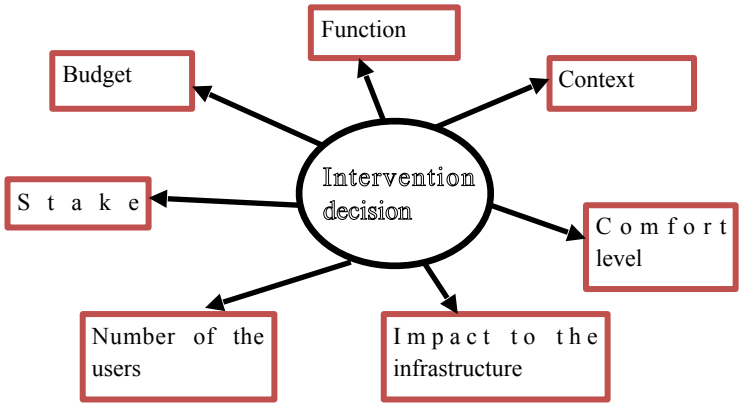

Figure 2: Intervention decision

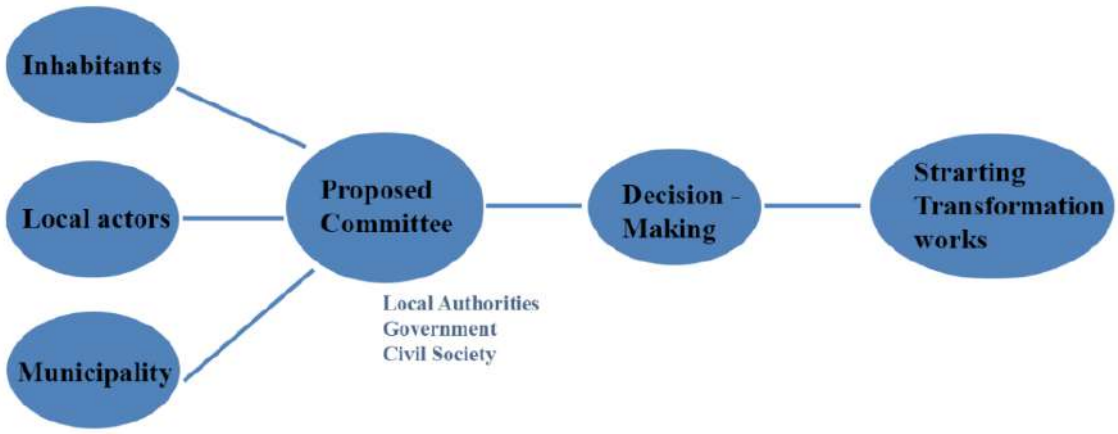

Figure 3: The actors of the adaptive re-use team

4. Discussion

The Medina of Fez as the listed historic site facing many challenges, needs to be preserved and meet the requirements of the modern life like with the other medinas. Although being a former capital of Morocco and now still keeping its importance as a cultural centre, its glory is shaded by the low-income population and uncontrolled growth in the numbers of the new comers and tourists. The fact that the owners of the buildings have an intention to leave Medina of Fez in order to find a modern life coupled with the immigration of the countryside low-income people with a hope to find a job in the city has brought serious problems to the site. The change of local profile and abandonment of the buildings are the main reasons of the preservation problems as well as the old infrastructure and its limited capacity.

Adaptive re-use as a more recent and trend strategy has attracted the attention of the owners and has created a reason to return back to the Medina of Fez. Particular interest is given to the tourism potential which includes positive and negative effects. Therefore, the urgency and priority to its consequences are pointed out in this study.

5. Conclusion and final remarks

Adaptive re-use approach as a strategy of preservation attracts interest of investors in Moroccan cities such as Marrakech, Essaouira and Fez whose first objective is participation in the tourism development. The way of contributing to the tourism development is to revitalize historic sites. However, these intentions have created their new dispute, dilemma and discussions. Encouragement of re-use and increase of tourism potential in one hand may seem as advantage, however, on the other hand, if it is not restricted, it may cause serious infrastructure and lifeline problems, and dramatic loss of traditional pattern.

Adaptive re-use process when applied inline with heritage best practice positively effects the social and cultural environment by maintaining heritage significance of buildings and ensures their long-term survival. With a special focus on traditional old houses, the process of adaptive re-use is part of a move to adapt the built environment to a contemporary lifestyle without detrimentally affecting their heritage values. Even though adaptive re-use strategy can be a backbone for preservation of cultural heritage and ensures protection of tangible values, it increases tourism industry as a key economic driver and needs to be managed thoroughly. In this sense, the way of collaboration of public and private stakeholders in order to enhance resilience and to control impact of tourism is crucial.

Adaptive re-use strategy is a valuable way to preserve heritage buildings in Medina of Fez. This strategy has three main inputs to the city. The first one is taking back the glory of the place by the return of the owners, increasing the role of the primary actors in heritage and encouragement of the cultural identity preservation. The second one is to create new job opportunities for unemployed people. The third one is the increase in the number of tourists. However, the consequences of these three seemingly positive inputs need to be considered in a holistic way within resilience of the cities.

Acknowledgements

The authors wish to acknowledge the BAU Graduate School of Natural and Applied Sciences where part of this study has been conducted as a Master thesis. Additionally, the authors would like to thank the President of ADER Fez agency Mr. Serrhini, the Architect Mr. Kabbaj and the Director of UIR (International University of Rabat) Prof. Dr. Bennani for their time during the interviews and for their comments that that provided invaluable input to this study.

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Disaster risk mitigation for World Heritage city: case of Walled City of Ahmedabad in India

Pratima Singh [a,*]

[a] Nirma University, India

Abstract

In many cities the oldest parts are those that house not only the heritage of the city but also are amongst the most densely populated parts of the city. Such parts are also frequented by visitors, sellers and purchasers of goods while housing bustling formal and informal markets. Such parts of the city in general do not witness the local authroities exercising urban planning tools for land development and thus remain with the same spatial design and state temporally sans interventions required for Disaster Risk Mitigation. The walled city of Ahmedabad, has recently been declared as a UNESCO World Heritage City. Disaster Risk mitigation is an important agenda to be looked into now that the footfall to the walled city is likely to increase with tourists and tourism related activities that are expected to increase spatially and temporally. A study conducted in the walled city part of Ahmedabad for one of the 'pols' and its surrounding area revealed through use of GIS and RS techniques, house hold surveys, focussed group discussions, spatial arrangement of built form and their use; that there is an imperative need to have urban planning interventions such as local area plans that incorporate disaster risk reduction measures like vulnerability and risk assessment so as to safeguard the interests of the local community as well and that of people frequenting this part of the city for various purposes.

Keywords: Heritage; Disaster; Mitigation; Historic City

1. Introduction

Disasters have been frequenting the earth since time immemorial. Over time there has been an unprecedented increase in the world population, most of which lives in Asia. Numerous studies, papers and reports have pointed out to the increasing trend of disaster events both nature sent and human induced. The number of people impacted by disasters is disproportiontely more in Asia and hence countries like India tipping to become the most populous need to consider taking Disaster Risk Reduction measures from every point of concern on a priority basis.

In many cities across the globe and even in India, the oldest parts are those that house not only the heritage of the city but also are amongst the most densely populated parts of the city. Such parts are also frequented by visitors, sellers and purchasers of goods while housing bustling formal and informal markets. In the South Asian context particulary taking the case of such older parts of the cities in India, it is seen that in general, such parts do not witness the local authorities exercising urban planning tools for land development and thus remain with the same spatial design temporally sans interventions required for Disaster Risk Mitigation (DRM).

Through use of Geographic Information Systems (GIS) and Remote Sensing (RS) techniques, house hold surveys, built form use and spatial arrangement of built form, this paper discusses about a study conducted in the walled city part of Ahmedabad for one of the 'pols' and its surrounding area. The study revealed that there is an imperative need to have urban planning interventions with respect to disaster risk reduction so as to safeguard the interests of the local community as well and that of people frequenting this part of the city for trade and commerce, tourism, religious and social purposes.

1.1.Objectives

The objective of the study was to understand the need for disaster risk mitigation of heritage city taking the case of one micro neighbourhood - Pol in Khadia area which falls in Ward no.3 in Ahmedabad for understanding the DRM related issues.

* Corresponding author. E-mail address: singhpratima@yahoo.com

2. Study Area

The city of Ahmedabad, one of the fastest growing cities in India is inhabitated by over 6 million people and is the seventh largest city of the country. The walled city as per 2011 census had a population of 367953 which was about 6% of the city population during that time. The city is one of the fastest growing cities of the world and has recently (2017) been declared as a UNESCO World Heritage City due to it Outstanding Universal Value - OUV as per criteria ii (exhibit an important interchange of human values), v (outstanding example of human settlement) & vi (associated with events or living traditions, with ideas, or with beliefs.....).

The city limits are expanding by leaps and bounds with land being allocated for various land uses in the decadal development plans prepared by the local urban development authority. A study of the previous two development plans (1987, 2002 and 2011) revealed that in each of the development plans the walled (old) city of Ahmedabad which is the area considered per-se for acheivement of World Heritage city status due to its outstanding universal value, has not been focussed upon (in terms of land use planning, urban planning proposals, etc.) one of the reasons for this being due to the presence of several heritage monuments notified by the government in this part of the city.

2.1.Development Planning in Ahmedabad

Development plans for the city are prepared by the local urban development authority on a decadal basis for guided urban development. In case of Ahmedabad it is the Ahmedabad Urban Development Authority (AUDA) which prepares the development plans. With respect to the walled city of Ahmedabad, these development plans do not show proposed interventions of urban planning.

Over the decades with the rapid physical expansion of Ahmedabad city, the original inhabitants living in 'Pols' has decreased with people gradually shifting their residences and/or business to the newly developed areas largely located in the western part of the city.

The oldest part of the city has landuses comprising of residential (traditional 'pol' housing), mixed (residential and cum commercial), commercial, light manufacturing, institutional, religious, recreational as well as open spaces spread over an area of about 5.51 sq.kms and consisting of about one sixth of the total number of wards of Ahmedabad city. Infact, this is the busiest part of the city diurinally. This part of the city is the commercial hub of the city with the major grain, fruit, meat and poultry, fabric, utensils, etc. markets and city's main railway and bus terminus located right beside it.

2.2.Urban Form of Ahmedabad Old City

Near the Sabarmati river bank, the Bhadra fort was built in close proximity to which was the military establishment. After this, the fort walls along with the 12 gates of the city and few 'pols' were constructed. The first pol to be constructed was the 'Mahurat Pol' which adjoins Manek Chowk - an important landmark in the walled city and Ahmedabad. In terms of the morphology in west to east direction of the walled city it is seen that there was a river (Sabarmati), fort with fort walls, the market area (presently known as the Bhadra Plaza), one of the 12 gates of the city ('Teen Darwaja'), the market and Pols inside the 12 gates and then the fort walls of the city.

Subsequently, other Pols started getting constructed usually by owner driven construction and today there are hundreds of Pols in the walled city of Ahmedabad. The pols were constructed over Sultanate rule, Maratha rule and British rule and there after independent India rule the flavour of which, is amply evident in the built form. Drainage came during the British rule.

The Bhadra fort and the Jami Masjid and Teen Darwaja are aligned on the same axis with the market area existing between Teen Darwaja and Gandhi road side main entrance of Jami Masjid. A maximum of 2 FSI is permissible in the old city of Ahmedabad which indicated prevalence of building heights predominantly ranging upto 6 to 10 metres.

A hierarchical organisation of house, *pol*, *pura* and city is seen in the old city of Ahmedabad. There are over 600 pols in the old city. Communities from various religions such as Hindus, Muslim, Jain and other communities reside in these pols. Pols for Hindus and Muslims are almost always separate.

Houses in 'Pols' or 'Pol' houses are mainly made of intricately carved structure of timber and stone. It is 'green' in several respects (especially in the context of Ahmedabad city experiencing hot and dry climate) such

as having a central courtyard for light and ventilation, underground '*tankas*' (tanks) with connections to the roof for roof top rain water harvesting, narrow streets with Pol houses on either side providing shading to the road and to each other. Also, indirectly a no vehicle (4 wheeler) zone is facilitated in the inner lanes of the Pols, *otlas* for social interaction in these semi open spaces, bird feeder in common space as well as inbuilt on the exterior façade of the walls of Pol houses. The *'pol'* are characterised by a series of courtyard houses, often ranging between 50 to 100 units, with shared longitudinal walls arranged along a narrow winding street accessed by a controlled gateway and ending in a cul-de-sac (Shah, 2016). The timber and stone structure and shared longitudinal wall facilitate in keeping the Pol houses intact from hazards such as earthquakes. During the earthquake of 26th January 2001, the other parts of the city witnessed building collapse however, the built form in the old city remained largely undamaged with few exceptions such as certain elements of the Jami Masjid.

The pols were initially based upon the concept where each component acts as a self sufficient secure unit while being integrally linked with others and has given rise to an urban system of exceptional homogeneity based on community agreements and cultural values. For example each Pol had people living of a specific community e.g. brahmins from Hindu religion, Jain religion, Muslim religion, etc.

With the passage of time, Ahmedabad's walled city needs to be prepared to also welcome and safeguard the interests of toursim which is witnessing a rise - one probable reason is due to the recent acheivement of the World Heritage City tag. Heritage walks are conducted through about a route of 1.5 km across the walled city of Ahmedabad which gives tourists a glimpse of the heritage structures most of which are occupied by people living, working, etc. within these structures. Hence Disaster Risk mitigation is an important agenda to be looked into in depth in order to safe guard not only the interests of the tourists and visitors, but also that of the local population as well as floating population arriving from nearby urban and rural areas.

2.3.Study methodology

The study methodology involved literature review, secondary data collection, site recognition and survey, discussions with officials of local authority including the experts from fire and emergency services, household surveys and focussed group discussions with local community (residents of the pol), people running businesses, tourist gudies, shoppers living within the old city as well as those coming from outside. The paper presents the summary of data and secondary information available from various sources.

2.4.The study Pol

For the study one Pol (Lakhia ni Pol) and its surrounding area was selected based upon the fact that it located in the oldest part of the city (Khadia) and also is centrally located within the walled city. Lakhia ni Pol has 65 houses 20 household surveys were conducted. The pol has structures with floors ranging from single storied to two and three storied structures. Barring a few houses, most of the pol houses are occupied. Many of such houses are occupied by in-migrants (mainly from the neighbouring state of Rajasthan). There is one main access to the Pol and another smaller exit/access. Field surveys revealed that there were two other exits which were closed with walls built at the exit point of the 'pol'. Internal road widths of the Pols ranged from less than 3 metres to 1.5 meter in certain parts. Almost three fourths of the land area is built up. Majority of the Pol houses presently (as per 2018 survey) have mixed landuse. There is one Pol house which has only the plinth left with the walls, roof and entire house collapsed with only few of its walls standing. Such space acts as an open space for children to play.

As per the survey conducted by the urban local authority (Ahmedabad Municipal Corporation) apart from other 'pols' of the walled city, notified buildings in Grade III are also located in Lakhia ni Pol which are in good condition – there are 9 such buildings in this category which is almost one in every seven buildings in the Pol. Almost 14% of the houses are notified which is higher than the average percentage of houses notified in all Pols. Thus from heritage point of the view this Pol is significant in contributing to the heritage quotient of the old city of Ahmedabad.

During the primary survey it was observed that in majority (75%) of total number of buildings renovation has been carried out e.g. change of flooring material (from Indian Patent stone/Kota stone to vitrified ceramic tiles), modifications in internal space. One house had undergone an entire remodelling with the new built form being one constructed as per present conventional practices. In terms of landuse, about a thirds of the houses had

mixed land use (i.e. residential cum commercial - such as shop houses (such group of shop houses are locally known as '*ols*') wherein commercial part (shop/workshop)can be on the ground floor whereas the residential area is located on the first and second floor).

3. Discussion on probable hazard mitigation

Fire emerged as a disaster that needs to be seriously taken into consideration as the house structure is a timber frame structure as also the wooden joists (beams), columns, floor slabs, sloping pitched roofs, staircase, etc. Moreover, as mentioned earlier some houses now have mixed landuse for which all houses basically were not planned when initially constructed, neither did fire safety norms exist when the houses were originally built and so fire safety provisions were not planned. The houses are aligned in a row and incase there is a fire event, it could spread to other houses and buildings in Pols.

About 600 fires incidences took place during the past year and the same was attended to by the Fire and Emergency Services department of the local authority (Ahmedabad Municipal Corporation). The equipment available with the department include three major types of vehicles – one is big sized fire fighter (tender) having equipments and tools such as hammers, cutters, ropes, about 11m (35') ladder, breathing apparatus, etc. and having a storage capacity of 5000 litres; one mini sized fire fighter with mist having 2000 litre capacity equipped with two types of hose reel nozzle (one is the 75 litres of mist water per minute can be used and the second is the hose reel nozzle with 100 to 150 litre per minute extinguishing capacity); the third are the two wheelers ('bullet' motor bikes) having storage tanks (2 tanks per bike eachof 9 litre capacity) for converting 9 litre in the form of 900 litres of foam to be used for extinguishing). While the big sized vehicles need a road width of 2 to 3.5 metre depending upon their varying widths and heights (in majority of Pols there is a room above the entrance gate used earlier for guarding the Pol which restricts the entry of the big sized fire fighting tender), the bikes prove more useful interms of moving inside the pols due to availability of height clearance which otherwise is an obstruction for big size fire tenders. The bikes loaded with tanks containing fire extinguishing material which can be taken through the narrow and irregular lanes within pol fare better in reaching through the narrow lanes due to the limited capacity of the tanks loaded with fire extinguishing material which can last for 1.5 to 3 minutes during the fire fighting operation. In case of emergency situation, there needs to be a plan which is implementable in order to evacuate the people. Such a plan does not exist presently. Lack of awareness about impending perceived risks was seen across the respondent groups. In case an untoward fire incident, due to narrow road/street widths the existing equipment available with would not be sufficient due to lack of accessibility to the small lanes with cul-de sac and often blocked exits. Presently the fire and emergency services of the local authority has water tenders of 10,000 and 20,000 litres capacity which can be brought upto the main road from where water can be transported through hose reel, with this water can be available for supply for about 6 hours for fire fighting purpose.

There are fire hydrants in the walled city however, the fire and emergency services are unable to utilise the water due to lack of sufficient pressure available in the water pipe network. An alternate water supply line is required to be used exclusively for fire fighting purpose in case need arises and based on what was mentioned earlier, on an average the fire and emergency services of the local authority needs at least 50 calls a month with the figures fluctuating month wise e.g. more calls in summer months (March to June). Majority of the calls on a day to basis are for dousing fires related to short circuit, blast created due to leakage/bursting of 20 kg cylinders filled with liquid petroleum gas (LPG). It is important to note the issue of prolific use of LPG cylinder not only by residents (who refuse to take the commercial gas pipeline connection due to fear of gas leakage and their houses being constructed out of timber which is highly inflammable) but also by the commercial enterprises such as gold smiths, etc.

4. Conclusions and implications

According to the draft General Development Control Regulations for the year 2021, a local area plan would be prepared which would consider safety aspect apart from other aspects of development planning. However, there is a need for preparation of Local Area Plan which has a specific theme related to vulnerability and risk assessment for the walled city and this aspect which is related to safety needs to be taken up as an integral part of the proposed local area plan for the walled city. The local area plan then has to be integrated seamlessly as part of the city development planning proposals including those mentioned in the development plan. Such a local area plan related to vulnerability and risk assessment for the entire walled city needs to be developed which

would work towards promotion of safeguarding the interests of the people visiting the old city for tourism, shopping, vending, business, etc. The implications of implementation of such measures will help in risk mitigation efforts not only in the walled city part of Ahmedabad but also for the rest of the city and other urban areas in the state of Gujarat, India.

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A suite of built-environment oriented metrics for enhancing community resilience in high-density cities

Jiduo Xing [a], Thomas Shiu Tong Ng [a,*], Frank Jun Xu [a]

[a] Department of Civil Engineering, University of Hong Kong, China

Abstract

A robust, interconnected and smart built environment holds a prominent position in providing a liveable and resilient society with economic vitality and sustainable development. The failure of any subdivisions could cause cascading catastrophes to adjacent and/or interdependent components or even the dysfunction of the whole community. It has been recognized that infrastructure resilience could help communities of various scales tackle the unprecedented challenges arising from natural disasters, man-made threats, climate extremes and chronic stresses. Although a variety of community resilience frameworks have been proposed, they may not satisfy the demands of high-density cities like Hong Kong to enhance community infrastructure resilience against prevailing high-density specified concerns, such as congested living environment, deteriorated infrastructure facilities, and fragility of infrastructures during times of crisis. This paper aims to devise a suite of built environment oriented metrics for decision makers in high-density cities to evaluate community infrastructure resilience and optimize community resilience management and operation. These metrics are designed by filtering out and synergizing representative built environment relevant indicators from published literatures, as well as by developing new ones to meet the congruent needs of high-density cities. Meanwhile, interviews, focus group meetings are convened for validating the proposed metrics and unveiling possible improvements.

Keywords: Community resilience; built environment; metrics; high-density cities; infrastructure resilience.

1. Introduction

Rapid urbanization has become an unprecedented challenge to our society through modern history. In 2018, the number of megacities around the world has boosted to 37, up from 19 in 2007; 55.4% of the world's population live in urban areas and Asia areas account for most of them (Demographia, 2018). Unpredictable and frequent natural and man-made disruptions and ever-changing extreme climate have resulted in enormous economic losses and untoward casualties in these megacities. Further, a growing stock of aging and tightly coupled infrastructures and buildings, extreme precipitation and temperatures exacerbate the challenges of urban management and sustainable development.

Recently, the concept of community resilience, beyond conventional risk management practices, has incrementally been adopted widely to tackle the uncertain black-swan events occurring in interdependent and integrated urban systems. Despite the trail of toolkits, frameworks, models and practices that have been proposed under the 'whole community approach' umbrella (FEMA, 2011), high-density cities may need an enriched version to enhance the resilience of their built environment by appraising and monitoring the resilience performance via a hierarchy of metrics, as well as by elucidating the complicated relationships between built capital and other community capitals.

The resilience and smartness of built environment could be fully achieved via customer-oriented operation and management practices. A community's competitiveness and its dwellers' well-being rely largely on its networked built environment assets and services (including buildings and other infrastructures). The adaptability of built environment against cascading failures on par with the changing demands and perceptions of community residents to infrastructure service disruptions have to be considered from lifecycle perspectives with a system thinking philosophy (BSI, 2016).

In order to fill the aforementioned research gaps, this paper aims to propose a suite of built environment oriented resilience metrics to help decision makers of communities in high-density cities evaluate and track community infrastructure resilience for harmonized infrastructures operation and better community resilience management. First, an exhaustive review is carried out on resilience concepts, community infrastructure systems,

* Corresponding author. E-mail address: tstng@hku.hk

and published community resilience frameworks and indicators. Subsequently, the proposed built environment oriented metrics are presented. The metrics not only synergize the existing indicators targeting to improve the resilience of dense urban communities, but also integrate the newly developed ones for meeting the urgent needs of high-density communities. The contribution of the proposed metrics to the realm of community resilience research and our ongoing and future works are discussed shortly in the final section of this paper.

2. Related work

2.1.High-density development and management challenges

Nowadays, an ever-growing number of cities around the world are facing rapid urban sprawl due to burgeoning population growth, massive immigration, scarcity of land resources and, now and then, inaccessible topography, all of which lead to a high density of population and buildings. In order to resolve housing problem and provide dwellers with high living quality, these cities put more efforts on developing into a high-rise urban form in the wake of vertical space utilization, which finally induces the compact city urban development strategy. The concept of compact city has been frequently articulated in a series of research as a resilient and sustainable urban form, since it shortens the average travel distance for dwellers, reduces the energy consumption and pollution, intensifies social interaction, and so on (Neuman, 2005).

However, these cities are becoming highly fragile and vulnerable to sudden perturbation or chronic stresses. According to the 100 Resilient Cities initiative (www.100resilientcities.org), 19 out of its 98 member cities are high-density cities, i.e. with a residential density of over 7,000 persons per square kilometre. Among the pressing resilience challenges facing these cities the top three are: rainfall flooding due to the high rate of impervious surface coverage; disease outbreak because of the congested living environment and dense building clusters; and infrastructure failures resulting from services provision overload and large quantities of aging and tightly coupled infrastructure assets.

2.2.Community resilience frameworks

To date, there is no broadly agreed definition of the term resilience. Holling (1973) defines '*resilience*' as a measure of a system's ability to absorb disruptions without changing any status parameters. Other domains of resilience include engineering, economics, psychology and sociology resilience. Bruneau *et al.* (2003) have developed a 4R (robustness, redundancy, resourcefulness and rapidity of recovery) framework to investigate community resilience against earthquake. Through the remainder of this paper, resilience is adopted as the ability of an entity to *"anticipate, absorb, adapt to and rapidly recover from unexpected hazards"*, and characterized as absorptive capability, adaptive capability and restorative capability (Nan & Sansavini, 2017). Community is considered as a socio-technical place with geographical boundaries under the jurisdiction of a government structure, which is operationalized and managed by a group of people and organizations sharing the common interests. Community resilience depends on the ability of a community to *"prepare and plan for, absorb and recover from, adapt to and learn from adverse events"* (NIST, 2015).

The representative community resilience frameworks and indicators include the: Disaster Resilience Scorecard (UNISDR, 2014); City Resilience Framework (CRF) and City Resilience Index (CRI) (Rockefeller Foundation & Arup, 2014); empirically-based resilience metrics called the Baseline Resilience Indicators for Communities (BRIC) (Cutter *et al.*, 2014); and Community Resilience Planning Guide (NIST, 2015). Most of these frameworks focus on depicting the static capabilities of a community, and they lack consideration on the time-evolving characteristics and dynamic network features of the community. Additionally, these works invariably follow the 'whole community approach' that depicts different community capitals equally. Nevertheless, a smart, reliable and integrated built environment could play a more important role in bolstering community economic and social development and safeguarding citizens' standard of living and even survival during times of crisis (Aktan *et al.*, 2016). Therefore, in-depth inquiries on community infrastructure resilience need to be put forward, and particularly built environment centric community resilience indicators should be investigated comprehensively.

2.3. Community-infrastructure systems

Rinaldi *et al.* (2001) lay the foundation for understanding the interdependencies between different infrastructure systems, and group infrastructure interdependency into four categories: *physical, cyber, geographic* and *logical*. Infrastructure interdependency could occur within one single asset (*internal interdependency*) or among various assets (*external interdependency*) (Nan & Sansavini, 2017). Interdependency could be a double-edged sword: on one hand, they can provide backup and buffer for each other as networks; on the other hand, any failure of one node could cause negative cascading catastrophes to others through the connected edges (Ceskavich & Sasani, 2017). With the formulation of cyber-physical systems enabled by emerging information and communication technology, the interconnections among infrastructures have grown to become more intricate. Interdependency is increasingly becoming an indispensable variable when assessing the resilience of community infrastructures, which can be perceived as an integrated *'complex adaptive system'* (Rinaldi *et al.*, 2001) or *'system-of-systems'* (BSI, 2016; Nan & Sansavini, 2017).

Built environment no longer merely consists of physical systems, but has evolved into a human-oriented complex system involving engineered, human, economic and environmental aspects (Aktan *et al.*, 2016). Certain emphasis should be paid on recognizing the direct or indirect impacts that physical infrastructures engender on non-engineered components. Nevertheless, there is currently no sound protocol covering all relevant socio-technical perspectives and stakeholders. Therefore, it is of immense importance to establish community infrastructure resilience metrics, which integrate community resilience and infrastructure interdependency analysis covering both socio and technical aspects in an easy to understood form. Furthermore, community resilience management metrics should also be included to assist decision-makers in improving community resilience through effective, user-friendly and reliable manners.

3. The proposed built environment oriented community resilience metrics

3.1. Methodology

To filter out the built environment oriented resilience metrics from existing research, a comprehensive desktop study was conducted to scrutinize the published literatures, reports, codes and standards on infrastructure, community and urban resilience. Experiences and lessons from real-life case studies are also investigated to obtain a holistic review on relevant research and practices. Then, interviews were designed and organized with experts from government departments, industrial stakeholders and community dwellers to unravel their insights, concerns and needs regarding community resilience. The first round interview focused on clarifying the unique characteristics of high-density communities, presenting the filtered out metrics candidates to the interviewees, and asking them to help select the metrics that are suitable for communities with compact built environment, like Hong Kong.

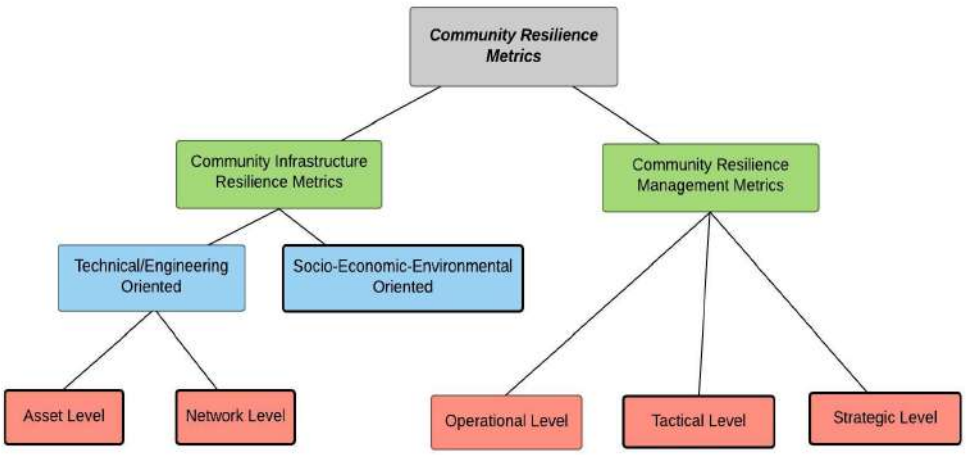

Figure 1: The proposed conceptual framework of built environment oriented resilience assessment metrics.

Building on these substantial inquiries, a suite of built environment oriented metrics are established. As shown in Figure 1, the metrics can be recast into a hierarchical tree with two branches: community infrastructure

resilience metrics and resilience management metrics. Community infrastructure resilience metrics can be further divided into technical / engineering oriented and socio-economic-environmental oriented metrics. From technical / engineering oriented perspective, it can be studied at individual asset level or at *'system of systems'* level (i.e. network level). Besides, metrics can be distinguished as to the resilience of hard assets (e.g. building stocks, electric power stations) and soft assets (e.g. hospitals, emergency shelters). Moreover, separate indicators are needed to estimate the resilience of newly-built and deteriorated infrastructures. Community resilience management metrics can be categorized into three levels: strategic, tactical and operational metrics.

3.2.Community infrastructure resilience metrics

Asset level and network level metrics

(1) Asset level metrics

Table 1 shows examples of selected and developed resilience indicators at asset level. The resilience of a single infrastructure asset is studied at the asset level, which is distinguished from the analysis at network level in terms of the number of assets considered. The metrics focus on depicting the absorptivity, redundancy through alternative suppliers, spare capacity and buffer, as well as restorative capability. From a lifecycle perspective, the combined effects of performance loss and post-event restoration rapidity are also critical factors in terms of restorative capability influencing asset resilience.

Table 1: Examples of indicators for asset level resilience.

Hard assets	
Absorptivity	• Average interruption duration • Average interruption frequency
Redundancy	• Number of different supply sources providing at least X service generation capacity • De-rated capacity margin: the amount of excess service supply above peak demand (Rockefeller Foundation & Arup, 2014)
Restorative capability	• Average time to clear incident (Cambridge Systematics *et al.*, 2006) • Percentage of individual assets functional immediately/hours/days/weeks/years afterwards
Hard assets under aging condition	
Current condition	• Percent length/count/area in good/fair/poor condition (Cambridge Systematics *et al.*, 2006) • Deterioration patterns and rates
Remaining structural capacity	• Percent asset quantity with fewer than 5 years remaining service life (Cambridge Systematics *et al.*, 2006)
Soft assets	
• Number of staff • Number of critical equipment	

High-density and developed cities like Hong Kong need to design new performance metrics or upgrade existing ones to improve the resilience of their large amount of deteriorated infrastructure assets for meeting their citizens' growing demands. Conventional structural design codes only account for initial structural safety without considering the time-dependent uncertainties due to aging, fatigue, corrosion, diffusion and deterioration processes (Biondini & Frangopol, 2016). These detrimental effects amplify the structural vulnerability, shorten the structural lifetime, and result in unanticipated collapse during extreme events. Therefore, efforts pertinent to lifecycle performance of aging structures should be devoted. Through periodical inspection and monitoring, current asset condition, deterioration property identification and lifecycle remaining structural capacities would be obtained as indicators to assess resilience.

Social facilities are salient to the well-being and survival of community residents especially during the strike of hazards. For example, after an encounter with a sudden hazard, hospitals are confronted with a perpetual and massive inflow of causalities. Therefore, the capacity of resources including human and equipment is deem most important to maintain function of providing victims medical rescue, and reconstruct and recover from temporary malfunction.

(2) Network level metrics

At the network level, community infrastructures converge on a system of numerous interconnected assets, dubbed as nodes, as well as physical and relational linkages among nodes (Ouyang, 2014). Given failure at the source nodes, the metrics characterize the direct or indirect cascading impacts of the failure on the whole system due to external interdependency. Both functional and topological interdependency are considered; and topology-based performance and flow-based functional performance are utilized to derive the resilience metrics (Table 2). In reference to Zimmerman *et al*. (2017), a delaying effect at the temporal scale should be regarded as a key factor to reveal degree of interconnectivity. Therefore, additional indicators are proposed by portraying the time delay due to the degree of coupling, coupling order and frequency of cascading impact manifestation on networked assets. However, insofar as the entire lifecycle of infrastructure systems undergoing perturbation is concerned, relatively little existing literature elaborates on assessing interdependency at the restoration stage.

Table 2: Examples of indicators for network level resilience.

Topology-based performance	(Ouyang, 2014; Ghosn *et al*., 2016)
• Number of normal or failed components/nodes	
• Degree of nodes	
• Connectivity loss	
• Spatial proximity of the connected nodes: Average of the shortest path lengths between any two nodes	
Flow-based functional performance	(Ghosn *et al*., 2016)
• Flow: Actual rate at which service pass through a given node or link	
• Capacity: Maximum flow allowed by a given node or link	
• Service flow reduction: the ratio of the amount of current flow during time of disturbance to that in normal condition	
Delaying effect	
• Recovery time for the supported asset returning to normal operation state, once the supporting asset is fully recovered	
• Frequency of failures for supported asset given the condition of supporting asset failure	
• Time delay of failure occurrence between supporting asset and supported asset	

Socio-economic-environmental oriented resilience metrics

Operating and managing physical assets needs to take into account other intangible community assets, such as social networks, human interactions, economic concerns and environmental impacts. The primary goal of community infrastructure is to serve citizens and satisfy their daily demands. The concept of *'system-of-systems'* refers to not only infrastructures, but also the whole community involving other non-technical capitals that might influence the built environment in complex manners. Unlike other research where the six community capitals are considered equally to devise community resilience metrics (Cutter *et al*., 2014), this research sets social, economic and environmental capitals to be built environment centric. To apply the customer focus principle, the metrics in Table 3 could be included to measure community resilience based on customer satisfaction rating and the degree of public engagement in the decision-making processes for community management.

Table 3: Examples of socio-economic-environmental oriented resilience indicators.

Social capital		
Customer perception	• Number of complaint received regarding the service quality per year • Customer ratings regarding service quality (Cambridge Systematics *et al.*, 2006)	
Societal participation	• Number of projects that hold public consultations before construction	
Security, survival and safety	• Number of people seeking temporary public shelter after the hazards (Ceskavich & Sasani, 2017) • Average time for the repair staff to arrive the collapse site • Annual number of injuries or fatalities due to infrastructure failures	
Economical capital		
User costs	• Average costs spent on the service per year per customer/ household	
Cost efficiency	• Operations and maintenance (O&M) cost ratio • Agency cost due to deferred maintenance	(Cambridge Systematics *et al.*, 2006)
Emergency response	• Emergency planning budget as a percentage of total community budget • Percentage of buildings with insurance cover for high risk hazards relevant to the community	(Rockefeller Foundation & Arup, 2014)
Environmental capital		(Cambridge Systematics *et al.*, 2006)
• Volume of greenhouse gases generated per year • Number of incidents consisting of hazardous materials • Fuel/Energy consumption per unit		

3.3.Community resilience management metrics

Community infrastructure resilience is often at odds with resilience management. The former one focuses on the self-ability of physical assets while the latter refers to the ability of the actors, organizations that are responsible for improving these infrastructures' resilience through proper operations and efficient management practices. As for a high-density city, infrastructures bear a great burden of customer service demand per unit area. Therefore, an effective, scientific and authority-centralized resilience management is indispensable. Particularly, the severity of aftermath of the hazards could go beyond what were expected. Taking the Typhoon Mangkhut which hit Hong Kong in September 2018 as an example. The effects of public transport failures, electricity shutdown as well as the paucity of temporary shelters were fatal in Hong Kong, compared with other lower-density cities in Guangdong province. Furthermore, it is common for high-density cities to stimulate the gaping public administration problems and weak cooperation between government departments. For instance, after the Typhoon Mangkhut, it took an officer several hours to identify which department was in charge of the falling trees. Due to the significance of collective engagement of all related stakeholders among different government departments and lessons from the *100 Resilient Cities* experiences, it might be imperative to dispatch a Chief Resilience Officer (CRO) (Rockefeller Foundation & Arup, 2014) who is independently in charging of coordinating across governments to facilitate communications among stakeholders towards building resilience in the face of sudden shocks.

4. Conclusion and future work

High-density cities like Hong Kong around the world are facing unprecedented challenges to deal with the increasingly frequent natural disasters, man-made threats and chronic stresses due to rapid urbanization, growing demands, limited resources and climate changes. Meanwhile, the built environment in these cities is becoming cumulatively interconnected than ever before. However, existing resilience research and practices neither specify the notable features of high-density cities, nor pay adequate attention to the pivotal role of built environment in the context of community resilience.

To fill the research gaps, a suite of built environment oriented metrics for enhancing community infrastructure resilience in high-density cities is proposed in this paper. The metrics could help guide relevant stakeholders obtain a holistic understanding on the resilience level of their communities for better decisions in

community infrastructure investment and resources allocation. Based on a conceptual framework for clarifying different metrics into a hierarchy tree, examples of the devised suite of built environment oriented metrics are presented. Part of these indicators are filtered out and synergized from published works while the others are newly-developed targeting the notable requirements of high-density cities. Being a preliminary study of several ongoing research projects, the findings in this paper still need to be enriched, validated and verified through different case studies. Further exploration could also include the development of a user-friendly community resilience management system to obtain, integrate and crowdsource the data required to calculate the resilience indicators, as well as to present the indicators to end users with easy-to-understand interfaces.

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Building disaster resilience within the hotel sector: a mixed methods study

Nancy Brown [a,*], Jane Rovins [a], Caroline Orchiston [b], Shirley Feldmann-Jensen [c], David Johnston [a, d]

[a] Joint Centre for Disaster Research, Massey University, New Zealand
[b] Centre for Sustainability, University of Otago, New Zealand
[c] School of Criminology, Criminal Justice, and Emergency Management, California State University, USA
[d] GNS Science, New Zealand

Abstract

Understanding what disaster resilience means for hotels, and what gaps organisations may have, is crucial to planning disaster resilience building strategies. The objective of this research was to define the characteristics of disaster resilience in the hotel industry and develop measures to explore strengths and gaps in resilience. This research developed a framework outlining capital-based predictors customised for the hotel sector. The *Disaster Resilience Framework for Hotels* (DRFH) considers economic, social, human, physical, natural, and cultural capital as components of disaster resilience. This view of capitals combines both potential and actual resources to contribute to adaptive capacity; the ability of an organisation to withstand and recover from shocks. The DRFH is explored through a mixed methods study of hotels in two areas of New Zealand (Greater Wellington and Hawke's Bay). A triangulation of survey data, interviews, and published secondary data provides insight into the status of disaster resilience for these hotels. A safety culture combined with social capital stocks and human capital skills make for a solid disaster resilience foundation. Gaps included a lack of all-hazard planning, the need to integrate staff in the planning process, and a need to better connect with other organisations that may be assets during disasters.

Keywords: Tourism; Disaster; Resilience; Hotel; *Disaster Resilience Framework for Hotels* (DRFH)

1. Introduction

Within the tourism industry, resilience to disasters is becoming increasingly studied exposing the need for industry-specific measures (Hall *et al.*, 2018). The tourism sector's total contribution to the global gross domestic product (GDP) for 2016 was 10.2% generating 1 in 10 jobs in the global economy (World Travel and Tourism Council, 2017). The hotel sector demonstrates its importance to the tourism industry as a whole by contributing to:

- The local economy and overall employment (Lee *et al.*, 2013)
- Providing accommodations for tourists and convention attendees (Orchiston & Espiner, 2017) who will ultimately contribute to the economic wellbeing of communities
- Have special value during disaster recovery to provide accommodations for evacuees (Nguyen *et al.*, 2017), critical service staff (Yamamura & Welsh, 2018), and response workers (Neef & Wasi, 2017) as well as local employment.

Organisations that are resilient to disaster recover faster from disruption (Bruneau *et al.*, 2003). The ability to house guests in the aftermath of a disaster is a benefit to the hotel's bottom line. Additionally, as mentioned above, the communities need facilities for persons aiding in recovery and sources of income for local community members. Building disaster resilience from a holistic perspective, refining and supporting an integrative framework with quantitative, qualitative, and secondary data is the objective of this study. The goal is to create a complete picture of disaster resilience for the hotel sector. With that in mind, the research answers the following research question and sub-questions: How can the hotel sector increase their disaster resiliency, and be better able to protect the lives of their guests and staff, and the livelihoods and local economy following a disaster?

1a. How is disaster resilience defined in a hotel sector context?

* Corresponding author. E-mail address: n.brown1@massey.ac.nz

1b. What indicators assist in determining disaster resilience for the hotel sector?

1c. Are hotels in areas of New Zealand resilient to disaster?

1d. Do barriers exist to increasing disaster resilience for hotels in New Zealand?

2. Methods

Two tourism destinations in New Zealand, Wellington and Hawke's Bay, were used in the research. The greater Wellington area has a population of 471,315 (Statistics New Zealand, 2013). Hawke's Bay population is 151,179 (Statistics New Zealand, 2013). In the past eight years New Zealand has experienced some significant seismic events including two earthquakes in Christchurch (September 2010 Mw7.1 and February 2011 Mw6.3) and the Kaikōura earthquake, November 2016 (Mw7.8) (GNS Science, 2016). These earthquakes disrupted normal regional tourism flows for extended periods of time. The size of the study areas allow for a sample of all the hotels in the areas, as opposed to a stratified sample. Wellington had 28 hotels open during the study period; Hawke's Bay had 18. Hotels ranged from multi-national corporate properties to smaller boutique hotels.

The *Disaster Resilience Framework for Hotels* (DRFH) developed by Brown, Orchiston *et al.* (2018) was used as the foundation for all data collection (Figure 1). This framework was conceptualised based on a review of literature done to unpack the complexity of disaster resilience in the hotel sector (Brown *et al.*, 2017) and expands and customises a previous framework for community resilience by Mayunga (2007). A full discussion of predictors and resources used in their development can be found in Brown, Orchiston *et al.*, (2018). The research used a mixed methods approach. By combining quantitative and qualitative methods the results can be triangulated to offset the weakness of one method with the strengths of the other (Molina- Azorín & Font, 2015). To that end this study used an explanatory sequential design; the second phase helps explain finding from the first phase (Badiee, Wang, & Creswell, 2012). Collection and analysis of the quantitative data was followed by qualitative interviews which offer insights into specific issues, building a clearer understanding of the context, and add a greater understanding of some of the quantitative results.

The survey questions were generated from the predictors and measures suggested in Brown, Orchiston *et al.* (2018) (Figure 1). The exploratory survey was designed using a five-point Likert scale with 1 for strongly agree and 5 for strongly disagree (except demographic questions). A descriptive analysis provided percentages of staff and managers that agree/disagree with statements. Means were also developed to contrast differences between GMs and staff, and WL and HB. The survey was emailed to all GMs in the study areas, with a request to circulate among staff (Brown, Rovins *et al.*, 2018). Responses for the survey data included 74% of general managers (GMs) in Wellington (N=20) and 72% (N= 13) of GMs in Hawke's Bay. Staff numbers included N= 13 for Hawke's Bay and N=33 for Wellington.

Figure 1: Disaster Resilience Framework for Hotels (Brown, Orchiston et al., 2018)

A series of in-depth qualitative interviews were conducted with a sample of the hotels from each area. Hotels were selected based on their engagement with the survey and willingness to continue participation in the study. Interview questions were also designed based on the six capital groups when possible and supplemented by secondary data collection in areas not covered by interviews. Through a total of 25 interviews at five different hotels (WL N=13; HB N=12) saturation of data was reached. Interviews included staff from a wide variety of departments and duty managers. GMs (N=7) were also part of the data collection.

3. Results and discussion

In addition to analysis of the data collected, as a whole, this paper also aims to develop a deeper understanding of disaster resilience for hotels in the study area (Creswell & Plano Clark, 2017). Data from the two studies (including Brown, Rovins *et al.*, 2018) is compared and contrasted to improve the understanding of the results from each method.

3.1.Economic capital

Tourism industry secondary data and the GM and staff answers to survey questions and interview topics show complementary pictures. In all cases the data shows economic prosperity for the tourism sector and that economic capital resources would be available if needed following a disaster. Stronger economic conditions before a disaster contribute to decreased effects when disaster strikes (Kim & Marcouiller, 2015).

3.2.Social Capital

A good range of social capital resources to draw on in a disaster is supported by the data. Survey and interview responses suggest there is a team approach to day to day operations and ideas and inputs are welcomed by managers (Brown, Rovins *et al.*, 2018). Silos between departments are being combated by friendships and social connections across departments.

Social capital resources were valuable in the time immediately following the Kaikōura earthquake, supporting the concept of social capital's contribution to overall resilience to disaster (Faulkner, 2001, Norris *et al.*, 2008, Kwok *et al.*, 2016). Staff pulled together, volunteered assistance, and showed capacities to work together under difficult circumstances.

Building relationships with other organisations (Lee *et al.*, 2013) outside of the hotel was one area managers might find value in considering as a platform for improving overall disaster resilience. In interviews, staff discussed waiting for engineers to inspect property post-Kaikōura Earthquake which may have contributed to the score. Wellington managers (25%) did not feel they were building the inter-organisational relationships they might need. As one manager discussed, the Kaikōura Earthquake opened up a lot of considerations and learnings. The shaking felt by staff and guests coupled with the time of day- shortly after midnight, provided unique challenges to the minimum staff on duty at that time.

3.3.Human Capital

The data showed human capital resources available for both areas. General managers and staff were in agreement overall that the facilities could react flexibly and decisively in a disaster to keep the organisation moving forward. The use of different methods of gathering data exposed some gaps in the human capital resources; additional attention to these areas could improve disaster resilience for hotels.

Surveys showed that staff had participated in trainings and exercises (Brown, Rovins *et al.*, 2018), however, interviews revealed that these preparations were primarily fire drills. Staff indicated they would find exercises concerning different scenarios useful. Staff need training in a variety of scenarios; actions can differ based on the threat (Gunter, 2005). A more inclusive approach to disaster planning may also be warranted, which would also help improve staffs confidence in the handling of a variety of disaster types.

Hotel staff and managers indicated they had problem-solving skills, proactive leaders, some staff could access the property by foot if needed and were able to make decisions quickly when needed. The importance of adaptive capacity was illustrated by hotels in Hong Kong during the SARS outbreak (Lo *et al.*, 2007). Wellington exhibited adaptive capacity through actions taken in the wake of the Kaikōura earthquake. Food and

beverage adaptations, communications with guests and media, and staff volunteerism all point to the hotels' ability to adapt to unfolding situations.

Based on the data from surveys, there is no clear picture of how easily staff could get to work if they could not drive into the hotel, which for earthquake hazards can become a factor. The survey showed 50% of Hawke's Bay staff and 25% of Wellington staff lived too far to walk to work if needed (Brown, Rovins, 2018). In interviews, 24% of Hawke's Bay and 47% of Wellington felt they would be unable to get to the hotel following a disaster. However, sufficient numbers of staff, after the Kaikōura Earthquake, were able to get to hotels to provide key assistance to minimal staff on duty at midnight. Together the existing and ad hoc staff were able to assist and care for guests while maintaining readiness for possible aftershocks

3.4.Physical Capital

Based on all data collected hotels have physical capital resources available in case of disaster. Both life safety measures and business continuity structures are present. Only a very few of hotels surveyed (n=2) do not meet 100% of current building standards (Brown, Rovins *et al.*, 2018). All are required by law to have evacuation plans in place that have been approved by fire services. Staff are aware of building seismic compliance statistics and in Wellington all staff interviewed were able to state the percentage of compliance (e.g. "Our hotel is 110% of standards"). One gap highlighted during the interviews- in Wellington, it is unclear if some of the buildings in the tsunami evacuation zones could be suited to vertical evacuation. Vertical evacuation robustness should be determined and socialised among staff.

Another area for improvement is alternate power generation capacity. In Wellington, 73% of hotels do not have back-up power alternatives, in Hawke's Bay 50% do not. In a study of hotels involved in the 2003 black-out in eastern North America, 48% of hotels surveyed did not have power generators and relied exclusively on a battery back-up system that lasts only one-two hours to allow for evacuation (Kwortnik, 2005). The extended time of the black-out caused guest service interruption.

Based on both surveys and interviews critical data is being backed-up at regular daily intervals and hard copies are available if needed in the majority of hotels (Brown, Rovins *et al.* 2018). This important practice is an industry standard in Wellington and Hawke's Bay.

3.5.Natural Capital

As with physical capital, there are many positive predictors of natural capital to build disaster resilience in Wellington and Hawke's Bay. In interviews and surveys staff and managers agreed that the environment is considered in policies and procedures, hotels are participating in recycling, and the some risk from natural hazards can be mitigated through good evacuation routes if needed (Brown, Rovins *et al.* 2018).

Secondary data also shows that New Zealand has put attention to the sustainability of important natural resources that attract tourism (The Treasury, 2016). Research and study into the risks from natural hazards are robust and ongoing. New communication tools are being developed as shown by Hawke's Bay Emergency Management web page which allows an address input to show exact position on tsunami evacuation maps (Hawke's Bay Emergency Management Group, 2018).

3.6. Cultural Capital

The importance of cultural capital relates to knowledge of local hazards and protective actions as well as cultural influences on the local system that influence hazard knowledge, risk, and mitigation strategies. Survey findings measured cultural capital available based on length of time in New Zealand. More than 75% of GMs and staff were in New Zealand during the Christchurch earthquake and all experienced the Kaikōura event. Recent disaster experience in the country exposed the staff and GMs to a disaster and an opportunity to consider how an earthquake may affect them in the future.

The experience with disasters in recent years may also influence the safety culture in New Zealand. Interviews showed that literally everyone knew current messaging for earthquake and tsunami, i.e. *drop, cover, hold,* and *long, strong, get gone* and understood what protective actions should be taken. During interviews 80% of people reported emergency kits in their homes. One area of consideration in the safety culture being developed is the possible prioritisation of guests over staff. Based on interview responses, many hotels evacuation policies have staff report to the warden in the lobby and then send staff back up to floors to clear the

floors of guests. Staff also discussed in interviews their responsibility to secure the safety of guests. Managers may want to consider scenarios where staff safety requires guests to self-evacuate with processes that improve communications of evacuations to all areas of the hotel. Once in the lobby staff may be safer heading to assembly points, instead of performing roles that may be better suited to professionals.

The following Table 1 highlights the combined finding of the qualitative and quantitative research (Brown, Rovins at al., 2018) done with hotels.

Table 1: Summary of findings from mixed-methods data analysis

Economic Capital
• Financial strength: Tourism industry experiencing growth including an increase in hotel guest nights. 40% of hotels do not have financial reserves. Disaster management is not part of the budget.
• Diversity of income: Increases in the diversity of customer bases are happening and supported by marketing efforts.
• Staff economic resilience: Growth in tourism jobs and longevity of employment are supported by regular savings by staff. Much of the staff do not have insurance on personal property.
Social Capital
• Social cohesion/connectedness/networks: Close intra-organisational networks. Higher in Wellington post-Kaikoura earthquake. Need to increase management support of social activities for staff cohesion development.
• Capacity to work as a group: Demonstrated thinking on their feet and pulling together
• Trust: Some concerns about organisational and management priorities but confidence in plans. Leadership takes thoughtful actions and values input from staff.
Human capital
• Health and wellbeing: Medical insurance available and high perceived control for staff and GMs.
• Skills: Employees have some experience in fire evacuations exercises and special trainings (e.g. first aid). Need all hazards skills and attention to disabled guest processes. Also need to clarify skills available during each shift and consider cross-training.
• Capacity to adapt: Employees are ready willing and able to assist in a disaster. Managers showed creative adaptation but need to consider guest satisfaction when possible. Many staff and GMs could not get to work in some types of disasters.
• Knowledge: Staff and managers have an understanding of basic evacuation protocols and industry experience. Lack of all-hazards protective action knowledge. Guests need additional multi-hazard information.
• Business continuity: Critical data is handled with disruptions of service considered. Leadership in key areas is available, but cross-training needs improvement. Communications tool needed in emergency response should be developed prior to events.
Physical Capital
• Life safety: Building standards are being met. Evacuation routes are well known. Building height factors into service levels when elevators are inaccessible. Power back-up capacity needs improvement. Develop an multi-hazard evacuation protocols. Emergency supplies of food and water also need development.
• Business continuity: Critical data protection is integrated into basic processes.
Natural Capital
• Hotel's exposure to natural hazard risks: Natural hazard risk is considered by research and policy organisations and protective actions are available in the natural environment in many cases (e.g. higher ground).
• Hotels effects on the local environment: Organisations dedicated to natural environment protection are present. Sustainable activities are being considered and research is ongoing. Hotels need to act as watchdogs for natural environment protection.
Cultural Capital

- Safety culture exists. Previous experiences of local hazards are influencing new actions and strategies. The duty of care for guests in integrated into the culture. Some lack of cultural knowledge may influence the lack of tsunami strategies in Wellington. Staff safety needs to be balanced with guest safety.

4. Conclusions

Arguably, the most prominent barrier to building resilience to disaster is time, followed by money. This research found managers are often fully committed to business as usual, day-to-day operational concerns. However, it may be that with limited effort managers can engage their staff in the process, relieve much of the workload, and thereby enhance social capital, human capital, and build disaster resilience. A limitation of the study includes the localised nature of the data and variables making widespread generalisation inappropriate. Future research looking at refining predictors through case studies of areas with different risks and challenges will add to the knowledge significantly. This all-hazards framework could benefit from data from areas with high risk from terrorism and weather-related disasters.

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A case study for resilient urban waterfront regeneration

Blake Jackson [a,*]

[a] Stantec Buildings Group, USA

Abstract

This paper examines *The Eddy*, completed in 2017, which is a new mixed-use multifamily housing scheme in Boston, Massachusetts (USA) that exemplifies the nexus of public and private partnerships, resulting in enhanced resiliency for the individual property and its surrounding neighbourhood. It is situated in the historic neighbourhood of East Boston on low-lying, former industrial land, which has for centuries been an entryway for flood waters into the neighbourhood. During its redevelopment from an industrial storage facility into luxury rental housing, this project was seen as a lynchpin to a larger plan by the city to help mitigate climate change factors – rising sea levels, increased heat, and increased precipitation – for the entire neighbourhood by weaving it into existing and planned "hard" and "soft" infrastructure projects. This paper explores the drivers for these measures on the project and the strategies employed by the designers and the municipality, which resulted in greater sustainability, increased resiliency, social benefits for the community, and benefits to the owner. It will explore in detail how site, landscape, architecture, mechanical systems, and interior design each play a crucial role in the purported outcomes, and it will conclude through the sharing of economic metrics derived from the client relative to the performance of the building during its first year of operations, specifically regarding marketability, operational cost savings, and a return on investment for utilizing a design approach championing both resiliency and sustainability in tandem. The main goal of this paper is to illustrate how successful public and private partnerships can be leveraged to promote cooperation, applicable within any waterfront city, whereby cities can continue to grow, densify, and celebrate their places on the waterfront while promoting increased resiliency, sustainability, and public space.

Keywords: Resiliency; Sustainability; Housing; Climate Change; Urban Planning

1. Introduction

Humanity is urbanizing faster than at any other time in history, and the inexorable drive for increased density and our innate desire to be nearby waterfronts, where applicable, is driving development. Historically, cities grew around sources of navigable water for the purposes of commerce, with most historical development occurring on coasts and/or along navigable rivers. Particularly for post-industrial cities, waterfronts in growing and rapidly urbanizing cities enrich connectivity to history, nature, and recreation through memorable open spaces. Cities around the globe as diverse as Cardiff, Wales (UK), Portland, Maine (USA) and Hamburg, Germany – to list a few – are growing back towards the sea to replace former industrial lands with new mixed-use urban, waterfront living. Despite the global trend towards urban growth, threats to these cities, posed by climate change and natural disasters, are many and vary depending upon each location. This was recently experienced by North American and Caribbean nations during 2017's hurricane season where three 100-year storms (Harvey, Irma and Maria) wreaked havoc, specifically upon islands and low-lying coastal regions. What then lies ahead for our waterfront cities pending a less predictable and more dynamic future as they strive for intelligent growth?

2. Objectives

The aim of this paper is to explore the above question while looking at a case study in Boston, Massachusetts (USA). Boston is not only one of the most highly vulnerable cities to climate change in North America (Figure 1), but it is also one of the fastest growing cities in the US, undergoing one of its most rapid growth period in its 388-year history. The city currently anticipates an additional 130,000 citizens estimated by 2030, fuelled by the city operating as a regional, national and global nexus of finance, education, healthcare, research and entrepreneurship. Such growth always comes with challenges, and for Boston, it is in the form of a housing shortage and overall lack of space to grow (Tumber, 2014). From its founding in 1630, the city quickly outgrew its location at the end of the Shawmut peninsula and began what would be centuries of land reclamation (Figure 2). These reclamations, indicative of the current urban morphology, transformed low-lying tidal flats into areas of commerce (17th and 18th centuries) and industry (19th and 20th centuries), adapting and growing as the city's population grew and as

* Corresponding author. E-mail address: blake.jackson@stantec.com

economic situations emerged and shifted. The result is a city very much defined by its relationship to the water with billions of investment dollars now transforming low-lying, former-industrial coastal areas into new urban neighbourhoods to accommodate "Information Age" growth – despite knowledge that sea level rise is inevitable.

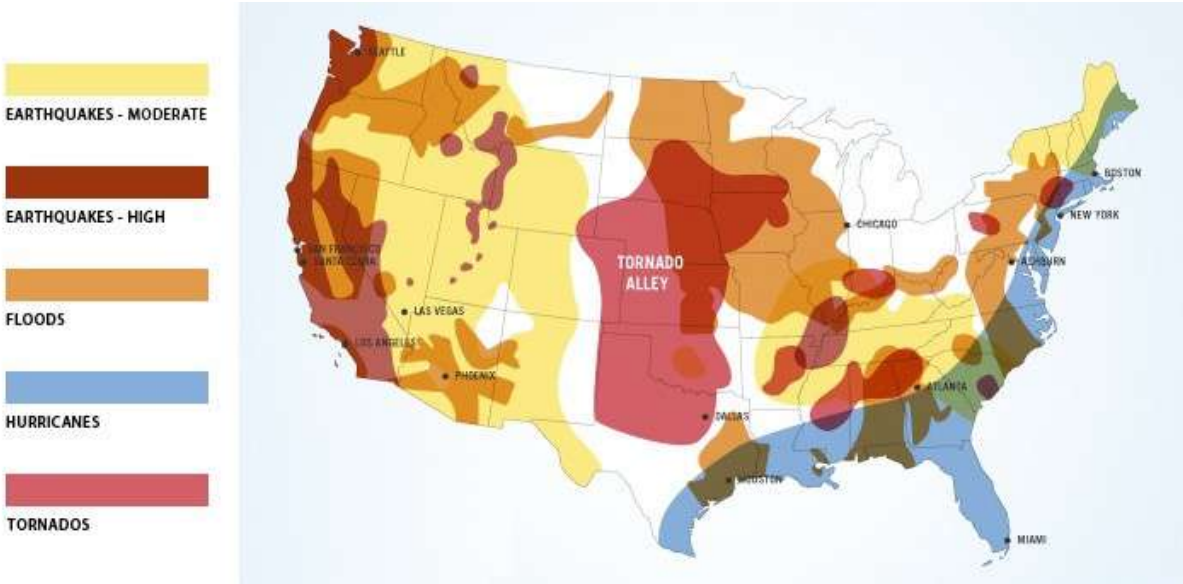

Figure 1: Overlay of regional natural disaster risks relative to major US cities.

Figure 2: Illustration of the extent of historical land reclamation across Boston.

While the challenge of climate change questions the rationale of developing in such places to begin with, the potential rewards are too tempting to resist; thus, developers are learning to formulate cost-effective strategies for such high-risk areas, which protect built and existing development beyond and grant greater waterfront access by enhancing the public realm around waterfronts. An example of such a catalytic development in Boston, replicable in other waterfront cities, is The Eddy, a 24,850 square metre $104 million mixed-use residential housing scheme on 1.62 hectares of previously underdeveloped waterfront in East Boston, one of the oldest, lowest-lying and most climate change vulnerable neighbourhoods in the city (Figure 3). This project, designed by Stantec for the developer Gerding Edlen, features 259 studios, one-bedroom and two-bedroom rental units, a 465 square metre commercial restaurant (open to the public), parking, and new waterfront parks. This paper will build upon the economic drivers for this project by next exploring the municipal leadership which wove this

project into larger goals of the city and how policy became a driver for resiliency for the site and the neighbourhood beyond.

Figure 3: Modern aerial view of Boston with The Eddy pinned on the map.

3. Methods

Cities can and should play a leadership role in utilizing growth-oriented development as a tool to ensure long-term climate change mitigation. Cities historically grew organically and sporadically; yet, modern municipal planning authorities employ stringent rules regarding building massing, appropriate mixes of uses, infrastructure connectivity, etc., all which are tools that can be leveraged to promote resiliency and sustainability. Some rare exceptions, such as Houston, Texas (USA), exercise few zoning restrictions to promote density, sustainability, and resiliency. This *laisse-faire* attitude, according to Wikipedia (2018), towards planning was a major factor in the scale of devastation left by Hurricane Harvey (2017), the wettest and costliest ($125-billion) tropical cyclone in US history, which dumped 1-metre of rainfall over four days, resulting in catastrophic flooding. For a low-lying metropolis decimated by urban sprawl, the existing in place "soft" (landscaping) and "hard" (storm sewers) infrastructure was simply overwhelmed by a such powerful storm – the new norm.

Table 1: 2017 Top 10 States for LEED.

Rank	State	Certified Square Metres	M² per Capita	Certified Projects
1	Massachusetts	2,725,625	0.39	130
2	New York	6,108,318	0.32	192
3	Illinois	4,048,561	0.31	135
4	Hawaii	419,900	0.29	16
5	Maryland	1,472,948	0.24	105
6	Minnesota	1,209,417	0.21	47
7	Georgia	2,196,047	0.21	71
8	California	8,292,388	0.20	475
9	Virginia	1,727,020	0.20	152
10	Colorado	1,058,906	0.18	76
**	Washington DC	2,226,591	3.2	139

3.1.Article 80

Boston has spent fourteen years learning from the misfortune of other major US coastal cities, New Orleans during Katrina (2005) and New York City during Sandy (2012), to be prepared for the beginning of the climate change era: rising sea level, increased heat and increased precipitation. To begin the process of building a more resilient, sustainable city, parcel by parcel, the City of Boston's permitting authority – the Boston Planning and Development Agency (BPDA) – initiated an ordinance called Article 80. This ordinance applies to all "large" projects (9,300 square metres, or larger), requiring them to demonstrate the ability to meet LEED Silver certification (since 2007) and to supply a resiliency checklist (since 2013) in order to obtain a building permit. These tools have both been instrumental in forcing developers and designers to consider both holistic sustainability and climate change early and often throughout the early design process. Table 1, interpolated from the USGBC website (2017), illustrates how Massachusetts, with Boston as the economic engine, has leveraged this program to result in the highest number of LEED buildings in gross square metres per capita and is recognized ahead of even California as the most energy efficient state in the US by the American Council for Energy Efficient Economy (ACEEE), 2017-2018. Regarding resiliency, the municipality is working with various research organizations to do site-specific mapping of risks to identify future floodplains, to identify datum lines for the location of grade level and critical infrastructure (parcel by parcel) and is even requiring teams to commit to the future planning for climate change mitigation during building's operations. To support designers and their clients, the city developed the Climate Ready Boston Map Explorer tool (Figure 4), which is an online geographic information (GIS) mapping technology that looks parcel-by-parcel at each plot within the city and layers various climate change impacts and social vulnerabilities projected over time in 2030, 2050, and 2070. This free tool helps visualise these impacts over time towards designing for better outcomes.

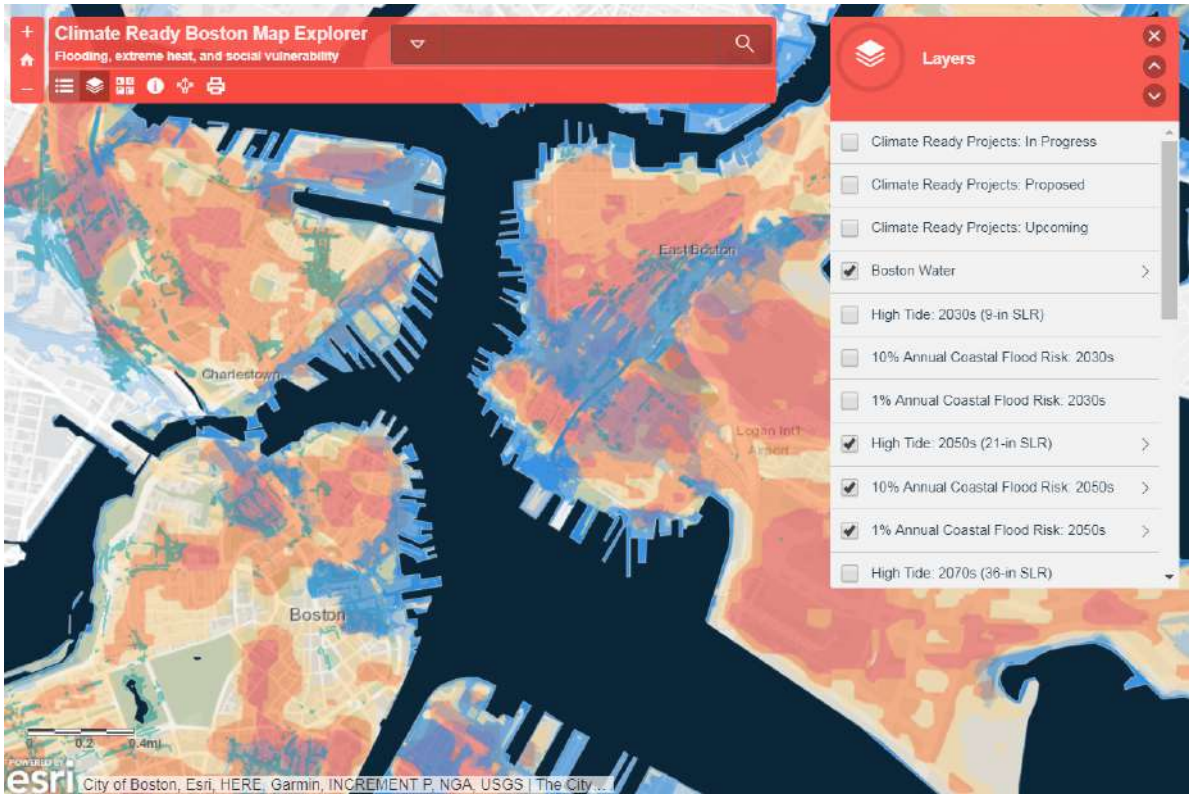

Figure 4: A view of Boston within the Climate Ready Boston Map Explorer tool (*The Eddy* circled).

3.2.Imagine Boston 2030

Continuing to build upon the success of Article 80, the City of Boston launched its first comprehensive masterplan in over fifty years, called *Imagine Boston 2030*. This plan offers a vision for future growth and prosperity for the city, predicated upon growth, stringent climate change goals, increased resiliency, and inclusion (Emanuel, 2017). This plan strategically identified a variety of neighbourhood-specific solutions where a triumvirate of policy and "hard" and soft" infrastructure projects would unfold overtime to achieve these goals. With its planning vision, permitting "gate-keeping", and a long-range view, the city is using public/private partnerships methodically to weave them together into a larger plan of existing and on-the-boards projects which

together will result in a unified new edge of the city waterfront – this new "buffer" serving to protect the existing development beyond. *The Eddy* was one such early development, which became the catalyst within the East Boston neighbourhood portion of the plan, the redevelopment of its parcel serving as the genesis of protecting its vulnerable edge and the neighbours beyond by linking with existing parts of the masterplan (Figs. 5 and 6). To achieve this, the city relaxed zoning for the developer, who would end up paying for this connection and the future protection of the neighbourhood, to allow for greater height and density. A win-win for all parties involved, the developer gained a larger, more valuable building, the neighbourhood gained protection and enhanced green spaces, and the city completed a critical piece of their Imagine Boston 2030 masterplan.

Figure 5: East Boston, *The Eddy* circled, showing future climate change predictions for 23cm of sea level rise by 2030 and 92cm by 2070.

Figure 6: View of the implementation of the East Boston Imagine Boston 2030 masterplan's unified waterfront.

4. Design strategies

Not only was the BPDA a major sounding board for resiliency; the developer came with a brief, which understood the vulnerabilities onsite and requested the design team create a scheme which could maintain

normal operations, standalone, for three days after a major disruption – mostly anticipating major coastal flooding. The design team understood that all the building's systems would need to work in concert to achieve this goal, and utilising the LEED compliance requirements, committed during the Article 80 and permitting process, the team was able to bundle what may have been perceived as cost premiums for resiliency into the baseline design of the project. Several aspects of the site design were created considering both sustainability and resiliency. One example is in the requirement that projects designate 30% of the site area as open, public space, while also restoring 30% of the site using native vegetation. These spaces, onsite and on certain designated rooftops, serve as semi-public amenities, help the project earn LEED points, and they increase resiliency. For example, native plantings were selected based on their beautification potential, potable water demand reduction, and for their ability to survive saltwater inundation. The manipulation of the landscape, was also a critical aspect of built-in resiliency. Subtle, three-dimensional landforms lend visual interest, carving out various spaces within the landscape; however, they also can break down storm surge forces moving over them while funnelling water via gravity back out to the waters' edge after an event (Figure 7). A critical theme explored here, and elsewhere in the project, is the concept that one strategy serves an equally important purpose during both times of regular operation and disruption.

Figure 7: *The Eddy* nestled within the Harborwalk, surrounded by "green" buffers on two waterfront sides.

Additional savings came from logical space planning and site manipulation to prioritize protection of critical infrastructure onsite and within the structure. Despite having a high overall water table, it is common in space-cramped Boston to place electrical equipment and emergency back-up generators below grade. This introduces a significant cost for projects because the common mitigation strategy is to build a watertight basement with back-up sump pumps for the inevitable leakage which ensues as buildings settle over time. *The Eddy* overcame this expense through placing these generators on the rooftop along with four days' worth of fuel. While the rooftop could have been used for renewable energy technologies, the compact floor plates would not have sufficiently supplied enough energy for such a large building, meaningfully. Rather, all critical HVAC&R equipment, which did not require municipal access, was placed on the roof to protect it from flood waters. This includes an onside combined heat and power (CHP) plant. This energy conservation measure offers additional redundancy to grid-supplied power and steam, and it resulted in $150,000 of annual energy cost savings on the owner-operated

project. Lastly, no critical program is located at grade. Only the lobby, retail and parking are there as an added level of redundancy in case rising tides exceed the currently projected models. Grade, plus an indoor/outdoor amenity level on level 1, means all dwelling units are sufficiently protected on level two with 13 meters of vertical separation from the 500-year floodplain.

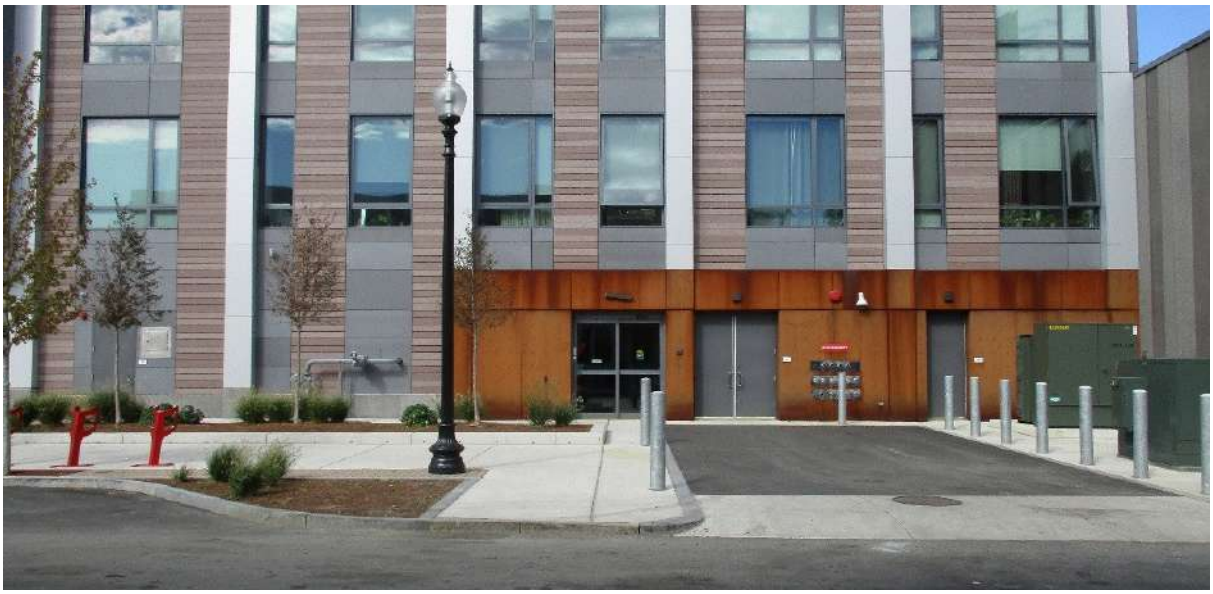

Figure 8: New grade elevation above the 500-year floodplain safely, cost-effectively houses critical infrastructure.

In an interview with the design team, (Jackson, et al., 2017), it was learned the grade datum was elevated through recycling onsite soil excavated from the excavations for foundations to build a mound for the building to sit on, safely above the site-specific 500-year floodplain. By doing this, the ground floor is given an extra layer of protect while avoiding the expense of transporting the partially contaminated soils offsite for remediation and disposal. Instead, it was cheaply encapsulated onsite and used as a plenum for the main building entry (Figure 8). This new datum provides a safe place onsite, along a public way, where grade-mandatory electrical equipment, utility connections, and egress routes can safely land outdoors for ease of access, especially useful during times of disruption. In additional to "soft" measures onsite (landscaping), "hard" infrastructure was also updated, including repairing and enhancing both the length and height of the existing sea wall surrounding the site on two sides.

Entrances along the ground floor are protected, the majority of which are oriented away from the coastal sides of the building. In the event of flooding, the interiors of these spaces are designed using a technique called wet-floodproofing. This technique includes designing spaces with non-porous materials which can easily be squeegeed and air dried, making recovery time post flooding faster, and it reduces waste from not needing to refurbish damaged materials needing replacement if wetted. Additionally, *The Eddy* features a resilient materials palette of hearty, durable materials (metal panel, wood, glass, and precast concrete) which can resist hurricane force winds, saltwater, and which will weather and patina overtime without costly maintenance. These selections helped control cost, while contributing towards LEED certification for regionality, recycled content, and other attributes.

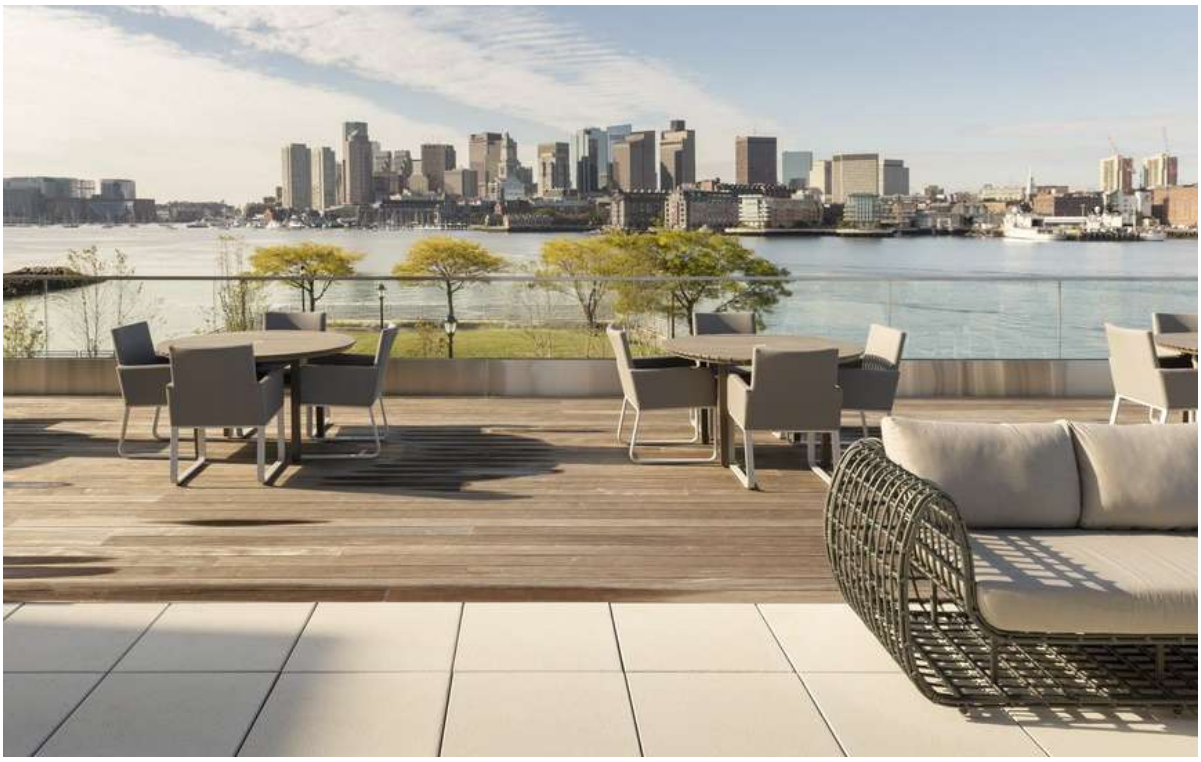

Figure 9: A view towards the downtown skyline from the first-floor amenity level's intensive rooftop.

5. Results

These strategies explained in the previous section are not a radical departure from code compliant construction in Boston and elsewhere; yet, they promote a unique, place-based approach towards designing for waterfront sites which celebrates place rather than retreat from waterfront locations. The resulting design creates a harmonious balance amongst the many drivers for space, budget, and programmatic needs – appropriate for viability in an expensive-to-build-in construction market and competitive housing market. The generous public space provided by the development provides much needed social spaces, including a water taxi which connects to downtown Boston, new fishing stations, public art, a new signature restaurant, and enhances 335 meters of the Boston Harborwalk, a 70-kilometre semi-continuous linear park along the entire Boston waterfront, for socialisation and enjoyment of residents and the community alike. These strategies illustrate the synergy between resiliency and sustainability for first cost and operational cost savings when planned for in tandem, and for the developer, these have become a hallmark for their company branding.

The project went above and beyond the requirement for demonstration of LEED Silver (minimum Article 80 requirement), earning LEED Gold certification. From an interview with the owner (Jackson, B. and Edlen, M., 2017) here, and across their portfolio, Gerding Edlen sees resilient development achieving top-of-market pricing, which means between 2-18% above neighbourhood median leasing rates, overall faster leasing of these properties – also due to the propensity for proximity to water – and higher occupancy rates with better occupant retention over time. While LEED demonstrated a six-figure annual cost savings, regarding energy consumption, and the building is leasing well – both feats not to be scoffed at – the biggest return on investment for resiliency came in the form of an often-non-considered party crucial to the development proforma and process – insurers. In a major development industry study by the Urban Land Institute, ULI, (Marschall and McCormick, 2015), the insurance underwriter, Affiliated FM, was able to substantially reduce the premium associated with such a risky site, because of the demonstration of built-in resiliency and redundancy, from $10 million to $1 million. Considering that the project budget was $104 million, this represents an overall 8.65% initial savings, much of which went into funding additional sustainability and resiliency strategies onsite. Considering the industry rule of thumb in the northeast US that the cost for LEED Gold certification is between 1-5% premium, these measures more than paid for the BPDA requirements, giving the development a "greener" building and major marketing advantage – all a win-win for the developer, the community, and the environment.

6. Final remarks

This project provides insight into how waterfront developments anywhere can serve as a catalyst for larger private and public benefits through public/private partnerships which prioritize collaboration, tools, common sense approaches, and incentives to realize greater sustainability, resiliency, and to narrate a positive future along the waterfront. Until municipalities move beyond the fear of loss towards helping projects realize cost avoidance as a means to create higher value, cities will continue to struggle to balance climate change and future uncertainty. Planning is a decisive tool, which encourages many independent parties to act in unison towards a shared vision, rather than each project reinventing the wheel of what resiliency means for their project alone. Hopefully, the 2017 hurricane season has served as a reminder of how pertinent this discussion is and the greater the need for urban resilience. Developments, like *The Eddy*, and others, create pathways towards a future where climate uncertainty will not be detrimental to the promise of urban vitality that lies within our waterfront cities across the globe. Particularly there, this relationship serves as a major attraction fuelling unprecedented growth, which shows no signs of slowing down.

Acknowledgements

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Urban image analysis based on nitrogen dioxide (NO2) as a polluting agent; case study: historical center of the city of Cuenca

Sandra Cobos [a,*], Enma Espinosa [a], María Aguirre [a], Deisy Reyes [a]

[a] Universidad Católica de Cuenca, Ecuador

Abstract

The economic development characteristic of intermediate cities such as Cuenca, in Ecuador, produces high environmental pollution due to gas emissions which is mainly produced by the progressive growth of vehicles. Its implications have been widely debated by a public health standpoint. However, there is also evidence of damage over the urban image perception. This reality becomes even more sensitive in areas with heritage value. Therefore, the main aim of this paper is to analyze the urban heritage image, considering NO_2 as the main polluting agent in the Historic Center of Cuenca. For this purpose, a spatial modeling of NO_2 distribution was carried out to identify two pairs of analyzing points according to their similarity of NO_2 concentration. Subsequently, a photographic survey and a classification of pathological damages were done over historical materials. As a result, the NO_2 concentration´s spatial distribution presents concentric rings patterns, where the highest values occurs in the Respect and Priority Area with ranges between 24.11 and 29.1 μg/m^3. The principal damage over the historical material is the dirt by deposit with a total area of 107.55 m^2 over the four analyzed sections.

Keywords: Urban mage; Nitrogen Dioxide; Spatial Distribution; Historical Center; Cuenca.

1. Introduction

The urban image, more than a simple physical space, is seen as a perception of the individual that through the senses, allows to receive, process, and organize the information provided by the urban environment (Zoido et al., 2000). According to Kevin Lynch, this image is constituted by external points such as buildings, signs, and other urban furniture, called landmarks, which can become significant elements, depending on the historical association that each of them represents for society (Lynch, 1956). As part of this image, and by the action of external, internal and environmental phenomena, the existence of deterioration symptoms has become a visible part of it.

Pathological processes present at urban areas and industrial zones, among other factors, are produced by the presence of polluting gases. These elements are carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), suspended particles (P.M) that result from combustion, and the wear of tires and brakes on the pavement. From all these gases, NO_2 is highlighted because it acts in synergy with SO_2 to destroy the construction materials that evidence the passing of time by corroding fabrics. Thus, these two gases are considered the main atmospheric pollutants by anthropogenic activities (Kucera and Fitz, 1995; Kornartit and Chiraporn, 2005). NO_2 is mainly emitted by diesel engines and results from the oxidation of NO, exceeding its corrosion level by four times. It is reddish with a strong smell and toxicity levels (Contreras Ochando, 2016), which, when hydrated in the atmosphere, forms nitric acid (HNO_3) that comes down as acid rain. Some of the effects of this gas on the materials are dirt deposit, differential washing, corrosion, discoloration and a variety of chemical reactions depending on the type of material on which it is deposited, as well as the deterioration signs with different forms and development levels; therefore with a variety of aesthetic and constructive incidences.

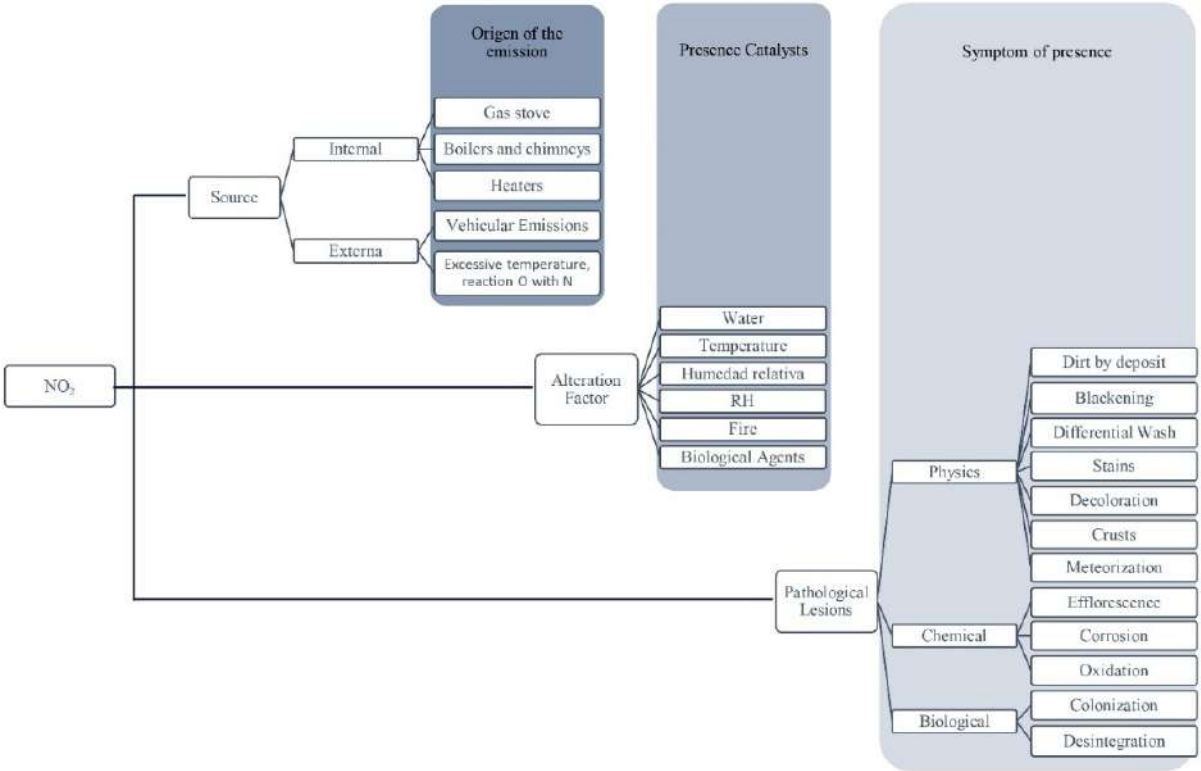
The historic center of *Santa Ana de los Rios de Cuenca*, declared a World Heritage Site on December 1, 1999, is a reference point for constructive, culture and urban-architectural identity, which forces the maintenance and preservation of its universal value. This necessity is far from the nostalgia of the late nineteenth and twentieth centuries (Turner, 2007) marked by major destructive events; not because they have ceased, but because their action has moved to conservational and anthropic context, and also to those indirectly related to NO_2 (Figure 1). Information gathering has confirmed that the production sources of this deterioration agent are external, although it has not been verified that the internal ones such as gas stoves, boilers, chimneys, portable heaters, and similar ones, had reported incidences. It is also of interest to study air quality internally, since in the

* Corresponding author. E-mail address: scobosm@ucacue.edu.ec

case of Cuenca, up to now the evaluation has only been carried out externally.

The diversity of signs present in the historical materials reveals the ecosystem's imbalance. From the specific case of NO_2, the first step towards its mitigation is to carry out an Anamnesis (ICOMOS, 2003) of each one of the incidence factors, as well as the buildings' simple and historical materials. Likewise, to establish actions focused on both preventive and corrective conservation, in order to achieve healthy environments, both for human occupation and for the permanence of the built legacy, understood as a non-renewable resource. In order to do this, it is essential to have an environmental monitoring for the management of the city's air quality. In Ecuador, Quito and Cuenca are the only cities that have such an infrastructure. In the latter case, the network has 20 monitoring stations, which record values of SO_2, NO_2, Ozone O_3, PM10 and $PM_{2.5}$, Sedimentable Particles PS, Volatile Organic Compounds VOC, and Carbon Monoxide CO (Jerves Cobo and Armijo Arcos, 2016). It has been working since 2008 and it complies with the recommendations of the United States Environmental Protection Agency (USEPA). All of monitoring stations, except the one that measures ozone, have a neighboring scale. Its spatial distribution is subject to criteria of population density, gas concentration, distance between vehicular circulation routes and stations, altitude to the analyzer, horizontal and vertical distance from the support structures to the analyzer, obstacles, free space, among other recommendations established by USEPA and the equipment manufacturers.

Figure 1: Sources, catalysts of NO2 signs and its presence in the construction materials of the Historic Center of



Cuenca. Source: (Ministerio Coordinador del Patrimonio, 2012; De Jongh et al., 2009; Canadian Conservation Institute, 2016; Achig et al., 2016)

In concern to what has been exposed, the main aim of the present study is to analyze the urban heritage image of Cuenca's Historical Center in terms of NO_2. For this purpose, the spatial modeling, based on geographic interpolation techniques allowed the identification of 4 sample points, in which a photographic, planimetric and the characterization of pathological damages in historical materials was carried out, which finally allowed the discussion about the urban image generated by these elements.

2. Data and Methods

2.1 Data

The authors used data from the city's air quality monitoring network, spatially located as it is shown in Figure 2. As there was record of the NO_2 concentration from 2008-2014, an average of this period was required.

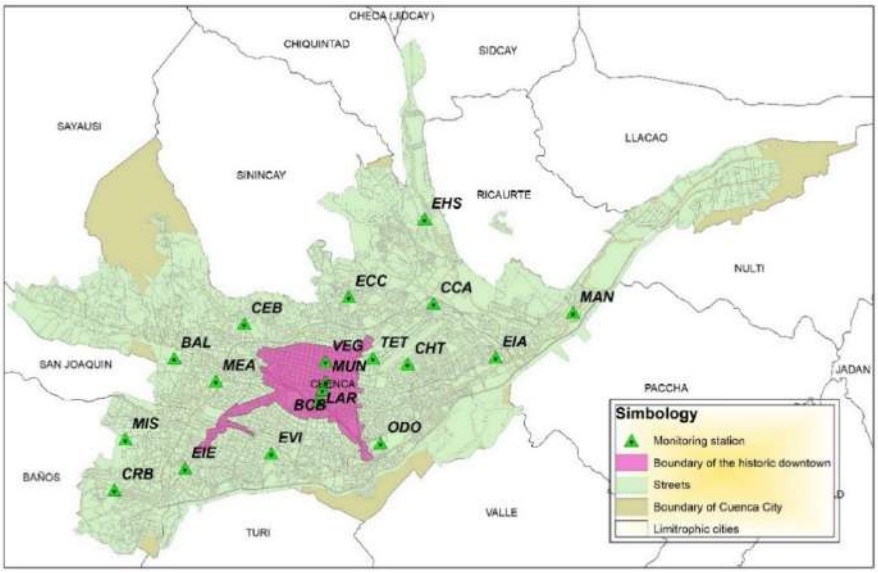


Figure 2: Location of the monitoring stations. Prepared by the authors.

2.2 Methods

1. Air Pollutants Special behavior - Interpolation

Air pollution simulation models describe mathematically the gases behavior between the emission points and the final concentrations, which is measured by the receiving air quality monitoring stations. The influence of meteorological factors such as wind direction and speed, temperature, solar radiation, and rainfall, among others; cause variation on the concentration magnitude. It is to the fact that the gases has found in the atmosphere a mechanism to transport, disperse, and transform (Contreras Ochando, 2016). In fact, the variations in values are mostly due to atmospheric effects and turbulence originated in uneven areas (areas with higher buildings' density), than to changes in the emission source itself (World Health Organization, 2006). The Interpolation values estimation technique, which is based on known points, is used for the construction of these models. This process is limited because of the heterogeneous distribution of stations, the insufficient number of known points and their correlation.

For the present study, three interpolation algorithms have been used to model the NO_2 spatial behavior. The first one was the Ordinary Kriging, which is a linear statistical interpolation that assigns greater weight to the known data that is closest to the point that is calculated. It uses the variogram function so that the error associated with the predictor is lower than any other linear summation (Fuenzalida-Díaz, 2015). Its use is recommended when there is little-known data (Sharker and Karimi, 2014) and the variable behavior in the space is known. The second interpolation process is called Inverse Distance Weighting – IDW. It is deterministic and gives greater importance to the nearest known measurements, but the weighting of the known points is done using the inverse function of the distance to the desired point. This method is fast and, similar to the Kriging, it assumes a linear distribution of data. However, it tends to generate circles or pits around the sampling points (Villatoro et al., 2008), This method provides better results when the data are highly densified and have an irregular spatial distribution (Sharker and Karimi, 2014; Kumar et al., 2016). The third method called Spline with Tension corresponds to the Radial Basis Functions - RBF This interpolation provides better results on even topographic surfaces and differ from polynomial interpolations such as the conventional Spline because the latter is an inaccurate interpolator (Kumar et al., 2016).

2. Urban – Architectural survey

2.1. Photographic and planimetric Survey

The in situ photographic and dimensional material survey was carried out on the four sectors of interest derived from the interpolation process. A cross morphology, with an influence radius of one block oriented towards the four cardinal points, was applied starting from a two streets point of intersection because the highest contamination levels are found in the corners (Albizuri-Churruca, 2016). This way, graphics support can be obtained from observation data, starting from a more general, and then going to a more detailed level. This type

of observation allows data to be analyzed and interpreted (Mileto and Vegas, 2010) to describe the material components and state of conservation.

2.2. Surveys

In addition to the photographic analysis, the urban image analysis uses other qualitative techniques that allow the incorporation of the socio-symbolic component, by means of the subjectivity interaction in the territory individual's perception (Lindón, 2007). This feature is largely determined by gender, age, social status and length of residence (Rubio and Santarelli, 2005). In order to achieve this, the survey has been included as a primary information gathering technique, consisting of eight close-ended questions.

2.3. Classification of pathological damages in historical materials

As part of the analytical process, the particular and differentiated identification of pathological damages allows the organization of the damaged materials. This way, the level of NO_2 impact on the urban image and on its historical landscape is quantified and qualified. Likewise, the damages derived from the direct action of this pollutant, as well as of those in which it acts in a synergistic manner with other variables, are established. This process is carried out with the basis on the proposal illustrated in Figure 1.

3. Results and Discussion

After applying the three interpolation algorithms, Ordinary Kriging, Spline with Tension, and IDW; it can be stated that the algorithm that best spatially models the behavior of NO_2, in function of its Root Mean Square - RMS, is the Ordinary Kriging. It presented a RMS of 6.23, while the Spline with Tension provided a value of 6.40, and the IDW gives 7.28 (Figure 3). According to the spatial model, the Historic Center of Cuenca presents NO_2 concentrations that range between 15.02 and 29.085 µg / m^3; moving far away from the maximum annual average established by The World Health Organization - WHO to protect public health which is 40 µg / m^3 (World Health Organization. 2006). However, its permanent and progressive impact on historical materials, which has not been assessed or defined, may result in irreversible damage.

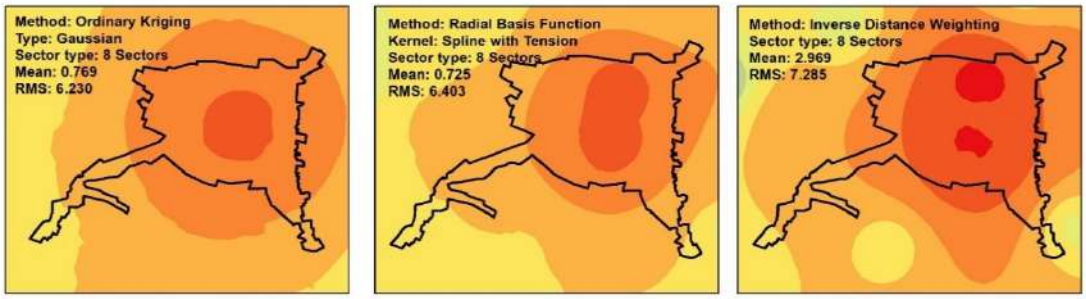


Figure 3: Spatial models according to the three interpolation methods. Prepared by the authors.

The spatial distribution shows concentric rings patterns, where the highest concentration of NO_2 occurs in the first inner ring with ranges between 24.11 and 29.1 µg/m^3. This zone includes the Respect Area and it extends up to part of the Priority Area. The first one is made up by the Central Park and eight blocks around it and the second one, includes surrounding sections. Here, two sampling points were established on the streets *Presidente Córdova* and *Vega Muñoz*. In the second ring, from the inside out, the two remaining points were located on the corners of *San Sebastian* and *San Blas* churches. They presented a lower concentrations of NO_2 ranging between 20,27 and 24,11 µg/m^3 (Figure 4).

It can be seen that the spatial distribution model of the NO_2´s concentration, is directly related to the heritage value of the area. That is to say, the greater the historical value, the greater the contamination level. This fact can be explained by the lack of green areas due to the replacement of the block centers, i.e. patios and vegetable gardens, by parking lots (Hermida et al., 2015); the great vertical densification and the intensive replacement of residential to commercial land use.

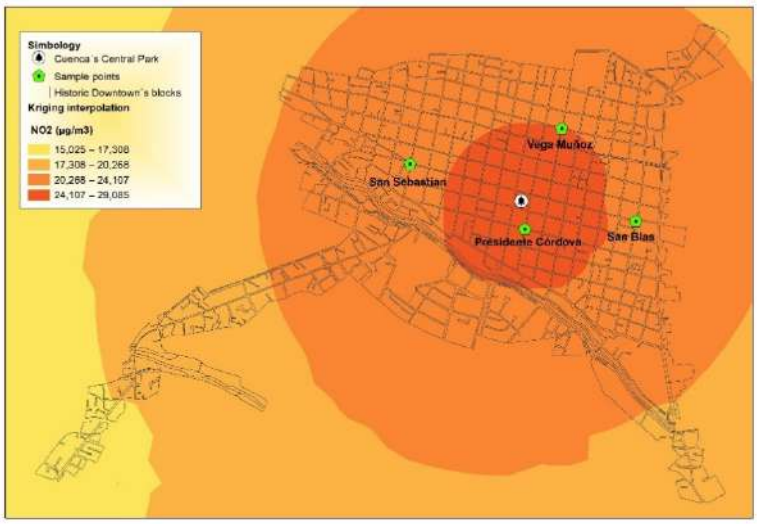


Figure 4: Spatial distribution of NO_2 at the Historic Center of Cuenca. Prepared by the authors.

The preservation's condition of the four urban sections reveals the particular circumstances of the immediate context. First, the San Blas section, is made up of buildings corresponding to different historical periods, heritage values and uses. The greater damages are found at the plinth, in the areas of direct contact with the sidewalk, where rainwater and the action of NO_2, among other gases and particles suspended in the air converge. This is a constant behavior in all of the four cases, where the principal damage is the dirt by deposit. On more luminous surfaces, the signs of deterioration are greater than on those darker. Something similar happens in more elaborated and irregular architectural styles. The recessed, winding or embroidered surfaces (Calle Medina and Espinoza Abad, 2003), the later one in the particular case of Cuenca, maximizes the deterioration, and promotes the generation of other types of damage, such as biological colonization of birds, rodents, and insects, as well as the settlement of other organisms, capable of migrating, from the nearby areas. The existence of plazas and vegetation is a very important factor that contrasts with the other cases and mitigates to some extent the adverse effects of the environment to the fact that it presents just a 4.78% of deteriorated area (Figure 5).

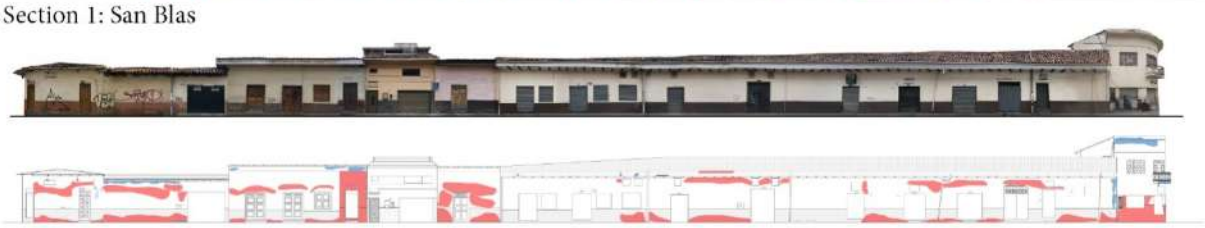
In the second case, San Sebastian Section, the low urban configuration and the predominance of overhanging walls, evidence the deterioration of large areas, 17,30% of its total front surface. This fact is directly related to the formal definition of the façade, the light and luminous color, and the roughness of the surface that is defined by the singularity and intrinsic character of the manual work, which is characteristic of the artisanal neighborhoods, configured during the Colony. This marked condition evidences that although the historical links are indissoluble in reference to *San Blas*, the preservation conditions of the environment are distant so the deterioration is higher in spite of being exposed to similar contamination levels. Cases 3 and 4 correspond to *Vega Muñoz* and *Presidente Córdova* respectively. They are located in the heart of the city with similar contamination conditions but present contrasting conditions. The remarkable variation of styles, densities, uses, and intensity, show that although the last case is markedly more exposed and vulnerable to deterioration caused by NO_2. The maintenance conditions that make the development of productive activities feasible, contrast it to the fact that just 5.28% of its area present damage. Likewise, large windows reduces the visible deterioration impact. In the other case, *Vega Muñoz,* with a deterioration area of 21%, accentuate the deterioration appearance, presenting the larger area dirt by deposit with 107.55 m^2. Despite this, there is no evidence of corrective actions, similar to what happened at *San Sebastián*, where there are also large surfaces and luminous colors. In all the cases, the presence of intense vehicular combustion gases generates evident damages that require taking the corrective maintenance actions to avoid triggering other deterioration processes.

Figure 5: Case study. Four sections in the historic centre of Cuenca. Prepared by the authors.

Some materials with marked historic presence, such as brick, earth, wrought iron, and travertine produce greater damages than the contemporary materials such as aluminum, concrete or glass. This behavior obeys to the materials handling and the artisan work.

Through the survey it was possible to identify the buildings owners' perception about the surroundings. A subjectivity that does not differ from the spatial analysis and the typification of the materials's pathologies. In average, 50% of the buildings, on the four sections, are annually intervened, 45% due to environmental damages. It is because the 97% of inhabitants considers that the air pollution has caused damages on their infrastructure,

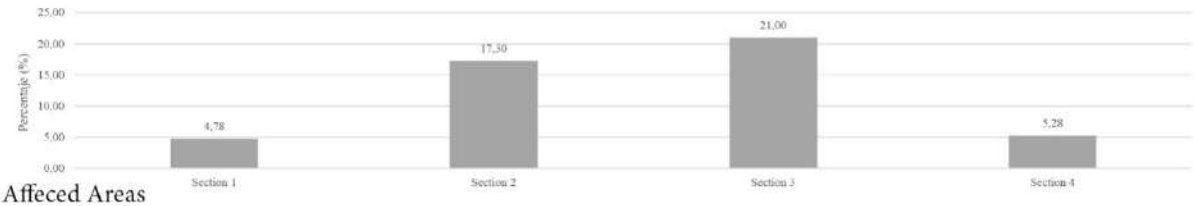
Section 1: San Blas



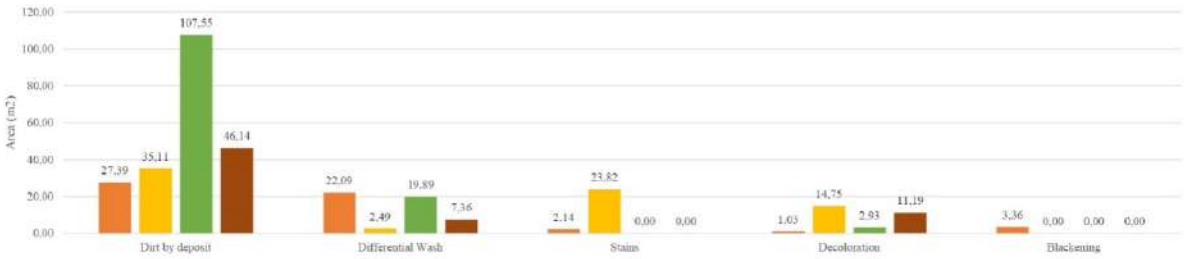
Section 2: San Sebastián

Section 3: Vega Muñoz

Section 4: Presidente Córdova



Affeced Areas



Types of injuries

principally on the paintings in a 67% of the places. These facts, among others, have influenced on the population's perception where the majority qualifies as regular the *Vega Muñoz* and *Presidente Córdova´s*

environment, where there is more traffic than *San Sebastián* and *San Blas*. Here, the majority have an acceptable perception.

The diverse scenarios studied indicate that the perception of the urban image maintains a close relationship with the socio-economic conditions of the population. This situation can be evidenced in housing construction, which occupies most of the urban space and presents greater deterioration. The perception of the urban image as it reveals itself in the architectural elements is conditioned to periodic maintenance works, regeneration activities and the state of abandonment or usage usurpation (Choay, 2007). These activities, perceived by the community, generate either empowerment or rejection, and consequently, the strengthening of social values, and the potential for preservation.

4. Conclusions

From the preservation and monumental management point of view, architecture and city are understood as products of complex processes that, not only involve the city's physical aspect, but the cultural, aesthetic, spiritual, social and economic values. The first, of a temporary nature, which is affected by NO_2, does not represent a guarantee of integral preservation by itself. Therefore, it is essential to achieve social recognition based on a true sense of empowerment in order to implement corrective and preventive measures in buildings and the environment respectively.

Riegl's historical approach and the value of seniority, or that of Ruskin and the evidence of the passage of time, are still represented today. The contrast of heritage and its ability to adapt to the current times is defined on the basis of real estate and tourism pressure, at the expense of the products of temporal and collective synergy, such as identity and authenticity, represents a segment of deterioration that, together with the environmental phenomena, defines the future spectrum. To address the issue, there are a variety of variables. The evaluation of the binomial deterioration and its causes, with heritage value and cultural significance, is a permanent task, often understood as two, of parallel progress and independent results.

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Risk and resilience: Baiame's Cave and creation landscape, NSW, Australia

Catherine Forbes [a,*], Tim Owen [a], Sharon Veale [a]

[a] GML Heritage, Australia

Abstract

For Aboriginal people on the east coast of New South Wales (NSW), Australia, Baiame is the creator. At Baiame's Cave, located in the Upper Hunter Valley, Baiame is depicted on the rear wall of an overhanging rock shelter that overlooks a broad grassy valley. He is represented as an eagle with penetrating eyes, soaring over the land he created. The site is of immense cultural significance to the Wonnarua people and other Aboriginal people in the region and beyond. The significance of the place is recognised by statutory protection on two separate NSW heritage lists. The site is currently facing environmental and land use pressure, including coal mining and continued agricultural production, with additional pressures from increased visitation and cultural tourism. To manage the risks to the place, the Wonnarua people have built relationships with local land owners and public authorities. In seeking continued access to the cave, which is on privately owned land, they have worked with key stakeholders to identify and manage risks to the land, the cave, its artwork, its immediate landscape setting and the broader landscape over which it looks. A multidisciplinary team of specialists in cultural heritage, Aboriginal archaeology, rock art conservation and risk management, undertook on-site workshops with Wonnarua elders, local property owners and community representatives with the following aims: to identify risks to the site from both natural and human hazards (wildfire, flood, drought, vandalism, mining and wear and tear); to develop mitigation strategies to minimize the risks; and to facilitate educational opportunities for sharing Aboriginal culture and knowledge within both the local Aboriginal community and the broader Australian community. The outcome from this consultation was developed into a risk management strategy for Baiame Cave and its associated cultural landscape. The paper seeks to provide an understanding of the Aboriginal attachment to Baiame Cave and the land, and the cooperative approach adopted to land management to build sustainable forms of cultural and environmental resilience for heritage. The risk management strategy is essential to supporting cultural resilience, intergenerational equity and revitalization of traditional customs, beliefs and cultural practices within the Wonnarua community.

Keywords: cultural landscape; nature-culture relationship; resilience through sustainable land management; risk management; traditional knowledge

1. Introduction

Baiame Cave is an Aboriginal rock art site, located on private property near Milbrodale, in the Upper Hunter Valley, New South Wales (NSW) (Figure 1). The cave is 20 kilometres southwest of the town of Singleton and one kilometre southwest of the town of Milbrodale, on the western side of Bulga Creek.

Facing the northeast, Baiame Cave is located within a sandstone escarpment on the fringe of a valley. It is situated in the foothills at the transition between the valley floodplain and the higher bisected sandstone landscapes of the Hornsby Plateau. The cave is located approximately 24 metres above the valley floor and provides expansive views of the Hunter Valley (Figure 2). The cave itself has been formed over millennia through natural weathering processes typical of such sandstone and which result in shelters forming in bands as weathering works backwards and upwards from a weak point.

On the rear sandstone 'wall' of the cave, Aboriginal artwork in white and red pigment is visible (Figure 3). A large male figure with unusually large white eyes and extended outstretched arms is the key visual motif. The male figure is located just off the cave's centre point. The figure is understood to be a representation of Baiame, an ancestral creator being and the 'Father of All'. A series of stencils are also visible within the cave interior, including hand prints, boomerangs, a hafted axe, and what appears to be a spear (Table 1).

The property on which the cave is situated is a working farm. Activities undertaken on the property include grazing, cropping and recreation. Public access to the cave is by permission, but generally allowed for Aboriginal people, members of the public, school groups and tourists to the region. The site is accessed by

* Corresponding author. E-mail address: catherinehforbes@gmail.com

public and then private roads, both sealed and unsealed. Facilities at the cave are limited but include stairs and a viewing platform, with a single interpretive sign.

Figure 1: Location of the Baiame Cave, NSW, Australia. Source: GML Heritage 2018.

Figure 2: At dawn, view from Baiame Cave overlooking the sweeping valley to the northeast. Source: Authors 2017.

Figure 3: Baiame and associated artwork within the Baiame Cave, during recording by the project team. Source: Authors 2017.

1.1.Heritage listings

Baiame Cave and the wider cultural landscape setting is of spiritual, social, aesthetic, historical and scientific significance to the local Aboriginal people and the wider community, both Australian and international. In recognition of its significant heritage values, Baiame Cave is listed on the NSW State Heritage Register, under the *Heritage Act 1977* (NSW) (the Heritage Act). The cave is also a declared 'Aboriginal Place' under Section 84 of the *National Parks and Wildlife Act 1974* (NSW) (the NPW Act). These two separate acts are regulated by the Office of Environment and Heritage (OEH) and the Heritage Division of the OEH.

1.2.Project objectives

Baiame Cave has a low tolerance to change. Identifying realistic and practical ways of managing risk was a key objective shared by both the landowner and the Wonnarua people. The project objective for the local Aboriginal community was to develop community driven management planning that maintains their relationship with the landowner and leverages new opportunities afforded by the heritage listing—for instance, accessing government grants for heritage management and interpretation. Management planning therefore needed to be developed with community concerns at the forefront—not academic thought or regulatory constraints. Community driven management could reduce actual risks, whilst enhancing the economic and social (including health) wellbeing of the local Aboriginal community.

Priority 3 of the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations 2015) underpinned the development of management for the place, notably:

> Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation (United Nations 2015:19).

Despite the place's significant heritage values, Baiame Cave is considered vulnerable to multiple impacts resultant from unrestricted and uncontrolled access. The key risks include direct and indirect impacts to the art, and changes to environmental conditions that may materially alter the place, including the cultural landscape setting. Potential threats such as incompatible land uses and increasing public visitation, as well as dust, vibration, fire and water ingress also pose threats to the values.

The statutory regulators, the NSW Office of Environment and Heritage (OEH) and Heritage Division, strongly encouraged the preparation of a management plan for the cave and required the preparation of a Conservation Management Plan (CMP) to support the State Heritage Register listing. The management plan needed to respond to the heritage values of the Aboriginal Place and set out management policy to conserve the heritage significance of the place for current and future generations, with policy to conserve and ensure continuing protective care. A CMP was therefore developed to provide a framework for the short and long-term future conservation and management of the site (GML 2018).

1.3.Project collaborators

The CMP was developed collaboratively with heritage consultants GML Heritage (GML), Stepwise Heritage and Tourism Pty Ltd (Stepwise) and the Baiame Cave Working Group (the working group). The working group comprised the landowner, local Wonnarua people, key tourism stakeholders and the OEH.

2. Methodology

A multidisciplinary team, including Aboriginal archaeologist, rock art conservator, cultural heritage and risk management specialists, undertook a series of on-site (on Country) inspections and workshops with representatives of the Wonnarua Nation, local property owners and community representatives. These engagements were aimed at:

- identifying risks to the site from both natural and human hazards;
- developing mitigation strategies to minimize the risks;
- facilitating educational opportunities for sharing Aboriginal culture and knowledge;
- ensuring sustainable land management and intergenerational equity; and
- preparing a risk management strategy for Baiame Cave and its associated cultural landscape.

Underpinning these aims were the Sendai Framework Priority 3 principles.

3. Baiame Cave—the place

3.1.Baiame Cave—a physical description

Baiame Cave has always attracted interest from visitors and academics. It was first recorded in 1893 by Robert Hamilton Mathews (1841–1918), a surveyor and anthropologist. Mathews prepared the first written description of Baiame Cave (Mathews 1893), which provides 'baseline' information. The information assists in the development of an 'understanding' of the cave, the artwork and the broader physical context. Given Mathews' description was recorded over 100 years ago, it provides evidence that is useful for the assessment of the cave's current physical condition and the rate of change over time.

The art within Baiame Caves is distributed across the rear of the shelter (Figure 3). In 2017, for the purposes of the condition assessment, the shelter wall was divided into three panels (Figures 4 to 6). Panel boundaries were determined by a logical separation provided by two distinct vertical fissures in the rear wall of the shelter.

Table 1 provides an overview of the art located on each panel. Two different techniques of applying paint were noted, which provided context for Aboriginal tradition associated with maintenance of the art within the shelter.

Table 1: Art Positioned Within Each Panel at Baiame Cave

Panel	#	Motif	Technique	Colour	Comments
A	1	Hand (left) with half of forearm	Stencil	White	
	2	Boomerang	Stencil	White	
	3	Axe	Stencil	White	
	9	Extended arm of anthropomorph	Dry pigment	Red + white	
B	4	Stick	Stencil	White	
	5	Hand (right) with forearm	Stencil	White	
	6	Hand (left)	Stencil	White	
	7	Axe	Stencil	White	
	8	Hand (right)	Stencil	White	
	9	Anthropomorph	Wet and dry	Red + white	Red infill wet and dry. Dry white outline. Wet solid infill eyes. Wet solid patch on lower abdomen
	10	Non-figurative (vertical tally mark)	Wet solid infill	White	To left of anthropomorph
	11	Non-figurative (vertical tally mark)	Wet solid infill	White	To left of anthropomorph
	12	Non-figurative (vertical tally mark)	Wet solid infill	White	To left of anthropomorph
	13	Non-figurative (vertical tally mark)	Wet solid infill	White	To right of anthropomorph
	14	Non-figurative (vertical tally mark)	Wet solid infill	White	To right of anthropomorph
	15	Non-figurative (vertical tally mark)	Wet solid infill	White	To right of anthropomorph
	16	Non-figurative (vertical tally mark)	Wet solid infill	White	To right of anthropomorph
	17	Boomerang	Stencil	White + black	Black may have been added at a later date
	18	Boomerang	Stencil	White	
	19	Hand (left)	Stencil	White	
C		No art has been recorded on this panel			
Other possible motifs recorded by others that require location confirmation					
		Anthropomorph	Dry infill	Black	Recorded by Macdonald 1986
		Macropod	Dry outline	White	Recorded by Macdonald 1986
		Macropod		Black	Noted by Creamer and Kelly in 1974
		Boomerang	Dry outline	Red + black	Recorded by Macdonald 1986
		Boomerang	Dry outline	Black	Recorded by Macdonald 1986
		Unidentified solid	Dry infill	White	Recorded by Macdonald 1986
		Unidentified solid	Dry infill	Black	Recorded by Macdonald 1986

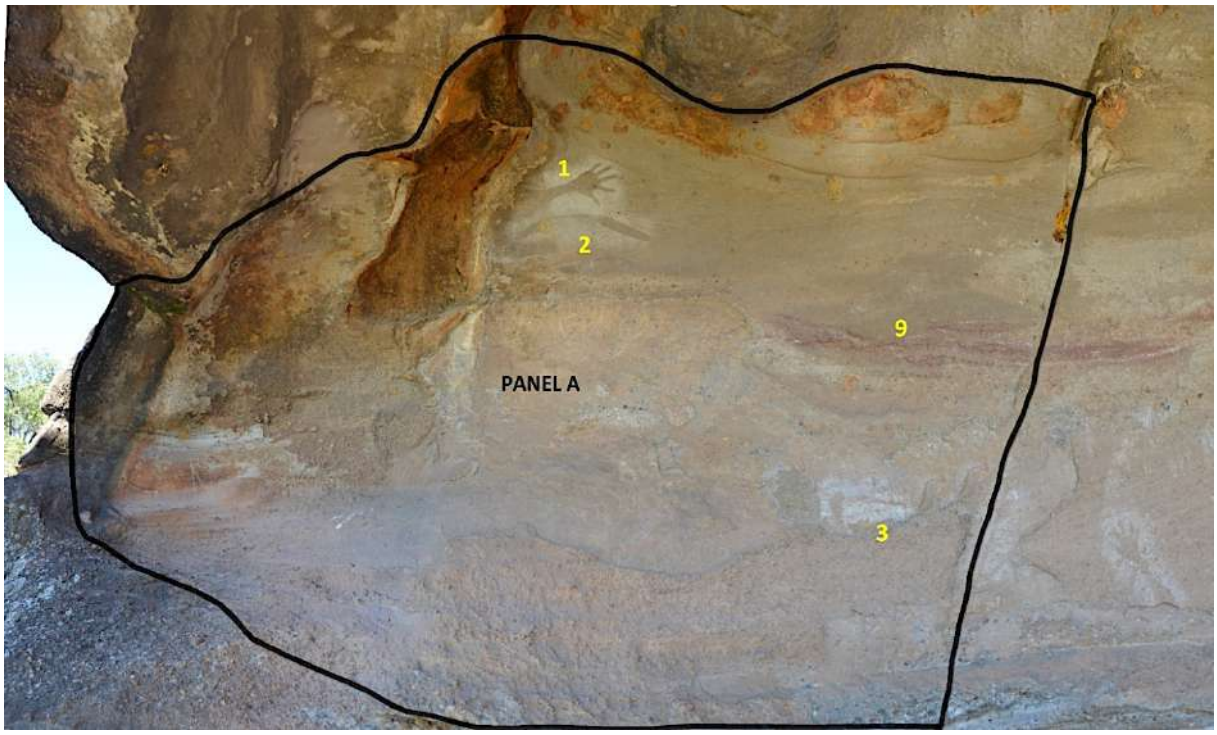

Figure 4: Panel A, located on the left side of the cave. (Source: GML 2017).

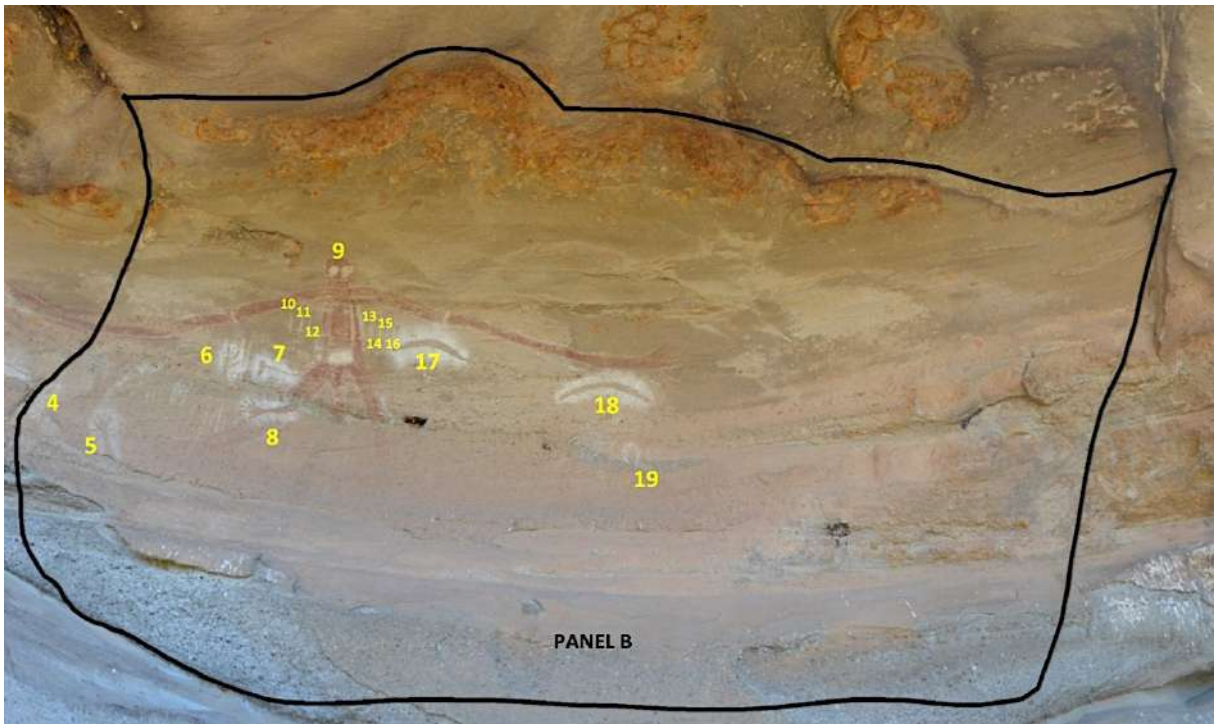

Figure 5: Panel B, located in the centre of the cave. (Source: GML 2017).

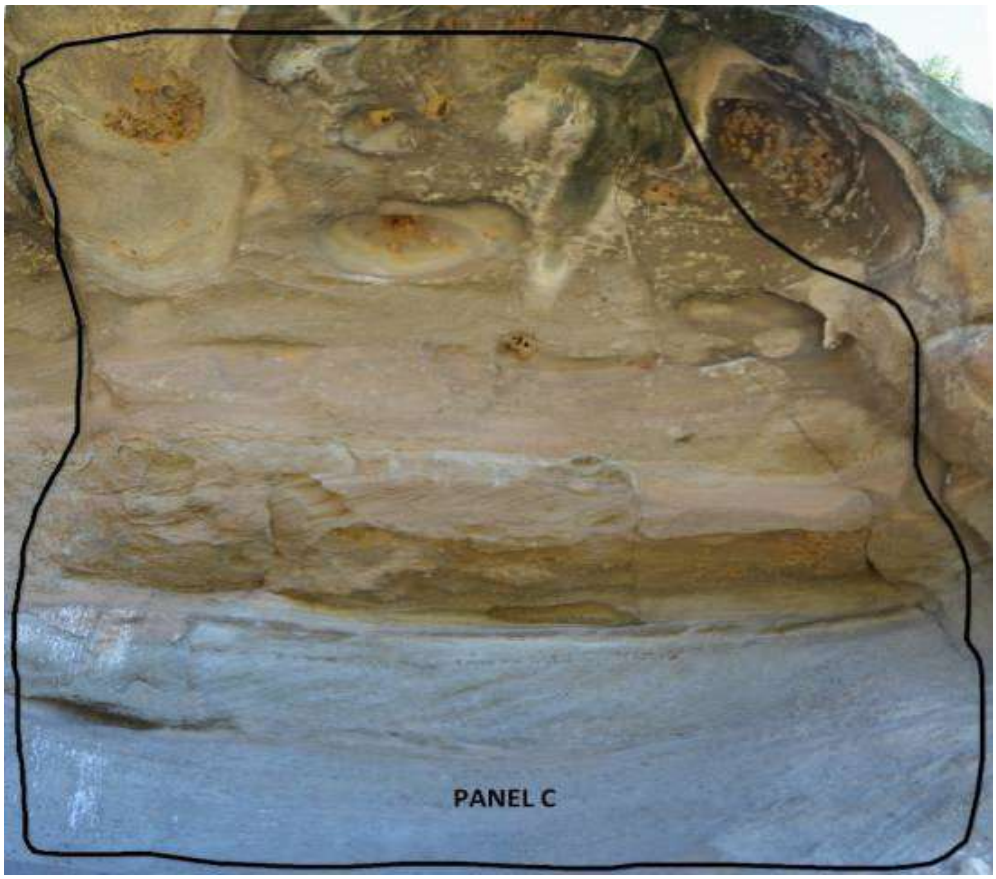

Figure 6: Panel C, located on the right side of the cave. No art is located on this panel. (Source: GML 2017).

3.2.The Cultural landscape

Baiame Cave is located on the slopes of a low rocky escarpment of Hawkesbury Sandstone. The cave is located on a curve in the escarpment and provides an expansive over a wide flat valley to the northeast (Figure 2). The sun rises over an adjacent escarpment to the east, but soon floods the cave with direct sunlight, which persists until midday.

The valley is surrounded and defined by undulating forested hills. Rocky sandstone outcrops on the tops of the spurs that extend into the valley stand like sentinels over the valley. A river and its tributaries flow eastwards through the valley. The valley was originally wooded. The cave is elevated and enjoys panoramic views across the valley towards Mount Royal.

The sweeping relatively flat valley floor located in front of the cave may be connected with male ceremony. Mathews certainly indicated there was an association between the land form and its potential use by Aboriginal people for the *Bora* ceremony:

> In front of this cave there is a large level valley, timbered with large and lofty trees, well suited for a Bora ground, and I think it more than probable that Boras were held here, and that the figures in the cave are connected with the ceremonies which took place on such occasions. There was plenty of good water in the Bulgar Creek close by, and good hunting grounds all around (Mathews 1893, pp. 355).

The level valley to the northwest presents aesthetic and sensory characteristics. The view into the cave is across a rural landscape which provides expansive and direct views to the artwork within the cave. Appreciation of the art is entirely possible without needing to enter the actual cave. This may be significant in terms of how Aboriginal people used, appreciated and practised their culture in relation to the cave in the past. The second quality is acoustic. People speaking at normal levels inside the shelter can be heard clearly at a distance of 100m downslope from the shelter. Sound is amplified by the shelter and projected across the valley floor. This aural quality may have been a significant quality associated with the place's use. It is now considered to be part of the sensory experience of the cultural landscape.

4. Findings

Weathering processes and natural hazards such as wildfire, flood and drought were found to pose risks to the valley landscape, the rock shelter and artwork. Human induced threats, including increased visitation, vandalism, and coal mining, were also found to present risks. Maintaining the valley and its current landform and agricultural use, within the broader setting of forested hillslopes is considered essential for sustaining cultural values associated with the cave.

The greatest threat, however, was identified as the loss of cultural knowledge. Dispossession through colonial occupation of Wonnarua land and the forced removal of Aboriginal people, including the prevention of the use of Aboriginal language and transmission of cultural knowledge and practices has impacted the Aboriginal knowledge systems. This has been a key issue for Aboriginal people since 1788 when the British Government claimed ownership of Australia. Australia's Indigenous peoples, like many indigenous cultures subject to colonisation, remain 'disadvantaged' today with successive policies perpetuating social and economic disadvantage across generations. The Australian Government is working to redress inequities and has implemented a program called 'Closing the Gap':

> In 2018, Closing the Gap remains a shared commitment. It is the story of a shared journey to continue to work together and enable and empower Aboriginal and Torres Strait Islander people to live healthy and prosperous lives. This journey continues to draw on the enduring wisdom, strength and resilience learned over thousands of years of Aboriginal and Torres Strait Islander civilisation (PMC 2018).

The 'gap' was opened in 1788 with the arrival of the British. From the early nineteenth century, a systematic process was implemented to 'civilise' Aboriginal people and dissociate them from their land, cultural traditions and knowledge systems. In 1809, NSW Governor Lachlan Macquarie was instructed to '*conciliate the affection of the Aborigines and to prescribe that British subjects live in amity and kindness with them'*. The position of ecclesiastical bodies was more direct—the colonial head of the Church of England, Samuel Marsden, had also been advised by the London Missionary Society in 1810, that he should *'contribute to the Civilisation of the Heathen and thus prepare them for the reception of moral and religious instruction'* (NSW State Heritage Register 2018). One consequential outcome was the establishment of the Black Native Institute in Parramatta (1814-1823), followed by the Blacktown Native Institute (1823-1829) (both located in Sydney, NSW); these institutes removed Aboriginal children from their parents and instructed them according to European worldviews. While one needs to read and interpret European observations of Aboriginal people and culture with caution, the loss of cultural knowledge is evident in 1893 in a published recording of Baiame Cave:

> I was informed by Mr. W. G. McAlpin, who is now eighty-four years of age, and has resided in the neighbourhood for the last fifty years, that the figures in this cave were there when he first came to the district; and even at that time the drawings were beyond the knowledge of the local blacks [sic] (Mathews 1893:356).

Colonial expansion into the Upper Hunter commenced in the 1820s, with land grants along the Hunter River. The process of colonisation resulted in the spread of disease against which Aboriginal people had little or no immunity, and 'frontier wars', with skirmishes, military intervention and deaths amongst the British and Aboriginal population (Gollan 1993). Underscoring this struggle for land and natural resources, was the general belief amongst the colonialists that Australia was 'terra nullius', or 'nobody's land'. It was also thought that Aboriginal people were nomadic, had no concept of land ownership and did not have an attachment to or sovereignty over land (a concept only refuted in 1992 during the *Mabo* case).

4.1.Aboriginal reconciliation and reconnection

Despite the 1893 report to the contrary, Wonnarua Aboriginal people have maintained traditions and connections with their Country, which includes the Baiame Cave. The Aboriginal community, comprising several families and individuals, have described the social and traditional importance of Baiame and the Baiame Cave. These individuals hold specific knowledge of the place and associated traditional practices.

Traditional knowledge and the ability to speak for Country may vary within an Aboriginal community, and this situation applies to Baiame Cave. Given the historical circumstances of Aboriginal people's lives there are often different opinions and interpretations regarding cultural meanings and protocols. This results in different requirements for ownership, access, maintenance, ongoing use, presentation and interpretation. Nevertheless, it is agreed that Baiame Cave is of heritage value and there is a continuing responsibility to ensure its protective care.

The State heritage listing was a direct consequence of the Aboriginal community's commitment to recognition of the place's value and to its long-term conservation. The listing allowed the Aboriginal community to access government grant funding, which supported the Baiame Cave CMP project. The Aboriginal community, assisted by local landowners and regional stakeholders was able to tender the CMP project, define the brief and establish the required scope of work. The need for an external supplier to prepare the CMP was due to the complexities of CMP preparation (and required endorsement by the NSW Heritage Council), coupled with the need to seek specialist conservation advice.

The approach adopted during the development of the CMP was driven by the Baiame Cave working party—with the Aboriginal community empowered to provide the direction and decisions relating to the place. A series of working party consultation meetings were held on site (within and adjacent to the Baiame Cave). This provided a phenomenological approach to the management; when key issues were discussed, they could be articulated by individuals through a process of physical demonstration.

For instance, the current access route into the shelter is via a steep slope, which was deemed by the Aboriginal community to be inconsistent with the values of the place. Robust discussions were able to explore new options for an access route by physically walking proposed new approaches to the site, and allowing all Aboriginal community members present to provide opinions on the merits, or otherwise, of the current and proposed access. During the conservation assessment, Aboriginal people were able to work with the conservator, providing cultural input into the methods of paint application and the meaning of the different elements being recorded at the site—this significantly increased the understanding for future conservation requirements. The planning requirements for future heritage interpretation was substantially driven by the Aboriginal community. Working with the landowners, the project team was able to understand key operational and visitor management issues to develop conservation policy to mitigate and reduce the key risks.

5. Conclusions

Australian Aboriginal people have demonstrated tremendous resilience through 230 years of colonial settlement and repression. Aboriginal culture is part of a deep lived continuum. Returning to Country, combined with renewal and revival of culture and knowledge is part of the everyday life within Aboriginal communities. In addition, Aboriginal people are increasingly sharing their culture and values with the broader Australian community.

At Baiame Cave, the Wonnarua people seek to share their culture and educate others in understanding the land, the human relationship with nature and the sustainable management of natural resources. The approach to development of the Baiame Cave CMP has demonstrated that Aboriginal traditions and understanding provide sustainable approaches to heritage management, which contribute to the life and wellbeing in the community. The Sendai Framework provided a sound basis for development of the CMP, which placed the requirements of, and the benefits for, the local Aboriginal community at the centre of the project.

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Understanding and communicating risk to cultural heritage: the future of preserving the past

Barbara Minguez Garcia [a,*]

[a] World Bank, USA

Abstract

Recent earthquakes in Mexico (2017), Italy (2016), Myanmar (2016), and Nepal (2015) have made it clear that the past is not safe. Earthquakes, floods, landslides and fires threaten treasured heritage worldwide. After the M7.1 earthquake in Mexico, 1,847 heritage building were damaged–nearly 20% of the overall economic losses. Cultural heritage is not just about monuments or traditions, but about the people who identify with the underlying culture. Understanding this, we can help reduce irreplaceable losses and manage the economic repercussions. Therefore, the practices of disaster risk management and the preservation of cultural heritage need to find common ground for collaboration. Risk identification and communication for cultural heritage have proven a valuable methodology to bring together the disciplines for more effective action, so that professionals and stakeholders can understand the scope of cultural heritage at risk, and communicate likely impacts to inform planning and preparation. Interactive activities like the disaster imagination game developed in Japan can help communities—including neighbors, local authorities, and heritage specialists—to understand and communicate risk. This paper presents some methodologies and results from different multi-institutional activities designed to raise awareness, improve the understanding of risk and communication strategies, and support a multi-disciplinary network of practitioners, experts, and development partners.

Keywords: Cultural Heritage; Disaster Risk Management; Risk Communication; Communities; Sustainable Development.

1. Introduction: cultural heritage and disaster risk management

Disasters continue to pose an increasing threat around the world. Natural hazards are generally growing more frequent and intense due to climate change, and their impacts are proving more detrimental, as population growth and risk-prone urbanization put stress on development gains. Cultural heritage is especially vulnerable to disasters. Natural hazards cause damage to historic structures and sites and expose them to the risk of flawed post-disaster assessments and inopportune reconstruction efforts. For example, historic buildings do not react the same as new ones to seismic conditions and other threats, and engineers today may not fully understand how certain damaged historic structures will behave against further threats.

The heritage of every city, just as for every country, forms the identity of the people. Just as archaeology is not about the remains, but about the people who created them, cultural heritage is about the people who identify themselves with that culture. In post-disaster reconstruction, it is crucial to recover the character and integrity of the place, and therefore, preparedness and mitigation strategies should incorporate consideration of cultural heritage, in order to avoid irreplaceable losses.

Likewise, losses in cultural heritage caused by disasters directly affect a country's economy by negatively impacting economic activities, including the tourism sector and creative industries, in addition to social dimensions. Loss quantification, however, remains a challenge. For instance, the recent M7.1 earthquake in Mexico in 2017, highlighted that almost 20% of the overall economic losses were attributed to historic buildings. Nevertheless, economic valuation of these assets has been limited and indirect losses (e.g., lost tourism revenue, etc.) could make these losses much more significant.

Despite this, most World Heritage properties around the world are not prepared for disasters. According to UNESCO, out of the 845 cultural properties on the World Heritage List, very few have a disaster risk component in their conservation and management plans: around 37% of the cases have not identified risks; 30% identified risks but have not developed mitigation measures; and only 10% of the cases have a proper Risk Preparedness Plan.

* Corresponding author. E-mail address: bminguezgarcia@worldbank.org

The practices of disaster risk management and the preservation of cultural heritage need, therefore, to find common ground for collaboration. Risk identification and communication for cultural heritage have proven a valuable methodology to bring together the disciplines for more effective action, so that professionals and stakeholders can understand the scope of cultural heritage at risk, and communicate likely impacts to inform planning and preparation.

In this regard, international cooperation is crucial to support national and local efforts. Several examples of joint activities and collaborations illustrate how international institutions and experts are working to promote the integration of both disciplines, enhancing the global understanding of risk over cultural heritage assets and the use of communication tools to foster community engagement. Among them, some recent experiences reflected in this paper—including the cultural heritage sessions at the 2018 Understanding Risk Forum (UR2018)—brought together the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), the International Council on Monuments and Sites (ICOMOS) and its International Scientific Committee on Risk Preparedness (ICORP), and the Institute of Disaster Mitigation for Urban Cultural Heritage at Ritsumeikan University (R-DMUCH) from Kyoto, Japan.

1.1.Disaster risk management of cultural heritage: good practice from Japan

Japan has become a reference for the integration of both practices. The country's long and rich history has left it with an extensive and important cultural heritage, which includes its famed temples, shrines, castles, and many other notable monuments, as well as intangible heritage, including its culinary, theatre, festivals, and many other traditions. At the same time, it is a very hazard-prone country, threatened by earthquakes, tsunamis, typhoons, floods, and fires. These conditions have motivated actors across Japanese society to develop an extensive experience in disaster risk management for cultural heritage. Devastating events, such as the Kobe Earthquake in 1995 and the Great East Japan Earthquake and Tsunami in 2011, are two of the worst recent disasters from which Japan has recovered while prioritizing safeguarding its culture. These experiences are reflected in the country's regulations and their practical approach by implementing measures to reduce risks, becoming the seeds for a tradition of continuous improvement, which has proven an insightful model for other countries.

One of the best examples to illustrate Japan's experience is Kiyomizu-dera Temple Area in Kyoto a World Heritage Site. After having been rebuilt many times throughout its history due to fires, the temple counts today with an impressive firefighting system, including integrated surveillance, lightning prevention measures, and a community-targeted water supply system for fire response. It is an example of earthquake-resistant architecture and traditional Japanese roof retrofitting, as well as slope stabilization and monitoring system, which protect the site from landslides while have been carefully planned and completed in the site's cultural and aesthetic traditions.

Additionally, another key aspect in Kiyomizu-dera area is the community involvement in the protection of the temple and assistance in the case of emergency. Engaging community members, through different strategies, including simulations and drills, is crucial to communicate risk and provide understanding to act in case of disaster, and reinforce resilience.

2. Understanding risk: the first step to protect cultural heritage

In order to protect cultural heritage, preserve it for future generations, and contribute to ensuring resilient cities, the different stakeholders need to understand the relevant disaster risks. Identification and communication of risks to tangible and intangible assets allows site managers to design and execute measures to protect their heritage sites, local communities to plan and prepare for likely scenarios, and policymakers to prioritize investments to manage the risks.

In the case of a disaster, following the initial emergency response, which necessarily focuses on rescuing and saving lives, cultural and disaster risk management specialists should be ready to take specific measures to protect cultural heritage and ensure that important historic legacy is not lost forever. In this regard, and due to the complications that reconstruction of heritage often faces, the establishment of risk preparedness and mitigation measures is crucial for cultural heritage.

2.1.Key considerations to apply disaster risk management to cultural heritage

Due to its specific characteristics, cultural heritage differs from other sectors and it is particularly vulnerable to disasters. Important considerations for applying disaster risk management to cultural heritage sites include:

- Considering and including all the relevant components of cultural heritage: both tangible and intangible, movable and immovable (e.g. historic buildings, traditional practices, museum collections);
- Ensuring multi-hazard approach for all relevant risks, with special focus on potential secondary hazards (e.g., fire after earthquake);
- Considering potential underlying factors that might increase risks, such as previous restorations;
- Analyzing and addressing risks in and around the cultural property (e.g., structural weaknesses), as well as the surrounding environment (e.g., flood plains, erosion, weather and climate);
- Prioritizing human safety and ensuring livelihood, while integrating risk reduction measures preserving the cultural heritage values (e.g., designing safe areas without affecting the cultural landscape);
- Ensuring proactive planning to reduce risk, and to prepare and deliver emergency response, as well as long term resilient recovery, in cultural heritage sites;
- Emphasizing the active role of culture and heritage for disaster mitigation as a source of resilience (e.g., traditional resilient building, historic open spaces, shelters, and warning systems);
- Ensuring the integration of disaster risk management in sites management plans, connecting with the relevant disaster risk authorities at local, regional, and national levels;
- Mainstreaming cultural heritage into the different disaster management sectors, climate change adaptation and sustainable development agendas;
- Providing a territorial and ecological planning perspective to integrate disaster risk management and cultural heritage.

3. Community engagement strategies: the disaster imagination game

Disaster risk management of cultural heritage is not only a top-down process. Indeed, as examples from Japan show, it is more effective when national and subnational governments and agencies work closely with local communities.

Communities are often the main users and also custodians of their cultural heritage. They have the greatest interest in protecting their cultural properties, and therefore it would be critical to have them involved in conservation and management activities. Local communities are also key actors to provide emergency response during a hazardous event: they could respond faster, since they know the area better, and could reach out places before external emergency services would arrive. It is fundamental to ensure local communities are prepared and engaged in all the phases of the disaster risk management—including risk identification, risk reduction, preparedness and response, and recovery.

Interactive activities like the disaster imagination game (also known as DIG) can help communities—including neighbors, local authorities, and heritage specialists—to understand and communicate risk. This methodology, developed in Japan, brings together different stakeholders from a historic area to analyze and assess the situation, asking them to reflect on key questions related to a specific risk scenario in their cultural heritage area, and then prepare people and places to face possible disasters. Ultimately, they discuss and decide upon potential solutions to avoid or mitigate risk, along with preparedness measures and plans for emergency response. In addition to engaging participants in understanding and communicating risk to cultural heritage to spur actionable preparation and prevention action, this interactive activity also helps disaster risk management practitioners in understanding the specific challenges and needs of the cultural heritage sector.

3.1.The DIG methodology

The disaster imagination game is an initiative developed by T. Komura and A. Hirano (1997) based on the know-how of the Commanding Post Exercises of the Japan Self-Defense Force (JSDF). It is often used by university teams, such as R-DMUCH, to engage local communities in understanding disaster risk in their area, with special focus on cultural heritage assets. It consists in a simulation of disaster drill using maps and transparent overlays, to gather and display information in a visual way. By recording various details on the map,

participants can easily grasp the situation of affected areas, and discuss and exchange ideas on how to direct relief activities.

The DIG is easily replicable: it is simple, participatory, creative, and requires few resources to deploy. It is designed for professionals but also for volunteers without previous knowledge on disaster risk management or cultural heritage conservation. It serves as a capacity building tool, as well as to create synergies and establish connections for further collaborations among participants.

When development professionals apply DIG in local communities, the stakeholder participants are members of the same community/area, and usually come from different sectors and disciplines, including heritage managers, government officers, firefighters, religious leaders, neighbors, among others. They form groups of 4-6 community members, with support from a facilitator, who introduces and explains the natural hazards and potential disaster risk. Subsequently, they would follow the next steps:

- Work over their local map, locating green areas, water resources, cultural heritage assets, and potential people who would need support to evacuate.
- Adding a transparent sheet over the map, they would include potential disaster damages (e.g. damage / collapse of buildings, landslides, spread of fire, etc.).
- Each group would discuss and simulate disaster risk management measures such as first response, safe evacuation routes, support for people's assistance, so participants could build a clear image of a disaster situation, identifying challenges and discussing specific solutions to their district.
- Based on the outcome of the DIG workshop, participants could go around their area checking the actual situation, disaster risk management equipment and tools, location of emergency devices, availability of water resources and other ideas discussed during the session. The DIG workshop contributes to bottom-up disaster management planning, since local communities identify their own disaster risk management measures to be implemented on their site.

In case of developing the DIG in another context, such as a conference or forum, participants can play the role of a community stakeholder. For instance, during the 2018 Understanding Risk Forum held in Mexico City on May 14-18, 2018, participants engaged in a DIG simulation; the scenario presented was the case of an earthquake striking Kiyomizu-dera area in Kyoto, and the participants, who were mostly disaster risk management specialists, were asked to take up a randomly assigned role among: Kyoto City Department of Culture, Disaster Risk Management Department, Police Department, Fire Department, Mayor's Office; Kiyomizu Area Neighbor, Kiyomizu Temple Monk, and Kiyomizu Restaurant Owner.

Each table was provided with a base map of the area of Kiyomizu Temple, tracing paper, colored pens, post-it notes, and photographs of the area. Once the participants picked their roles on the imaginary "Kiyomizu Temple Disaster Risk Management Committee", they sought to understand the risks facing the area and the people who reside and visit there.

Using the base map, colored pens, and post-it notes, participants identified key points on the map, including: heritage buildings, water resources for firefighting, open/safe areas, and vulnerable areas for residents, tourists, as well as any other relevant point. After this, they used the tracing paper to imagine a severe earthquake striking in the area: using the pens and post-its they identified possible collapsed buildings; blockage of narrow streets (less than 4m width); routes where road blockages could occur and therefore emergency response teams could not access—and also firefighting or sheltering would be difficult; and they considered also water and power outages, marking hydrants or water equipment connected to the city water network, as well as firefighting systems or well pumping system connected to the electrical grid—imagining that the water and electrical systems could be damaged.

The next step was to imagine that a fire started. Participants were asked to mark 1-3 points where they believed the fire could start and identifying the direction of the spreading fire. They discussed potential firefighting methods, including water delivery. Using the colored pens and post-its, they traced and explained the possible routes to dispatch emergency teams, firefighting, access water, etc.

Subsequently, using the second transparency paper, participants drew a red circle with 50m radius around the fire points, indicating the potential area affected if firefighting was not successful after a period of 60 minutes. Then, they imagined the evacuation options from buildings to safe spaces, in and around the red circle areas, keeping in mind the routes that were blocked, and seeking the routes that should lead to safe areas, both for people and movable heritage.

The final part of the exercise consisted in discussing different questions such as: what was at risk? (e.g., specific cultural assets, residents, tourists); how exposed to hazards? (e.g., how and how often will hazards affect this?); how vulnerable? (e.g., what are the specific vulnerabilities, such as flammability, lack of awareness, etc.?); how bad? (what would happen to people/cultural heritage site? could the people/items be rescued? could the site be repaired or replaced?). Finally, participants identified the 2-3 top measures that could have reduced the damage and adversely effects (particularly on cultural heritage) and/or improved preparedness.

Figure 1: DIG developed at the 2018 Understanding Risk Forum in Mexico.

4. Conclusions and lessons learned

Bottom-up approaches to foster disaster risk understanding, especially in cultural and historic contexts, are fundamental to protect heritage and improve urban resilience. There is an increasing interest in developing methodologies and proving results from different multi-institutional collaborations and activities, designed to raise awareness on the growing need for disaster risk management of cultural heritage. These experiences help improving the understanding of risk assessment processes and communication strategies, while at the same time support a multi-disciplinary network of practitioners, experts, and development partners, fostering international cooperation to improve resilience at different levels.

However, there are still many opportunities to improve resilience in cultural heritage sites, historic cities, and urban contexts. Some considerations to maintain progress and momentum would include:

- Emphasizing communication and collaboration, including exchange of data/information, between Disaster Risk Management and Cultural Heritage agencies;
- Promoting the development of common definitions, protocols and standard formats for collecting and storing disaster loss data on cultural heritage at the national level, through the involvement of statistical agencies and other relevant organizations;

- Fostering the development of quantitative and qualitative tools for risk assessment of cultural heritage sites and museums;
- Supporting and encouraging the use of games and simulation exercises for developing disaster scenarios through engagement of various stakeholders, including local communities;
- Making risk information available in understandable and usable formats to be used by managers of cultural heritage sites.

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A living cultural landscape: the Farm Pond Landscape in Taoyuan, Taiwan as an example

Wan-Wen Huang [a,*]

[a] Yuan Ze University, Taiwan

Abstract

Farm Pond is a unique cultural and natural landscape in Taiwan, although it is often mistaken for natural creation. Farm Pond not only reflects the natural environment conditions such as hydrology, climate, topography and soil on Taoyuan plateau, but also expresses the wisdom of Hakka people and their rice culture. However, in recent years, with the rise of industrialization and urbanization, the focus of industrial development in the Taoyuan has shifted from agriculture to processing and electronics industry. The economic function of the water storage in the Farm Pond is no longer in sight. Therefore, the function of Farm Pond and the surrounding green farmlands, as well as the development of the neighbouring community, are all need to be redefined. This study proposes three directions that give modern "Farm Pond" a new meaning for urban functions and places. (1) The field of urban leisure: Farm Pond Ecological Park (2) The field of landscape art: Art works intervention and education promotion (3) The field of partnership community: Re-linking the broken relationship between the "communities, green field, and local living culture". It is hoped that the conclusions proposed in this study will be helpful to the future use of Farm Pond and the definition of places, and is different from the methods and strategies for the preservation of traditional cultural landscapes.

Keywords: Farm Pond; Urban Cultural Landscape; Urban Leisure; Land Art; Partnership Community.

1. Introduction

Taiwan cultural heritage preservation act three: "The definition of landscape refers to natural area, terrain, plants and mineral that possess the natural value for preservation." Some scholars believe that natural landscape refers to all visible visual objects on the earth's surface, also known as landscapes. Landscape can be divided into two category according to the formation, the "natural landscape" shaped by the nature, and the "cultural landscape" shaped by human interference. The farm ponds in this study encompasses a large expanse of ponds located in the Taoyuan plateau, which are shaped by the early Hakka immigrants, constructed into the agricultural irrigation system by making use of the local natural ponds. Therefore they possess both cultural and natural significance. Firstly bearing of the testimony to the development of agricultural farmland and multiple information of the nature such as the natural water system, geographical index such as terrain, soil and etc of the Taoyuan plateau. Secondly, reflects the wisdom of Hakka and their rice culture. The farm pond being unique in Taiwan, the living cultural landscape which are currently underused.

When one arrive at the doorway of Taiwan, Taoyuan International Airport, one will see from the airplane that there are plenty of sparkling blue ponds spread out on the Taoyuan plateau, these are the study object of this research, the farm pond. If one do not have the chance to have the view of the Taoyuan plateau from the airplane, one will not realize the existence and beauty of the farm pond from the horizon. The farm pond no longer function as agricultural irrigation system as the change in modern lifestyle and the industry structure. Therefore, many dwellers, both immigrant and local, who stayed here for decades do not know the existence of the farm pond and the cultural significance. Thus derive the subject of this paper, the new definition and revival of the farm pond in the modern urban context.

2. The birth and death of Farm Pond

The history of farm pond began with the of Hakka immigrants. Due to the shortage of underground water, short and fast flowing rivers and other reasons, it is unable to accumulate water resources for irrigation purposes on the Taoyuan Plateau, with the characteristic of high viscosity and low permeability of the red soil, early

* Corresponding author. E-mail address: wanwen.huang@gmail.com

immigrants began to excavate farm ponds on higher ground for cultivation. The density and quantity of farm ponds in Taoyuan County are the highest in the country, accumulated to ten thousand and above in quantity, therefore named the hometown with thousand farm ponds. Villages, farmland and farm ponds are the very first cultural landscape on this land (Figure 1).

Later, the irrigation system excavated by the Japanese government during the Japanese occupation period (Taoyuan irrigation system 1916-1924) and the rural community housing that emerged in the 50s and 60s brought more population and settlement to Taoyuan. The irrigation function of the farm pond has been gradually replaced after the construction of Shimen reservoir, farmland and agricultural activities decrease with the increase in industrialization. The pollution from the factories affected the water quality of the farm pond resulting in abandoned farmland. The total area of farm pond has been reduced from 9,000 hectares to 2,900 hectares. In recent years, urbanization and industrialization contributed to the shift from agriculture to industry and commerce, farm pond no longer serve their purposes, gradually being developed into industrial or commercial use land. The function of farm ponds and the relationship of neighboring community need to be reconsidered (Figure 2).

Figure 1: Villages, farmland and farm ponds are the first cultural landscape in Taoyuan, Tiawan.

Figure 2: In recent years, farm pond gradually being developed into industrial or commercial use land.

The Taoyuan Municipal Government and the Shimen Joint Irrigation own more than 700 ponds (public farm ponds) to date. In addition to the purpose of irrigation, the farm ponds are rented to the public for farming of fish and shrimp. The other 2,000 privately owned farm ponds are used for both fish and shrimp farms and feng-shui ponds. With the trend of promoting Urban Leisure, Land Art and Ecosystem renewal, there are collaboration between the local government and the Shimen Joint Irrigation Association to develop these ponds as public space for urban recreation and sightseeing. For example, Green Pond Park, located near the high-speed rail Taoyuan Station, and Pate Farm Ponds Ecological Park, located in Bade City are constructed with ecological method. Art intervention is one of the strategies adopted by the Taoyuan Municipal Government to promote tourism. The effort on organizing large-scale art festivals and cultural activities seems to be in vain as there is no significant increase of understanding and identity of the landscape amongst the residents. Therefore, the purpose and operation of the Taoyuan Landscape Art Festival need to be reviewed and adjusted.

The core theory in this study is that "farm pond does not only function as irrigation system, but also represents a system of production, living and ecology." Therefore, the existence of farm pond has a strong symbiotic relationship with neighboring paddy fields, settlements and environmental ecosystems. In other words, it is to reconnect the current relationship between community, green space and farm pond culture, and redefine the modern farm pond with new urban functions and sense of place.

3. Possibilities and development of morden farm pond

At present, the number of farm ponds in Taoyuan has been reduced to less than 2,000. More and more farm ponds have been filled and converted to commercial, industrial or residential uses. The main reasons are concluded as follows: (1) The industrial structure has changed from agricultural society to industrial and commercial society, so the demand for irrigation water has decreased. (2) Due to the increase of population and land demand, the farm ponds were filled into land for supply. (3) A large number of industries pollute the water quality of the pond, which is no longer suitable for irrigation. Therefore, the owner changes the land use for buildings, industrial and commercial land. (4) The government does not have easy to get public facilities, and the public farm ponds certainly become public construction lands.

Therefore, if farm pond is to be regarded as a living cultural landscape, it will need to respond the surrounding communities and residents, and adjust its urban functions and roles for changings of society, population, industrial structure and living requirement. The following discussion and research are the possibilities and development of farm pond in Taoyuan.

3.1.The field of urban leisure

The park is almost one of the indispensable places in our urban daily life, especially in high-density city. The park is an oasis of citizens' body and mind, and also a middle ground between of concrete forest and the nature. The birth of the Metropolitan Park began in the end of 19th century with a series of environmental conservation and rehabilitation campaigns promoted by the United States. It also contributed the concept and legislation of the national park system and public parks. It is the most important contribution in the history of landscape in the United States. Later, in the 1930s, due to the large number of cars being manufactured, the establishment of weekend systems, parks, and urban public transportation systems, place and planning of urban leisure were gradually taken seriously.

The average green ratio assigned to each person of the six metropolitan areas in Taiwan (average green area per 10,000 people, see Table 1), most of cities in Taiwan are below the WTO (World Health Organization) recommendations the 9 square meters, Taoyuan City is the last one, the average green ratio is only 3.11 square meters.

Table 1: Average green ratio of the six metropolitan areas in Taiwan.

City Name	Green Area	Average Green Ratio
Kaohsiung	3188.84 ha.	11.47 ㎡
Tainan	1574.97	8.35 ㎡
Taichung	2028	7.45 ㎡
Taipei	1309.65	4.85 ㎡
New Taipei	1345.76	3.39 ㎡
Taoyuan	642.52	3.11 ㎡

average green area per 10,000 people (Feb. 2017) WTO >9㎡

Therefore, the existing farm pond in Taoyuan has the potential to develop the Metropolitan or community ecological park. In almost every neighborhood of Taoyuan, there are 1 or 2 mini farm ponds. If the ecology and water quality of each mini community ponds can be rehabilitated and the surrounding environment and facilities can be reorganized, then the farm ponds can be used for the residents as an open space of community. In addition to strengthening the connection and awareness of community, the community pond park can also connect more activities related to ecology, culture, and urban farming in different neighborhood. Community Pond Park may be more helpful than the large-scale metropolitan ecological park to citizens' life (Figure 3).

Figure 3: Pate Farm Ponds Ecological Park, located in Bade City are constructed with ecological pool.

Experience the excellent living environment of the city must be from a park. Actually in Taiwan, there are few good parks and good park designs are rare. The problems force on park design and management. Most of the parks are filled with children play facilities. The landscape design is too artificial and boring, and there are too few natural elements such as plants and pools. Moreover, the management system of the park is not yet completed and cannot effectively provide more services. For an example, if we start from the Community Pond Park and hold citizen participation workshops during the design process, thinking of the public space for citizens' life in Taoyuan? What kind of Farm Pond Rehabilitation can make the next generation more able to feel the sunlight, clean water, and fresh air? The management and maintenance of the Community Pond Park may also be released by the public sector to allow residents or universities to adopt, so that the operation of the Pond Park will be sustainable and the opportunities for use will be enhanced.

By this way, whether it is the mini Community Pond Park or the larger metropolitan Pond Ecological Park, it can bring the following three benefits: (1) Through the citizen participation, the urban leisure and recreation space can be shaped (2) Rehabilitation of the ecosystem of farm pond and the inheritance of local culture (3) Promote the communication and cultural identity of the residents, and establish a mechanism for the sustainable management of the Pond Park.

3.2. The field of land art

Land art is also known as Landscape Art or Earthworks, is an art movement emerged from the 1970s where artists use rich natural landscape as source of artistic creation, by using natural resources found on-site for sculpture and art-making, an art form representing the relationship between man and nature.

Landscape artists believe that museums or galleries should not be the only setting to display art, nor should they be the exclusive patent of a few bourgeoisie. The central idea of the landscape art is to explore the possibility of regional materials and break the boundaries between art and life. The landscape art also emphasizes natural time series and vitality. Its purpose is to involve the general public and to introduce the sense of place (genius loci) to the public. Other than being an art form, landscape art is also related to land rehabilitation programs. The most ambitious and intense artist is Michael Heizer, his art work Double negative being the most prominent example, brought landscape art into a new milestone, he implanted the idea of conservation into the making of landscape art. The motivation in conservation not only is for sustainability in land resource management, maintaining the beauty of nature and bringing about moral and spiritual advancement, the innovation of landscape art may evoke resonance from many, and serve as catalyst for more concrete environmental rehabilitation actions for rural and urban area.

Since 2013, the Taoyuan Municipal Government has started to specialize in the natural landscape and cultural landscapes of Shihu Stone Weir, farm pond and Beach Strand as the core of the planning and development of the Land Art Festival. The purpose of the development of the Landscape Festival is to introduce the public to the unique urban scene of Taoyuan, preserve these precarious natural and cultural landscapes, and most of all to promote tourism and enhance economic growth. Ever since the Dutch artist Florentijn Hofman's art work, the Rubber Duck being displayed during Taoyuan Landscape Art Festival in 2013, the festival became world-renowned (Figure 4). The landscape art festival started to invite local and foreign famous artists as celebrities in order to boost the number of tourists. The original purpose of the movement, to promote and preserve the landscape, has blurred out and faded away, while the public had been focusing on the artists. In view of the above, the traditional thinking of the organizer from the public sector need to be reviewed. Government-led planning shall involve the collaboration from private sector, academic groups, artists and residents.

Figure 4: The Rubber Duck being displayed during Taoyuan Land Art Festival in 2013.

The Taoyuan Landscape Art Festival is based on the "Setouchi Triennale" of the Seto Inland Sea International Art Festival in Kagawa Prefecture, Kagawa Prefecture, Japan. Therefore, there is a group of Japanese artists who have participated in the Taoyuan Landscape Art Festival for many years. Among them, the art making of artist Fujii Yoshinori and the extended impact of his artwork to the community are worthy of respect. Fujii's artwork, DOROBOT, features five robots made of bundles of hemp ropes, discarded water pipes and water tanks, applied with muddy water from the paddy field are installed on the fallow field. Community residents and student volunteers participated in the making of the robots. Half a year after the art festival, most of the artworks are dismantled. Amongst all, the fallow field from which Fujii's robots stands were cultivated, the robots grow and live with the locals, new picturesque scene are formed for every seasons. The artwork not only are preserved but enhanced voluntarily by the local because it is the collaboration work between the artist and the community (Figure 5).

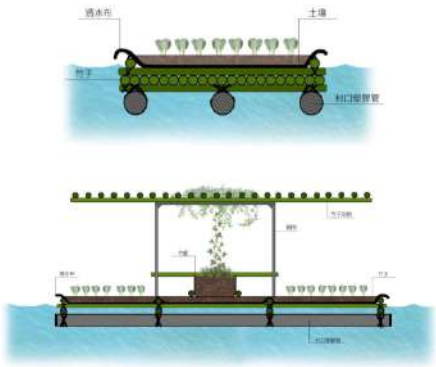
Figure 5: The artist Fujii Yoshinori and the extended impact of his artwork (DOROBOT) to the community in Taoyuan Taoyuan Land Art Festival in 2017.

The landscape art does not emphasize practicality, it uses natural force and material, to create an integrity of local culture and environment, encourages participation of both residents and visitors, thus promotes a brand new experiential discourse to embrace the force, beauty and operation of nature. There are three discourse to revitalization of farm pond with art intervention on implementation: (1) Rediscovery and Re-recognition of Regional Culture and Urban Landscape (2) The promotion of local aesthetics further led the local residents to participate and embrace the farm pond. (3) Emphasize the genius loci and develop the potential of urban idle farmland and green space.

3.3.The field of partnership community

"From the relationship between water and life, the desire to contact water and the need to be nourished by water is human nature. For rural villages, water is essential for basic living requirement, and their life is inseparable from water." Said by the residents who live most of their lifetime next to farm ponds. This shows the crucial relationship between the farm ponds and the surrounding settlements and farmland. However, with the transformation in urbanization and change in social living pattern, farm pond, which was originally used for agriculture irrigation and integrated closely with the community space, is facing the situation of being abandoned or land filled, as a result residents will be drifted away or have less contact with nature (waterfront and green space) and gradually lose the interest in farming as well as physical and mental health.

Gaoyuan Community, Longtan is the highest land in the southernmost tip of Taoyuan Terrace, about 300 meters above sea level. It belongs to a Hakka village with a vast land yet very low population. In early days, the villages used to grow tea and golden needle flower for a living. Because of the high terrain and red clay, there are still a few farm ponds in the community. At present, farm pond has lost the function of providing irrigation

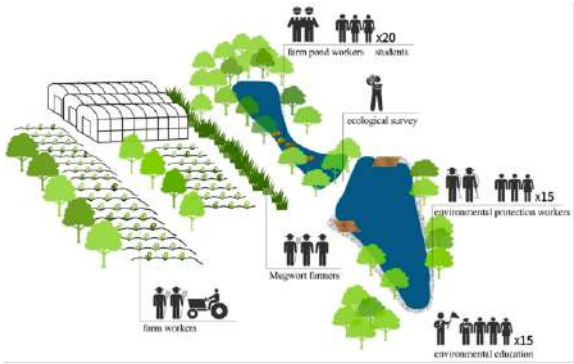


water and domestic water supply, and has gradually transformed into ecological pond. Through the rehabilitation and care of the community residents, the native aquatic plants, insects and organisms in the area gradually emerged, and the original ecological system of farm pond was restored. At present, the improvement of ecological landscape is carried out in the farm ponds, the residents take own initiative to study the work of floating island chinampa in Yilan (Figure 6), the development of wormwood Asian mugwort class, the floating island farming class chinampa farming class and the organic farming class organ farming class and other related urban farming groups (Figure 7).

Figure 6: Floating island chinampa. (drawing data from Chen-Ting Wu)

Figure 7: Working, learning, and experience-sharing together in Gaoyuan Community. (drawing data from Chen-Ting Wu).

These joint learning actions not only restored the original ruined landscape and ecosystem of the farm pond, but also created a new friendly and recurring production system to provide residents with healthy food, while organic agriculture and wormwood planting also brought new economic activities and industry models. More importantly, "working together" and "learning by doing" has cultivated positive learning atmosphere within community, including organic farming, the production of wooden furniture and the sharing of ecological environment knowledge. Farm pond has once again become the core of community life and production. Residents also understand the significance of ecological conservation through labor and co-learning. Above all,



the self-study self-made floating island farming area is not only the core of the space, but also symbolizes the returning of farm ponds.

The reclaimed farm pond has become a very important sharing site for the community, such joint learning actions, not only involve the farm pond, but also connect three core system, the life of the residents, environmental ecosystem and the farming production chain, in short, reshaping the community's social network. In recent years, the leader of the community and the residents to involve voluntarily in the revitalization of the farm pond and the community has increased, rely solely on the internal strength of the community is never enough. In terms of funding and creativity, assistance and support from external groups such as enterprises, institutions and professionals are always essential.

From the interviews of the residents, farm ponds are deemed as carrier of life, they are happy to sole, weed and harvest here, interweave their life with the farm ponds. The farm ponds is a living, it is a living landscape, and the residents see her grow, transform and thrive. From the perspective of shaping a community symbiosis, farm ponds can be developed into (1) Promotion and development of emerging organic agriculture, local food

and food culture (2) Establish a sustainable management mechanism for symbiosis between farm pond, green land and community (3) Promote communication and cooperation between communities and external groups.

4. Conclusions

From the Section 3, the rehabilitation of farm ponds in Taoyuan can be summarized in three main methods: “Urban Leisure”, “Art Intervention” and “Partnership Community”. Among them, "Urban Leisure" is based on the ecological viewpoint, clean and rehabilitates the farm pond into a metropolitan park for citizens. It has the significance of ecological education and reshaping the open space of the city. "Art intervention" mainly starts from the works of artists, and the art works causes visitors to think about natural landscapes and residents' cultures, and further guides the visitors to reflect and act. The "Partnership Community" is a mechanism for residents to learn, work and share together. It will first rehabilitate the pond and recover the original ecosystem, and then carry out a series of urban agriculture works. Residents learn, work and share together, and their lives are once again linked with the farm ponds (water) and green (land), and the relationship between the community, farm pond and the green is paragenesis.

The three methods can also work in tandem with various developments. For example, "Urban Leisure" + "Art Intervention" is the way in which the Taoyuan Land Art Festival is located in Pate From Ponds Ecological Park. "Urban Leisure" + "Partnership Community" is an extension of the community Pond Park. In addition, "Art Intervention" + "Shared Community" is the ideal of Japanese artist Fujii Yoshinori. As for the comprehensive application of the three methods, although there are no study cases, there is always an expectation that these methods of rehabilitation in the pond can be practiced one day, reflecting the Farm Pond in Taoyuan is still alive, as a living cultural landscape.

Acknowledgements

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Towards successful adaptation to climate change impact: an alternative approach for adaptation evaluation using cross-scale and time dimension analysis of formal adaptation impact to vulnerability at local level

Gusti Ayu Ketut Surtiari [a, b,*], Matthias Garschagen [c], Jakob Rhyner [c], Theo Kötter [b]

[a] Indonesian Institute of Sciences, Indonesia
[b] Universität Bonn, Germany
[c] Institute for Environment and Human Security (UNU-EHS), United Nations University, Germany

Abstract

While formal adaptations have been implemented across cities, the evaluation of the success to reduce vulnerability of the affected communities is still under-researched. The dynamics of vulnerability through interaction between adaptation and vulnerability provides an alternative to evaluate formal adaptations that implemented by government. This study proposes enabling factors namely perceptions and institutional factors that influence the changes of vulnerability components among the affected communities across time using a longitudinal research. Jakarta's coastal area that vulnerable to climate change impacts and affected by formal adaptations namely dyke, reservoir, and relocation, is selected as a case study. Empirical data collection consists of retrospective household surveys of 451 respondents combined with in-depth interviews, focus-group-discussions, and interviews with related-stakeholders. The triangulation of these different data sources within the integrated framework of the dynamics of vulnerability shows that the changes of vulnerability are based on the societal and institutional processes of each formal adaptation. The societal process shows less involved of local community and neglecting the role of urban informality tend to decrease capacity to adapt particularly regarding the declining of self-capacity perception to anticipate and cope risk to disaster. Moreover, the social capacity to maintain and enhance adaptive capacity namely social cohesion and mutual assistance have changed caused by institutional processes during the implementation of formal adaptations. The revealed-drivers of the change of vulnerability are useful to provide the preliminary likelihood for adaptation evaluation.

Keywords: adaptation evaluation, formal adaptation; urban informality, dynamics of vulnerability; Jakarta

1. Introduction

The commitment of countries to reduce the impact of climate change and manage risk to climate-related disasters have been shown from adaptation plans and actions across nations. Adaptation in this study is defined as the adjustment of processes and structures to respond and anticipate hazards by reducing vulnerability and moderate the potential harm, loss and damage caused by the hazards and gain potential benefit from the actions (IPCC, 2012). Adaptation can be formal and informal strategies based on the context and institutional processes (Birkmann *et al.*, 2010). Formal adaptation refers to the strategies implemented by government and informal strategies are applied by individual, household and private institutions (Ibid.). However, various studies revealed that adaptations could potentially cause another risk or increase vulnerability in the future (Adger, Arnell and Tompkins, 2005; Hallegatte, 2009; Barnett and O'Neill, 2010). For instance, adaptation to reduce risk to flood by constructing a sea dyke, whereas can reduce current exposure but cause another risk and increase vulnerability when it fails to respond higher sea level and storm surges (Adger, Arnell and Tompkins, 2005; IPCC, 2012; Hallegatte *et al.*, 2013). Potential vulnerability also emerges in the case of relocation as an adaptation when the new socio-economic and environment setting unable to support the well-being of relocated-families (Birkmann, 2011). Therefore, evaluation of adaptations at the early stage of implementation is important to avoid maladaptation or failure of adaptation (Bours, McGinn and Pringle, 2015).

Successful adaptation is challenging to be defined regarding the long horizon of time (Bours, McGinn and Pringle, 2015). Several approaches of adaptation evaluation are mainly using effectiveness and efficiency of the adaptation strategy to recognize the success of adaptation (Sanahuja, 2011; Dinshaw *et al.*, 2014). Meanwhile, the success to reduce vulnerability and risk is still lacking to be explored since it relies on the long process and

* Corresponding author. E-mail address: ayu.surtiari@gmail.com

uncertainty of incidents of extreme shocks and external stressors caused by the changing climate (Christiansen *et al.*, 2016; Magnan *et al.*, 2016). However, the dynamics nature of vulnerability could support the demand to assess long-term vulnerability as an outcome of the failure or success of adaptations (IPCC, 2012). It is fit with the nature of adaptation as a dynamics process (IPCC, 2012). This paper explore on how the dynamics of vulnerability could support the evaluation of formal adaptation based on a three-year longitudinal study. Formal adaptation and vulnerability is linked by enabling factors of human cognitive which represented by issues on perception and institutional factor namely formal and informal urban system.

2. The dynamics of vulnerability: an integrated framework

2.1.The understanding on dynamics and its potency to be incorporated into adaptation evaluation framework

Vulnerability to climate change which has a definition as the degree of a system to be harm by hazards (IPCC, 2012) is dynamic over time and scale (Birkmann, 2013). Existing studies have applied at least three approaches to assess the dynamics of vulnerability. First, historical approach by focusing on analysis of the pattern of social vulnerability in the past as such for the thirty years based on the socio-demographic indicators from the time series of population census data (Kashem, Wilson and Van Zandt, 2016) and focusing on the changing of exposure over time (Kuhlicke, 2010). Second, time dimension approach, for instance observing the distribution of people at risk in the morning, afternoon, and at night (Setiadi, 2014) and analysing the vulnerability before and after adaptations (Birkmann, 2013). Third, group category approach which analysing the impact of the same shocks to the different group (Leichenko and O'Brien, 2002).

As this study proposes the dynamics of vulnerability as an approach to evaluate adaptation, it needs to link between vulnerability and formal adaptation. Therefore the concept of adaptation as an action is applied (Eisenack and Stecker, 2012). Government acts as an operator and affected communities are the recipient of the impact of formal adaptations. The failure of adaptation can happen when the operators unable to provide robust and appropriate strategies to reduce risk and vulnerability or the recipients failed to adapt to the change caused by the adaptation provided by operator. However, based on the concept of structuration theory developed by Giddens, each individual as an actor has their own rational and strategy to respond risk (Fuchs, 2003; Thompson, 2012). The decision to take action and willingness to enhance or transform capacity to adapt relies on how people perceive risk which is constructed by knowledge and experiences (Pelling, 2011).

Moreover, self-efficacy leads to certain actions to respond to the risk of climate change impacts (Grothmann and Patt, 2005). Involving perception issues within adaptation evaluation is important regarding the potential impact and opportunity to take benefit from the formal adaptation among the affected communities. In addition, the willingness to take adaptive action is also influenced by the institutional process. In the case of informal settlement and urban poor, informal system plays significant role to build resilience (Simarmata, 2018). Urban poor has established their own adaptation plan to response to risks and putting their effort to adjust to the environmental change (Ibid.). The significant role of informal systems also has proved in the case of availability of support from formal institutions to response to a disaster (Voorst, 2016). Urban dwellers prefer to utilize informal institution with the basis of trust and acceptable procedure to provide them assistances during and after disaster rather than going through the formal institution with the particular bureaucracy (Ibid.).

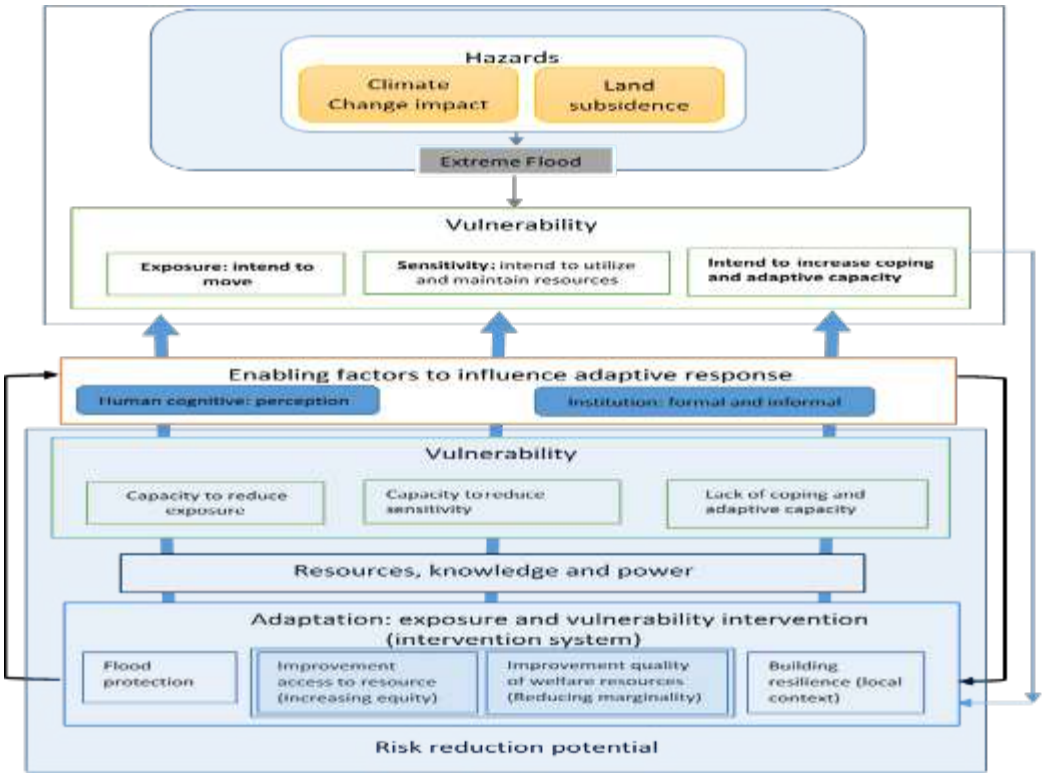

Figure 1: Framework of dynamics of vulnerability for adaptation evaluation. (Source: author based on Grothmann and Patt, 2005; Eisenack and Stecker, 2012; IPCC, 2012; Birkmann *et al.*, 2013; Garschagen, 2014)

2.2.Context and methodology to evaluate adaptation based on the dynamics of vulnerability

North Jakarta is one of the most vulnerable districts in Indonesia in regards the climate change impact particularly on sea level rise and increasing intensity and frequency of precipitation (Yusuf and Francisco, 2009; Firman *et al.*, 2011). Climate change triggers the worsen floods which interlinked with urbanization, land subsidence, and insufficient drainage system (Abidin *et al.*, 2011; Chaussard *et al.*, 2013; Budiyono *et al.*, 2015). Moreover, slums and informal housing have mushroomed along the coast and become highly vulnerable to extreme floods (Padawangi, 2012). Intensive formal adaptations have been implemented to respond to the increasing impact of extreme floods and related causes particularly land subsidence in Jakarta as such coastal dykes, water reservoirs, and relocation of slum dwellers. Those urban adaptations are mainly installed in the urban poor neighborhood in coastal Jakarta who are mostly migrants who work in informal and low skilled job in firms of the fisheries sector.

This study is based on qualitative and quantitative approaches using a longitudinal study that is defined as a process of data collection within a certain period of time (Yin, 2003). It is used to analyze the change of vulnerability components within three different times. First, the vulnerability before the implementation of formal adaptation (T_0). Second, the vulnerability in the first phase after the implementation of formal adaptation (T_1). Third, the vulnerability in the second phase after the implementation of formal adaptation (T_2). The data analysis is based on the two household surveys with 451 respondents, in-depth interviews to local leaders and selected households, semi-structured interviews with risk professionals, and focus group discussions among community members.

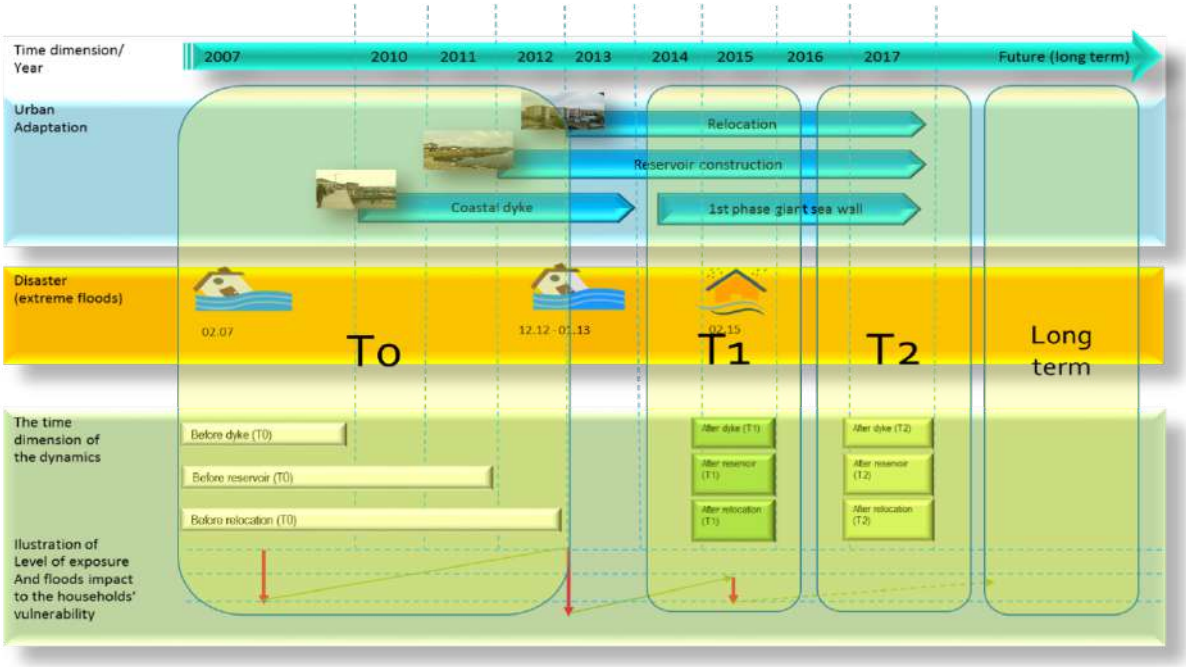

Figure 2: Time dimension of vulnerability changes analysis

The components of vulnerability in this study consist of exposure, sensitivity and adaptive capacity within the context of the Jakarta as a case study. The exposure is explained through the intensity to be exposed by flood, but it is not directly analyzed in this paper regarding the homogen result for all formal adaptation cases that mentioned in general for the regional level, the impact of flood has declined particularly the length of inundation. Therefore, this paper focusing on the change of sensitivity that is explained by the changes of livelihood and adaptive capacity that is represented by the social capacity such as social cohesion and mutual assistance amongst community member to respond to disaster and to adapt to the long-term risk. Perception issues is used to evaluate the likelihood of the capacity to adapt consists of the willingness to move. It included perception on formal adaptation which inform the impacts to a household's social-economic condition.

Figure 3: Case study location in the coastal of Jakarta (Source: Author based on Google Earth)

3. Result and discussion

3.1.The dynamics of sensitivity: livelihood

There are five type of jobs of livelihood among urban dwellers namely fisheries, services, trading, construction, and odd job. The dynamics is analysed by comparing before, the first and second stages after the implementation of adaptations. Study finds that formal adaptations have impacted direct and indirectly to the livelihood of urban dwellers. The result from the household survey shows that around 60 percent of respondents stated that they are affected by negative impact particularly for household economic condition. The impact varied from losing their job, changes of livelihood, decreasing income, and increasing expenditure. Around 10 percent of affected respondents lost their job in the first stage of implementation of adaptation. In the second stage, those families who lost their job could find another job in informal sectors. In the case of relocation, this study finds that some of the relocated families have to drop their job regarding the longer distance from their house to the place for working. Families who are losing their job in the case of coastal dykes are not directly caused by sea dyke but rather the reclamation project. During the study, reclamation of new islands is under construction in the front of Kamal Muara and Muara Angke and has caused high sedimentation on the river nearby and covered the fishing ground. However, an alternative strategy to survive has been shown by shifting their job to another one within the informal sector.

Figure 4: Distribution of respondents based on livelihood changes at three different time before and after the implementation of urban adaptation (Source: Author's HH survey, 2014; 2017)

3.2.The dynamics of adaptive capacity: social cohesion and mutual assistance

This paper presents two main indicators namely social cohesion and mutual assistance that based on the most sensitive indicators to build long-term adaptive action among urban poor to response disaster (Surtiari *et al.*, 2017). The implementation of three formal adaptations shows different societal and institutional processes that influence social cohesion and mutual assistance. In the case of relocation, the neighborhood has changed due to the lottery system to get the key of a house, and furthermore they are governed by a formal managerial system. Thus, relocated families need to adjust a new system, from the informal system with less bureaucracy into a formal one with a more paper works. In the case of reservoir normalization, respondents stated the issues on unclear of the flow of information particularly related to construction process and the issue compensation for the eviction and relocation. Thus, affected communities have a diverse understandings about the processes and consequences that affects the existing trust among community members and between community members with informal leaders. Trust is the main basis of social cohesion among urban dwellers. Moreover, the changes of social structure or the inappropriate institutional changes also influence the level of collective action among urban dwellers. This study finds that the likelihood of decreasing of mutual assistance relatively in the case of reservoir and relocation.

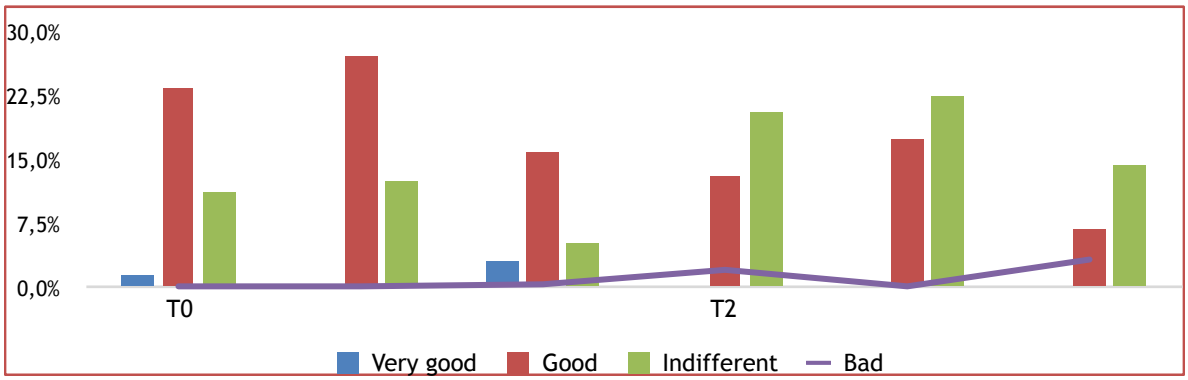

Figure 5: Percentage of respondents based on the changes of social cohesion before and after implementation of urban adaptation (Source: HH survey, 2014; 2017)

3.3.Perception to formal adaptation among affected communities

Perception of formal adaptation measures in this study is categorized as one of the factors that will influence the capacity to enhance and maintain adaptive actions. This research shows that the perception of different adaptation measures is significantly different among case studies (correlation is significant at the 5 percent level). In general, they stated that the measures are aiming to reduce risk to flood, but in the broader understanding, people mention the scoping area to be protected. People perceived that it is not sufficient enough to cover all area to be saved from flood and particularly it is not for urban poor. People who are living in a flood-prone area perceived that the root causes of flooding still persist and challenge them to accomplish successful adaptations. Thus, they keep consider their spontaneous strategy to anticipate and cope risk to disaster.

In the case of reservoir and relocation, respondents stated that the adaptation measures are useful mainly to respond the risk of flooding. However almost half of the respondent in the case of dyke construction indicated that the program is not affirmative. That is correlating with the knowledge about the climate change, the negative impact to the households, level of education, changing housing status, social cohesion, flood exposure, risk perception on floods, and income (correlation is significant at the one percent level). Perception of the adaptation also correlates with livelihood and experience to flood after adaptation is implemented (correlation is significant at the five percent level (2-tailed)). Overall, around 60 percent of respondents stated that the programs reservoir, dyke, and relocation are good. However, conflicting opinion arises among the coastal communities. Based on the in-depth interviews to the selected respondents in the case of the coastal dyke, they stated that the dyke construction will not solely be able to solve the problem of floods as long the construction of skyscrapers along the coast is still prominent. Moreover, for those who have a negative perception mainly because of they have an unintended impact on the construction (correlation is significant at the one percent level (2-tailed)). The level of poverty based on expenditure category has no significant correlation with their opinion to the adaptation measures.

4. Conclusion

In summary, instead of evaluating the decision-making process of the adaptation plan, this study could proposes the dynamics of vulnerability to support adaptation evaluation. The approach is proposing the drivers to shape vulnerability at present and therefore to provide preliminary description for the longer term vulnerability by considering human cognitive particularly perception to risk and to formal adaptation. In addition, institutional process and it relations with issues on perception will thus influence the decision to take adaptive action such as intention to move. The self-capacity perception is also proved as an important factors to enhance adaptive capacity (Grothmann and Patt, 2005) and this study shows formal adaptation could change it and lead to the more vulnerable in the future. There is a pitfall in the formal adaptation when it aims to formalize all the structure and neglects the role of informality. It is significantly proved that informal system is important for the success to reduce vulnerability which is shown by flexibility of informal sector for coping and anticipating economic pressures caused by formal adaptation. However, an important note is the subsistence economic activities is a big challenge in the future without the appropriate assistance and intervention.

As adaptation is a process with its dynamics nature, it can constantly influence the social structure of affected communities. Results show that when government try to formalize the local institution, the social structure of

local community tend to bind the people's ability to enhance adaptive capacity. Therefore, informality should be consider as one of positive contribution for the successful formal adaptation. Result of this study brings an important message that the success of formal adaptation is also depending on the involvement of urban dweller in the adaptation planning and implementation.

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Political barriers to Climate Change Adaptation in indigenous communities: a case study on the Mohawk Community of Kanesatake, Canada

Mahmood Fayazi [a,*], Isabelle-Anne Bisson [b], Olwen Bennett [c], Chantal Gougain-Poblete [c], Ghislaine Kieffer [c], Anna Sokolowski [c]

[a] Sichuan University and Hong Kong Polytechnic University, China
[b] TerraHumana Solutions, Canada
[c] McGill University, Canada

Abstract

The switch from climate change mitigation to the adaptation to its impacts or effects - which may be beneficial or adverse – initially appears to be a promising strategy. Academics and practitioners, however, confront limits and barriers to adaptation both in theory and practice. Despite the extensive efforts in understanding limits and barriers, little is known about political and institutional barriers, more specifically political challenges in Indigenous communities that typically nullify the effect of adaptation strategies. This study aims at bridging this knowledge gap by investigating the experience of the Mohawk community of Kanesatake, a First Nations community in Canada, during and after the 2017 floods in southeastern Quebec. This case study draws on data collected by reviewing documents, interviewing relevant stakeholders and experts, as well as a field visit. Results reveal the links between the proximate set of barriers and historical, political pressures in Indigenous communities. Findings explain that unhealed wounds in relationships among nations generate political and institutional hurdles, which eventually orchestrate the co-occurrence of multiple barriers. The findings reveal the fact that barriers are not mutually exclusive; in fact, they are often interdependent. Findings also prove the fact that policies fail if they disregard causal interdependencies.

Keywords: Climate Change Adaptation; Political Barriers; Institutional Fragmentation; Indigenous Community of Kanesatake; Canada.

1. Introduction

Insufficient efforts plus political and financial barriers to climate change mitigation necessitate adaptation to the undesirable, yet inevitable events in future. However, the translation of adaptation policies to practice encounters multidimensional challenges: economic, social, technological, ecological, and political. This study aims at examining the political and institutional barriers to climate change with a focus on Indigenous communities. Previous studies have shown how Indigenous populations could be disproportionately affected by climate change due to "existing social gradients in health, close relationships with a rapidly changing environment for livelihoods and well-being, and capacity challenges and colonial legacies" among other systemic barriers (Ford et al., 2018, p. 129). There is, however, still a gap of knowledge of how the challenging relationships of Indigenous communities and the national and local governments impact their adaptation to climate change. This paper seeks to answer this question by investigating the experiences of the Mohawk community of Kanesatake (a First Nation community located at the confluence of Ottawa and St. Lawrence rivers) after the 2017 floods in the Montreal agglomeration in Canada.

Findings reveal that unhealed wounds in relationships among nations underlie political and institutional barriers, which eventually nullify the effects of climate change adaptation efforts in Indigenous communities. The lack of land ownership rights, troubled relationship with the national and local governments, the lack of insurance, and the lack of social institutions such as police force and firefighters are acute examples of political and historical challenges in Indigenous communities. The remaining of this paper contains: first, a discussion on climate change adaptation barriers; second, the research methods applied in this study; third, research findings that describe the political and institutional barriers to climate change adaptation in Kanesatake; and finally, the discussion and conclusion sections that further elaborate on the theoretical and practical implications of the research findings.

* Corresponding author. E-mail address: mahmood.fayazi@umontreal.ca

2. Research method

This study was conducted in the winter of 2018 in collaboration with McGill University's School of Urban Planning Masters' program in Montreal, Canada. This research is a case study and uses an explanatory approach to investigate the Kanesatake community's experience in responding to and recovering after the 2017 floods in Quebec, Canada. Different sources of evidence have been used to collect data. The data collection process began with a site visit to the Mohawk community of Kanesatake in February 2018. During the visit, informal unstructured interviews were conducted with the Grand Chief and technical experts responsible for emergency management in the community to understand the overall impact of the floods and challenges during the emergency and recovery processes. Later, more interviews were conducted with the head of emergency preparedness program, the manager of the First Nation Adapt Program (a funding program under the federal government), as well as an expert in environmental impact and community needs assessment in Kanesatake.

We reviewed and analyzed several policy documents, press releases, and reports to understand causal components of historical conflicts and their impacts on the community's vulnerabilities to natural disasters. Also, the Grand Chief of the community gave a lecture at McGill University, during which time he was interviewed by students in the Masters' program. The interview allowed us to fill gaps in our findings, discover the links between distinct facts, and discuss further topics pertaining to Indigenous experiences and climate change in Canada. Consent for information sharing was obtained from all participants.

The research project adopted triangulation of data and methods to converge lines of inquiry (Yin, 2003, p. 98). In fact, data triangulation decreased the risk of the investigators' personal interpretation and minimized the danger of relying on incomplete information. In this study, the interviews and documents were analyzed using the qualitative content analysis method. The qualitative content analysis method lets researchers create a database and identify patterns in the data (Gläser & Laudel, 2013).

3. Results

In May 2017, extreme climate events resulted in unprecedented floods in southern Quebec, and more specifically in the Montreal agglomeration in Canada. According to the statistics, the winter of 2017 was the fourth warmest since 1948 and the accumulation of snow and rain was the second and third highest, respectively, in over 50 years. The accumulation of higher than normal precipitation plus quicker melting process of the snow cover caused severe floods in April and May 2017. As a result, more than 5,000 homes were flooded, with about 4,500 residences affected, and over 3,500 people evacuated from their homes (Communauté-Métropolitaine-de-Montréal, 2017). The floods affected almost every varied social group of residents from English-language wealthy minorities to middle-class immigrants, from French-dominant small cities to low-income neighborhoods and First Nation communities in the Montreal agglomeration. Among all, the Mohawk community of Kanesatake was severely affected and faced many hurdles during the emergency and recovery processes (Figure 1).

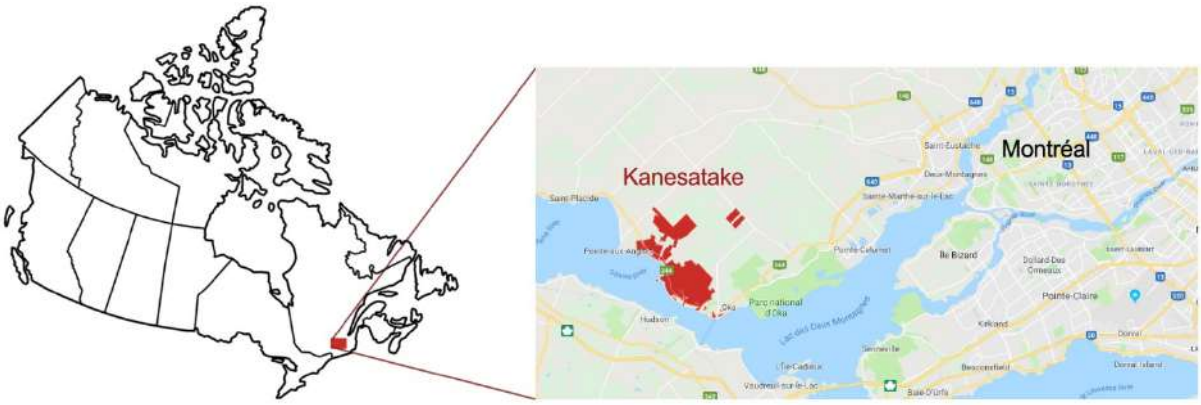

Figure 1: The location of Kanesatake at the confluence of the Ottawa and St. Lawrence rivers

In response to the floods, Kanesatake worked together to pile sandbags, help residents remove belongings from flooded homes, and to help communities to evacuate to safer ground (Figure 2). The emergency response required a concerted effort from many volunteers, including local community members, members from their sister Mohawk communities, Kahnawá:ke and Akwesasne, as well as some assistance from the neighboring settlements. This collaboration was a tremendous sign of resilience and strength; "When Mohawks mobilize, you

can't stop us" says Grand Chief of Kanesatake to the Montreal Gazette newspaper (Curtis, 2017). Despite the heroic reaction of the community to the emergency phase of the disaster, the recovery process appears to have been more challenging. During the time of this research, almost one year after the floods, the recovery process was ongoing and some people are still in need of permanent housing. The ability of the Mohawks of Kanesatake to respond to another disaster is still uncertain, the recovery process neglects to reduce future disaster risks, and the community is less prepared for the future floods. The investigations reveal several impediments to an appropriate recovery by Mohawks of Kanesatake. Among many other potential reasons, our findings identify the following barriers to the reduction of future disaster risks, preparedness for proper response and appropriate recovery in future, and in general, to adaptation to the increasing risks of climate-related disasters in future.

Figure 2: The 2017 floods in Kanesatake

3.1.Lack of secure land tenure

Kanesatake's land status is complicated and has caused many conflicts and disputes. According to the Constitution Act of 1867, Kanesatake is recognized as an Indigenous *territory* having no reserve status to their lands unlike other Indigenous groups in Canada. The complicated problem of land in Kanesatake traces back to their relations with the British and French Crowns before and after the American revolution. The Mohawks of Kanesatake are part of the Haudenosaunee – the Six Nations Confederacy in the North America – who moved to Canada after the American Revolution, once the British were defeated. From the British Crown, the Mohawks received land (known as the Grand River Tract) where the city of Montreal is now located (Fenton, 1998). Later in 1717, the French Crown granted the Lake of Two Mountains (a large area on the north shore of the Montreal island, believed to be Kanesatake's traditional grounds long before 1721) to the Sulpician Order that was a French company for training the priesthood candidates (Hurley, 2001). A condition of this grant was the establishment of a mission for the Indigenous population in the Seigneury lands, a process which involved the expropriation of Mohawk lands (Hurley, 2001; Ohnona, 2008). Later, Kanesatakes' restricted access to the lands ignited frequent conflicts over land ownership with the Sulpicians (Hurley, 2001).

To resolve the controversy, the Government of Canada agreed to purchase land lots from the Sulpicians, among other private owners, on behalf of the Kanesatake Mohawks in 1945 (Hurley, 2001). The lands involved in these transactions, however, are small parcels that are interspersed with privately-owned non-Indigenous lands in the village of Oka (Hurley, 2001; Ohnona, 2008). These, along with other lands purchased by the federal government in the 1960s and early 1980s, comprise what is a present-day patchwork of properties (Figure 1). In fact, the Kanesatake Mohawks do not consider this to be a settlement of their long-standing grievances over land claims.

Though the Mohawks have land rights in Kanesatake, the fact that these are federally-owned Crown lands, does not give the Mohawks any power over them (Hurley, 2001). Furthermore, the lack of official *reserve* status means there is "no clear legislative regime applicable to provide for local control and administration of these lands" (Hurley, 2001). This presents a practical barrier to cohesive land management and prevention of any invasion to their territory (Figure 3).

In 1988, one of the most heated disputes over land, which is known as the Oka Crisis, caused the involvement of the Canadian Armed Forces and left almost 100 people injured. The story began when the Oka Golf Club renewed its lease for an additional 35 years announcing to expand its development and build a condominium complex over Kanesatake's land. Tensions heightened throughout 1990 and the Mohawks responded to the threat of their land by creating barricades around their land. By August 1990, the Canadian Armed Forces around Montreal were called in, the residents of the village of Oka were evacuated, and eventually the barricades were bulldozed. The devastating physical and emotional wreckage caused by the

Armed Forces has left scars in the Kanesatake community as well as other Indigenous communities across Canada (MacLaine et al., 1990).

From a disaster management perspective, the chronological sequence of political crises exhausts Kanesatake's capacities and leaves them isolated, unprepared for responding to and recovering from further disturbing events. As an example, in the first days of the flooding in May 2017, when the water levels rose to extreme levels, the Canadian Army offered assistance in emergency relief and sandbagging. The offer, however, was immediately rejected by Kanesatake as it was a stark reminder of the Army's involvement in the Oka crisis (Smith, 2017).

Another inevitable consequence of the political and the land-related legal issues is the fact that the relocation strategy in the face of disasters is impracticable for the Mohawks of Kanesatake. Members of the Kanesatake community have no other territory and cannot take their land rights elsewhere (Simon, 2018). "If we move, we have to abandon our rights to land under the treaty," says Grand Chief Simon (Simon, 2018). Consequently, this is a significant barrier and prevents the community from retreating from flood-prone areas, which form a considerable portion of their territory that experiences floods almost every year. Adding to these frustrations, the Mohawks of Kanesatake are also ineligible for any land-based insurance as the federal government is the legal proprietor of their lands (Ohnona, 2008). In fact, this is a limitation that many First Nations communities in Canada experience (Figure 3).

3.2.Ambiguity of orders and inter-jurisdictional fragmentation

Relationships between First Nations communities and the local, provincial, and federal governments remain fragile. The historical disputes over lands and the role of the federal government as the legal proprietor loosen the Indigenous communities' ties with the local governments, which eventually constitutes considerable challenges. More importantly, the existing institutional fragmentations among the Indigenous communities, federal governments, and their provincial representatives prevent Indigenous communities from owning their own civil services. Kanesatake still suffers from the lack of a local police force, a fire station, an emergency management department, and many other institutions as the required budget, administrative structure, and the scope of responsibilities are still subject to disputes (Figure 3). Admittedly, if these clashes could be circumvented and Kanesatake had its own emergency and safety institutions, many adverse events and emergencies (such as the fire incident in 2015 that wholly burnt down a building) would be avoidable or at least less destructive (Curtis, 2015).

More telling still, healthier connections with the local and provincial governments would permit more appropriate responses to the extreme yet predictable rise of the water levels in 2017. Three weeks before the peak floods, a state of emergency was pre-emptively declared by the Kanesatake Band Council (Smith, 2017), informing the federal government of the risk of flooding and requesting assistance. The warning received no reaction from the authorities; it might not have been delivered to the right office or ignored because of bypassing the political orders (Figure 3). This is indeed an unconfirmed claim; however, the message would have probably received more consideration if it targeted the local and provincial authorities.

This ambiguity of orders and institutional fragmentations prevent effective communications such as the issue of life-saving notifications regarding the opening of upstream floodgates and the risk of extreme water level rise. Without the coordinated effort of the main reservoirs in attenuating the river's flow, the water levels at the Lake of Two Mountains during the peak levels in May could have reached 11,000 cubic meters per second if the dams were not holding back water (Communauté-Métropolitaine-de-Montréal, 2017). Whereas the limited reservoir capacity of the Carillon dam is undisputed, the lack of notification to the Kanesatake Band Council, advising of the opening of all the floodgates was a compounding factor in the flooding. Had the management of the dam notified to downstream officials, emergency efforts could have been stepped up to mitigate the additional flow of water (Figure 3). Therefore, opening of the Carillon dam floodgates plus the extreme climate events caused an unprecedented surge of the water levels by 20 feet on the shoreline of Kanesatake in early May 2017. This left the Kanesatake residents no chance to prepare in real time for the increasing levels of water into their community (Communauté-Métropolitaine-de-Montréal, 2017).

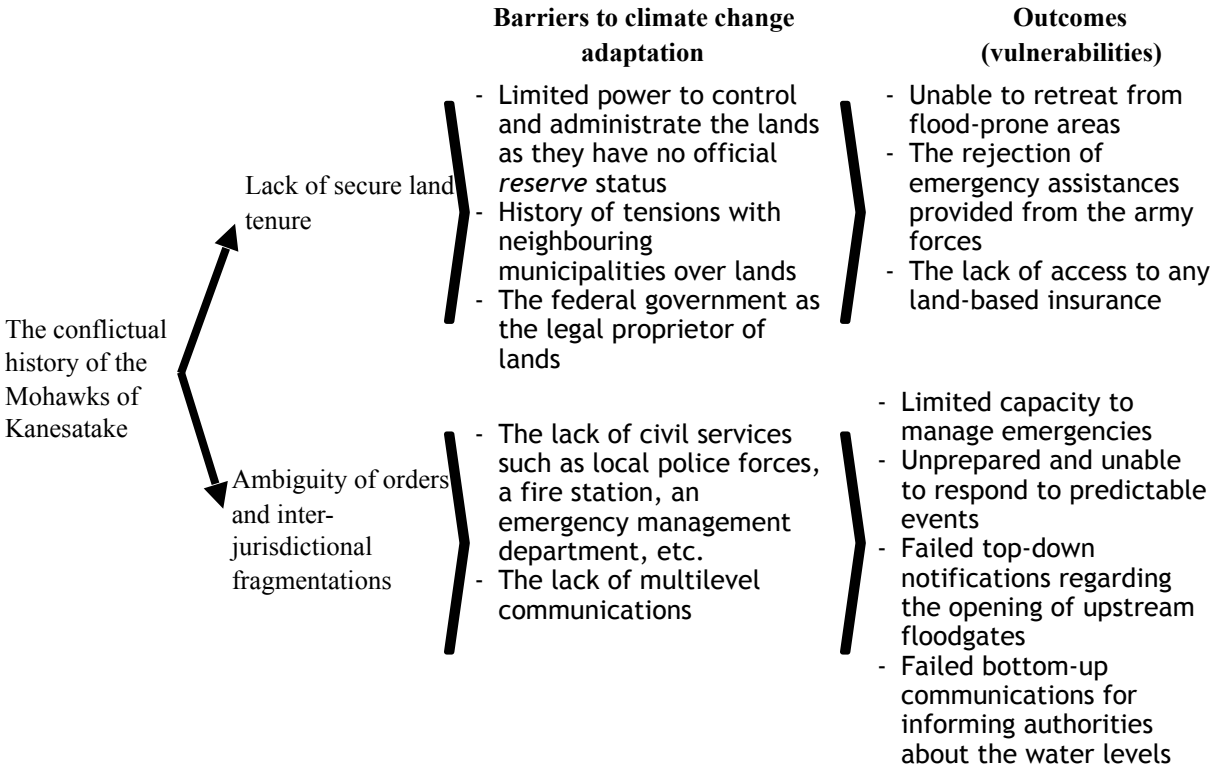

Figure 3: Political barriers to climate change adaptation as long-term consequences of the conflictual history in Indigenous communities

This study confronted several challenges and limitations, and findings should be taken prudently. The research was limited by time constraints, restricted access to members of the Kanesatake community, and insufficient academic research available on the adaptation of Indigenous communities to climate change. Moreover, this research remarks some marginally relevant factors to barriers to climate change adaptation, which are beyond the scope of this research. Further research, in fact, would therefore be required to obtain a fully comprehensive understanding of climate change adaptation in Indigenous communities.

4. Discussion and conclusion

In 2017, extreme climate conditions caused floods in Quebec, Canada. The water levels rapidly rose all around the Montréal agglomeration and affected diverse communities in different ways. Every affected community tells its own story and exhibits their capacities, vulnerabilities, and barriers to adaptation to climate-related disaster risks. These diversities offer an excellent opportunity to study multi-dimensional barriers - political barriers, in particular - to adaptation.

Our research reveals the link between the conflictual history of the Mohawk community of Kanesatake, the existing political barriers to climate change adaptation, and the community's exacerbated vulnerabilities. In Kanesatake, the historical disputes over lands and territories resulted in the lack of secure land tenure and indirectly resulted in troubled inter-jurisdictional relationships with the provincial and national governments. Consequently, these challenges generate political barriers such as tensions with the neighboring municipalities and the lack of power to control and administrate the lands, which ultimately exhaust their capacities and aggravate vulnerabilities. The outcomes are the land scarcity to retreat from flood-prone areas, the lack of trust

in the local and federal authorities in case of emergencies, restricted access to land-based insurance, and limited capacity to manage emergencies and predictable events, to name a few.

Our study demonstrates significant theoretical implications to barriers to climate change adaptation; political barriers that prevent the Indigenous communities from adaptation to the increasing risks of climate-related disasters. The results reveal the chronological sequences trace back to the conflictual events in history, allowing us to comprehend barriers in racial, ethnic, and minority groups that typically suffer from political tensions. Our findings also contribute to the theories indirectly; reminding the researchers of the interdependency of barriers as they may stand on the same causal factors. Although the political barriers have roots in historical events, they are not exclusive and independent. In fact, more research is required to reveal the interdependency of barriers and explain how common historical events underlie social, economic, technological, and environmental barriers.

We have also shown that there are relevant practical implications. First, our findings highlight the importance of political reconciliation between the levels of government and Indigenous communities. The global threats of climate change affect universally and require genuine, sustained, and inclusive efforts. This is, indeed, a highly complex issue and lies beyond the scope of this study. Second, it is crucial to define appropriate communication mechanisms between the Indigenous communities and different levels of government. Effective communication channels and procedures are required to bridge the inter-jurisdictional gaps. Finally, barriers to climate change adaptation are multidimensional and appear in different scales. Any attempt toward overcoming the barriers requires factual, comprehensive, and multidisciplinary understandings.

Severe and frequent extreme climate events will likely pose future challenges on the adaptive capacities of the Mohawk community of Kanesatake. Despite having a long history of managing seasonal flooding events, many politically-rooted challenges limit their capacities and exacerbate vulnerabilities. It is crucial that national and local authorities as well as the private sector join Kanesatake officials to solve the underlying factors of barriers. However, to discover more generalizable solutions and overcome barriers, comparative case studies are required to synthetize complexities into higher-order and explain what causes barriers and how they interact and change overtime in Indigenous communities. In fact, more research is necessary to explain the complexity of barriers in Indigenous communities and unveil unique challenges facing these marginalized communities.

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Awareness relevance in cities' climate change resilience building process, a literature review

Marta Iturriza [a,*], Leire Labaka [a], Jose M. Sarriegi [a]

[a] Tecnun, University of Navarre, Spain

Abstract

Climate change (CC) is one of the 21st century's major challenges. However, the complexity of CC and the existing passive behaviour of agents prevents CC from being dealt with efficiently. In this context, we explore the development of city resilience and awareness. This research studies a total of 48 papers resulting from a systematic literature review. The aims of the literature review are to define the relation between awareness and cities' CC resilience building processes and to assess the awareness building process. To that end, four research questions were defined and answered based on the 48 selected papers. The results of the analysis demonstrate the significant impact of developing awareness when building cities' CC resilience.

Keywords: climate change, resilience, awareness, behaviour

1. Introduction

Climate change (CC) is considered one of the 21st century's major challenges (IPCC, 2007). Over the last decade the effects of CC have increased, causing a higher frequency of heat waves, an increase in sea levels, more intense rainstorms and more frequent droughts (UNISDR, 2012).

The scientific community as well as citizens, governments and public and private companies are paying more attention to CC. Governments are developing plans of action in order to deal with this challenge in an incremental and multilevel way. However, confronting CC is one of the most complex and intricate challenge cities are dealing with due to its uncertainty and high impact (Anguelovski et al., 2014). Added to this complexity are the existing social barriers and CC denial, hampering efforts to efficiently face CC (Pescaroli, 2018). The complexity and barriers have led some agents to adopt a passive behaviour toward CC (Weber, 2010).

Recent disasters, such as the mudslides in California in 2018, make the population more aware of the vulnerabilities that emerge from CC and the need to act in the face of CC. This has been reflected in the increased number of studies and scientific information on CC (Newell et al., 2011). Following up on the available scientific information, policymakers are dealing with two main challenges:

- How to bring the studies into action in everyday activities.
- How to end passive behaviour.

In this context, the concept of city resilience is relevant for tackling both challenges. City resilience focuses on developing transversal prevention, preparedness, response and recovery capacities in order to face both predictable and unpredictable CC events (Boin & McConnell, 2007). Several processes and strategies are involved in building city resilience; these strategies bring together all the existing information and operationalize research results with the aim of being more CC resilient. However, the question of how to deal with passive behaviour toward CC has not been answered yet. This has led to maladaptation and wasted efforts (Smith Barry & Olga, 2001).

Evidence from the literature concludes that developing awareness is an effective way to obtain a transformation in behaviour (Henly-Shepard et al., 2015; Chappin et al., 2017). Awareness enhances communication among agents, proactivity and engagement, which increases city resilience levels and lessens the negative effects of CC (Luís et al., 2018; Redshaw et al., 2017; Burnside-Lawry & Carvalho, 2016). Based on this fact, this paper undertakes a review of the literature with two main objectives in mind:

- Assess the awareness building process.
- Analyse the relation between awareness and cities' CC resilience building process.

* Corresponding author. E-mail address: miturriza@tecnun.es

This paper is focused on the awareness level of the agents involved in cities' CC resilience building process. These agents are: governments, governmental associations, international, regional and civil society organizations, donors, the private sector, academia and professional associations, and citizens.

2. State of the art

This section presents the challenge of CC, the existing barriers to and behaviours with respect to CC, the concept of city resilience, and the concept of awareness.

2.1. Climate change

The Intergovernmental Panel on Climate Change (IPCC) states that CC refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007). Similarly, the United Nations Framework Convention on CC defines CC as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCC, 1992). Both definitions consider CC to be variable over time and the result of human activity or natural processes.

The IPCC affirms that the change in the global climate is now unequivocal (IPCC, 2007) and its effects are underway, with consequences for both urban and rural areas (Solomon et al., 2007). Indeed, CC will aggravate the already known climate issues and highlight the needs and vulnerabilities of basic services, critical infrastructures, markets, emergent sectors and underdeveloped areas (Pidgeon, 2012). For example, Greenland's ice is melting due to the temperature rise, leading to higher sea levels and reducing useable land and citizens' wellbeing (Gregory et al., 2004). Therefore, there is urgent need to act and face the challenge of CC in order to mitigate its effects and consequences.

2.2.Climate change behaviour and barriers

Over the past decade CC events have increased society's concern about CC. However, there are still several barriers that prevent agents from facing CC effectively. For instance, agents do not identify CC as a "first row" issue; instead, concerns regarding health, finances, and other social issues that appear more tangible are usually prioritized (Reynolds et al., 2010). Additionally, agents regard CC as an issue that is far removed in time and space, as they believe that CC is not going to affect them in the upcoming years (Etkin & Ho, 2007). Moreover, part of society has reported being overwhelmed due to having too much contradictory information (Reynolds et al., 2010). The general public also believes that CC is being used for political and economic gain.

As a consequence of these barriers, agents exhibit passive behaviour toward CC. Agents' behaviour is directly related to their awareness level. Studies like the one by Stoll-Kleemann et al. and Norgaard demonstrate that a high awareness level leads to the development of proactive behaviour (Stoll-Kleemann & Jaeger, 2001; Norgaard, 2006). However, the same studies address the difficulty of evolving from exhibiting passive behaviour to exhibiting proactive behaviour. Based on the above studies, this paper classifies CC-related behaviours in three types:

- Passive behaviour: not aware and not proactive.
- Static behaviour: aware and not proactive.
- Proactive behaviour: aware and proactive.

2.3.City resilience

The literature provides several definitions for the concept of city resilience (Malalgoda et al., 2013). However, in this study, we follow the one given by the Smart Mature Resilience (SMR) project as it provides a holistic perspective. SMR defines city resilience as "the ability of a city to resist, absorb, adapt to and recover from acute shocks and chronic stresses to keep critical services functioning, and to monitor and learn from on-going processes through city and cross-regional collaboration, to increase adaptive abilities and strengthen preparedness by anticipating and appropriately responding to future challenges" (Gonzalez et al., 2011).

Several studies and projects have developed conceptual models and frameworks to define the attributes and actions needed to improve the resilience level of cities (Kontokosta & Malik, 2018). UNISDR launched several studies that indicate the city resilience levels through indicators. The *Making Cities Resilient* campaign included

a list of ten actions that are necessary for building city resilience (Johnson & Blackburn, 2014). Following this campaign, the *Sendai Framework for Disaster Risk Reduction* emphasised the importance of having engaged and committed governments and communities in reducing the effects and consequences of vulnerabilities and hazards (Anon, 2015). In the same vein, the 100RC programme provides the *City Resilience Framework*, which sets out twelve indicators that describe the fundamental attributes of a disaster-resilient city. In a more recent study, the SMR project defined the European Management Guideline, which provides cities with a roadmap toward higher resilience levels (Gonzalez et al., 2011). However, the effectiveness of all these studies is not as high as expected due to external factors such as the passive behaviour of agents (Henly-Shepard et al., 2015; Chappin et al., 2017). Nevertheless, these studies do not specify how to build agents' awareness and encourage proactive behaviour.

2.4.Awareness

Awareness has been defined in several ways depending on the given use. Endsley and Bolstad (2009) defined awareness as "the accessibility of a comprehensive and coherent situation representation which is continuously being updated in accordance with the results of recurrent situation assessments". However, Maraña (2015) refers to awareness as "the ability of an entity to perceive, identify and be conscious of the possible events that can occur". UNISDR (2009) defines awareness as "the process of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards". While these various definitions share certain elements, there is no agreed upon definition of awareness.

3. Research methodology

To address our two main objectives, we performed a systematic literature review based on four research questions:

RQ1.-What are the mechanisms that develop awareness?

RQ2.-Which method is the most effective for developing CC awareness?

RQ3.-How can the relation between awareness and cities' resilience to CC be represented?

RQ4.-What are the consequences of developing awareness in cities' CC resilience building process?

3.1.Keywords and selection criteria

We selected the Scopus electronic database to perform the systematic literature review. Scopus not only indexes a larger number of journals than other databases, but it is also the largest searchable citation and abstract source for different scientific fields (Guz & Rushchitsky, 2009).

Three keywords comprised the base of the searches: "awareness" AND "climate change" AND "resilience". In order to answer each of the specific research questions, other keywords were added (Figure 1). Only journal articles published after 2000 and with at least two citations were selected. The fields of medicine, biology, earth sciences and agriculture were not taken into account.

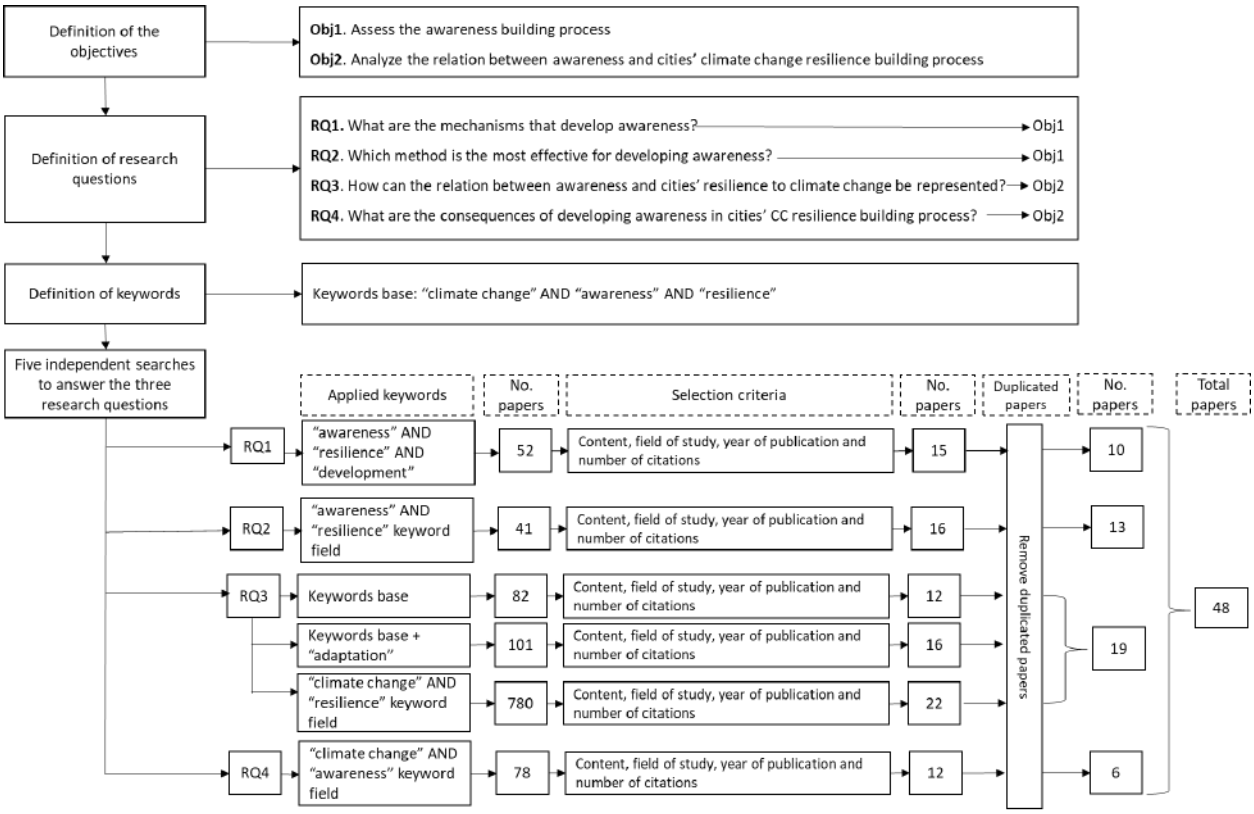
First, independent searches were carried out for each of the research questions (Figure 1). Once the first list of relevant articles was obtained, all the abstracts were read to ensure that the content of the papers was relevant. Then the full articles were overviewed thoroughly. During this process, papers were dismissed at different stages.

Finally, the duplicate papers were removed, leaving and a total of 48 papers: 10 for RQ1, 13 for RQ2, 19 for RQ3 and 6 for RQ4.

Figure 1: Research method

4. Results

In what follows, we present the results and the answer to the four research questions.



4.1.RQ1) What are the mechanism that develop awareness?

Awareness development has been referenced in different manners throughout the literature. However, based on the 48 selected papers, awareness development can be defined as the interaction between three mechanisms: attention, knowledge and experience.

Attention refers to being alert and having an interest in a topic. In order to know if agents pay attention to CC, indicators such as the number of studies related to CC, the number of CC-related news stories in the media or the number and quality of resilience strategies can be measured (Weber, 2010). For example, the scientific community pays attention to CC, as a high number of studies on CC can be found (Brody et al., 2008).

Knowledge refers to the accessibility and internalization of the available information. In the case of CC, a high number of studies have provided meaningful information on CC (Newell et al., 2011). As a example of how this information can be internalizes, Chappin et al. (2017) present a serious game that transfers information about sustainable habits and the agents using the game become more knowledgeable.

Experience refers to lived circumstances (Anguelovski et al., 2014). Having a great deal of experience with a topic entails being involved in that topic. In the case of CC, having experience means having lived through a consequence CC (Weber, 2010). For example, a citizen living in Norway will have more experience with extreme snowstorms and knowing how to deal with them than a person living in Spain.

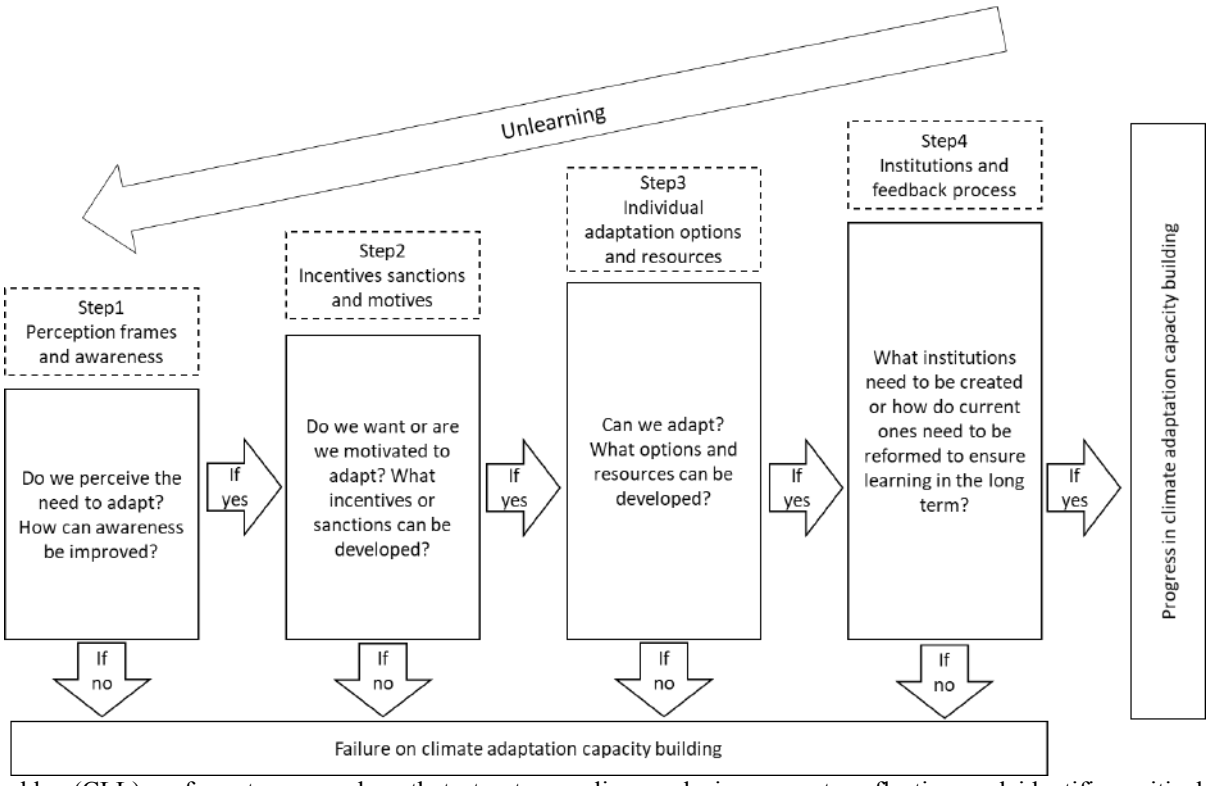
4.2.RQ2) Which method is the most effective for developing CC awareness?

Our literature review sought to find the most appropriate methods for developing awareness.

One method reported as effective is the serious game. Chappin et al. (2017) developed a game to increase awareness about sustainable cities. Their main hypothesis is that the serious game effectively engages the users' attention, which leads to higher knowledge levels, which in turn create greater awareness.

Another method is social learning, which was used by Henly-Shepard et al. (2015) to build higher awareness levels. Social learning consists of developing new collective capacities for dealing with common problems and implementing them in the long term (Tàbara et al., 2010). The Henly-Shepard et al. study brings together different contexts and experiences that shed light on how sustainability should be ensured. The agents participating in the exercise gained knowledge, which made them more aware.

However, the studies presented up to this point lack a defined methodology that uses a gradual procedure to specify the path toward higher awareness levels. In this context, Tàbara (2010) presented a climate learning



ladder (CLL), a four-step procedure that structure policy analysis, supports reflection and identifies critical decisions while building a capacity for climate adaptation (Figure 5).

Figure 2: CLL adapted from (Tàbara et al., 2010)

4.3.RQ3) How can the relation between awareness and cities' resilience to CC be represented?

The relevance of awareness to CC resilience building processes has been highlighted in all of the selected papers. However, not all of them represent the relation between resilience and awareness in the same way. For instance, given the relevant studies found in the literature, we classify the potential relation between awareness and city resilience to CC in three ways:

- Awareness is a precondition to cities' CC resilience building process (Figure 3).

Figure 3: Awareness as a precondition

Gurran et al. (2013) developed an adaptation ladder based on the resilience building processes, and it establishes awareness as the most basic need. Their study states that even if policies to face CC are in place, being aware is the first step, otherwise the effectiveness of the actions decreases. Similarly, Davoudi et al. (2013) presented a framework for analysing resilience building processes. After analysing several processes, such as the one followed by the City of London, their study concludes that a prerequisite for behaviour transformation is a minimum level of awareness.

- Awareness is a required element of cities' CC resilience building process (Figure 4).

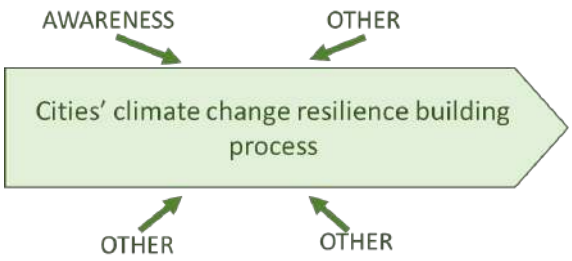


Figure 4: Awareness as a requirement

Tang et al. (2010) argued that awareness is one of the main components that ensures the quality and success of resilience building processes. Their study establishes three required components: awareness, analysis and actions. Similarly, Abegaz (2015) stated that developing a solid strategy requires a clearly set list of priorities. Abegaz concludes that one of the required priorities is developing awareness during the process.

- Awareness is the driver of continuous change during cities' CC resilience building process (Figure 5).

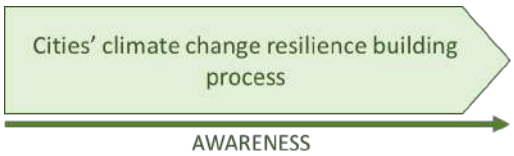


Figure 5: Awareness as the driver

UNISDR (2012) emphasised the importance of developing awareness during the process of building sustainable cities, as it acts as an engine throughout the process. Similarly, O'Sullivan et al. (2015) ran a participatory workshop and concluded that awareness acts a continuous driver to ensure the correct evolution of the processes.

4.4.RQ4) What are the consequences of developing awareness in cities' CC resilience building process?

In 2009 UN Secretary-General Ban Ki-Moon said "I call for the need of world leaders to address climate change and reduce the increasing risk of disasters and world leaders must include Mayors, townships and community leaders" (Ban Ki−moon, 2009). Since the last decade several cities and even countries have been immersed in CC resilience building processes. In this section, we present the consequences of developing awareness in cities' CC resilience building processes.

In addition to UNISDR, other authors have pointed out that developing awareness leads to higher commitment and engagement levels (UNISDR, 2012; D'Almeida Martins & da Costa Ferreira, 2011; Engle, 2011). More concretely, Engle states that the effectiveness of the process is increased considerably due to having commitment and engagement, and as a consequence a higher CC resilience level is achieved.

Bahadur and Tanner (2014) studied the process of building CC resilience in urban areas by reviewing the manner in which initiatives to build resilience affect agent participation. They concluded that awareness is key when there is a lack of resources, as being more aware increases the actions taken against CC since agents are ready to participate. They also argue that having an aware population increases communication among agents (Tàbara et al., 2010).

Finally, Henly-Shepard et al. (2015) presented a three-phase social learning framework to inform community disaster planning in relation to the potential impacts of a tsunami. Based on this specific scenario, they concluded that in order to achieve higher resilience levels, awareness is key as it facilitates collaboration among agents and the adoption of a holistic view.

5. Conclusions

Climate change is one of the most complex challenges that cities are facing. In order to confront it, city resilience needs to be developed. However, the passive behaviour of agents hampers cities' resilience building processes. The literature has shown that awareness is an effective way to deal with passive behaviour.

We performed a literature review based on four research questions, with the objective of studying the relevance of awareness in cities' resilience building processes. For each RQ, we drew the following conclusions:

- RQ1: Awareness interacts with attention, knowledge and experience during the development of awareness.
- RQ2: A graduated method similar to Tàbara et al.'s (2010) climate learning ladder should be applied in developing awareness.
- RQ3: Awareness is not only the first step prior to developing any process, it is also a requirement that must be met because it serves as a driver.
- RQ4: Awareness increases agents' commitment, engagement, communication levels, collaboration networks, and it leads them to a holistic perspective.

Acknowledgements

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Building urban critical infrastructure resilience to climate change

Cinta Lomba-Fernández [a,*], Josune Hernantes [a], Leire Labaka [a]

[a] Tecnun, University of Navarre, Spain

Abstract

In recent years, urban areas have been seriously affected by extreme weather events derived from climate change. The proper functioning of cities relies on properly functioning critical infrastructures, which are themselves vulnerable to the effects of climate change. In this context, resilience is becoming a potential strategy for dealing with the effects of climate change because of its adaptive approach, which takes into account the uncertainty and low probability of high-impact events but also the long-term impacts. This paper adopts a collaborative approach to analyse how climate change affects both urban critical infrastructures and society. Furthermore, it analyses the interdependent relationships among critical infrastructures, and the consequences of these interdependencies in climate change-related crises. A set of policies for improving critical infrastructures resilience is proposed along with a set of indicators for monitoring the evolution of crises over time.

Keywords: Climate Change, Critical Infrastructures, Resilience, Interdependencies, Collaborative Methodologies

1. Introduction

At present, 55% of the global population lives in urban areas, and the UN projects that this trend will continue, reaching 68% in 2050. The welfare of these urban areas is highly dependent on the proper functioning of critical infrastructures (CIs), which have grown in size and complexity in their bid to provide a high level of reliability and safety in their services. However, by doing so, they have also increased their vulnerability and degree of interdependency (Torabi et al., 2017).

Climate change (CC) has become a central concern on the global stage, as there is broad agreement among climate scientists that it is the cause of the rise in the frequency and intensity of weather events, such as droughts or floods, that have a direct impact on CIs and thus on the welfare of society (Füssel et al., 2017). In light of this situation, it is crucial to that the resilience level of CIs be enhanced in order to prevent and mitigate the impact of CC on urban areas and on society.

In the context of CC, resilience is defined as "the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain the essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation" (IPCC 2014). In this sense, resilience is strongly linked to disaster risk reduction, vulnerability reduction and sustainable development (Linkov et al., 2014; Shen et al., 2016).

CI resilience is considered a strategic property that enhances system capacities to adapt to and successfully face any type of crisis, in a changing environment. Several approaches and proposals for building CI resilience can be found in the literature (Labaka et al., 2016). Many of them focus on technical attributes, such as the robustness of the physical assets or their redundancy level, or adopt a risk management approach, considering system behaviour in terms of a specific risk (Francis and Bekera, 2014, Panteli et al., 2017). Others take an organizational resilience perspective, focusing on the sociotechnical attributes of CIs rather than on technical aspects (Brown et al., 2017). Furthermore, in the context of CC, most of the methodologies fail to offer a holistic view as they do not take into account long-term stressors or uncertainty in weather-related scenarios. With regard to urban CIs, different tools and methodologies are being developed to help cities and their infrastructures to face current global challenges, including CC, from a resilient approach (Smr-project.eu, 2018). Still others adopt risk assessment approaches, focusing on vulnerability analyses in light of previously identified risks (Resin-cities.eu, 2018).

Furthermore, it is important to bear in mind the relationships among CIs, as their interdependencies are the cause of cascading effects and can compromise recovery from a crisis (Ouyang and Wang, 2015). Although many studies have analysed urban CI interdependencies, they often focus on a specific CI and on the effect of an

* Corresponding author. E-mail address: clomba@tecnun.es

extreme weather-related event (Zimmerman et al., 2017) and therefore lack a more holistic analysis which takes into account urban CIs as a whole in the context of CC. This paper explains the collaborative process we used to gather information that could be used to improve the resilience level of urban CIs and characterize CC-related crises in the Basque Country (Spain), tackling CC from a holistic approach.

2. Methodology

A city's resilience level depends to a large extent on the resilience level of its CIs, which, in turn, depends on the resilience level of other CIs, given their interdependences. This paper aims to illustrate how CC affects urban CIs and consequently society, and to identify opportunities and mechanisms for improving their resilience.

Figure 1 describes the conceptual framework for this study. Working with CC-related crisis scenarios, we analyse the effect of CC on CIs, showing in greater depth how some CIs affect other CIs and society. Moreover, as CC changes the environment in which people live and the threats they are exposed to, it has impacts on people's way of life. Similarly, society plays an active role in the fight against CC by adopting different approaches: mitigation, adaptation and resilience to CC.

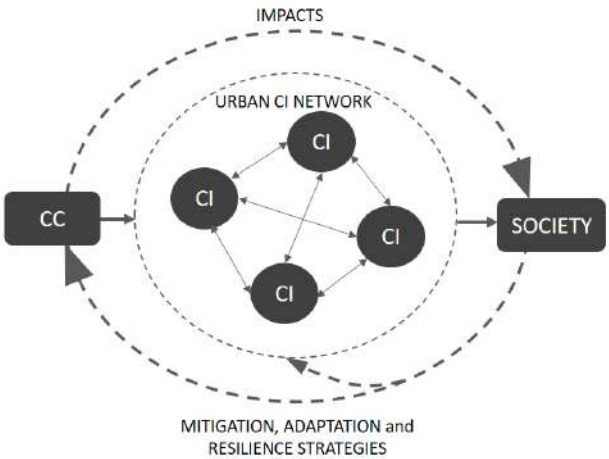

Figure 1: Conceptual framework for the analysis of the effect of CC on urban CIs.

Because knowledge about how CIs function with regard to impacts from CC is embedded in practitioners' minds, involving the relevant stakeholders is essential for enhancing urban CIs' resilience level from a holistic view. Collaborative methodologies, such as Group Model Building (GMB), can be very useful in this context, facilitating the involvement of experts from different sectors and eliciting their fragmented knowledge in order to contribute to a common goal (Scott et al. 2016).

In this research, we used GMB to elicit information from experts in the Basque Country about improving the resilience of urban CIs in the face of CC. Two different urban areas in the Basque Country were analysed: San Sebastián and Tolosa. These two cases were chosen mainly due to the following criteria: size, level of commitment in confronting CC, and CC impacts.

San Sebastián is the third largest city in the Basque Country in terms of population and services. Being a coastal city, it is exposed to hazards from the sea (storms) and on land (excessive rainfall and river flooding). San Sebastián has shown a strong commitment in the fight against CC, having presented in June 2018 its first CC action plan, "Plan de acción Klima 2050".

Tolosa is a medium-sized inland town, and the work it has undertaken in the fight against CC is still incipient. Tolosa is prone to river flooding and to landslides caused by rainfall. In the long term, the consequences of CC on the biodiversity are experienced in both municipalities, though they are more evident in Tolosa as small-scale agricultural activity takes place in the larger municipal area.

Four workshops were organized in these cities, and the participants were a set of 30 experts from different sectors: energy, water, health, transport, first responders, the environment and the public administration.

3. Results

In this study, CIs were analysed from a broad sectorial perspective rather than focusing on subsectors or specific assets. The exercises carried out in the workshops identified of the effects of CC on CIs. Then, the interdependencies among CIs were analysed. We then studied the impact of a specific CI on society in the short and long term, and finally we examined the direct impact of CC on society (see Figure 1). Finally, a set of indicators and policies for monitoring and improving the resilience level of CIs in CC-related crises were proposed.

3.1.CC affecting CIs

Based on previous studies by the Basque Government (Klimatek, 2016), two crisis scenarios were used for the analysis, where short- and long-term stressors were taken into account. The first scenario, representing an extreme weather event, was a chain of squalls affecting the city for three days and characterized by very high winds and severe rainfalls in the city and neighbouring areas. The second scenario represented long-term stressors, where the crisis proposed was a week-long summer heat wave after an exceptionally dry season.

Participants were invited to establish the degree to which each scenario was critical for the CIs. They had to quantify the criticality level on a scale from 0 (very low) to 5 (very high). Moreover, they were asked to identify the consequences of the crisis when it strikes.

In the case of the extreme weather event, the experts agreed that the most vulnerable sectors are those whose facilities are likely to be affected by such extreme events. The energy sector was rated especially vulnerable with a score of 5, due to the exposure faced by its facilities. The experts also identified numerous specific impacts; in the case of power, impacts include the toppling of pylons and the flooding of substations and transformer stations. In the heat wave scenario, the energy sector was not perceived to be particularly vulnerable, as it was given a value of 1. This scenario rates very highly, however, for the health sector, as heat waves have a significant impact on vulnerable populations such as the sick, elderly and young children. Were this same scenario to last a month, the water sector would also be affected in terms of capacity and quality.

3.2.CIs affecting CIs

The interdependencies among CIs mean that the failure of one CI can spread to others due to indirect impacts and the cascading effects that aggravate the crisis situation and ultimately affect society. We worked with the experts on an interdependency matrix (8 sectors by 8 sectors) to analyse these interdependencies in depth.

The participants were asked to identify evidence of a severe failure for each CI sector and the impacts its failure would have on the CIs. Moreover, they were tasked with indicating a range for how long the affected sector could maintain its autonomy before the dependency became critical and led to cascade failure. The analysis revealed that the most critical infrastructures are in the energy (electricity in particular), communication and transport sectors, since they have a strong influence on the proper functioning of the rest of the CIs. Table 1 shows the effects experienced by analysed CIs when the energy sector fails.

Table 1: Dependency matrix due to failure of the energy system.

Effect on Failed CI	WATER	INFORMATION AND COMMUNICATION TECHNOLOGIES	TRANSPORT	HEALTH
ENERGY	Failure of electrical systems (pumps, control systems, sensors, etc.) in supply, waste and treatment networks. No information about water supply. No fuel for generators.	Failure of antennas. Failure of servers, no data. No mobile communications.	Failure of traffic control systems. Failure of fuel distribution systems. Failure of electrical transport (train, bus or car).	Failure of electrical systems (outpatient clinics do not have power generators). Cancelation of scheduled operations. No access to patient histories.
Effect on Failed CI	FOOD	FINANCIAL SYSTEM	CIVIL ADMINISTRATION	LAW AND ORDER AND PUBLIC SAFETY
ENERGY	• Failure of production (factories and farms) and conservation systems. • Shops suffer economic losses (cannot open and perishable products damaged).	• Adverse effects on banking systems and transactions. Failure of automated teller machines and electronic payments.	Collapse of on-line and electronic services (small towns don't have generators). Failure of public services like street lightning, etc.	Social alarm. Failure of services. Mobility limited due to fuel limitations. Security cameras do not work. Emergency call centres affected.

Participants found it difficult to establish the time range in which a CI could function autonomously before the dependency became critical, as it depends on the redundancy and auxiliary resources of the affected CI. This fact highlights that once the sectorial dependency analysis has been carried out, a more detailed analysis must be performed based on the city context.

3.3.CIs affecting society

The welfare of society depends on the proper performance of CIs, and society is the most affected when CIs fail. In order to establish mechanisms for mitigating and avoiding the effects of those failures, it is crucial to understand the whole sequence of impacts, both direct and indirect, in the short and long term.

This knowledge will be useful for the development of CC adaptation plans and for the design of CIs, taking into account CC perspective. Furthermore, identifying the impacts will lead to more effective crisis management, as preparation and restoration actions can be identified.

Figure 2 shows part of the sequence of direct and indirect impacts that are the result of crises in the energy sector over the short, medium and long term, as identified by the experts in the workshops.

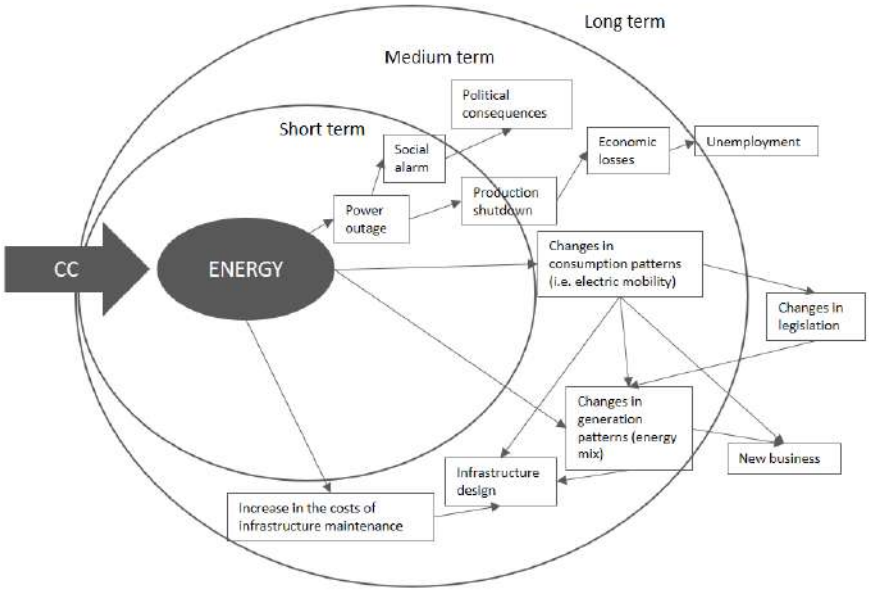

Figure 2: Sequence of impacts on the energy sector in the short, medium and long term due to CC

CC affects the energy sector and causes direct impacts and cascading effects on other CIs. The failure derives over the long term socioeconomic consequences like unemployment, changes in legislation or new business related to new energy generation and consumption patterns and CI design.

3.4.CC and society

Society is exposed to weather extremes and long-term stressors derived from CC. In order to study the potential crises related to CC and their impacts on society from different perspectives, our research applies two units of analysis: the peak of the crisis and the lifecycle of the crisis (Labaka, et al., 2011).

For the peak of the crisis, we focused on how CC-related crises can be characterized through key impact indicators and response actions. However, for the lifecycle of the crisis, we studied how preparation and prevention activities affect the response and the recovery phases.

The process led to the identification of a set of relevant indicators which will let us represent and monitor the evolution of any crisis over time. The indicators were classified in four categories: situational awareness, resources, critical infrastructures and social anxiety. Table 2 shows some of the identified indicators.

Table 2: Indicators for the peak of the crisis.

DIMENSION	INDICATOR
SITUATIONAL AWARENESS	Weather alerts (rainfall, storms, heat waves, etc.).
	Level indicators (dams, rivers, etc.).
RESOURCES	% of unmet needs.
	Extra resources in use.
CRITICAL INFRASTRUCTURES	% of critical services not supplied (electricity (Mwh), gas (m3), communications (Gb), water (m3)).
	% of physical infrastructure damaged.
SOCIAL ANXIETY	Number of calls to the emergency call centres.

In addition, we extracted a set of policies for enhancing the resilience level of urban CIs in the face of CC. Policies were classified in the following resilience dimensions: preparedness, leadership, CIs, communication,

and cooperation. Moreover, we worked on how to integrate a CC perspective within urban CIs' plans by identifying both opportunities and the main barriers to the implementation process. Table 3 shows a sample of policies and barriers extracted from the workshops for the preparedness dimension.

Table 3: Example of preparation policies for enhancing resilience against CC and barriers to their implementation.

DIMENSION	POLICY	BARRIERS
PREPAREDNESS	Carry out training and drills.	Lack of political consensus on CC issues. Politicians do not take expert and CI opinion into account when legislating. Lack of knowledge about more sustainable solutions. Economic issues. Lack of citizen awareness about CC.
	Consider CC criteria in the design and planning of the new installations.	
	Carry out risk assessment and identification of critical points.	
	Design and implement resilience plans.	
	Promote CC awareness.	
	Update the panel of experts to give advice to decision makers on CC issues.	

Although from a CC perspective the most affected CIs are those with large facilities, such as energy or transport, when we analyse the crises in the long term, other CIs acquire relevance in terms of strengthening CI resilience. In this sense, research sector becomes relevant for the development of more sustainable solutions and the spread of knowledge. Public administrations also have a major role to play, as the CI resilience building process requires strong leadership and government commitment. The experts in our workshops highlighted the need for a long-term, unified and stable CC resilience strategy as a reference for future investments in planning. Moreover, awareness, education and cooperation among stakeholders are essential in the resilience building process.

4. Conclusions

The main findings from the GMB workshops were:

- Overall, the two CC-related case studies highlight that the magnitude of a crisis is perceived in terms of the resources or help needed. It is worth noting that the policies identified were different in both case studies. While bigger cities have their own resources to face crises, smaller cities depend on the collective use of resources. In this sense, one recurring idea was that cooperation and coordination, including citizen participation, is an important issue and imperative for small towns.
- The capacity to anticipate event occurrence is important. In this sense, historical data about weather-related indicators such as temperatures, precipitation data, water levels for rivers and dams or quality parameters for water and air, acquires relevance. Moreover, it is vital to have proper indicators and reliable information to monitor and anticipate potential crisis situations.
- Preparation is mandatory for dealing with CC-related crises. Activities promoting awareness about CC and effective ways to deal with CC like education, training, lessons learned management and continuous improvement, are key to enhancing the resilience level of urban CIs. Furthermore, the CC perspective must be included in the planning of new infrastructures. For that reason, both the public and private sectors should consider more sustainable solutions in new infrastructure design. In this sense, the main barriers identified were a lack of political consensus and policy continuity, and the perception that these solutions are more expensive.
- In the interdependencies analysis, the workshops showed that the CI experts are more aware of their dependencies than the ones they generate. Thus, it is necessary to work harder to understand the long-term impacts derived from the interdependency relationships among CIs. Furthermore, the experts found it difficult to establish a time range for the criticality of the dependency, since the analysis has been sectorial. In this sense a more detailed analysis must be performed, taking into account specific assets in order to set appropriate alternatives in case of failure and improve infrastructure design.

- CC does not affect every CI in the same way. Some of them are more vulnerable to certain sudden events, like extreme events, but others are more sensitive to long-term stressors, which are difficult to predict at the moment due to the uncertainty of CC projections.

Acknowledgements

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Towards sustainable fishery: building back better fishing communities after the Great East Japan Earthquake 2011

Yuri Oki [a,*], Hiroshi Kitazato [a]

[a] Tokyo University of Marine Science and Technology, Japan

Abstract

The Great East Japan Earthquake in 2011 caused damage to one third of the fishing communities along the Pacific ocean of the Tohoku coastal area. The Tohoku Eco-system Associated Marine Science (TEAMS) project was launched in 2011 to track and monitor changes in coastal marine environment and ecosystems, and to deliver science-based information relating to fishing grounds and coastal marine environment to fishing co-operatives and fishermen. The objective of this project is to disseminate scientific findings pertaining to marine ecosystems so that fishermen and fishing communities are informed of the impacts and recovery of marine ecosystem. For example, a sample site observed damage and disappearance of seaweeds immediately after the earthquake, however after a certain period of time showed signs of recovery. Fishing industry is entirely dependent on coastal marine ecosystem and thus dissemination of science-based information during the recovery phase has -and still remains - as challenging yet important task. Interviews were conducted to find how fishermen responded after the earthquake and tsunami. Findings from fieldwork involving interviews and participant observation suggest fishermen were aware of the environmental pressure caused by the overcrowding of aquaculture rafts in the bay and its negative impact on the growth of marine species like oyster, and post tsunami opted for sustainable aquaculture methods.

Keywords: Great East Japan Earthquake, Marine Ecosystem, Fishing Communities, Science-Based, Habitat Mapping.

1. The Great East Japan Earthquake in 2011 and Tohoku Ecosystem Associated Marine Science (TEAMS) project

In 2011, the earthquake and tsunami of the Great East Japan Earthquake caused considerable damage to the coastal areas facing the Pacific ocean of the north-eastern area of Japan, known as the Tohoku region. The piling up of rubble, loss of seaweed beds and tidal flats, and accumulation of sand and mud on reefs resulted in drastic changes in marine ecosystems, coastal aquaculture farms, and fishing grounds. As a consequence, restoration of marine ecosystems, and reconstruction of fishing communities and fishery in the coastal areas have become imminent agenda. The *Basic Guidelines for Reconstruction in response to the Great East Japan Earthquake* states "it is necessary to investigate marine ecosystems that were drastically changed by the disaster, to reconstruct fishery grounds, and to form networks among universities, research institutes and private companies that are conducive to the creation of related industries" (Reconstruction Headquarters in response to the Great East Japan Earthquake, 2011). Fishery grounds and marine resources can be restored through reconstruction of seedling systems for fishes like salmon and trout, and restoring seaweed beds and tidal flats that serve as nursery ground for baby fishes. What is required the most in the post-tsunami phase is to track the changes of marine environment so that fishermen and the coastal fishery will have a better understanding of fishing grounds and to manage marine resources based on scientific findings.

The Tohoku Ecosystem Associated Marine Sciences (TEAMS) project was launched in 2011 to systematically promote monitoring, research, and development in the Pacific Coastal areas of the Tohoku region affected by the tsunami and earthquake (Kijima A. et al., 2018). Fully supported by the Japanese Ministry of Education, Culture, Sports, Science and Technology of Japan, the TEAMS project formed a network of marine science researchers in universities and research institutes in Japan. The mission of the TEAMS project is to undertake investigations and research on marine ecosystems in the coastal and offshore areas of the Tohoku region and support restoration and reconstruction of fishery stakeholders in cooperation with local governments, relevant ministries and agencies, and contribute to the restoration and building resilience of the fishery in Tohoku region. Figure 1 shows the monitoring sites and bays along the pacific of Miyagi and Iwate prefecture affected

* Corresponding author. E-mail address: yuri.oki@kaiyodai.ac.jp

by the earthquake and tsunami. TEAMS project brings together the intelligence of researchers in the field of marine science and technology throughout Japan and carries out investigations on physical and chemical environments and biological dynamics in the area, and clarifies factors controlling the dynamics of marine ecosystems, and aim to provide scientific findings and information that contribute to determine the fishery grounds and to estimate the existing marine resources.

Figure 1: Map of TEAMS monitoring sites (Kitazato et al. 2018)

2. Building fishing communities back better

Responding to vulnerability in the coastal area at the global scale is imminent. The Great East Japan Earthquake was an unprecedented crisis causing damage of approximately sixteen thousand people dead and five thousand missing (UNISDR, 2017, p.12). If we take a look at the globe, human populations and activities are often concentrated along coasts, and coastal ecosystems are consequently altered making coastal areas prone to natural hazards and risks. According to Adger et al. (2005, 1036), 23% of the world's population lives within 100 kilometers of the coast, and the percentage is expected to rise to 50 percent by 2030. Consequently, the 50% of the world's population will be exposed to coastal hazards such as flooding, tsunamis, hurricanes/typhoons, and other marine-related disasters. Adger et al. warns that resilience can erode over time driven by natural and human-induced threats, such as environmental change and human actions. The erosion of resilience thereby makes coastal areas more vulnerable to hazards and disasters. When tsunami hit the Tohoku region of Japan, inundation height reached maximum of 40 meters in altitude destroying coastal infrastructures, fishing ports and aquaculture grounds, houses and other lifeline infrastructures.

Vulnerabilities condition the magnitude or the severity of undesirable outcomes brought by hazardous events (Tuler et al., 2008). Thereby when addressing vulnerability of coastal areas affected by the earthquake and tsunami, we refer to the following two. First, is the function of the stresses in which ecology and the environment experience when hazardous events occur, and the nature's capability to cope with such hazards. Second, we refer vulnerability as the function of the stresses people experience due to undesirable hazards and their ability to cope with them. The first indicate the vulnerability of coastal ecological system and marine environment, whereas the second focuses on vulnerabilities on land and human activities in coastal communities.

Natural disasters like earthquake and tsunami are imminent threat to those living along the coastal shores. The purpose of this paper is to identify coastal vulnerabilities, such as disturbance in marine ecosystem and its impact on fishing communities, by reviewing case examples and experiences learnt from the Great East Japan

Earthquake. We elaborate on the factors and conditions that shape the building of marine environment and fishing communities back better during the period of recovery, rehabilitation, and reconstruction.

The following sections of this paper proceed as follows. First covers the methodology and research scope. Next we share academic findings on the disturbance of marine ecosystem by showing case examples of sea-grass beds that disappeared due to tsunami, which resulted in the increase in the number of sea-urchins that consequently led to sea desertification. Followed by an example of a community in Togura, Minamisanriku town that received international accreditation on oyster farming for sustainable and disaster resilient aquaculture.

3. Methodology

The methodology consists of a combination of interviews and participant observation with fishermen and other stakeholders in the fishing industry, and analysis of secondary sources including publications from local government, non-profit organizations, and academic articles. Participant observation was conducted in towns of Onagawa and Minamisanriku, both situated along the Pacific coast of Miyagi prefecture. A total of six fieldworks were completed from December 2017 to June 2018. Interviews and participant observation was most suitable for this research as the author was able to collect as many responses on ideas that shaped fishermen's thinking on how to build fishing communities back better in disaster stricken communities. Collected responses were organized and categorized into concepts with detailed episodes of sustainable (or non-sustainable) fishing in the local fishing communities. Approximately seventy responses were collected from the fishermen, workers of fishing industry, government officials, and local citizens. However, not all interviews were conducted in the exact same setting and manner due to time constraints of the interviewee.

4. Toward disaster risk resilient fishery

This section is composed of two parts. First part gives a summary of findings by TEAMS researchers on the impact of tsunami on seagrass and seaweed beds in two case example bays of Otsuchi and Shizugawa. The second part introduces the example of international accredited oyster aquaculture farm for sustainable fishery in Togura area of Shizugawa bay. The propose of this section is to highlight the findings on vulnerability and resilience of marine ecosystems at times of tsunami, and to show how human activities can help build back coastal marine environment by improving aquaculture farming, by taking into consideration the environmental capacity in which the bay can hold, and balancing out with the fishing activities exercised in the coastal area.

4.1.Findings from the TEAMS project

Biodiversity in coastal shorelines, including sea-grass beds, rocky shores, and tidal flats influence vulnerability in fishing communities located along the coastlines. After a careful on-ground investigation along the shoreline in towns of Otsuchi and Minamisanriku, a group of researchers from TEAMS project found that sea-grass beds in both towns have minimized due to tsunami (Komatsu, T. et al., 2015; Aoki M. et al., 2013). In Otsuchi town, sea-grass beds were washed away more so in the inner bay, as the Tsunami had hit the most in the furthest point of the inner bay, and then rippled off the side along the coast (*see* Figure 2). Whereas seaweed beds around the entrance of the bay to the middle part of the bay remained after the tsunami. In Shizugawa bay, the damage on seaweed beds on rocky substrates were not as significant as the impact it had on the sandy substrates, due to large displacement of sand driven by the tsunami (Komatsu T. et al., 2018). Komatsu T. et al. (2018) found that seagrass beds showed signs of recovery by 2014 in most areas, except in areas where restoration and construction activities to elevate ground level for houses have caused turbid waters.

Seagrass and seaweed beds are vital for sustainable fishery and to protect the biodiversity of the coastal ecosystem because both serve as an important nursery habitat and shelter for diverse species of fishes and invertebrates that move to other ecosystems in the ocean as they mature. Not only do seagrass and seaweed beds are important to the marine ecosystem, the dense root systems of seagrass beds extending deeply into sand and mud bottoms secure the seabed, preventing sandy sediments from being washed away and protect coasts, coastal habitats, and communities from erosion and from strong ocean storms.

The disappearance of sea-grass beds is dependent on the geography of the coastline that consequently shapes the pathway of tsunami. Biodiversity bolsters resilience as species respond differently to environmental change, and disappearance of a group of species is compensated by increase in another group of species (Adger et al. 2005). The earthquake and tsunami changed the coastal eco-tone of the Tohoku area that originally consisted of patches of bio-diverse ecosystems that formed a transition zone between the land and the sea. Thereby

monitoring of temporal and spatial changes of the eco-tone before, and after the earthquake, is important to identify the biodiversity of the coastal areas and its marine ecosystem. A group of researchers from TEAMS were able to identify seaweed beds that existed prior to tsunami showed signs of increase in seaweed bed volume even after the Tsunami (Komatsu T. et al., 2018). Researchers have also found that hard substrates needed for seaweed to attach, such as debris of buildings and concrete blocks washed away from land by the tsunami had become a new home for seaweeds, and contributed to the increase in the number of seaweed beds. However, sea grass and seaweeds are now in grazing pressure due to increase in the number of sea urchins since 2014 partly due to lack of fishing pressure on sea-urchins. Similarly, in Otsuchi bay of Iwate Prefecture, abundance of sea urchin and abalone was found in TEAMS monitoring survey (Hayakawa J. et al., 2017). Sea urchins were washed away to a deeper sea bottom and reduction were observed immediately after the tsunami, followed by a rapid recovery due to a successful recruitment of sea urchins continued on several years after 2011 as coralline algae (diet and protection shelter for sea urchins) areas expanded to deeper zones of the bay (Kawamura et al. 2014, Hayakawa et al. 2017).

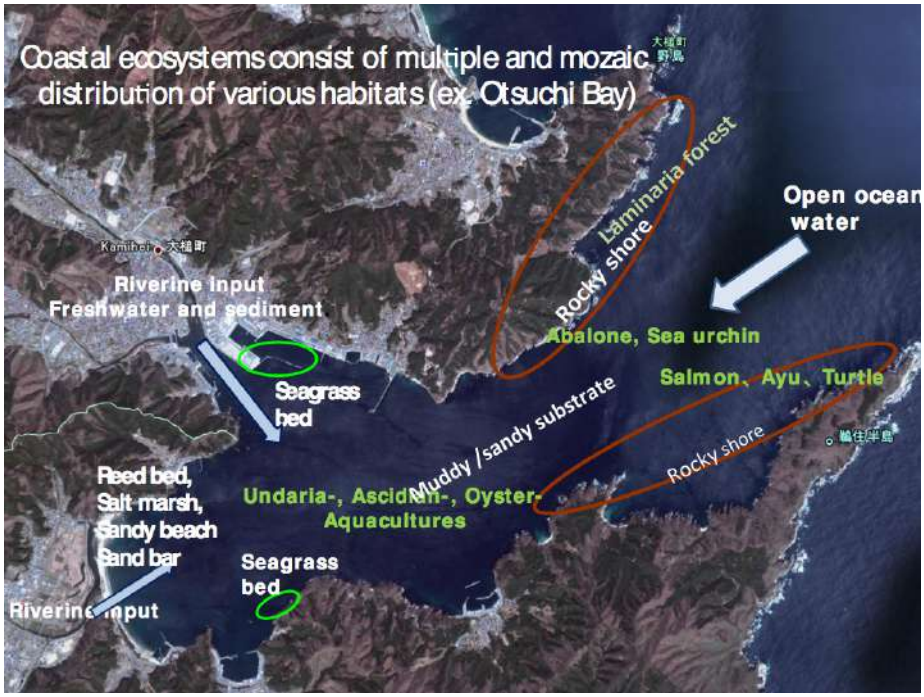

Figure 2: Habitat areas of sea grass beds in Otsuchi bay, Iwate prefecture (Kitazato et al. 2018)

4.2.Disaster resilient sustainable fishing; example of Togura ASC oyster farm

Prior to the tsunami, fishermen in Togura area of Shizugawa bay, fisherman cooperatives ran family oriented, small-scale oyster aquaculture farms. In the span of thirty years, the distance between each oyster rafts became smaller and closer, and just before the Tsunami hit in 2011 the distance became as close to ten meters which caused overcrowding. As more greedy fishermen placed new rafts, the growth speed of oyster slowed down as oysters were not able to take in enough nutrients as it used to due to overcrowding of rafts in the bay. It took only a year for the oysters to harvest when the father of Mr. Kiyoharu Goto (Head of Oyster Committee of Shizugawa Fisherman Cooperatives, Togura branch) started his oyster farm. When it was time for his son to succeed the family business, harvest time became as long as two to three years as growth speed worsened. The more the fishermen placed new rafts into the bay the more the quality and sustainability of the marine environment lessened. The leaders of each shore loosely managed the numbers of rafts, and drastic measures to solve the problem of raft overcrowding never became the priority before the tsunami. Although members like Mr. Goto and his colleagues were customary aware of the lack in quality control of marine environment can lead to serious consequences in the growth of oysters, fishermen in Togura were unable to review and reduce the burden on the environment.

During the interview with Mr. Goto, he reflects back the time before the Tsunami, *"We knew from experience that overcrowding was not good for the marine environment as it can lead to change in the growth of oysters and*

alter harvesting cycle from one year to two years to three years. I...together with my fellow fishermen in Togura felt the need to act and rectify the issue but we knew there would be strong opposition from other fishermen, and attempts to prompt actions before the Tsunami was never realized." (Oki 2018).

The tsunami destroyed many aquaculture facilities located along the shoreline and more than 1000 farming rafts existed in Togura were washed away and destroyed completely. The Togura fishing community has withstood many natural disasters like tsunami and typhoons since aquaculture first started in 1899. However the Great East Japan Earthquake was nothing comparable to that of the previous tsunamis. Mr. Goto, being appointed as the head of the oyster committee after the earthquake, envisioned of restoring back the marine environment to that of his father's generation; when marine ecosystem was sustainable, and sea surfaces were not overcrowded with farming rafts and quality oysters were able to harvest in a year. This meant reducing the total number of rafts to one third of that before the earthquake. Commonly understood by the fishermen, downsizing the number of rafts meant a decrease in oyster production and yield. Mr. Goto was constantly faced with criticism and opposition from his fellow oyster committee members. Yet, his strong determination of making the marine environment back better than before gradually gained support from the fishermen of Togura oyster committee.

Full-fledged support and consensus from all 39 stake-holding members of the oyster committee were gained after a pilot study showed a sample oyster becoming as big as 20 grams in just four months, where before it took two to three years. Mr. Fujio Abe, head of Shizugawa Fishermen Cooperatives Togura branch reflects back the time when Mr. Goto was faced with strong opposition from his fellow fishermen "*Reducing rafts meant reviewing the number of rafts each fishermen possessed prior to the earthquake. Fishermen protested to the idea because they wanted to protect the sales they would have received had they not reduced their original number of rafts. But we had to do it in order to sustain our marine resources. It was for the sake of our sustainable future to pass it onto the next generation. Luckily we had supporting external organizations like the World Wide Fund for Nature (WWF) and environmental consultancy firm to apply for internationally accredited fishery eco-label; the Aquaculture Stewardship Council (ASC).*" (Oki 2018). The Togura ASC oyster farm became a successful example of earthquake and tsunami experienced community that managed to restore local marine environment by lowering the environmental impact from aquaculture, and improving the sustainability of marine ecosystem.

5. Conclusion, policy recommendations, and next steps

Findings from TEAMS project implies coastal ecosystems, such as the example of seagrass and seaweed beds provide important environment for coastal fisheries, and the impact of tsunami can wash away important habitats for marine animals. Sea urchins living in seaweed beds are often target species for fishermen due to their good market prices, and thereby loss of seagrass and seaweed beds disturb coastal ecosystem and habitats. Rapid abundance of sea urchins imposes negative impact on the ecosystem as they consume seaweeds and other seagrass species. Thereby a sudden increase in the number of sea urchins can lead to acute sea desertification making other marine animals to lose habitat. Consequently sea desertification can lead to production of low-market quality sea urchins, loss of nursery habitat for baby fishes and other marine species dependent on seagrass and seaweed beds.

ASC certified Togura oyster is an exemplary best practice of an earthquake and tsunami stricken community that had successfully re-built their source of livelihood -aquaculture farming- back in a more sustainable and resilient way. Improving coastal marine environment to a more sustainable state as a method of 'Build Back Better' is an effective approach in preserving marine ecotone and animal habitats and making human social-economic activities sustainable.

The results from the fieldwork suggest the need to construct a comprehensive marine ecosystem habitat map so the fishermen are informed not only about the coastal environment in which they live in, but to understand the cycle of marine ecosystem that serve as a basis of their livelihood. Another implication from the findings suggests the necessity to design and develop a sustainable fishing plan for implementation by the local government. The establishment of a sustainable fishing plan enables fishermen to make decisions based on scientific evidence, and enhances marine resource management so it could be passed on to future generations. The main conclusion reached from the research findings was the importance of integrating the knowledge of local fishermen and science-based knowledge obtained by monitoring the changes in marine ecosystem for disaster risk management, the sustainable development of coastal marine ecosystems and for building back better tsunami affected fishing communities.

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An innovative strategy to increase the resilience of flood-vulnerable communities while reducing risk of population displacement and psychological trauma

Elizabeth English [a, b,*], Meiyi Chen [a], Rebecca Zarins [a]

[a] University of Waterloo, Canada
[b] Buoyant Foundation Project, USA

Abstract

Protecting communities from the displacement and psychological trauma that accompany natural disasters is a challenging prospect. Vulnerable communities are faced with responding to increasing climate change-induced crises, often having only a limited set of tools that are inadequate to cope with the intensity and urgency of post-crisis circumstances. The increasing frequency of natural hazardous events requires forward-looking strategies to limit the likelihood that hazards will evolve into disasters, impacting communities and leading to repetitive loss and the need to rebuild. To date, standard flood mitigation strategies have relied on systems that either attempt to control water or avoid it. Instead, how might we embrace the climate changes that are occurring and better adapt ourselves and our buildings to accommodate flooding? One solution is the implementation of amphibious architecture, specifically, buoyant foundations. Buoyant foundations are a cost-effective, adaptive flood risk reduction strategy that works in synchrony with a region's natural cycles of flooding. Buoyant foundations are a retrofit to an existing building that enables it to rise and float on the surface of water when flooding occurs and later return to its original position as the floodwater recedes. It is a damage prevention strategy that has much to offer to communities in crisis that have few, if any, other low-cost, low-impact, culturally acceptable flood risk reduction options that create minimal disruption to daily life. This paper includes case studies of amphibious prototypes developed for specific flood-prone locations in Nicaragua and Vietnam.

Keywords: Amphibious Construction; Flood Risk Reduction; Climate Change Adaptation; Population Displacement; Forced Relocation.

1. Introduction

Flooding is one of the most common and destructive natural hazards, accounting for 47% of all weather-related disasters, and causing more damage worldwide than any other type of natural hazardous event (Alinovi, 2017). Climate change has led to an increase in the frequency of flooding, causing devastating effects on vulnerable communities. As sea levels rise and urbanization grows in flood-prone areas, the number of people exposed to flood inundation, storm surges and seasonal river floods increases. Government funded relocation programs to protect communities are expensive and are proving to be unsuccessful as populations that have been mandatorily relocated often return to their place of origin. Being close to a water source is critical for indigenous communities as they rely on it for food, livestock and agricultural purposes. While often seen as a reasonable option, relocating such communities to new locations that are far away from critical resources is clearly not an ideal solution.

Severe flooding can have significant psychological impacts on a community. Disasters like floods can pose issues during the initial event (primary stressor) but often result in problems that continue afterwards during lengthy recovery periods (secondary stressor) (Fussell & Lowe, 2014). Recent studies of post-disaster displacement prove that there is more trauma and psychological damage among participants who were displaced, resulting in symptoms of depression, anxiety, and post-traumatic stress disorder even a year after the disaster. Fussell and Lowe looked at four factors that determine the severity of stress associated with displacement: geographic distance, type of housing, number of times moved, and time spent in temporary housing. Three distinct profiles were identified and it was found that individuals who were relocated maintained higher levels of stress than those who could return home after a disaster. In addition, people who spent a significant amount of time moving or living in temporary housing had substantial increases in stress levels.

* Corresponding author. E-mail address: ecenglish@uwaterloo.ca

Displacement is a particularly harmful form of disaster management as it drastically alters routine and social support systems. Where people live, whom they interact with and where they work are only some of the areas in which displacement has a dramatic impact. Other stressors might include limited access to healthcare, exercise, the ability to contact friends and family, discrimination, continued physical danger, and isolation (Fussell & Lowe, 2014). Psychological effects from disasters are vastly underreported and there are few related studies when compared to economic impacts of the same events. While commonly seen as separate issues, emotional and monetary costs are both important and related aspects of recovery and are interconnected more than is often recognized. Poor mental health makes managing and solving stressful situations particularly challenging during relocation. In addition, the ability to find and maintain employment is strongly tied to one's mental health (Harnois & Gabriel, 2000) and also plays a crucial role in one's ability to recover financially from a disaster. Relocation impacts far more than simply a person's physical location—in the long term, it has proven not merely ineffective but damaging for residents in flood-prone regions.

Current flood mitigation strategies that attempt to control or alter the environment are also proving to be ineffective over time. Erecting barriers may provide temporary protection from flooding, but consequences are magnified when the system ultimately fails. Instead of trying to fight sea level rise, it is a better choice to work *with* it to minimize physical and psychological damages. It is imperative to reconsider the traditional relationship of a city with water to focus on flood resilience rather than flood defence. Unique and creative solutions are needed to respond to the negative impacts of displacement and repetitive rebuilding caused by flooding and climate change.

Amphibious construction is an innovative approach to flood mitigation that addresses these issues. A buoyant foundation retrofit will allow a house to rise with the water during a flood event and return to the ground when the flood water subsides, keeping inhabitants safe while reducing property damage. It is an adaptive flood risk reduction strategy that works with the region's natural cycles of flooding rather than attempting to control them.

The amphibious retrofit concept features three basic components: a buoyancy system that displaces water and provides flotation during the flood, a vertical guidance system to prevent lateral movement of the house as it rises and falls, and a structural subframe that connects these new components to the existing house. A buoyant foundation can accommodate varying levels of water and is less susceptible to hurricane and wind damage compared to statically elevated homes (English et al., 2017) (Figure 1). Buoyant foundations are ideal for houses that are already elevated and are in locations that do not have fast-flowing floodwater. Although the solution is not universally applicable for all flood situations, it is a viable strategy for many vulnerable communities. The simplicity of the design allows for customization to each individual situation. The use of local materials and construction techniques is encouraged when implementing the system, and key issues for the specific area can be appropriately addressed. Buoyant foundations are designed to be easily replicated for ease of installation by local inhabitants, thus not only providing a mitigation strategy but also supporting the local economy and promoting community resilience and independence. Amphibious architecture offers an innovative, economical, and culturally sensitive option for flood-vulnerable communities.

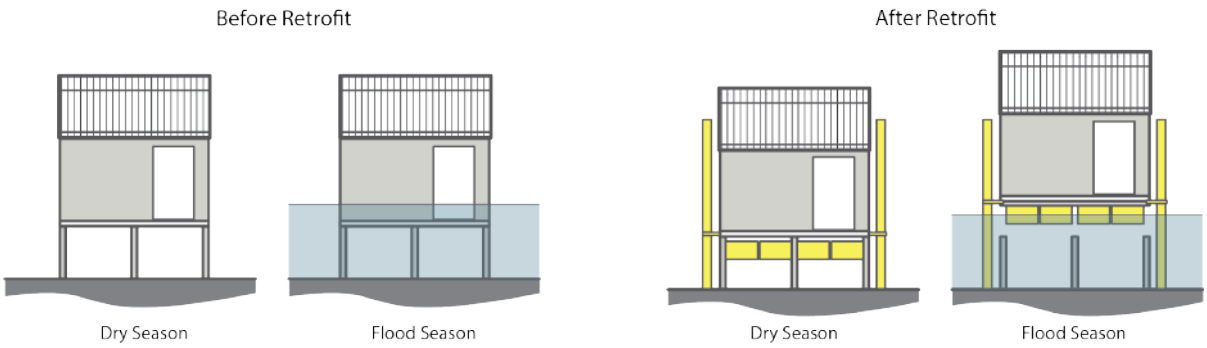

Figure 1: Diagrams showing how a regular elevated house compares to an amphibious retrofit during flooding (*drawing by Teresa Tran (BFP)*)

2. Casa Anfibia, Malacatoya, Nicaragua

Nicaragua is experiencing social and economic crises that threaten vulnerable and low-income communities located in flood-prone areas. These communities have difficulty adapting to rising sea levels as they often do not have the resources either to build flood protection or to relocate to a safer place of their own choosing. The Nicaraguan government resettlement programs for such communities have been largely unsuccessful since many people abandon the government-provided housing to return to the locations of their former homes. These populations rely heavily on the local water and food supplies in their home regions and resist adapting to the unfamiliar and unfavourable conditions of the new resettlement locations. Casa Anfibia is a proposal that would allow local people to retain their own homes as their place of residence and withstand flooding, encouraging an end to the negative cycles of relocating and rebuilding (English et al., 2016).

Nicaragua is home to one of the largest tropical forests in the western hemisphere, however the forest is currently threatened by timber and agricultural industrial interests. Deforestation is a national concern, contributing to temperature increase and making the region more vulnerable to the impacts of climate change. Today, there are only three million hectares remaining of the eight million hectares of forest that existed in 1950. Forests act as a natural shield against extreme weather such as storms and hurricanes and help to regulate rainfall. Without the protection of forests to mitigate destructive forces, communities are more susceptible to disasters, such as occurred in Hurricanes Mitch and Felix. Biologist and geographer Jaimie Incer Barguero reports that, "Rain causes greater damage to land stripped of its trees than to forested areas" (Silva, 2007). Officials credited trees for weakening the intensity of storms during Hurricane Felix.

When the water level of the river is high, the Malacatoya community is only accessible by boat, and flooding encroaches on residents who live along the banks of the river. The government solution to this dangerous situation is to evacuate and relocate the affected families. However, according to Roger Caray, a pastor of the community, 92 percent of people forcibly relocated by the government leave the place of resettlement to return to debilitated conditions (Laffay, 2012) (Figure 2). Many residents have lived along the river for their whole lives and are unwilling to leave. They are aware of the risks associated with living in close proximity to the river; however, they find there is more for them there than in the new locations. While it is also a dangerous force, the river provides everything they need to survive. Local residents depend on the fertile soil for raising food, and the river provides access to a virtually unlimited supply of water for daily living, agriculture, and livestock. Relocation disrupts established social networks and access to their main sources of sustenance and income, namely agriculture and fishing. The prevailing sentiment of the community as voiced by a resident is "life wouldn't be the same somewhere else" (Laffay, 2012).

Figure 2: View of the Malacatoya River (left); houses reoccupied by residents post-displacement (right) (*courtesy of CO2Bambu*)

The site chosen for the installation of amphibious foundations along the Malacatoya River is located between Lake Managua and Lake Nicaragua. This region is prone to natural hazards such as earthquakes, hurricanes, and seasonal flooding. Communities in the area suffer from chronic flooding and other major issues such as poverty, legal vulnerability, and the threat of displacement. Amphibious foundations have been proposed by the Buoyant Foundation Project (BFP) as an affordable solution for flood resilient housing that would allow residents to continue their traditional way of living, and minimize unnecessary trauma caused by displacement and loss.

Casa Anfibia (Figure 3) is a design proposal for the Malacatoya Community intended to allow residents to remain in their homes during flooding. The structure is designed to be built with recycled and renewable materials, and the technology is intended to be easily transferable and adaptable to a range of locations and scenarios. Recycled plastic barrels are suggested for the buoyancy elements due to their low cost and local availability. Bamboo is selected as the construction material for the frame because it is lightweight, thus reducing the cost of the buoyancy system. Bamboo is also desirable because of its small carbon footprint—35 percent lower than concrete block—and it is a renewable resource that can be regrown quickly, addressing the local issue of rampant deforestation (Hammond, 2008). Nicaraguans employed in forest harvesting operations are often very poor and have no other sources of income. It is intended that the amphibious foundation projects could also contribute to growing the local economy. These simple new houses for Malacatoya are designed with amphibious foundations so as to provide low cost, flood protected living quarters that include a surrounding deck to accommodate livestock, ultimately supporting residents in their desire to maintain their way of life in their place of origin.

Figure 3: Casa Anfibia, the design proposal for the Malacatoya community (*Image by Zak Fish (BFP)*)

The project could serve as an example to be replicated in other flood prone regions. Low income communities are the most vulnerable to natural disasters. Amphibious foundations are a disaster mitigation method that would allow communities to break out of the cycle of relocation and rebuilding that currently plagues their lives. There is substantial evidence that the current approach of relocating populations to higher ground does not work. Displacement can introduce additional stress to vulnerable communities in a disaster by altering residents' daily routines and bringing feelings of isolation. Amphibious construction offers a strategy for low income residents to remain on their land safely, improve their quality of life, and keep their communities intact. Although the proposed project along the Malacatoya River has not been implemented, the concepts described above have been developed further and adapted to other BFP projects.

3. Mekong Delta, Vietnam

The second case study is an ongoing project, funded by the Global Resilience Partnership Water Window Challenge and the Z Zurich Foundation, that has recently completed construction in the Mekong Delta, Vietnam. The project is a 22-month international collaboration among Canadian and Vietnamese universities, government agencies and non-profit organizations to develop amphibious retrofits for Vietnamese rice farmers' houses. The project strategy is to test amphibious retrofit prototypes and develop a replicable model, allowing for easy, low-cost implementation throughout the region. Once established, the system can be expanded and reproduced throughout the country, encouraging a community-driven approach for further development and implementation.

In Vietnam, water is a part of everyday life. A complex system of rivers and canals weaves through the region. These waterways are used for transportation, floating markets and community activities. Vietnam is facing major challenges, as it is one of the countries most vulnerable to sea rise, with a majority of the population living in coastal and deltaic zones. This makes disaster management, particularly flood and storm control, a top priority for the government.

The Mekong Delta is a low-lying plain, located less than three metres above sea level, and is highly susceptible to floods caused by rising sea levels and climate change (Figure 4). Flooding is an annual event in the region and it provides important benefits to local agricultural and aquacultural production. The Mekong

Delta region provides a majority of the staple food and fish for the rest of the country and is considered Vietnam's rice basket. It is a densely populated area, home to over 17 million people. With climate change and upriver dam-building, there is an increased risk of potentially disastrous floods. Annual runoff from the upper basin of the Mekong Delta is estimated to increase by 21 percent by 2030, with annual precipitation expected to increase by 200mm each year (Eastham et al., 2008). Climate specialists have estimated that the sea level will rise by 0.8 meters by 2100, resulting in 40 percent of the Mekong Delta being submerged. If nothing is done, nearly one third of the local population will be affected and many will be forced to relocate.

Figure 4: Houses in the Mekong Delta, during flood season (*image by Elizabeth English (BFP)*)

Previous government strategies for dealing with extreme flooding have included constructing dike and canal systems to control water flow and providing loans to homeowners for relocation. These methods have limited long-term effectiveness and fail to meet the needs of local people. The installed dikes were meant to protect people, but have significantly interfered with the natural ecosystem, making food production difficult for low-income agricultural and aquacultural farmers (Chapman, 2018). Relocation and resettlement programs are common practice in Vietnam but these solutions are not always successful. Relocated residents are provided with grants to support the costs associated with moving, but many have reported decreases in income and an inability to repay their debts after relocation (Chun, 2015). Residents have developed their own solutions for flood mitigation including elevating their houses, however static elevation cannot accommodate gradually increasing flood levels without repeated expensive renovations.

Although amphibious construction is a new approach to housing in Vietnam, it had been welcomed by the residents as a viable flood mitigation strategy because it combines the local architectural typologies of houses elevated on stilts and floating structures. Earlier this year, the Buoyant Foundation Project worked in Vietnam to retrofit four houses in the Mekong Delta, two of them in An Giang Province and two in Long An Province.

The floating rice district in An Giang is an ideal location for the first phase of the project, since placing amphibious prototypes in the rice fields will most certainly cause the houses to float, thus allowing the collection of performance data during the flood season. The project's first client is Nguyen Van Nao, a rice farmer in Tri Ton District in An Giang Province. Nao's home is newly constructed for this project and is situated in the rice field behind his current house, in a location that floods regularly every year. The buoyancy for Nao's house is provided by recycled jugs bundled together and tied up with rope to the structure under the house. Skirt boards surround the jugs to protect them from the force of flowing water and prevent their being washed away. A simple sleeve detail is used: a thick rope looped around each of the guidance posts, keeping the house in place laterally as it rises and falls with the level of the floodwater (Figure 5).

Figure 5: Nguyen Van Nao's house, a new built house (left) and the sleeve detail used (right) (*images by Elizabeth English (BFP)*)

The second prototype in An Giang belongs to Nao's younger brother Nguyen Van Lac, also a rice farmer. His home was originally located on the edge of the path lining the bank of the canal but was mandated to be moved to allow for widening the path into a narrow road. His existing house was moved back, away from the road, into the rice field behind it (Figure 6). The design for this amphibious retrofit was slightly modified from Nao's house, with a more complex sleeve detail comprised of wood wrapped with rope to frame each guidance post.

Figure 6: Nguyen Van Lac's house, which was moved back from the road (*images by Teresa Tran (left), Elizabeth English (right) (BFP)*)

There were also two prototypes constructed in Long An Province, both of them retrofits to existing houses remaining in their original locations. The amphibious retrofit for Dang Van Nang's house required that the wooden posts supporting his house be replaced with stone columns for better structural support. The buoyancy elements were recycled plastic barrels, more expensive than the jugs used for the other retrofits but more familiar to the local residents as flotation devices. In this case the guidance posts had rope-wrapped wooden sleeves, similar to those of Lac's house in An Giang (Figure 7). The retrofit to Nguyen Thi Dung's house was similar to Nao's, using recycled jugs and a simple rope sleeve. Each of the retrofit designs is slightly different to allow comparisons of their behaviour during a flood. There was visible improvement in the construction of the details as the crew gained experience with each project. As of July 2018, all four retrofits were completed and ready to be monitored in the upcoming monsoon season to gather data on how each system performs. Not only will data be gathered regarding the physical performance of the buoyant foundation systems, but the reactions and responses of the residents will be recorded to document occupant satisfaction and to better understand the impacts of this flood mitigation strategy on the community.

Figure 7: Dang Van Nang's house (left) and the more complex sleeve detail (right) (*images by Elizabeth English (BFP)*)

In a future scaling-up phase, additional houses in the Mekong Delta will be retrofitted with amphibious foundations and improvements will be made to the retrofit design based on the gathered data. Training manuals will be compiled as guides for amphibious construction and as a basic cost estimation tool. These prototypes will help reduce upfront engineering costs for the systems when they are later implemented in other vulnerable areas.

The strategy of amphibious retrofitting uses local construction materials and techniques, making it socially and economically feasible for the communities of the Mekong Delta. The low cost and easily accessible materials provide low-income communities with better access to flood mitigation technologies. The long-term objective of the project is for buoyant foundations to be adopted as a viable strategy for flood mitigation and climate change adaptation. The retrofits are designed using local materials and construction methods so that the technique will eventually be replicable independently by the residents themselves. A major benefit of this practice is that each retrofit creates a framework for the community to build on in the future, contributing to the Buoyant Foundation Project's ultimate goal of helping to create self-sufficient and resilient communities.

4. Conclusions

Due to changes in the global climate and rapidly growing populations, the threat of flooding is at the forefront of global issues. Cities are facing more extreme flooding with increasing frequency. As population steadily grows, people around the world will experience greater social and economic damage with each flood. Floods can disrupt lives, create trauma, trigger displacement and introduce costs that low-income families cannot afford. The stresses of dealing with natural disasters and displacement can have grave negative impacts on wellbeing and mental health. It is imperative to rethink the current strategies that work against nature and instead strive to implement approaches that accommodate the natural course of water. Amphibious foundations are a way of working in harmony with nature, providing low-income communities with flood protection that is culturally and environmentally sensitive with minimal impact on daily life. Amphibious retrofit construction can be applied to individual buildings or neighbourhoods and provides numerous potential benefits in comparison to alternative strategies. An amphibious approach allows homeowners to keep their houses safe without the devastation of repetitive damage or the trauma of forced removal from their homes and communities.

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Learning from less-advantaged communities how to cope with natural disasters

Shenuka de Sylva [a,*], Brenda Vale [a]

[a] Victoria University of Wellington, New Zealand

Abstract

This paper poses the question as to why communities with few resources at their disposal often seem better able to cope with natural disasters than developed communities. The paper highlights the strategies for dealing with natural hazards found in developed countries, particularly concentrating on the recent floods in Europe that are shown to have been produced by climate change, and the prevention and avoidance methods proposed in the face of future flooding. Using two case studies, one from the Pacific Islands and one from South Asia the paper then looks at how traditional communities have adapted through organic processes to natural hazards. The paper discusses the resilience of communities in Niue and Cambodia and the attitudes that have enabled them to utilise traditional knowledge to develop vernacular strategies for dealing with natural hazards. These organically evolving adaptive strategies for hazard prevention differ from the westernised approaches of containment and control through engineering systems. The paper concludes by speculating on how the approaches used by communities with few resources and the strategies they have developed for increasing resilience to future disasters could be applied to the European context, given climate change is leading to more severe flooding and in 50 years living with regular flooding may be more common place.

Keywords: Natural hazards; vernacular systems; traditional practices; adaptive approaches; resilience

1. Introduction

Ever since in the UK the new wealthy families as a result of the industrial revolution migrated to suburbs in the south west of the city to avoid pollution from the factory chimneys blowing over their heads it is the poor who have to put up with living in less than ideal circumstances. If you have little money you have to live on the cheapest areas of land and this is often land that is polluted or prone to natural disasters, such as flooding. As will be shown in the case studies later in this paper this means that ways have to be found of living with natural disaster such as floods, whether these happen annually or intermittently. When it comes to human resilience it is the poorer members of society who have the quality in abundance, whereas the wealthier members of society tend to think resilience comes from having sufficient money to deal with a problem (Vale and Garcia, 2016). Increasingly however the value of properties in affluent suburbs that are now at risk of flooding because of climate change are dropping, forcing the wealthy to sell at a loss as those who can afford to buy in such suburbs opt to move to higher ground to avoid the problem (Brasilerio, 2018).

It is thus apparent that flooding due to global warming is an increasing risk that will affect the rich as well as the poor (Kundzewicz et al., 2005; Min et al., 2011; Pall et al, 2011). Despite calls to curb the human induced emissions that are leading to global warming, such as the Paris accord, it is now clear that no such reductions are happening. This is evidenced by the results of the earlier Kyoto Protocol. Although it only affected countries that signed up and although some signatory countries did reduce emissions, it has become apparent that this was achieved by exporting carbon-intensive production to other parts of the world that had not signed up to the protocol. As a result it seems the Kyoto Protocol did not reduce emissions and may even have increased them (Aichele, 2011). It seems the risk of flooding through climate change is inevitable.

2. Method

This paper takes a case study approach to seeking ways of adapting to extreme weather conditions, in this case floods. It begins by looking at western methods of flood control and in particular the Netherlands and the UK and then compares these with case studies from Asia. It uses the comparisons to return to the European examples to see how adaptation to flooding might be achieved in different ways.

* Corresponding author. E-mail address: shenuka.desylva@vuw.ac.nz

3. European flood control

In his account of the great Mississippi flood Garcilaso de la Vega, a member of Hernando de Soto's 1543 Spanish expedition observed how the Indians had built their homes on high ground in response to the 14 year annual flood and when this was not an option the raised hand-built mounds on which they took refuge (Barry, 1998). This practice was later adopted by early settlers along the Mississippi and is one which has found relevance in the 21st century Dutch project 'Room for the River' where giant 20 acre mounds 7-8m high known as 'safe islands' were constructed to relocate displaced farms as the old flood plains were reclaimed to accommodate the flooding of the Rhine. Estimated at a cost of 2.3 billion euro the 'Room for the River' project not only displaced communities but also destroyed ecosystems and natural environments through its extensive excavation, earth moving, dyke relocation and building of 'safe islands'. The Dutch have long recognised that if you want to keep water out you build dykes to protect the land but they have also come to recognise that when these fail the damage can be catastrophic. To reduce future disaster incidents the Dutch are now focused on widening and lowering flood plains so as to make room for more water when rivers flood (Rijkswaterstaat, n.d.). This solution is akin to the traditional flooding of water meadows, or irrigated grass pasture, that has been a feature of southern England since 1600 AD (Cook *et al.*, 2015) where rural areas are flooded to prevent the water reaching populated urban areas.

Alongside costly engineering solutions as those used in the Dutch 'Room for the River' project the sea wall has been used for centuries to protect human settlement from coastal erosion. Modern examples of such an approach are the Thames Barrier in London, built as a result of east coast and Thames estuary floods in 1953 (Met Office, 2017) and the Oosterscheldekering storm surge barrier in Rotterdam (Fagan, 2013, p.219). While modern sea walls are one way to avoid the effects of sea level rise not every community wants such barriers or can afford them although they also want to avoid flooding. In addition in recent years forced relocation has become a popular passive flood prevention strategy amongst governments of both developed and developing countries. Seen as both a disaster mitigation and environmental reclamation strategy the Austrian government in 2016 offered the small community of 154 homes in Eferdinger Becken, Upper Austria which sits in the floodplains of the Danube 80% of their property values if they agreed to relocate. The balance 20% was allocated for the demolition of homes and re-cultivation of the land (EEA, 2017).

The buyout was estimated to cost 325 million Euros. While eighty homeowners accepted the offer and were relocated to a designated site claimed from forest and semi natural areas within the region those who stayed, mostly the elderly, were restricted to living in the upper levels of their homes (EEA, 2017). The negative consequences of forced relocation on the health, social and economic wellbeing of both the dispossessed and host communities is also widely known as is that of abandoning disaster prone sites and infrastructure (Cernea, 2000; Ferris, 2011; Oliver-Smith, 2009, 2010). The complexity of relocation and the inadequacy of government processes for successful resettlement of communities is a key reason for this and are evidenced by the numerous efforts of the UNISDR and the World Bank and their extensive policies on disaster and poverty risk reduction, resettlement and resilience building. However the inevitable outcome of more climate change related flood events is that relocation may seem like the easy option.

The situations highlighted above demonstrate the increasing awareness of the inadequacy of traditional European and westernised practices of controlling flood waters and the need for sustainable long term solutions. However the environmental implications of such largescale engineering feats and relocation endeavours and their social and economic consequences need greater consideration of ecological and sustainable solutions. Such solutions may occur alongside cheaper mitigation strategies at the small scale, such as the installation of concrete walls and rubber sealed flood gates in houses along the banks of the River Ouse in York, UK (Dhonau *et al.*, 2017) and bolting down manhole covers. In addition domestic scale solutions for adapting to flooding have been devised at a domestic level and involve not storing valuables or having expensive furnishings at low levels likely to flood (Osberghaus, 2015). The case studies discussed later in this paper show a similar behavioural approach to flood mitigation in traditional communities who live with floods.

4. Alternative responses to natural hazards

The two Pacific and Asian case studies show how communities in Niue and Cambodia have adjusted to live with periodic environmental hazards. Living with floods is not ideal but is possible when weather related hazards such as cyclones and excessive rain cannot be avoided. These communities, especially in the case of Cambodia, have come to rely on the periodic floods for their livelihoods. It is the attitude to floods and to natural hazards that is of particular interest for this paper.

4.1. *Case studies*

4.1.1. *Niuean response to natural hazards*

Extreme weather events such as cyclones and consequent tsunamis have had a devastating impact on Niue for generations significantly undermining its economy and socio-cultural fabric (Barker, 2000). Factors like westernised and climatically inappropriate building materials, methods and practices, and poor planning have contributed to aggravating the devastating effects of natural hazards. The demoralising outcomes of ongoing damage to lives, property, public infrastructure, and livelihood sources have driven Niueans to find safety and security in emigration to New Zealand (Barker, 2000). This has contributed to Niue's economic decline as well as its population decline. Cyclone Heta in 2004, which destroyed Aliluki located to the south of the island's capital Alofi, caused an exodus of Niueans to New Zealand (Barnett, 2012) and disrupted the gradual stabilisation of population numbers Nuie had begun to experience.

What has become evident from the studies that have been carried out since Cyclone Heta and the tsunami that resulted was that Alofi, the more modern and built-up capital of the island and Aliluki where the islands hospital, museum, hotel, library and apartment complex was located, had originally been established by early missionaries on a highly exposed coastal stretch of land. This was in stark contrast to the locals who possessed an intimate understanding of the island and its weather conditions and had settled themselves in naturally protected areas surrounded by trees. For generations they also maintained an architectural tradition of low buildings. Following Cyclone Heta these communities experienced much less damage. This situation demonstrates the seriousness of not planning and building and utlising materials, methods and practices suited to the local conditions. Some Niuean elders interviewed in relation to the research project that informs this study have indicated a lost tradition of stone buildings with walls over a metre thick that were capable of withstanding the forces of natural hazards. These they believe were demolished early in the 20th century following the occupation of the island by missionaries who feared their collapse in cyclones. The buildings that have replaced the simpler traditional thatched domestic scale architectures of Niue are made of imported materials such as concrete and sheet iron, neither of which is suited to the tropical heat or the hazardous conditions of the island (Barker, 2000). The buildings damaged by Cyclone Heta in Aliluki were constructed using imported materials. Houses built with the same materials in local villages are now abandoned or damaged beyond repair. Elders of the community have also revealed that the loss of lives in disaster situations has traditionally been low as people follow traditional safety practices by taking refuge in caves and amongst the large above ground root networks of well-established banyan trees, locally known as the 'Ovava' tree.

While traditional responses demonstrate the ability of the local people to use their own skills and knowledge to adapt to extreme conditions, continuing to take refuge in trees is perhaps not a feasible solution long-term and the decision to abandon the places where they live is likely to happen more with the increasing frequency and intensity of natural hazards. Urgent action is therefore needed to increase the resilience of the built environment and communities to the growing effects of climate change and, at the same time, cater for local aspirations for modernisation. Solutions to these issues can be found in traditional practices if one chooses not to dismiss them as primitive but instead to investigate them closely. To the Nuiean people the structural integrity of an architecture informed by the lifesaving Ovava tree and constructed using light weight tensile materials that can be grown, harvested and treated locally such as bamboo, combined with traditional cladding materials like woven coconut palm fronds and lashing techniques, may provide the sustainable and resilient solutions they need. Such a biophilic design approach may resonate well with the local communities, reduce importation of more costly building materials and bring multiple benefits, including increased livelihood opportunities.

4.1.2. *Responses of the Tonle Sap communities to annual flooding*

The traditional communities of the Tonle Sap in Cambodia have devised unique ways of occupying an unstable environment through considered adaptation and have as a result benefited from the hydrological and ecological fluctuations of their natural environment. To live on Southeast Asia's largest wetland, which expands and contracts annually from a lake of 2600sq.km to one of 15000sq.km with its water levels rising from a dry season low of 1.5m to a wet season high of 9m (Arias, 2014) is no easy task. This situation has forced the communities residing on the Tonle Sap to be tenacious and resilient. Having recognised the invaluable benefits of the reversal flow of the Meekong, the annual flood pulse, and the rich food sources it produces, people have settled around the Tonle Sap in two types of architecture, floating and elevated (Evans, 2004; Grundy-Warr, 2016). This is an architecture that has found harmony with its natural environmental conditions through processes of adaptation over time. The floating architecture in the form of house and shop boats and ancillary

structures on rafts rises vertically with the waters and moves horizontally as the water body expands and contracts (Evans, 2004; Grundy-Warr, 2016).

The elevated architecture in the form of stilt houses located 6-9m above ground level sits beyond the gallery forests and along the Tonle Sap's feeder rivers and waterways (Au Morris, 2014). A wide central spine road emerges during the dry season and enables each elevated home to be accessed via tall ladders, stairs and multi-purpose platforms. It becomes a central spine of activity used for commuting, transportation, gathering, trade and even drying fish. As the waters of the lake rise and boats replace modes of land transportation, ground level functions gradually move upwards and the elevated platforms and rafts begin to serve as access points to homes, fish drying and production platforms, shops, markets and social gathering and recreational space (Au Morris, 2014). At the height of the flood when the entire Lake region is transformed into a water world and communities are completely isolated from land, boats and rafts are adapted for all types of use, and life around the Tonle Sap Lake continues without disruption (Au Morris, 2014). Children as young as 3-4 years fearlessly row themselves to school or play dates, and old ladies row their way around the community socialising with neighbours as they trade or do their grocery shopping. The flood to these communities is a norm, respected and appreciated for the benefits it brings to the environment and themselves.

Timber, bamboo, palm thatch and other vernacular materials are utilised for construction of stilt houses and ancillary structures, including aquaculture pens under floating homes and sheltered pens built on rafts for livestock. These architectures have been developed and located on their watery sites to withstand both the fluctuations of the lake waters, and environmental conditions including winds and tropical storms (Au Morris, 2014; Evans, 2004; Grundy-Warr, 2016). In recent times these communities have come under threat from extensive dam building activities on the upper precincts of the Meekong, capitalist enterprises around the Tonle Sap, and ill-informed modernisation practices and polluting activities (Dugan, 2010, Kummu, 2008). However, as the effects of climate change becomes more pronounced globally and the shortcomings of conventional static living environments and modern infrastructure become apparent, the Tonle Sap's traditional amphibious and dynamic communities, along with their architectures and attitudes to the natural environment, offer potential solutions for future housing and community developments in coastal, riverine and low lying areas prone to flood.

5. Concluding discussion

The first thing the two case studies show is that communities have learned through adaptive techniques to deal with environmental hazards. The first case study shows the significance of environmental awareness and planning accordingly, and the second case study shows that we can live with regular flooding and natural hazards if prepared for this. The attitude of the Tonle Sap communities runs counter to the westernised attitude to floods as something to avoid, whether through engineering works or by deeming land prone to flooding as unsuitable for human habitation. Berman (2010), reflecting on westernised attitudes to water and land following the disastrous outcomes of Hurricane Katrina, concluded "we have come to realize that our highly orchestrated, static levee flood control systems, intent on constraining and neutralizing the environmental fluctuation impacting our cities, have also been partially responsible for unintentionally amplifying urban and ecological risks." The vernacular examples show how it is possible to adjust living to cope with fluctuating conditions. These traditional or vernacular infrastructure solutions and non-westernised attitudes to occupying an environment are proving to be far more effective and sustainable, and as Oliver (1992) and Schilderman, (2011) have pointed out dismissing them as primitive or temporary could be detrimental to our future wellbeing. Their attitude to dealing with natural hazards is to a great extent aligned with the ecological resilience rather than the engineering resilience approach to the built environment rather (Garcia and Vale, 2017). The vernacular examples of Niue and Tonle Sap have the characteristics of ecological resilience as ways have been found of adapting to changes in weather events and to water levels, while still retaining the identity of the communities. The Tonle Sap communities assume it is possible to return to the same state as previously after an event like a major flood. The ecological approach sees the system change adapt to the event without having to shift to a new state. This is increasingly important as it becomes obvious that modern infrastructure developments, including widespread urbanisation and inappropriate construction methods, are together now making the largest contribution to the disastrous outcomes of unusual weather events (Berman, 2010; Oliver-Smith, 2009 & 2010). Given climate change is leading to more severe weather events and more flooding it is now urgent that developed societies devise more fluid geographical approaches to living with water, a situation that will become more common place than the familiar static systems and controls of the engineering resilience approach.

Key findings of the paper demonstrate that adaptation and learning to live with flooding rather than avoidance or control is the future. Past attempts to control flooding have proved to be costly failures and recent large scale engineering endeavours that often emulate historic practices provide short term respite at huge environmental costs. Vernacular communities in Cambodia living on the flood plains of the Tonle Sap have developed a resilience to the extensive flooding that occurs annually and provides valuable lessons for European communities, planners and policy makers. At the same time traditional knowledge enabled the tiny island nation of Nuie established on a coral atoll to cope with extreme weather events for generations prior to western influences. The resilience of these poor communities and the sustainability of the vernacular systems they have devised is a direct outcome of their attitudes to natural hazards and is admirable not only for the ecological sensitivity of their strategies but also for the creativity they offer if we take the time to investigate their potential for future solutions.

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Multicriteria risk assessment-based evacuation management

Dario Masucci [a,*], Cosimo Palazzo [a], Stefano Panzieri [a]

[a] University of Roma Tre, Italy

Abstract

Modern society is exposed both to natural and artificial disasters related to human activity. Those same disasters can have a great impact on citizens, private and public assets. Unfortunately, as a matter of fact, it is only after losing several lives because of human errors and plans that turned out to be ineffective, that society has realized the need to improve emergency procedures introducing new solutions and instruments. Nowadays, scientific community is greatly interested in Emergency Management, and it has started to exploit the new Computer and Automation technologies involved into the Smart Cities ecosystems. The authors define some guidelines in order to design an effective Decision Support System by identifying potential emergency scenarios, including regulations referred both to the human behaviour and to the safety standards on infrastructure. Thanks to a Dynamic Risk Assessment, such a DSS can process heterogeneous data and carry out an active support for the building's evacuation procedures. The proposed architecture consists of a hybrid approach based on techniques and models of operational research and management engineering. Through this strategy, the authors implement a smart decision-making system able to provide the optimal evacuation routes from a building after the catastrophic event onset.

Keywords: Emergency Management; Smart Cities; Decision Support System; Risk Assessment; Buildings Resilience.

1. Introduction

The exodus of people threatened by any critical event, such as a fire, is acknowledged as being key because it is aimed at ensuring the safety of people. The emergency evacuation process is very complex. Actually, being an activity conditioned by many factors it requires a thorough study: in addition to traditional factors, such as exodus routes and building's characteristics, also people psychological conditions have to be taken into account. One of the causes that can generate panic is the incorrect preparation of a system that guarantees an adequate way of escape for the occupants. The results could be helpful in developing tools to support the building evacuation management issues. Though each situation is different there are some common aspects to all types of emergencies that involve the building evacuation. In fact, in several occasions, experience has highlighted that the onset of unsustainable critical conditions can strongly influence the occupant's exodus. The fundamental parameters that characterize a critical situation are temperature and heat excess, evacuation routes visibility, presence of smoke, carbon monoxide and dioxide concentration. In particular, the presence of smoke affects visibility and orientation, and it makes more difficult to reach the safety exits. Low visibility must be added to the light dispersion due to smoke and the toxic effect that the components of combustion produce on the human body. For these reasons, all occupants must be able to behave properly wherever an emergency occurs.

The authors aim at defining and developing an innovative decision-supporting system able to process the heterogeneous available data and evaluate the decision-maker preferences, typically the emergency Manager. The tool operates in buildings evacuation procedures and compartments' isolation to isolate the emergency. The resolution strategy consists of two main phases: a) the preliminary phase, "*offline*", defines the building model and all the possible evacuation paths; b) the operational phase, "*online*", gives - in pseudo real time - the operational suggestions, according to the detected emergencies and their development. DSS elaborates an automated response that could speed up the evacuation process and assist Civil Protection reaction immediately after the catastrophic event onset. The pursued objectives are mainly: a) People Protection and evacuation; b) Assets and equipment protection; c) Critical event confinement.

* Corresponding author. E-mail address: dario.masucci@uniroma3.it

2. Related works

LV, Y., et al. (2013) propose an approach for Emergency Evacuation Management (EEM) based on Risk Analysis, highlighting the importance of understanding the nature of risks involved. An interval parameter joint-probabilistic integer programming (IJIP) was used to generate a range of decision alternatives, scheduling the evacuation routes generating optimal evacuation schemes. There are several methods which deal with coefficients expressed as probability distribution, such as:

- Stochastic integer programming (SIP) – M. Branda (2012);
- Fuzzy integer programming (FIP) [3] – Tan Qian, et al. (2011);
- Interval integer programming (IIP) [4] – C.Z. Wu. Et al. (2010).

Although the authors appreciate and identify the potential of a probabilistic-based approach, they also know limits and difficulties in implementing such techniques in complex and changeable scenarios. In fact, one of the most critical aspects is to provide a valuable Risk Assessment (RA) able to cope with the intricate patterns of the real world.

Yu, Jia, et al. (2018) elaborate an approach identifiable as a simulation-based decision-making strategy, representing a complex and dynamic system, such as smart building scenarios. They propose a well-defined framework using the Multi-criteria evaluation Analytic Hierarchy Process (AHP) method. Whilst AHP is a powerful technique, it is difficult to implement it in a dynamic Real-Time information system.

Mei Yanlan and Xie Kefan (2018) present a model able to select emergency evacuation strategy, in an underground station, with an approach based on triangular intuitionistic fuzzy number (TIFN) and then sort the different strategies using The Elimination Et Choice Translation Reality (ELECTRE) method. Although, the authors agree with the use of ELECTRE method, TIFN could jeopardize the final results due to possible human decision-makers interaction where linguistic variables are transformed into triangular intuitionistic fuzzy numbers.

3. Integrated decision making

Decision Support System (DSS) usually consists of a computer system that, starting from a huge amount of data, provides useful information to increase the analysis effectiveness in a short time. It should not be considered only as a computer application, but also as a business intelligence system able to guide and support decision-making in all its aspects. The proposed solution is composed by an intelligent decision-making system that provides the optimal evacuation routes from any building sector. Reacting to the onset of abnormal behaviour in a building, such a system proceeds to mitigate the emergency controlling fire-fighting automatic devices. It is based on a Real-Time system able to take heterogeneous data and normalize them. Thanks to a continuously updated data system a Dynamic Risk Assessment (DRA) is provided. Such DRA is automatically calculated through an agent-based simulation capable of reproducing the 'domino effect' due to modelled dependencies and interdependencies. The output consists of a valuable amount of punctual risk metrics that represent a 'possible' near future critical scenario. Subsequently, an Expert System ELECTRE-based ranks the optimal emergency paths from each sector to emergency exits. In particular:

- ***CISIApro Engine*** is a hybrid validation tool that performs data fusion, collecting information from different SCADA systems and from additional data sources. With CISIApro it is possible to understand the consequences of negative events, such as failures, natural disasters or cyber-attacks. This module is crucial to the risk prediction as an assessment of the anomalous events propagation and the potential damage that could affect critical infrastructures.
- ***Expert System***, based on optimization algorithms and multi-criteria methods, provides evacuation routes from every building sector, according to the emergencies onset and their expected development. The Expert System uses data provided by CISIApro and it processes an optimum response to face the particular emergency scenario.

The authors define an efficient decision-making tool, adaptable to many situations and able to provide strategic information. In the developed DSS six decision-making phases can be distinguished:

1. Building model design;
2. All possible evacuation paths definition;

3. Emergency localization, recognition and dimensioning;
4. Event risk propagation;
5. Sectors integrity analysis;
6. Evacuation paths identification.

3.1.Expert System – Minimum path

Minimal path search problem has been addressed using graph-based representation. Given a not-oriented graph $G = (V, E)$, at each arc $e = (u, v) \in E$ is associated a weight $p_{u,v} \in \mathscr{R}$. For each oriented path it is possible to define the weight $p(P)$ of path p as the sum of the arcs' weights belonging to P:

$$p(P) = \sum_{(u,v)\in P} p_{u,v}$$

The problem can be expressed as follow:

Given two nodes $u \in V$ and $v \in V$, the problem is to find an oriented path $P^*(u, v)$ in G from u to v that has minimum weight. Dijkstra algorithm allows to solve the minimum path problem between two nodes in case all the arcs weights are not negative. The authors chose this algorithm because it achieves a better computational complexity than many other analysed strategies. Thanks to this approach they calculate all the possible evacuation routes from every office.

3.2.CISIApro – Dynamic Risk Assessment

Typically, the Risk Assessment (RA) is associated to a cumbersome process that starts from a complex Risk Analysis passing through the involvement of 'domain' experts. Most of the time, such a process provides static tools unable to cope with the real needs in specific critical situations. This is precisely why the authors adopt a dynamic risk-based approach. This technique has been used and validated in several European Projects. According to C.Palazzo (2018), implementing a Dynamic Risk Assessment (DRA) means having a real-time agent-based simulation able to assess the risk due to *'possible'* cascading effects. With CISIApro software, authors model the *building* case study and introduce Risk Metrics according to fire propagation in an indoor environment.

3.3.Expert System – Multi-criteria decision method

ELECTRE family methods implement the Pareto optimum concept as a decision-making rule and create ordered alternatives according to different criteria. They identify the ***optimal Pareto*** alternatives that are *not dominated* by others. Such algorithm selects the most efficient *compromise* using the *preference* information provided by the decision maker. The second version of these methodologies, ELECTRE II, introduces four threshold values to increase the level of information and make more informed choices.

Some correspondences must be considered. The alternatives represent the evacuation routes and they are enhanced by the criteria suggested by the *decisor*.

Criteria identification realizes a mush up between:

- *Real information* obtainable through an environmental monitoring system;
- *Plausible information* concerning the event propagation, in the near future, prepared by risk predictor.

4. Algorithm description

Planned stages to be applied are described above.

4.1.Preliminary Stage 1

Referring to the building planimetry, a non-oriented and connected graph is generated. Edges represent sectors and arcs give the *'possibility'* of moving from one sector to another. Dijkstra algorithm is applied to obtain the minimum paths from source nodes to reach end nodes. The evacuation routes are defined in accordance with the Emergency Management Plan developed for the specific building.

Input: E set of building sectors, and graph $G(S,\ T,\ P,\ A)$:

- $S \subset E$ set of offices;
- $T \subset E$ set of corridors;
- $P \subset E$ set of exits
- A set of arcs according to the building planimetry.

Output: Evacuation paths and sectors that compose them.

Procedure: Dijkstra algorithm is applied to graph $G(S, T, P, A)$ to identify the optimal path from each office, in terms of distance.

4.2.Preliminary Stage 2

Each path is considered as a sectors sequence characterized by some fundamental parameters such as integrity. Similarly, evacuation paths can be valued by aggregating information about parameters from each sector that belongs to the path.

Input: building planimetry and data acquired from field.

Output:

- *Fire propagation index* in sector;
- *Fire Risk index* characterised by sector's position and isolation.

Procedure: Round table is made. Close collaboration with experts allows to define a plausible indoor behaviour of fire.

4.3.On-Line Stage 1

DSS proceeds to identify the alarm level in each sector, comparing the event intensity level with predetermined values called *event status threshold values*, defined in accordance with the Civil Protection states of activation. Magnitude valorisation is obtained by CISIApro. Each alarm level corresponds to an intervention standard. Countermeasures, fire doors closing and fire-fighting water devices opening, are activated.

Input:

- s building sectors
- $event\_value_i$ = fire rate of sector i (i = 1,…, s)
- threshold values: attention, warning, alarm, emergency
- Available fire-fighting actuations.

Output: Alarms type and level for each sector involved, fire-fighting countermeasures to implement.

Procedure: $event\_value_i$ is compared to threshold values to define the sector state. Procedure is repeated for each sector.

4.4.On-Line Stage 2

CISIApro engine, defined as *Hybrid Evaluation Tool*, gets information of data systems, normalize them and dynamically produces a risk assessment. Thanks to its features, CISIApro estimates the *impact* according to *'triggered entities'* (fire or gas sensors) and possible *Risk Exposure* due to modelled interdependencies.

Input:

- s building sector
- Fire sensor data;
- Fire door state;

Output: Dynamic Risk Evaluation over the building.

Procedure: Using a particular propagation rule that considers complex cascading effects, CISIApro defines the *Operational Level* of an entity. It represents the entity ability to produce defined level of resources depending on the availability of received resources, on the propagation of faults and on the functionality of the entity itself.

Using specific inverse proportionality relationships with the operational level, CISIApro evaluates the *Risk Impact* and *Risk Exposure Indexes* for each *triggered* entity.

4.5.On-Line Stage 3

DSS defines sector integrity as the weighted sum of measures derived from the Risk Predictor:

$$i_{int} = 0{,}5 \bullet fire\_event\_value + 0{,}5 \bullet fire\_risk\_value$$

Index of each sector is compared with the event threshold values to determine the integrity level. Each level corresponds to an emergency evacuation standard.

Input:

- s building sectors
- i_{int_i} = sector's structural integrity ($i = 1,\ldots, s$)
- threshold values: attention, warning, alarm, emergency
- Evacuation Standard.

Output: Each sector integrity and its sorting according to decreasing indexes.

Procedure: DSS establishes the sector structural integrity to identify all sectors' state. After that, sectors are ordered by decreasing integrity index to facilitate the evacuation starting from most compromised sectors.

4.6.On-Line Stage 4

DSS identifies the best exodus routes from each sector. The aim is to minimize the time required to complete evacuation operations, using routes that have a *lower risk index*. The sectors belonging to the chosen route increase their crowd index according to the number of people expected. The algorithm defines an alternative/ criteria matrix, whose elements represent the alternatives' enhancement based on each criterion.

Input:

- s' sectors to evacuate $\subset s$ building sectors
- p alternatives (evacuation paths)
- c criteria valued for each path:
  - *Lighting* (maximize);
  - CO_2 *concentration* (minimize);
  - *Smoke presence* (minimize);
  - *Occupants number* (minimize);
  - *Fire Rate Index* (minimize);
  - *Fire Risk Index* (minimize);
  - *Monitorability* (minimize)
  - *Distance* (minimize);
- Threshold values: weak/strong concordance and discordance

Output: Optimal evacuation paths, from occupied sector.

Procedure: following the sectors order, according to increasing values of i_{int_i}, algorithm considers each occupied source sector and applies the ELECTRE II algorithm. The first classified alternative will be suggested.

An innovative aspect of proposed architecture concerns the capability of auto-generating all the values needed to fill the Alternatives/Criteria matrixes required by ELECTRE II. Following this approach, it is possible to speed up the entire process, leading computational time below the second.

5. Reference scenario, results and conclusion

The authors simulate a case study very similar to reality considering a single floor of a company where work offices, rendezvous points, emergency exits and corridors are located. However, thanks to its flexibility, this approach can be easily extended to different infrastructures, hospitals and malls.

5.1.Reference scenario

Figure 1: Floor planimetry

The faced scenario considers building offices involved in a seismic event that causes structural damages to *E5* and fire in *R2* due to a short-circuit in the electrical panel (Figure 1).

Sectors are characterized by different measures:

Table 1: Considered measures.

Measures	Description
[redacted]	Maximum expected crowding
[redacted]	Lighting value
[redacted]	Fire smoke presence
[redacted]	Toxic substances concentration
[redacted]	Fire Propagation Risk Index (event risk)
[redacted]	Fire Status Index (event rate)
[redacted]	Sector Monitorability

The correspondence between alarm level and possible countermeasures is outlined in the table below:

Table 2: State/Countermeasures.

Sector state	Countermeasures
[redacted]	No actions
[redacted]	Light signals with LED
[redacted]	Light signals with LED and acoustic signalling via siren
[redacted]	As previous, plus fire doors automatic closure, if present
[redacted]	As previous, plus firefighting devices activation

5.2.Results

Authors show the results obtained by applying the elaborated strategy on the scenario. In order to highlight the framework behaviour, simulation considers three occupied rooms O6, O9, and O14.

Offline stage

Starting from the floor planimetry (Figure 1), the authors implement a coherent model (Figure 2) and generate graph G(S,T,P,A) (Figure 3).

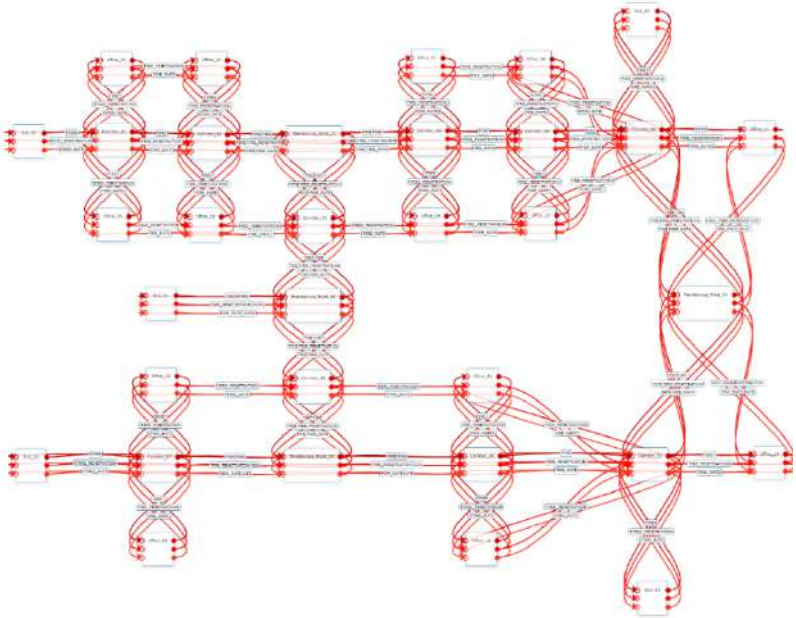
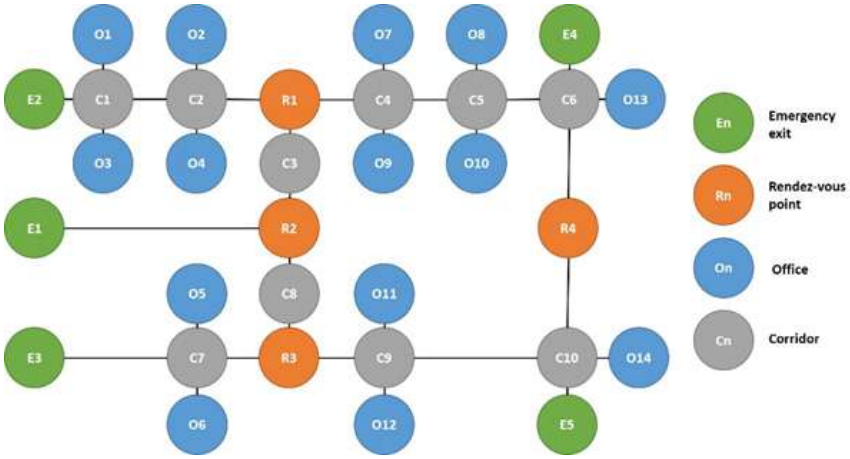


Figure 2: CISIApro model

Figure 3: G graph

A variation of the Dijkstra algorithm is applied and the following paths are obtained:

Table 3: evacuation routes.



Path	O6	O9	O14
1.	O6, C7, EE3	O9, C4, RP1, C2, C1, EE2	O14, C10, EE5
2.	O6, C7, RP3, C8, RP2, EE1	O9, C4, RP1, C3, RP2, EE1	O14, C10, C9, RP3, C7, EE3
3.	O6, C7, RP3, C8, RP2, C3, RP1, C2, C1, EE2	O9, C4, RP1, C3, RP2, C8, RP3, C7, EE3	O14, C10, C9, RP3, C8, RP2, EE1
4.	O6, C7, RP3, C8, RP2, C3, RP1, C4, C5, C6, EE4	O9, C4, RP1, C3, RP2, C8, RP3, C9, C10, EE5	O14, C10, C9, RP3, C8, RP2, C3, RP1, C2, C1, EE2
5.	O6, C7, RP3, C8, RP2, C3, RP1, C4, C5, C6, RP4, C10, EE5	O9, C4, RP1, C3, RP2, C8, RP3, C9, C10, RP4, C6, EE4	O14, C10, C9, RP3, C8, RP2, C3, RP1, C4, C5, C6, EE4
6.	O6, C7, RP3, C9, C10, EE5	O9, C4, C5, C6, EE4	O14, C10, R4, C6, EE4
7.	O6, C7, RP3, C9, C10, RP4, C6, EE4	O9, C4, C5, C6, RP4, C10, EE5	O14, C10, R4, C6, C5, C4, RP1, C2, C1, EE2
8.	O6, C7, RP3, C9, C10, RP4, C6, C5, C4, RP1, C2, C1, EE2	O9, C4, C5, C6, RP4, C10, C9, RP3, C7, EE3	O14, C10, R4, C6, C5, C4, RP1, C3, RP2, EE1
9.	O6, C7, RP3, C9, C10, RP4, C6, C5, C4, RP1, C3, RP2, EE1	O9, C4, C5, C6, RP4, C10, C9, RP3, C8, RP2, EE1	O14, C10, R4, C6, C5, C4, RP1, C3, RP2, C8, RP3, C7, EE3

Emergency localization

After a first evaluation of the Risk Predictor, all sectors are affected by the event. Table 4 shows the status and countermeasures to be applied.

Table 4: countermeasures suggested.

State	Sector	Countermeasure
Attention	E2	Light signals with LED
Warning	O6, O14, C1, C2, C4, C5, C6, C7, C9, C10, R4, E3	Light signals with LED and acoustic signalling via siren
Emergency	O9, R1, R3	As previous, plus fire doors automatic closure, if present

Risk propagation

Risk Predictor simulates fire propagation, this time considering the mitigation due to the countermeasures: Fire doors isolate fire and automatic water devices decrease fire magnitude.

At the end of this phase, the Expert System acquires all the information necessary to process its answer, Table 5.

Table 5: criteria valorisation.

Sector	Lumen	CO^2	Smoke	Overcrowding	Fire Rate	Fire Risk	Integrity	Monitorability
O1	400	700	NO	0	0,33 | **0,33**	0,33 | **0,21**	0,27	YES
O2	400	700	NO	0	0,41 | **0,41**	0,41 | **0,26**	0,54	YES
O3	400	700	NO	0	0,51 | **0,51**	0,33 | **0,21**	0,36	YES
O4	400	700	NO	0	0,64 | **0,64**	0,41 | **0,40**	0,52	YES
O5	400	700	NO	0	0,64 | **0,64**	0,41 | **0,40**	0,52	YES
O6	600	1000	NO	**3**	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
O7	400	700	NO	0	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
O8	400	700	NO	0	0,33 | **0,33**	0,33 | **0,21**	0,27	YES
O9	600	850	NO	**2**	0,64 | **0,64**	0,41 | **0,40**	0,52	YES
O10	400	700	NO	0	0,51 | **0,51**	0,33 | **0,21**	0,36	YES
O11	400	700	NO	0	0,64 | **0,64**	0,41 | **0,40**	0,52	YES
O12	400	700	NO	0	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
O13	400	700	NO	0	0,33 | **0,33**	0,26 | **0,17**	0,25	YES
O14	700	1200	NO	**10**	0,41 | **0,41**	0,33 | **0,21**	0,31	YES
C1	350	2500	NO	0	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
C2	350	2500	NO	0	0,51 | **0,51**	0,51 | **0,32**	0,41	YES
C3	150	4500	**YES**	0	0,80 | **0,70**	0,80 | **0,70**	0,7	YES
C4	350	2500	NO	0	0,51 | **0,51**	0,51 | **0,32**	0,41	YES
C5	350	2500	NO	0	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
C6	400	1500	NO	0	0,41 | **0,41**	0,33 | **0,21**	0,31	YES
C7	350	2500	NO	0	0,51 | **0,51**	0,51 | **0,32**	0,41	YES
C8	150	4500	**YES**	0	0,80 | **0,70**	0,80 | **0,70**	0,7	YES
C9	350	2500	NO	0	0,51 | **0,51**	0,51 | **0,32**	0,41	YES
C10	400	1500	NO	0	0,51 | **0,51**	0,41 | **0,26**	0,38	YES
R1	200	4000	**YES**	0	0,64 | **0,64**	0,64 | **0,40**	0,52	YES
R2	100	5000	**YES**	0	1 | **0,90**	1 | **0,90**	0,9	YES
R3	200	4000	**YES**	0	0,64 | **0,64**	0,64 | **0,40**	0,52	YES
R4	400	700	NO	0	0,41 | **0,41**	0,33 | **0,21**	0,31	YES
E1	400	700	NO	0	0,80 | **0,70**	0,80 | **0,70**	0,7	YES
E2	400	700	NO	0	0,33 | **0,33**	0,33 | **0,21**	0,27	YES
E3	400	700	NO	0 | 3 *(step 2)*	0,41 | **0,41**	0,41 | **0,26**	0,33	YES
E4	400	700	NO	0 | 2 *(step 1)*	0,33 | **0,33**	0,26 | **0,17**	0,25	YES
E5	100	700	NO	0	0,41 | **0,41**	0,33 | **0,21**	0,31	**NO**

Integrity analysis

Integrity index of each sector is calculated to determine the evacuation urgency.

Table 6: evacuation order.

Sector	[redacted]	Evacuation order
O6	0,33	2
O9	0,52	1
O14	0,31	3

Exodus routes identification

Each evacuation route is valued considering its sector composition according to the different criteria. The weight array expresses decision maker's preferences, $w = \{0.25,\ 0.25,\ 0.25,\ 0.25,\ 1, 0.25,\ 1, 1\}$.

The results of O9 and O6 sectors are omitted, as trivial, while results related to sector O14 are shown being more interesting.

- The path from O9 sector to the emergency exit E2 is shorter but also riskier. It crosses R1, close to sectors in alarm, and it has closed fire doors that slowdown the evacuation. The optimal route suggested is n°6 to E4.
- The closest and safest exit from the O6 room is E3. So, evacuation route suggested is n°1.
- For the O14 sector the alternative/criterion matrix is

Table 7: O14 A/C matrix.

	C1	C2	C3	C4	C5	C6	C7	C8
A1	400	1133	0	10	0,44	0,22	0	7,5
A2	400	1133	0	10	0,44	0,22	0	7,5
A3	328	2771	3	10	0,62	0,50	1	19,5
A4	304	2990	5	10	0,57	0,42	1	29
A5	312	2867	5	12	0,55	0,40	1	34
A6	460	1120	0	12	0,41	0,21	1	20,5
A7	390	1960	1	10	0,45	0,27	1	29
A8	345	2410	3	10	0,56	0,42	1	30,5
A9	319	2700	5	13	0,55	0,40	1	40

The closest exit to the O14 is E5 but it is condemned. The second exit considered is E3, but it is riskier, and it crosses R3, close to sectors in alarm. It has fire doors closed, and it is also used by the three people from O6. Instead, the E4 exit is longer by a few meters, but less risky and crowded. For these reasons the evacuation route is n°6 to E4.

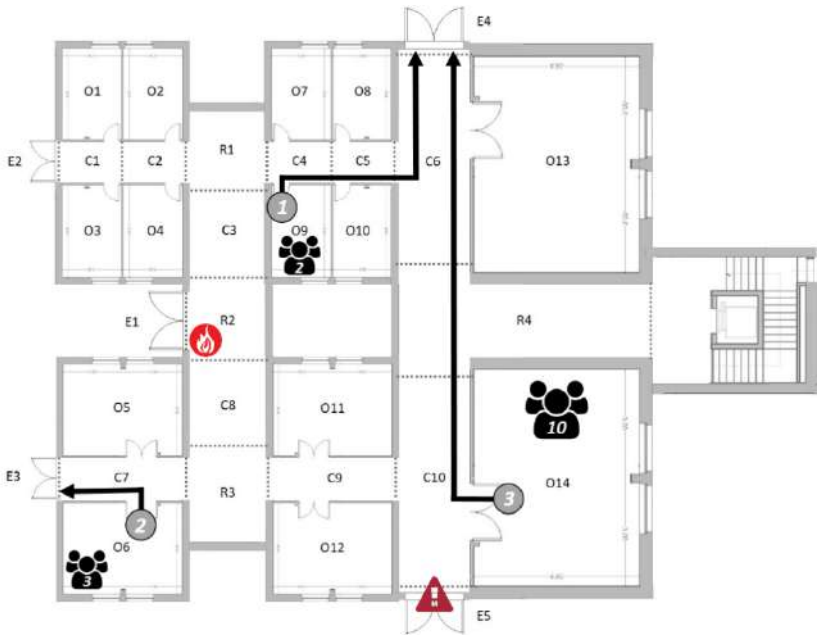


Figure 4: Emergency evacuation plan

5.3.Conclusions

During an emergency evacuation from a building, choosing the safest exodus way is an example of a decision that must be taken as soon as possible. Uncertainties or wrong decisions can cause confusion and panic among the occupants, a situation that can easily result in rescue delays and, in the worst case, in loss of human lives.

The Evacuation Management strategy proposed by the authors consists of interaction between two main modules, the Risk Predictor and the Expert System, capable of collecting, integrating and processing data from heterogeneous sources, i.e. sensors and decision maker opinions.

The main objective is to manage a fire onset in a building and to intervene punctually, in particular:

- Identify, localize and indicate flames presence;
- Implement the correct countermeasures to isolate fire and attenuate its intensity;
- Provide optimal evacuation routes.

The information shall also be made available to Civil Protection to better manage their resources during the operation. The case study foresees the simultaneous presence of a fire and a structural failure that made two of the five emergency exits unusable. As expected, the DSS's response activates countermeasures in the areas affected by the event and suggests the safest exodus routes. Over this case study, a framework has been tested on a wide range of multi-emergence scenarios, always producing excellent results, both in terms of computational time during processing, and in terms of suggested countermeasures effectiveness. Thanks to its modularity and scalability, the DSS can be easily customized for any indoor reality, such as hospitals, offices, universities, etc. Connecting the DSS to a supervision and control system active on a real building would be useful for refining the instrument and evaluating its goodness even in a real and complex situation. Given the topic's importance, the authors are currently engaged in the development of an autonomous decision support system able to manage the process with the minimum intervention by the operator. The framework can be improved by defining and introducing more detailed assessments of fire physics and flame propagation in an indoor environment. In addition, expanding the management process to a multi-floor evacuation would increase the completeness of the DSS. However, at present, it creates a good compromise between a huge amount of acquired heterogeneous data and the computational time used to reach the solution.

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Comparative study of infrastructure resilience policies and practices for bay areas

Yifan Zhang [a], Thomas Shiu Tong Ng [a,*], Frank Jun Xu [a]

[a] Department of Civil Engineering, University of Hong Kong, China

Abstract

Infrastructures provide a large number of fundamental and necessary systems, facilities and services that underpin the prosperity, and balanced development of our society. Recent studies have defined the concept of infrastructure resilience as the ability of an infrastructure system to cope with, resist, absorb, recover from or adapt to disruptions. The four well-known bay areas in the world – San Francisco, New York, Tokyo and Guangdong-Hong Kong-Macau bay areas – have already implemented a variety of policies and practices respectively to improve regional infrastructure resilience. This paper aims to compare different policies and practices in order to identify the gaps and common grounds between the Guangdong-Hong Kong-Macau Greater Bay Area and the others. Comparative case studies are conducted to obtain a holistic understanding on the infrastructure resilience policies and strategies various bay areas have adopted. First, the concepts of regional infrastructure resilience and city cluster, as well as the basic information of the four bay areas are summarised and introduced. Then, infrastructure resilience policies and implemented measures are reviewed to examine how common hazards facing these bay areas are tackled and how they would influence infrastructure systems. Finally, common grounds, and gaps of infrastructure resilience among the four bay areas are discussed.

Keywords: regional infrastructure resilience; bay areas; city cluster; comparative case study; infrastructure systems

1. Introduction

Infrastructures as fundamental and essential facilities and services have been supporting sustainable and balanced development in both developing and developed countries. However, recent studies have shown that infrastructure systems in most cities worldwide are becoming much more vulnerable to climate change and potential hazards. Many cities are directly exposed to various natural or man-made hazards, such as flooding, sea level rise and earthquakes. Recent examples include Hurricane Katrina in 2005, Hurricane Sandy in 2012, Typhoon Haiyan in 2014, and Typhoon Hato in 2017 (Pielke et al., 2008; Xian et al., 2015; Hatzikyriakou et al., 2015; Mori et al., 2014). In late 2015, extreme typhoon adversely affected the greater Tokyo Bay Area. Under these circumstances, how to improve the resilience of infrastructure systems and maintain their adaptability to climate and disaster risks becomes vital for balanced urbanisation and regional planning worldwide.

Research has shown that infrastructure systems in coastal cities of both developed and developing countries have experienced frequent coastal risks. These coastal cities with low-lying shorelines are susceptible to flooding, sea level rise, active earthquake faults, and socio-economic inequities (BARC, 2017). The coastal metropolitan areas, counties, cities and towns, which are connected by complex and interdependent transportation network around the shorelines make up a bay area (Dabson et al., 2012). There are four well-known bay areas: the San Francisco Bay Area, New York Metropolitan Area, Greater Tokyo Area and Guangdong-Hong Kong-Macau (G-H-M) Greater Bay Area (hereinafter referred to as the G-H-M Greater Bay Area).

It is interesting to conduct a comparative case studies on the bay areas' resilience policies and practices. First, they are integrated business and economic hubs of three largest economies (e.g. USA, Japan and China) worldwide, however, with completely different governmental policies and political systems. Second, all the four bay areas have high-density cities around and dense population within the boundaries. Third, they are technological centres of their own countries. Fourth, the infrastructure systems within each of the bay areas are interdependent and interconnected, which boost communication and cooperation among the city clusters located in the areas. Hence, it is important to strengthen the regional infrastructure resilience in order to better prepare for challenges, including both the increasing impact of climate change and existing hazards.

* Corresponding author. E-mail address: tstng@hku.hk

This article first presents the profiles of the four bay areas. Case studies are then conducted to analyse the common hazards they are facing, as well as the common grounds and gaps of their infrastructure resilience policies and practices. It is envisaged that the results of the case studies can assist other bay areas or coastal city clusters to build more resilient future.

2. Profiles of regional infrastructure resilience in the four bay areas

World-class bay areas such as the San Francisco Bay Area, New York Metropolitan Area, Greater Tokyo Area, and G-H-M Greater Bay Area have open economic structures, efficient resource allocation capabilities and strong communication networks. Therefore, they have played a central role in leading innovation and promoting new paths for global development and technological change.

2.1. San Francisco Bay Area

San Francisco Bay, which lies in the Northern California, is the economic, cultural, and technological centre of the United States. It has approximately 7.1 million inhabitants. As the backbone of the bay area, the region's infrastructure system is highly susceptible and vulnerable to flooding, sea level rise, and earthquakes. Referring to the indicated extreme values analysis, the "100-year" flood height can reach 3.1 feet above local mean higher high water (MHHW). In records dating from 1976 to 2016, it reached 3.05 feet MHHW in 1983. Due to the infrastructure interdependency, disruptions to one section of bridge, road, trail or pipeline may cause secondary and cascading impacts on other modes of infrastructure system (BARC, 2017). Additionally, it is expected that there is a 76 percent possibility that the San Francisco Bay will experience a 7.0 magnitude earthquake in the next 30 years, which is similar to the 1989 Loma Prieta earthquake or the 1906 San Francisco earthquake (Bristow et al., 2010). The infrastructure system will be most at risk and hence substantially impact the whole region.

2.2.New York Metropolitan Bay

New York Metropolitan Bay lies on the east coast of the United States, which is the nation's busiest and top inter-junction for international flights and passenger and air freight flights. Suffering from increased sea level rise, heat waves, flash flooding and storms, there is a risk at people's residence, infrastructure, socioeconomic, and ecological resources.

According to the record, since 1815, there are almost 15 hurricanes striking NYC coastal area, causing considerable damage and economic losses (Su, 2016). In the meantime, sea level rise is projected to increase the likelihood, intensity, frequency and duration of coastal flooding. The 1/100 year flooding is likely to occur approximately four times as often in 2080, while the 1/500 year flooding may occur once a 200 years. The flood height will increase to 9.4 feet and 11.5 feet for the 1/100 and 1/500 flood zones in 2080 respectively (Horton et al., 2010). All the coastal infrastructure systems are only inches above current sea level, which are susceptible and vulnerable to flooding and sea level rise.

2.3.Greater Tokyo Area

Greater Tokyo Area, located in the southern region of Japan and covers 36,700 kilometre square meters, is the business and transportation centre in Japan. It is made up of Tokyo and the other three cities including Saitama, Kanagawa, and Chiba as well as home to around 26 percent of Japan's total population (The World Bank, 2009). As a highly concentrated population and assets centre, hazards like earthquakes, tsunamis, flooding and sea level rise have very high impact on the people and the region.

Given that earthquakes are a fact of daily life in Japan, they have invested a lot in earthquake mitigation plan and owned a series of mature prevention measures. A 9.1 magnitude earthquake took place 231 miles northeast of Tokyo at a depth of 15.2 miles causing a tsunami with 30-foot waves (The World Bank, 2009). It damaged most critical infrastructure system including several nuclear reactors located about 40 miles of Sendai and caused nearly 20,000 deaths. During the boost economic growth time, the extraction of large amounts of groundwater makes the whole region below the average sea level. In the meantime, storms and typhoons will cause severe flooding as well.

2.4.G-H-M Greater Bay Area

G-H-M Greater Bay Area, as a new developing world-class city cluster across the Guangdong, Hong Kong and Macau regions is made up of 11 cities including Hong Kong, Macau, Guangzhou, Shenzhen, Foshan, Dongguan, Zhuhai, Zhongshan, Jiangmen, Huizhou and Zhaoqing. Although there are not enough technological hubs and the draw of Wall Street, the region already has complimentary attributes that make the bay area successful and play a leading role worldwide. Last year, the overall GDP of all the 11 cities had already reached USD1.4 trillion, making up 12 percent of the whole nation. It is expected to lead an important role in advanced business, finance, trade, shipping and technology hub worldwide.

Guangdong Province, along the southern coastal China in the Pearl River Delta, as well as Hong Kong and Macau, are highly exposed to different kinds of typhoons, flooding, sea-level rise, and tropical cyclones (Sim et al., 2017). As the Hong Kong-Zhuhai-Macau Bridge is in operation, the connection among the 11 cities become much closer and tighter. Therefore, enhancing regional infrastructure resilience among the region has to be fallen in practice and requires corresponding implementation and policies.

3. Methodology and case studies

3.1.Methodology

Case study research provides better exploration and understanding of complicated issues especially through past studies. Through case studies both the process and outcome of a phenomenon can be better explained through complete observation, reconstruction and analysis of the cases under investigation by collecting both quantitative and qualitative data (Tellis, 1997). Four comparative case studies are conducted in this research on the general and hazard-specific policies and practices of the four global bay areas to enhance regional infrastructure resilience.

3.2.San Francisco Bay Area's regional infrastructure resilience plan

Coordinated work has been done to help the bay enhance regional infrastructure resilience and better prepare for the upcoming hazards through the cooperation of Bay Area Regional Collaborative (BARC), Association of Bay Area Governments (ABAG), San Francisco Bay Conservation and Development Commission (BCDC), and the newly consolidated Metropolitan Transportation Commission (MTC). These six major actions (BARC, 2017) mainly focus on: (i) developing a completed regional policy for climate change; (ii) providing much stronger policy leadership on improving infrastructure resilience; (iii) increasing funding sources for resilience and adaption; (iv) establishing a resilience team to tackle technical problems; (v) expand natural infrastructure network; and (vi) devising the Regional Advance Mitigation Program (RAMP).

USD303 billions of regional transportation investment has been made by expected revenues from federal, state, regional and local sources over the next 24 years. This investment focusing on operating, maintaining, and modernising the existing transportation system, and debt service and cost contingency reaches approximately 90 percent of Plan Bay Area 2040. In the meanwhile, to better improve regional resilience, BCDC and ABAG have co-worked on developing current Priority Development Areas (PDAs) and Priority Conservation Areas (PCAs). Caltrans and the Bay Area Toll Authority have allocated USD1.2 million to conduct a regional vulnerability assessment and a regional framework for transportation infrastructure, PDAs, PCAs, and vulnerable communities.

Accompanied by governmental policies and strategies, there are several a diversity of practices taken that mainly focus on transportation, housing and community, and natural shorelines which are shown in Table 1.

Transportation Infrastructure
• Invest in transportation network development
• Develop alternate routes and modes
• Operate, maintain, modernize, and expand existing transportation network
• Evaluation of hazards before infrastructure resilience planning
• "Hot spot" analyses to identify the most susceptible and vulnerable routes and nodes
• Increase the capacity of tidal weeks and channels crossed by the transportation network
• Raise the elevation of the permanent structures or below average sea level stations
• Install temporary barriers or waterproof enclosures to protect ground level or under ground level stations.
Housing and Population

Table 1: Practices taken by governments

proof foundations
ting System and residents' engagement sponse Team), Engagement in the Canal eparing for hazards
ures along the shoreline including tidal and
and mitigation plans

3.3.New York Metropolitan Bay's recommendations to improve infrastructure resilience

To make the NYC coastal area more resilient to hazards flooding, storms, and sea level rise, the National Flood Insurance Program (NFIP) coordinated by the Federal Emergency Management Agency (FEMA), NYC Department of City Planning enforce an integrated flood management plan to improve the regional infrastructure resilience.

The New York State Government Recommendations to Improve the Resilience of the Empire State's Infrastructure (2013) most focuses on regional coastal resilience and response to the recent, unprecedented, extreme weather events experienced by New York State and the bay region around. In order to deal with flooding problems, the tri-state government planned to develop a resilient plan for region wide hard and soft infrastructure, insurance, facilities, transportation infrastructure, parks, and coastal building protection. For example, New York City Government has invested nearly USD20 billion in the development of resilience plan, which consists of 250 initiatives. Accompanied by FEMA, the updated Flooding Maps are released within the 100-year and 500-year inundation lines and flood zones. These maps will help make people aware of the flood risks and therefore better prepare for response, risk communication and resilience planning strategies. In the meanwhile, the American Association of State Highway and Transportation Officials (AASHTO) and the American Society of Civil Engineers (ASCE) have updated the standards to face against natural events. Policies and strategies are concluded in Table 2.

Table 2: Practices taken by governments

Transportation Infrastructure
• Undertake a comprehensive risk assessment or inventory to develop a risk assessment framework • Priority classification for lifeline facilities when facing various extreme events to help transportation agencies identify the transportation investments • Improve and expand existing transportation networks to enhance redundancy • Relocation of selected power lines underground • Installation of storm surge barriers and reverse flow-tide gates, and pump houses above flood levels • Expand the region's transportation network to connect New York. New Jersey, and Connecticut • Make investments in new transportation systems that could provide multiple travel modes in case of individual systems breakdown • Building a new commuter tunnel under the Hudson River in New Jersey as well as a second bus terminal in Manhattan connecting NYC • Invest in extension of PATH and the Hudson-Bergen Light Rail and improve its carrying capacity
Energy
• Tri-State Energy Policy Task Force bring all the public officials, utility executives, generators, and other stakeholders plan to make the grid flexible, efficient, and resilient • Create intelligent "two-way" grid to replace traditional "one-way" network to generate power directly and more cost effectively • Adopt variable billing rates to make consumers to reduce energy use by changing behavior patterns in peak periods • Measure the energy use of each large building and make the data open to public to encourage property owners to invest in retrofits
Population and Insurance
• Use government-owned land to construct more affordable houses for all income levels; • Proactive strategy for monitoring hazards like Proactive Rental Inspection (PRI) in at-risk housings; • Launch the New York Works Task Force in May, 2012 to increase the economy, creating jobs, and enhancing life quality; • Develop insurance program to try to fully prevent the damage caused by extreme events.

3.4. Greater Tokyo Area's disaster reduction policies and practices

Considering the current situation, a series of steps are implemented to prevent flooding problems. The Ministry of Land, Infrastructure and Transportation (MLIT), and the Tokyo city government have invested billions of dollars into hazards preparation, response, recovery, and mitigation plan.

The Status of Disaster Management Measures in Japan has involved the implemented policies initiatives and strategies with a particular focus. Japan particularly focuses on the three points in DRR policies: (i) investment in DRR from the long-term perspective; (ii) build back better; and (iii) collaboration between the central governments and various actors.

Adopted by the cabinet on 3rd June 2014, the Fundamental Plan for National Resilience emphasises on addressing national resilience issues. Different from San Francisco Bay Area's resilience policy, the Fundamental Plan for Regional Resilience is regarded as a compliance to make local governments formulate their own resilience plan, which will be supported by relevant government ministries and agencies.

As earthquakes and flooding frequently happen to Greater Tokyo Area, evacuation sites and shelters are necessary for people to face the dangers of the imminent disasters. Table 3 has illustrated some of the resilience practices and strategies implemented by the government.

Table 3: Practices taken by governments

Transportation Infrastructure
• Reinforce transit route from Kanagawa and Chiba including regional rail lines • Enhancement of roads, highways, and trail lines as well as the promotion of research • Alternate routes for the vital districts is being promoted for ensuring interconnection among different transport modes • Cooperation between managers and private sectors needs to be improved
Flood Control
• Kanda River underground reservoir built in 2008 to prevent flooding and to be extended to Tokyo Bay • Metropolitan Area Outer Underground Discharge Channel located in the bay area has been fully used to drained floodwater to much safer and larger river • Build and effectively utilize dams through increase dam height to increase pondage • Construct storm-water tanks for housing, infiltration facilities and reservoirs for flood control
Energy
• Enhance response capacity of vital energy system through TMG climate change mitigation strategy • Strengthening local nuclear Disaster Risk Reduction (DDR) had been implemented by Nuclear Regulation in 2014 to reduce vulnerability to nuclear disasters • Cooperate with Trade and Industry, the Ministry of Economy will try to diversify supply sources concerning energy infrastructure and distribution networks
Population and Housing
• In 2013, the Disaster Countermeasures Basic Act was partially revised to ensure the full access to appropriate facilities where people can resident, stipulations were added to create designed evacuation system • Safety measures to prevent people from earthquakes are taken for high-rise buildings • Conduct reinforcement work for some routes and facilities like electricity, pipeline, gas, and water supply system • Practices for stranded people including investigating help and support from using public transports are taken under cooperation between transport government and institutions

Although the Metropolitan Area Outer Underground Discharge Channel is the world's largest underground flood prevention facility, for the time being it may not be able to prevent people living in Tokyo from flooding. The example of this huge infrastructure project implies that enhancing resilience is not a one-dimensional thing but requires multi-dimensional collaboration and time-being improvement.

3.5.G-H-M Greater Bay Area's resilience initiatives

Considering the important role Hong Kong plays, a series of initiative plans implemented by Hong Kong Observatory (HKO), Civil Engineering and Development Department (CEDD), Home Affairs Department (HAD) for increasing infrastructure resilience have been implemented by the government. For example, the UNISDR and the Hong Kong Polytechnic University have established a *Disaster Risk Reduction Collaboration Program* between February 2015 and March 2016 (Sim et al., 2017).

Hong Kong as a major regional transport and logistics hub in the Greater Bay Area has implemented a variety of resilience policies and strategies. Smart City Blueprint for Hong Kong released in December 2017 has made short, medium, and long-term recommendations focusing on six areas, namely: "smart government", "smart mobility", "smart living", "smart people", "smart economy", and "smart environment". Hong Kong owns and implements a critical infrastructure strategy to improve its critical infrastructure systems, utilities, and services, as well as establishes *The Critical Infrastructure Security Coordination Centre* (CISCC) in order to reduce critical infrastructure vulnerability to disruptions. Moreover, infrastructure resilience practices and measures taken in Hong Kong are shown in Table 4.

Table 4: Practices taken by Hong Kong governments

Transportation Infrastructure
• Transport Department (TD) implements the Intelligent Transport Systems e.g. "Hong Kong eTransport"
• Expand rail routes, options, and services to build up a more resilient transportation network system to accommodate sudden disruptions
• Supported by ICT system, to better send real-time message including traffic flow and traffic condition when facing extreme events
• Various risk assessment have been conducted on MTR to maintain safety under extreme weather conditions
• New design standards have been applied for new railway extension including prevention from rainstorm events with likelihood of occurrence: 1:200 years
Water System
• The Drainage Services Department (DSD) launched "Drainage Mater Plan" (DMP) covering all the flood prone areas to improve flood control
• Strom surge warning message will be sent from HKO to DSD and HAD when the sea level are forecast to reach the limited levels
• Real-time water level sensors are installed at the Happy Valley Underground Stormwater Storage Scheme to help water control
• The Water Supplies Department (WSD) implements the proposed seawater desalination plant in Tseung Kwan O to meet per day fresh water demand
• Artificial flood-lake is designed by CEDD to function as a flood attenuation facility for stormwater temporary storage
Energy
• Develop more renewable energy and enhance efforts in promoting energy saving;
• Adopt demand-side management strategies to better reduce the whole demand and meet the remaining demand;
• Encourage and promote energy efficient infrastructure.
Population and Housing
• Building resilience can be enhanced through certain building components as well as the comfort of residents;
• Develop flood pumping schemes to prevent buildings located on rural floodplains and below sea level to minimize excavation works in densely populated urban areas;
• DSD, HKO, and HAD have established a new mechanism to mitigate the adverse flooding impact on local residents;
• Strengthen the cooperation and collaboration among inhabitants, governments, and non-government organizations;
• Buildings along the shorelines and coastal areas should be especially designed to face extreme hazards like flooding and sea level rise.

As the Guangdong-Hong Kong-Macau Bridge is in operation, the relationship among the eleven cities become much close than before. Because of the interdependency and interconnection among regional infrastructure, enhancing infrastructure resilience in Guangdong Province become vital for people's lives.

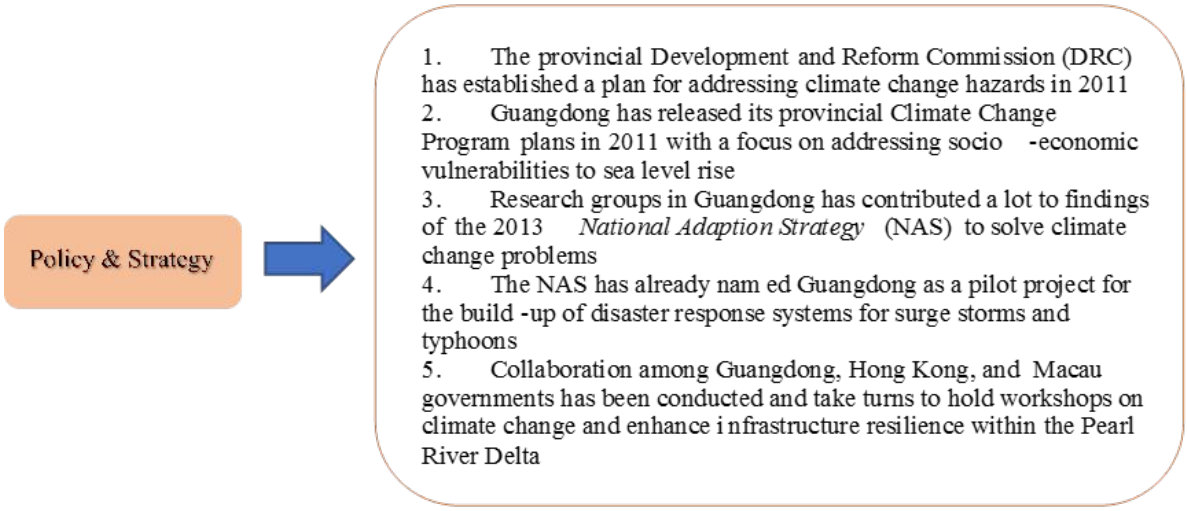

Figure 1: Guangdong province's resilience policy and strategy

4. Findings

The following preliminary results can be drawn from the comparative case studies of the four bay areas' regional infrastructure resilience policies, initiatives and practices:

- Enhancing the resilience of the transportation infrastructures is the focus of all the four bay areas' resilience policies and practices;
- Flooding is the top hazard the bay areas are striving to tackle as they all have vulnerable shorelines;
- Frequent earthquakes are also the common hazards that the New York Metropolitan Bay, G-H-M Greater Bay Area, San Francisco Bay Area and Greater Tokyo Area have been suffering from, and they have put forwarded a series of plans to reduce infrastructures' vulnerability to earthquakes;
- Unlike the two bay areas in the United States, Greater Tokyo Area's Fundamental Plan for Regional Resilience is regarded as a compliance to make local governments formulate their own policies;
- To better deal with nuclear challenges, governments in Greater Tokyo Area have implemented local nuclear DDR plan;
- Although the two American bay areas' resilience plans are more professional and mature than the ones of Asian countries, the practices implementation are still not ideal enough.

5. Conclusions

Regional infrastructure resilience, as a new and concerned topic worldwide has received more attention than before. There still lacks a unified definition and understanding. In the meanwhile, academic research is still needed on how to apply the resilience theory properly to routine practices of infrastructure asset operation and management.

By using case study as an analysis tool, the present paper compares regional infrastructure resilience policies and strategies implemented by the four bay areas to investigate differences and common grounds. The preliminary results reveal that there is still a lack of on-the-ground resilience management practices and resilience performance measures. As a newly founded bay area, the G-H-M Greater Bay Area where the cross-border infrastructures are becoming closer, more interconnected and interdependent than before still lacks a comprehensive resilience plan to enhance regional infrastructure resilience.

The future work would mainly include but is not limited to developing a framework for assessing the regional infrastructure resilience within the G-H-M Greater Bay Area considering city clusters, a study on the state-of-the-art review of computational tools and software for evaluating regional infrastructure resilience, the evaluation of infrastructure network resilience and interdependency, and developing a unified framework to improve the regional infrastructure resilience within bay areas.

Acknowledgements

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Risk-sensitive land-use planning for resilient urban building infrastructure: a study in Dhaka City

Abdul Latif Helaly [a,*], Humayun Kabir [b], Muhammad Ferdaus [c]

[a] Bangladesh Urban Resilience Project (RAJUK), Bangladesh
[b] University of Dhaka, Bangladesh
[c] BRAC University, Bangladesh

Abstract

Dhaka, the Capital City of Bangladesh, with an area of around 1,500 km^2 currently hosts nearly 18 million people and has experienced unplanned and haphazard development through phenomenal spatial growth in the last few decades. A significant part of the city's building infrastructure is at high risk of various disasters particularly earthquake due to construction activities on wetlands through land-filling. The present study based on primary (site response analysis, SWOC analysis, key informant interviews etc.) and secondary data suggests a risk sensitive land use planning given the potential risks of earthquake such as amplification and liquefaction. Maps concerning earthquake potential and earthquake micro-zonation of Dhaka have been prepared focusing ground response analysis. However, the study identified several factors (e.g. low public interest, lack of political will, deficiencies in management capacity, lack of budgetary allocations for proactive measures, weak link between existing laws governing DRR etc.) as the major barriers for ensuring risk sensitive landuse planning in the study area. The study also reveals that promoting risk sensitive landuse planning is likely to enhance city's infrastructural resilience and knowledge on mirco-zonation map prepared for Dhaka focusing earthquake hazards can effectively be applied in other earthquake vulnerable cities like Sylhet and Chittagong.

Keywords: Risk-sensitive land-use planning, amplification and liquefaction, resilient building infrastructure, Dhaka City

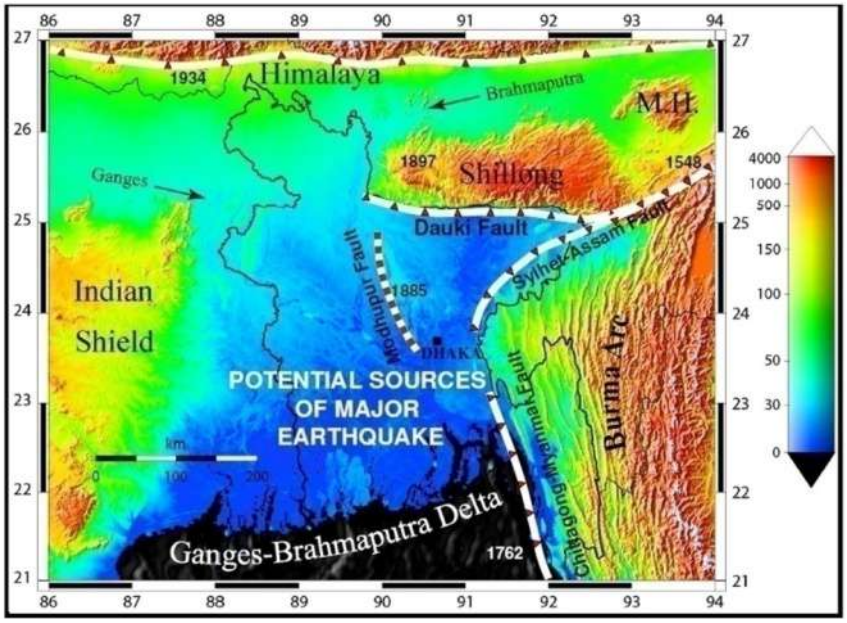
1. Introduction

Bangladesh is home to over 160 million people, with an area of 148000 km^2. Geographically the country is located in the north-eastern part of South Asia. The country experiences a number of natural disasters every year particularly floods, riverbank erosion, cyclone, earthquake, drought etc. Bangladesh, one of the most active deltas on earth in the Ganges-Brahmaputra-Meghna river system is almost entirely formed of recent alluvial and deltaic deposits. Topographically, Bangladesh is mainly composed of low-lying flat land with the exception of slightly elevated Pleistocene uplands in the central and north-western parts and Tertiary hilly terrain in the northeast and southeast parts. Dhaka is situated in the central part of the country on the bank of the Buriganga River and at the southern tip of the Madhupur Tract dating back to the Pleistocene age.

Topographically Dhaka is of low relief with many low depressions (Figure 1). The Pleistocene sediments of Madhupur Tract have been affected by numerous episodes of faulting. Dhaka lies within 50 to 500 km distances from the seismogenic faults and sits on the Burma Arc detachment fault. Dhaka city falls in seismic zone II of the seismic zoning map of Bangladesh (World Bank, 2014b). New parts of Dhaka city are now being built on unconsolidated alluvial sediments augmented by artificial fill. Such foundations are notoriously prone to enhanced shaking and damage during earthquakes. Unconsolidated sediment and artificial soil are prone to liquefaction and ground failure induced by earthquake shaking, as has been amply demonstrated historically during earthquakes in Bangladesh (World Bank, 2014c).

Dhaka with a population of 18 million is particularly vulnerable to earthquake, fire and water logging hazards, while it hosts 0.3 million buildings most of which are constructed without maintaining building compliances (BNBC, 2015). The older part (Dhaka South City Corporation) is mostly unplanned and accommodates buildings constructed by masons. Geographically, Dhaka is located in low-lying floodplain. The land is of only 14 m elevation from the mean sea level. The city is surrounded by a number of rivers and wetlands, most of which are illegally encroached, degraded and filled-up. In order to accommodate the growing number of population, the city is widely being extended to the wetlands. The extensive construction in the

* Corresponding author. E-mail address: helalyrajuk@yahoo.com



wetlands has made city's buildings highly vulnerable. In order to make millions of people safe from all types of natural hazards, the city has to be resilient from the perspectives of infrastructure, social, economic, environment etc. (RAJUK, 1995).

Figure 1: Digital Elevation Model (DEM) of Bangladesh and surroundings showing geological faults – potential sources of major earthquakes in Bangladesh.

The geomorphic units represent the soil conditions or surface geology of Dhaka with minor anthropogenic modifications. The city has been expanding rapidly even in the low-lying geomorphic units through land-filling for urban growth from 1960 (Kamal and Midorikawa, 2004). Classified fills are integrated with the pre-urban geomorphic- soil units as shown in Figure 2. This geo-morphological map also illustrates the urban sprawl on the low-lying geomorphic units until 2002. As surface sedimentary deposits amplify the seismic waves and geo-morphological map units represent the surface geology, these detailed delineated geomorphic units are used to estimate the seismic response of the ground.

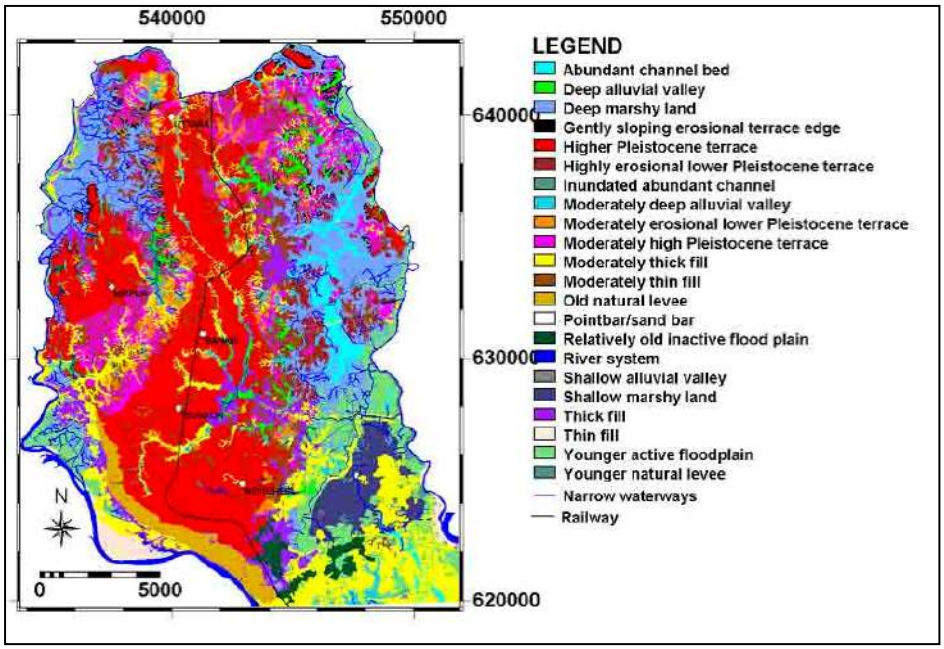


Figure 2: Geo-morphological map of Dhaka city area with the information of fill thickness (RAJUK, 2008)

2. Objectives of the study

The present study was an attempt to assess how risk sensitive landuse planning can be ensured and promoted. However, the study tries to produce potential earthquake hazard map focusing on amplification and liquefaction through ground response analysis of the study Area.

3. Materials and methods

The study is based both on primary and secondary data. Primary data were collected through site response analysis, ground response analysis, key informants interviews, gap analysis etc. The analysis of SWOC-Strengths (existing Dhaka Metropolitan Development Plan, Detail Area Plan, BNBC, building construction rules etc.), Weaknesses (lack of political will, deficiencies in management capacity etc.), Opportunities (availability of rules and regulation, institutions etc.) and Challenges (e.g. lack of implementation of rules and regulations, lack of public awareness etc.) helps to understand how the concerned agencies can be effective in achieving the goals in disaster risk management. In addition, the relevant institutions in Bangladesh have been consulted.

4. Land-use planning and resilient cities

Increasing urbanization resulting in poorly planned settlements is becoming a major driver of disaster risks. Rapid and uncontrolled urbanization is increasing the exposure of populations and infrastructure to potential hazards. Building a city's resilience to disasters should be on top of government's agenda since the loss of life, destruction of property, and disruption of essential services has huge socio-economic, and even political, implications (JICA, 2008; World Bank, 2014a). Development Agencies, Private Sectors and Non-Government Organizations (NGOs) are increasingly aware that there are ways to improve the resilience of populations and cities towards disasters. The UN Office for Disaster Risk Reduction (ISDR) has also released relevant guidelines and policy tools in order to help national and sub-national governments meet the objectives of HFA. One of its main goals is to encourage pro-active risk reduction (JICA, 2008). Behind the goal of shifting from reactive disaster management to pro-active disaster risk management is the overall goal to strengthen the resilience of people, communities, and institutions to disasters. The impact of natural and man-made hazards can be reduced through adequate planning and incorporating specific DRR measures in land use planning and urban development processes, thus minimizing the human, economic and environmental damage. By increasing the resilience of communities, DRR also improves the ability of people and infrastructure to recover from disasters.

5. Risk sensitive land-use planning

Risk-sensitivity integrates two new considerations into the conventional approach to landuse planning (disaster risk reduction parameters). Hazard, vulnerability, risk, and capacity parameters together with disaster/ emergency management requirements are identified, collected, and integrated with traditional landuse planning information (e.g., socioeconomic profiles, demographics, and transport networks), and integration through formal government activities. Measures are taken to ensure understanding, acceptance, and support for the plan; to improve the competency and knowledge about risk-sensitive landuse planning among planners and other professionals; and to raise the awareness and support of all stakeholders (GFFAO and EMI, 2010). Landuse planning involves an interactive and continuous process to regulate the use and development of land, allowing feedback between government planners and other stakeholders. Landuse management provides the regulatory and non-regulatory tools that enable the government to establish its mandate on land use (Earthquakes and Megacities Initiative, 2008). However, the present study emphasizes on earthquake hazard for preparing risk sensitive landuse planning as the detailed area plan of RAJUK (2010-2015) incorporates hazards like flood, fire etc. excluding earthquake. As stated above, Dhaka being located on floodplain is highly vulnerable to earthquake hazards like amplification and liquefaction.

6. Study area

Primarily Dhaka is selected as the study city and specifically *Jhilmil* Residential Project Area of RAJUK has been selected for site investigation and a total of 16 SPT tests have been done (Figure 3). The Project Area of *Jilmil* is located in the south-west of Dhaka, right bank of the Buriganga River and is adjacent to the Dhaka-Maowa Highway at Keraniganj. The study area is purposively selected as one of the authors of the paper has got extensive experience of working in the residential project area as a project director (Helaly, 2008). In addition,

the project being developed through land-filling on wetlands offers advantages of examining other parts of the city in a same manner. Therefore the experiments of the study performed at *Jhilmil* provides clear and practical glimpse of other parts of the city in suggesting risk sensitive landuse planning.

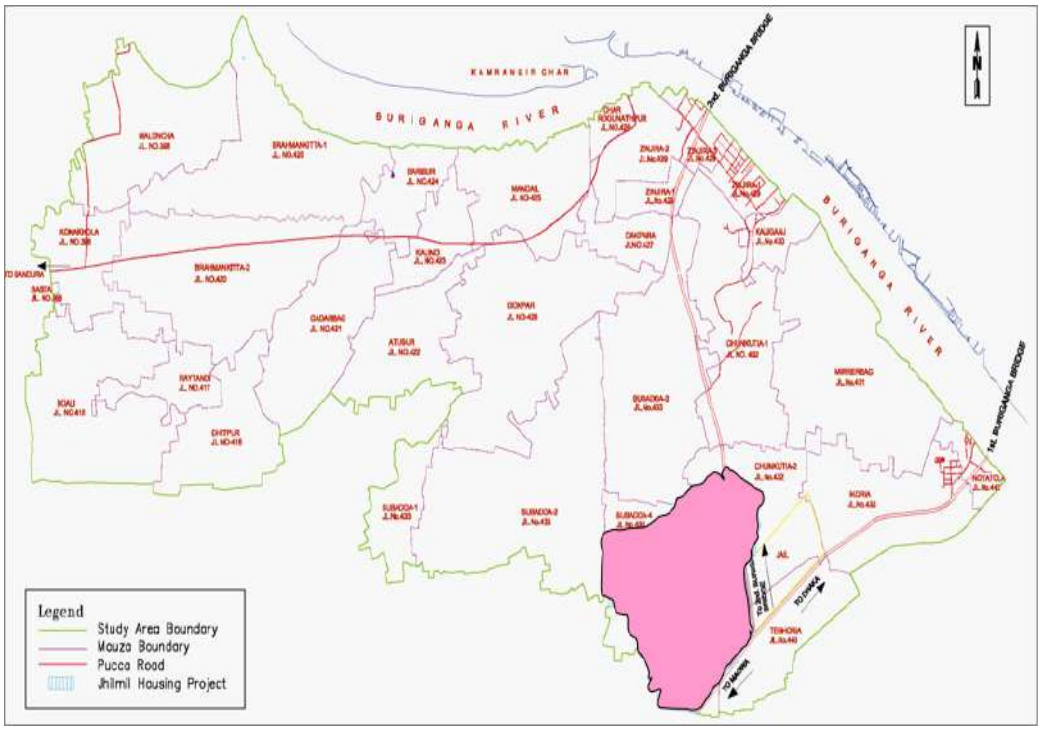


Figure 3: *Jhilmil* residential project area of RAJUK

7. Site amplification

To estimate the effect of an earthquake, it is necessary to assess the expected ground motion characteristics, and the subsequent response of soil and structures to those ground motions. A site amplification phenomenon is dependent on frequency of input motion. The characteristics of earthquake motions are influenced by a number of mechanisms related to the local soil and rock properties. Site amplification is quantified using the following equation, known as the amplification factor (Dowrick, 1996).

8. Site response analysis

During an earthquake, propagation of seismic waves through soil column alters the amplitude, frequency and duration of ground motion by the time it reaches the surface. The effects of ground motion are propagated in the form of waves from one medium to another. The evaluation of such response of the site to dynamic loading is termed as ground response analysis (Hossain, 2015). Site effects can be quantified by empirical correlations between rock outcrop motion and motion at soil sites. Different correlations are used for stiff soils and deep cohesion less soils. Ground response analysis also termed as soil amplification study comprises the calculation of site natural periods, ground motion amplification, evaluation of liquefaction potential, stability analysis etc. The important features that are considered for analysis are characteristics of soil overlying bedrock, bedrock location and inclination, topography of bedrock and soil deposits, faults in the soil deposits. A complete ground response analysis considers source, path and site amplification effects. Damping factors of the soil are difficult to be assessed. Important steps in site specific ground response analysis are dynamic characterization of the site and selection of rock motions. Empirical relationships are useful when large area is considered for response analysis and time is constrained.

9. Empirical relations

Shear wave velocity is a basic engineering tool required to define dynamic properties of soils. In many instances it may be preferable to determine Vs indirectly by common in-situ tests, such as the Standard Penetration Test. Many empirical correlations based on the Standard Penetration Test are broadly classified as regression

techniques shear wave velocity (*Vs*) is a principal geotechnical soil property for site response analysis. The published regression was divided into three groups, namely all soil types, cohesionless soil and cohesive soil.

10. Results of site investigation and discussion

10.1.Site-1

The Site includes only one layer i.e. sand layer. The site SPT N balues and shear wave velocities are shown in Appendix-A which is presented in a tabular form. From the Graph and Figure, it was observed that from soil surface up to 70 ft depth sand layer and SPT N values and Shear Wave Velocities (Vs) increased gradually in accordance with Depth. But after 15 ft depth SPT N values and Vs decreased slightly up to 25 ft. Again SPT N values and Vs increased gradually up to 45 ft and decreased slightly up to 50 ft in accordance with Depth. And finally in accordance with depth SPT N values and Vs increased gradually up to 70 ft.

10.2.Ground response analysis

During earthquake, propagation of seismic waves through soil column alters the amplitude, frequency and duration of ground motion by the time it reaches the surface. The effects of ground motion are propagated in the form of waves from one medium to another. So, physically it is problem of prediction of ground motion characteristics whereas mathematically it is a problem of the wave propagation in continuous medium. The evaluation of such response of the site to dynamic loading is termed as ground response analysis. The shear wave velocity (Vs) is one of the most important input parameter to represent the stiffness of the soil layers. Total ten locations were selected for Site Amplification Analysis in Dhaka city in this research. The shear wave velocity (Vs) was measured in ten selected locations of Dhaka city by using Suspension PS Logging equipment. In Dhaka City the depth of bedrock was unavailable due to lack of deep boreholes. In deep-soil (CDMP, 2009), rock depth was assumed to be below the last layer, so to prevent erroneous results the last layer was assumed to be the same up to a depth of 100m. For site response analysis by equivalent linear method the results are considered to be accurate for estimating PGA up to 3sec for general projects (Bendimerad et al., 2007; World Bank, 2014)).

10.3.Ground response analysis: Site-1

For ground response analysis, site within *Jhilmil* Residential Project of RAJUK was considered. The Standard Penetration Test (SPT) was performed on 5 February 2015. A 70ft borehole was done and test had been performed near 70ft. In order to prepare an earthquake potential map for the study area, maximum response spectra of four big earthquakes have been considered and compared as shown in Figure 4. Among the four earthquakes, Kobe Earthquake produces Maximum (0.1989g) peak spectral acceleration (PSA) for this site and Northridge Earthquake produces Minimum (0.0023g) peak spectral acceleration (PSA). It has been observed that initially ground surface response was less than earthquakes input motion response for site-1.

Maximum Peak Ground Acceleration (PGA): Maximum Peak round Acceleration (PGA) at different depths of four earthquakes for this site-1 is shown in Figure 4. PGA at surface and that at bedrock is obtained from the ground response analysis. The peak ground acceleration values at surface are observed within the range of 0.04678159 (Kocaeli earthquake) to 0.05966434 (Kobe earthquake) and that of the bedrock were observed to vary from 0.14273148 (Imperial Valley earthquake) to 0.18776899 (Northridge earthquake).

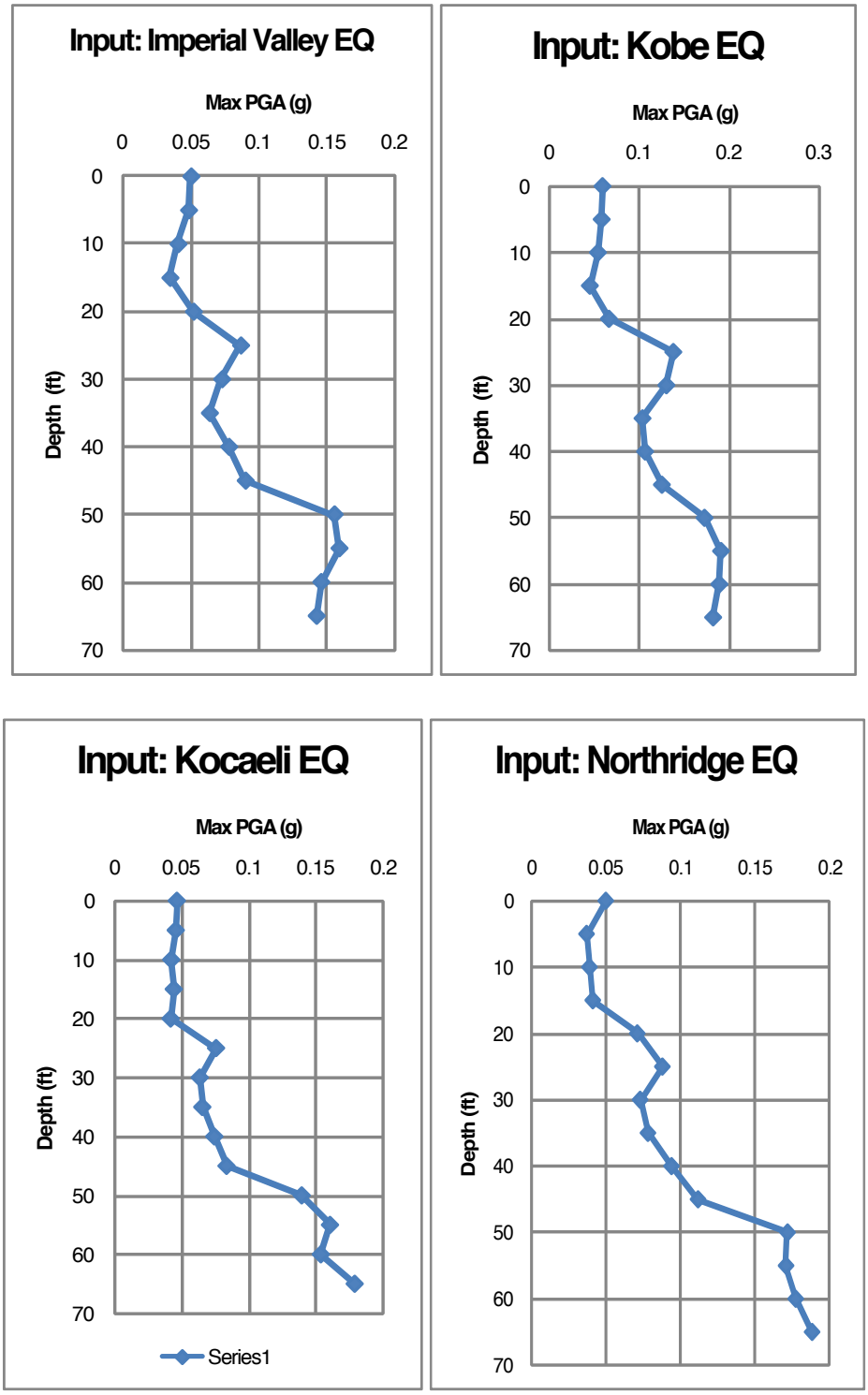


Figure 4: Maximum Peak Ground Acceleration for the Site-1 (EQ refers to earthquake)

Site amplification factors at sub surface layers are often used as one of the parameters for estimation of ground response. The amplification factor is the ratio of peak ground acceleration at surface to that of acceleration at bedrock. The amplification factors are determined as;

- Amplification Factor = PGA recorded at ground surface / PGA recorded at bedrock
- Amplification Factor (Imperial Valley EQ) = 0.35161507
- Amplification Factor (Kobe EQ) = 0.32813608
- Amplification Factor (Kocaeli EQ) = 0.2620055
- Amplification Factor (Northridge EQ) = 0.26719439

Hence, the amplification factors have also been computed and it was identified that similar to the peak ground acceleration values, the variation was within 0.2620055 (Kocaeli EQ) to 0.35161507 (Imperial Valley EQ) (Figure 5 and Figure 6).

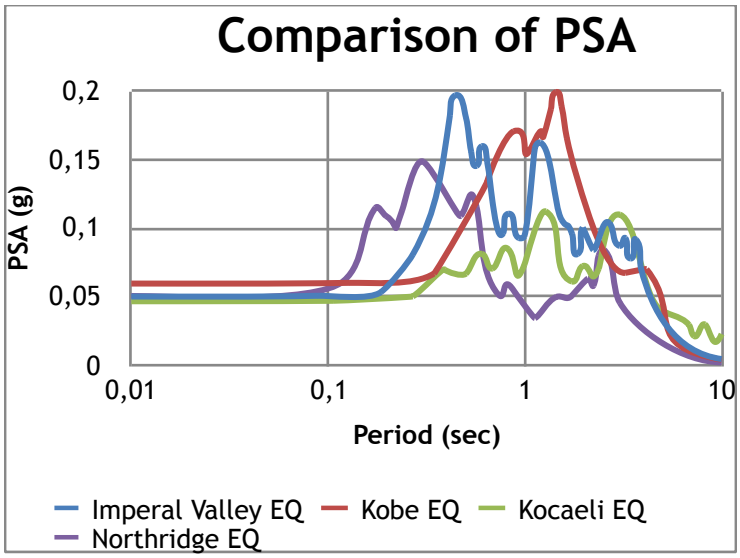


Figure 5: The comparison of PSA for Site-1

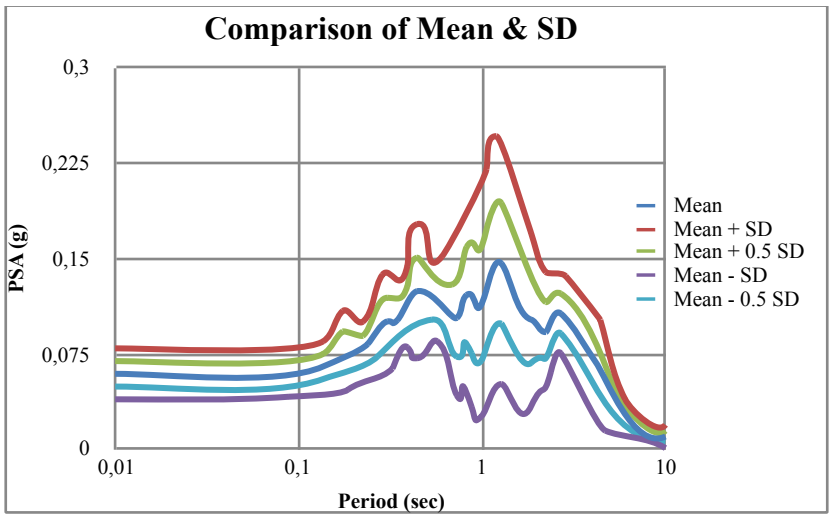


Figure 6: Comparison of mean and standard deviation (SD) for surface PSA for the Site-1

The highest and lowest values of Peak Spectral Acceleration (PSA) at different locations, Maximum PGA of surface soil at different locations and Maximum PGA of Bedrock at different locations are shown in Table 1 shows the Site amplification factors at different locations.

Table 1: Site amplification factor at different locations

Sl. No.	Location	Amplification factors			
		Imperial Valley EQ	Kobe EQ	Kocaeli EQ	Northridge EQ
1	Site-1	0.35161507	0.32813608	0.2620055	0.26719439
2	Site-2	0.26391872	0.30610397	0.18870993	0.1926386
3	Site-3	0.25832711	0.30208408	0.2674039	0.20170746
4	Site-4	0.27663846	0.35447927	0.23943166	0.198785
5	Site-5	0.25773673	0.28423762	0.19760395	0.17073998
6	Site-6	0.23160395	0.28423762	0.18001799	0.16348923
7	Site-7	0.28458195	0.33866059	0.23238876	0.24338813
8	Site-8	0.1944427	0.26516183	0.15392053	0.14256057
9	Site-9	0.37703616	0.33721382	0.29225912	0.28122988
10	Site-10	0.10385862	0.11525005	0.09627401	0.08081789
11	Site-11	0.33395246	0.33403164	0.27462164	0.24770441
12	Site-12	0.25900051	0.26537909	0.23521961	0.15553334
13	Site-13	0.38286735	0.42271234	0.34526044	0.29171216
14	Site-14	0.30533228	0.38853895	0.25508287	0.21698344
15	Site-15	0.41597244	0.43435569	0.32132321	0.25491764
16	Site-16	0.33063125	0.34670223	0.30392908	0.23343522

Source: Helaly, 2015

11. Conclusion and recommendations

Land-use planning is a key pillar of disaster risk reduction and sustainable development. The complexity of landuse planning processes and the broad range of stakeholders involved are recognized as a challenge that should be approached through consultative processes and inclusive participation of all those involved. Access to evidence-based information on historic events will help the projections of future scenarios. Private-Public Partnerships are required to enhance capacity to reduce risk. Furthermore, the public sector, the private sector and the communities need to incorporate disaster risk reduction measures in all their development-related activities and initiatives. Cultural considerations and ancestral knowledge need to be taken into considerations.

The present study recommends the following strategies in order to ensure risk sensitive landuse planning. Preparation of micro-zonation map for Dhaka City by assessing earthquake hazards like amplification and liquefaction are essential part of ensuring risk sensitive landuse. Avoiding Amplification susceptible soils or Building Amplification Resistant Structures need to be ensured. Avoiding liquefaction susceptible soils or Building Liquefaction Resistant Structures need to be constructed. The knowledge on mirco-zonation map prepared for Dhaka City focusing earthquake hazards can effectively be applied in other earthquake vulnerable cities like Sylhet and Chittagong.

In addition, a voluntary seismic retrofitting program for structures, supported by an incentive package and awareness program needs to be initiated. The acquisition of structures/lots for open space should be clustered around structures with very high vulnerability to minimize the number of displaced households. Critical facilities such as schools and health facilities such as hospitals as well as structures which can be used for post-emergency centers should be identified and seismically retrofitted or replaced depending on a benefit cost analysis. Infrastructure and critical lifelines (e.g., water, sanitation, power, communication, etc.) should be upgraded for seismic performance as an integral part of the redevelopment plan. Reactive approaches for handling natural

disasters as being exercised by many Asian nations must be replaced by a more proactive attitude against the risk. Building codes need to be practiced in the design and construction process by engineers.

Public should know that it is an essential task to have the building designs checked by qualified engineers if they are living in an area with recorded earthquake history. Local government authorities need to build special capacity among the technical staff in order to have a proper enforcing and monitoring processes. More stakeholders should get involved in key areas of earthquake risk reduction. Therefore complete risk mitigation is not practical unless authorities consider risk financing measures in larger cities in addition to physical risk reduction measures and policy interventions.

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Resilience, livability, and sustainability in the built environment after the Great East Japan Earthquake

Tamiyo Kondo [a,*]

[a] Kobe University, Japan

Abstract

How could we enhance systems resilience to achieve sustainability and livability in the built environment following mega disasters, by what kind of intervention, and by whom? The author defines post-disaster recovery as a process to regain and achieve livability, sustainability, and resilience; three abilities expected to be rebuilt in the built environment. The research question in this article explores the relationship among these three abilities after the Great East Japan Earthquake. This study uses Geographic Information System (GIS) analysis of census data to identify the transformation of the built environment and a questionnaire survey for homeowners. There are two driving forces of the built environment transformation. These are government-driven recovery projects and individual housing relocation without planning, both of which trigger polarization between people and places that make the built environment unsustainable. Government-driven projects improve robustness but disturb sustainability. Individuals' voluntary relocation represents resilient action, including robustness, rapidity, resourcefulness, and redundancy; however, this negatively impacts sustainability which means a trade-off relationship between with resilience. These results imply that government-driven projects need downsizing, and we have to rethink how to intervene to mobilize peoples' resilience to pursue sustainability and to redefine livability in the process of recovery to minimize trade-offs.

Keywords: Resilience; Relocation; Built environment; Housing reconstruction; the Great East Japan Earthquake

1. Introduction

This study focuses on the transformation of the built environment after a mega disaster. Thus, post-disaster recovery is defined as follows: it is a process to regain and achieve livability, sustainability, and resilience in the built environment. Rebuilding livability after a disaster is about building back people's lives. One of the slogans in disaster risk reduction is "Build back Better" however, this principle should be understood as proposed in the Sendai Framework (2015) ,within a broader approach that considers rebuilding people's lives and people-centered perspectives.

Amararunda and Haigh (2011) explain that it is necessary to understand what constitutes the built environment and the nature of the stakeholders involved in its creation and maintenance. What is essential is an interactive relationship between people and the environment. People's habitation forms the built environment, and this impacts people's living. The objective of built environment studies is to examine the relationship between people and the built environment to find a way to cope with this inconsistency (Mimura, 1998).

The final goal of this study is to answer the question "how could we enhance systems resilience to achieve sustainability and livability in the built environment following mega disasters, by what kind of intervention, and by whom?" In this article, the author sets the following research questions: What kind of relationship does sustainability, livability, and resiliency have, and by what kind of stakeholder involvement in the post-disaster recovery after the Great East Japan Earthquake (GEJE)?

Mega disasters present a constant threat to sustainability which is one of the reasons why the concept of resilience becomes important in disaster reduction and recovery. The following chapters describe the transformation of the built environment following a tsunami. This transformation is evaluated by the analysis of GIS census data (Statics Bureau 2010 and 2015) and an original survey conducted in 2016(Kondo and Karatani 2017). The GEJE brought massive human, physical, and economic loss from a giant tsunami and, simultaneously, nuclear power plants made this a complex disaster. Academics and planners should reconsider new approaches through this experience for the next tsunami in the following context such as disaster reduction countermeasures for repeated tsunamis every 100 to 150 years and recovery planning in depopulated societies. This is entirely different from the period of rapid economic growth that used government-driven urban

* Corresponding author. E-mail address: tamiyok@people.kobe-u.ac.jp

redevelopment projects which have still been used as key drivers of GEJE recovery. This planning approach in growth context need to be readjusted in the context of urban shrinkage.

2. Research framework on resilience in the built environment

Figure 1 shows the proposed research framework for resilience in the built environment which is developed from previous research on resilience, sustainability, livability, and the built environment (Bruneau et al. 2003, Lizarralde et al. 2015a, Bosher 2014, Gough 2015 and Marchese et al. 2018). The following three points could explain the characteristics of this figure.

First, the vertical axis is defined by *f (S: sustainability, L: livability, R: resilience)* "the quality of the built environment including three abilities." It is well-known that Bruneau et al. (2003) explain the role of resilience by visualizing a resilience triangle in a figure of which vertical axis is "infrastructure." As mentioned, recovery could be measured as a process of the built environment's transformation achieving sustainability, livability, and resilience. Bosher (2014) explains that "it is suggested that built-in resilience is a quality of a built environment capability to keep adapting to existing and emergent threats. Therefore, it is postulated that built-in resilience can be a quality, a process, and an end-state goal." The reason why resilience is included in the built environment is because of the interactive relationship characteristics mentioned in the introduction. A built environment is achieved through an active process through stakeholders' efforts, rather than by passively receiving its benefit.

Second, the gray triangle is the "disruption of livability," and the blue triangle is "enhancing sustainability and redefined livability." Livability should be built back in an early stage of recovery. After reducing the size of the gray triangle, the built environment has to pursue "sustainability." Masterson et al. (2014) explain this triangle as an "enhancement" of system capital. Gough (2015) examines the complementarity of livability and sustainability by scale, context, and potential, and explains that the context of livability is dynamic and allows changes over time compared to sustainability, which maintains a consistent vision. Post-disaster recovery for people is explained as an adaptive construction of social reality (Tatsuki et al. 2000). Gough (2015) and Tatsuki et al. (2000) imply that livability patterns for survivors might change in the aftermath or as a consequence of a disaster and should be redefined in post-disaster contexts through adaptation processes.

Third, the three built-in abilities in the built environment are regained and achieved by multi-stakeholders' resilience (4R: robustness, rapidity, resourcefulness/adaptability, and redundancy/flexibility). Marchese et al. (2018) demonstrated three generalized management frameworks for organizing sustainability and resilience which are 1) resilience as a component of sustainability, 2) sustainability as a component of resilience, and 3) resilience and sustainability as separate objectives. This paper assumes 1) as a tentative model for *f (S, L, R)*. Lizarralde et al. (2015a) clarified systems resilience by different scales, such as by 1) multiple levels of analysis and intervention: the individual, community, city, region, and national levels; 2) multiple time scales; 3) multiple sectors of intervention; and 4) multiple types of intervention and units of analysis.

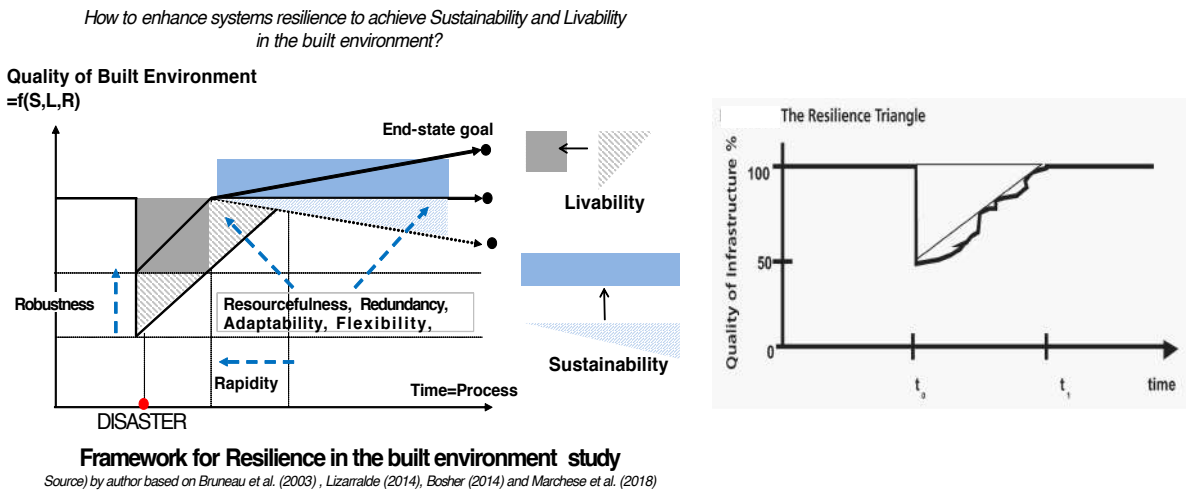

Figure 1: Research Framework for built environment study following disaster (on the left by author) and Resilience Triangle (on the right by Bruneau et al. 2003).

The following chapters describe resilience exercised by the government, community, and individuals after the Great East Japan Earthquake, and examine the question "does actor resilience function for achieving sustainability and livability in the built environment?" This paper focuses on relocation, resettlement, and displacement after a tsunami to understand the transformation of the built environment which will change sustainability and livability following a disaster. Each stakeholders' involvement in the built environment as a relocation and resettlement project will be analyzed.

3. Results: resilience, sustainability, and livability after the Great East Japan Earthquake

3.1.Resilience by government

The Great Tsunami in 2011 taught us that we need to prepare multiple layers of disaster reduction countermeasures. National government funding heightens coastal levees, land use control along the coast, and collective relocation to mountainside areas. What the national government recognizes as a top priority in post-disaster recovery is to develop safe residential land for survivors and future generations against the next tsunami. Local governments have designated hazardous zones which prohibit the construction of new residential buildings. Land use control restricting civil rights requires the government to compensate private properties. Subdivision on higher grounds, developed by collective relocation projects and property buyout payment for homeowners, function as funding support for housing reconstruction. It was essential for local governments to prevent population outflow in the depopulated Tohoku region. This is the same as the Road Home program following Hurricane Katrina in the U.S. which has two characteristics—a rebuilding program and a compensation program (Green and Olshansky 2010).

Figure 2 shows the speed of government intervention in recovery by project which includes safe land development for new residential areas and disaster public housing provisions for housing damage. This leads to an inevitable long-term project requiring people to wait for housing reconstruction. The figure also shows that the number of lots provided by government residential subdivision has decreased year by year.

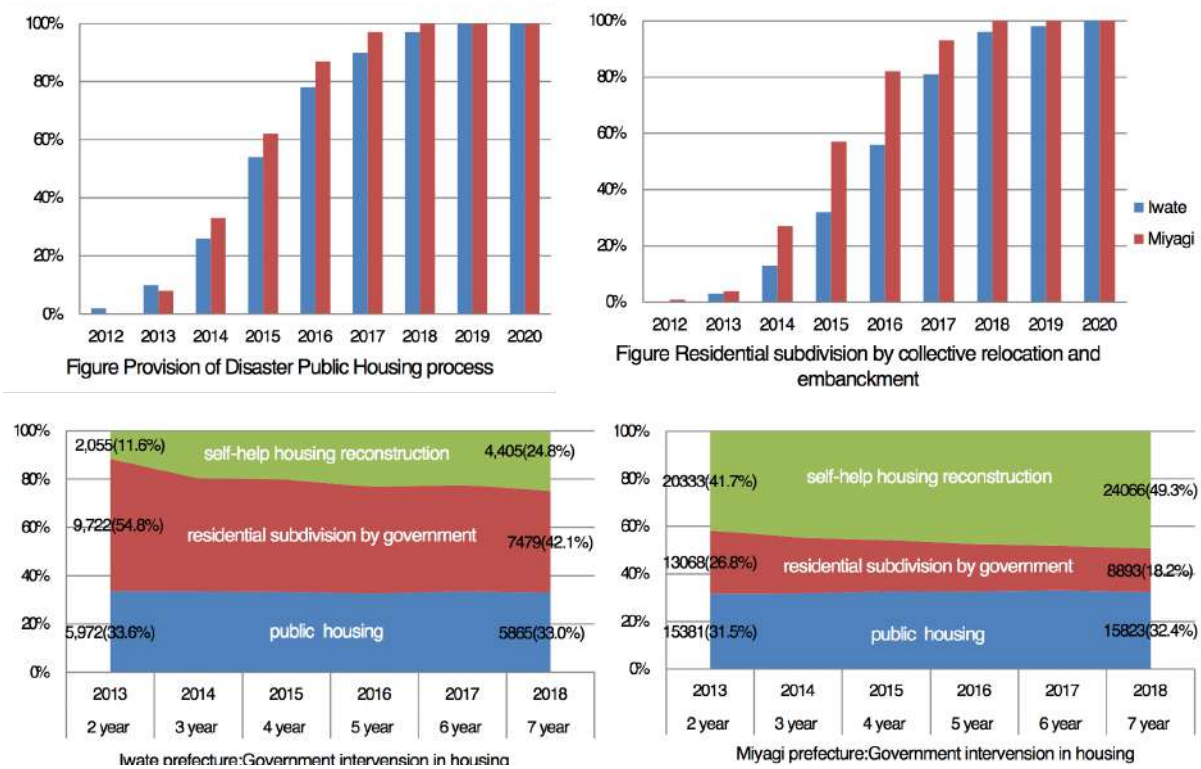

Figure 2: The intervention by government-driven project in Miyagi and Iwate prefecture.

Consequently, there are many vacant lots in subdivisions (indicated red in the bottom graph in Figure 2) because of peoples' withdrawal from a government-driven project. For example, the vacancy rate, which indicates that 60% of landowners have not decided to construct new housing on lots in Rikuzentakata (Tokai Shinpou 2017). The government exercised robust resilience, but the lacks other 3R: rapidity, resourcefulness to mobilize people's power, and redundancy which fails to adhere to developing an urban vision.

3.2.Resilience by community

Collective relocation can be categorized by the type of stakeholder involvement, which are government-driven and community-driven types. Decision-making power defines the level of involvement in determining where to relocate, the size of the group to relocate, and the design of the residential subdivision, etc. Community-driven collective relocation is a characteristic pattern seen in a rural settlement such as in fishing villages, which have a long history of being self-organized and highly independent communities with strong social ties. This paper does not have enough data on community resilience, although, based on continuing field visits by the author, the hypothesis is that self-decision making by "community" might be a key for successful relocation for physical, social, and economic sustainability. For example, in Rikuzentakata, Iwate prefecture, ten households relocated without government assistance. This is a form of self-help collective resettlement to an area very near where they used to live, and this helps sustain social kinship and people's livelihood within the village. Self-help collective resettlement will likely become infill development without the investment of substantial public infrastructure construction. Self-determination is crucial for sustainable recovery for people's livelihood and community.

3.3.Resilience by individuals/households

Kondo and Karatani (2017) studied self-help housing reconstructions with relocation, which is seen as an embodiment of individual resilience. This is one housing recovery type observed after the 3.11 tsunami where households decided where to relocate to beyond government-driven safe land development (such as collective relocation and land embankments in the city center). Residents sought quick housing reconstruction where they could achieve a feeling of security. That government-driven urban redevelopment projects pursuing "safety" have not provided "secured" places for survivors to restart their life has been demonstrated in other studies (Kondo and Karatani 2018).

Figure 3 shows the urban sprawl spatial pattern by new housing reconstruction following the tsunami. It is demonstrated that aggregation of self-help housing reconstructions with relocation significantly influence the transformation of urban built environments. This is inconsistent with the future spatial planning vision developed by the local government's post-disaster recovery planning. Kondo and Karatani (2017) found that there are two spatial patterns—the sprawl and infill development types. The sprawl type of spatial patterns requires people to have access to vehicles to sustain their livelihoods. This is difficult for elderly people who are far from the city center and have lost their human networks in previous neighborhoods along the coast.

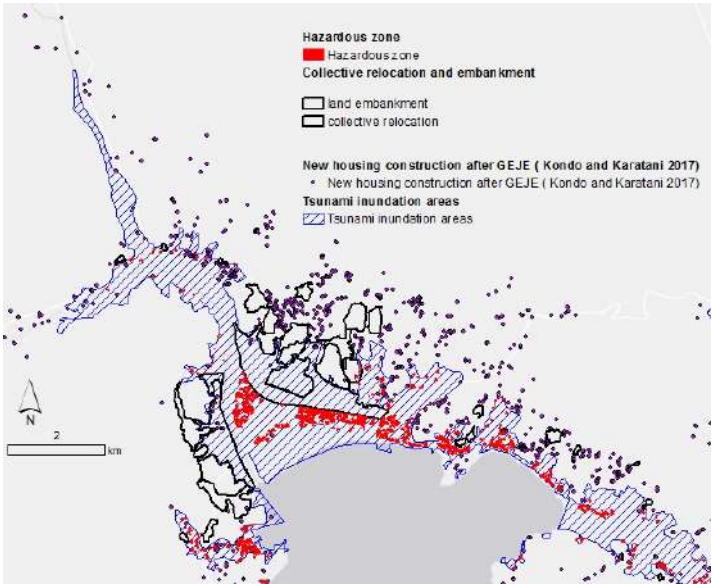

Figure 3: Sprawl pattern by new housing construction following the tsunami (city of Rikuzentakata).

3.4.Sustainability by population and urban footprint

A sustainability index is generally understood as representing social, economic, physical, and environmental sustainability. This section measures sustainability by population and urban footprint which are significant components of the built environment. The GIS of census mesh data before (2010) and following the tsunami

(2015) by the Environmental Systems Research Institute, Inc.(ESRI) was used to analyze three quantitative values—density, urban footprint, and polarization between the mountainside and low-lying areas (Figure 4). The visualization of population and buildings show us that the built environment after the tsunami triggered low-density, urban sprawl, and polarization between inland and coastal areas. This change requires significant infrastructure management costs threatening the economic sustainability of municipalities, while polarization raises questions concerning social sustainability. This physical pattern threatens sustainability in depopulated societies which need to be coordinated as mentioned later.

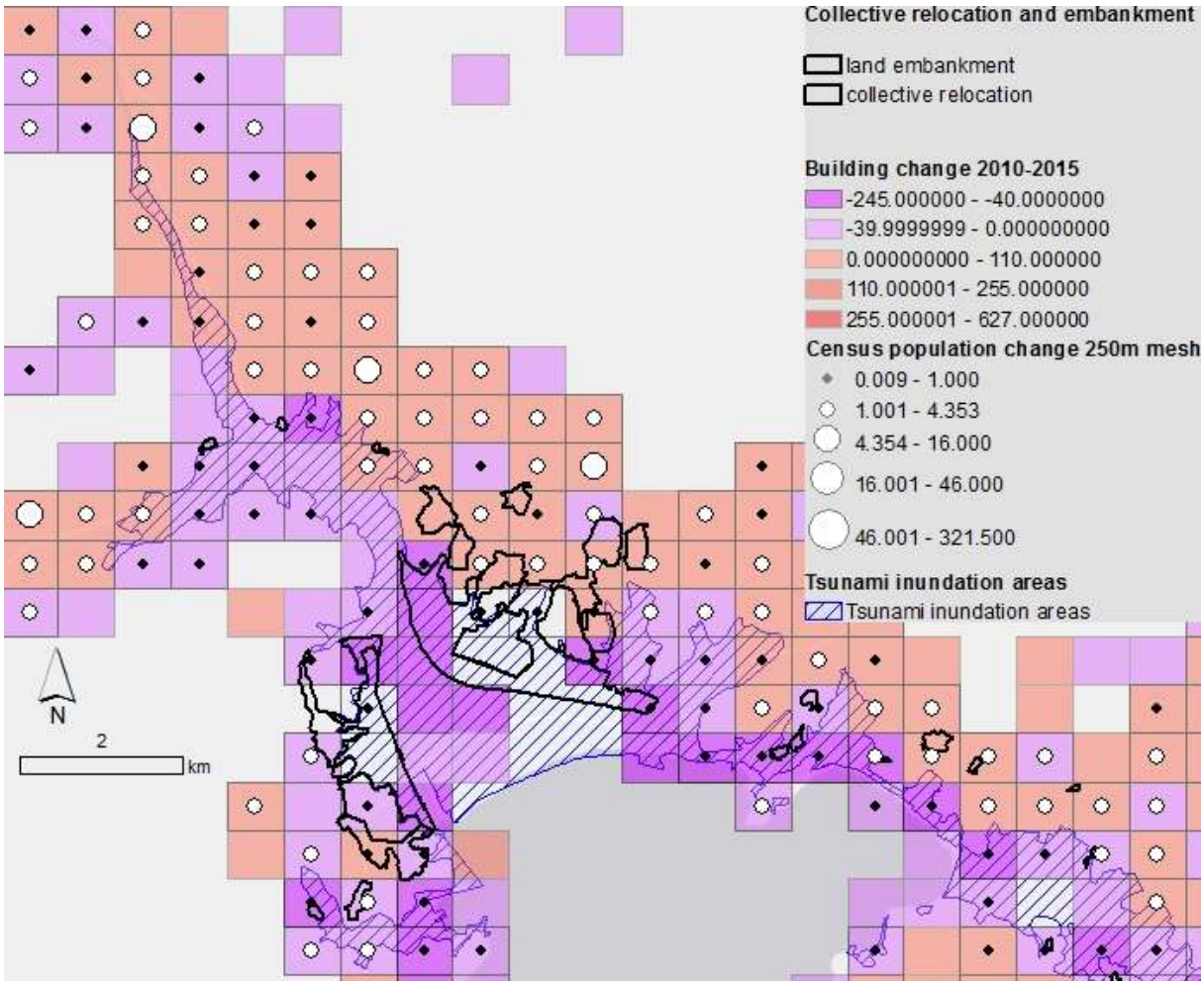

Figure 4: Polarization between the mountainside and coastal areas after the tsunami (city of Rikuzentakata).

3.5.Livability

Livability is constructed by the sum of the factors that adds up to a community's quality of life. It focuses on the human experience and is specific to place and time. Livability is about "now" and "here" (Gough 2015).

This section explores "mobility" as a livability index because the built environment's transformation following the tsunami requires the consideration of new public transformation systems and routes. In Rikuzentakata, the Japan Railway Company (JR) decided not to reconstruct their railroad along the coast, but operate a Bus Rail Transit (BRT) system for permanent public transportation instead. BRT began its operation two years after the tsunami. This route relocated to the mountainside to avoid the tsunami inundated area and the city center embankment area until 2014. It seems that this re-routed public transportation occurred to help self-relocated homeowners, especially the elderly, who do not drive cars. However, after seven years, the route changed to accommodate a collective relocation subdivision and city center developed in the city center embankment area. Rikuzentakata has begun a circulation route this year to connect the mountainside and city center areas; however, the bus only operates three times a day. This proves that the city government only cares about the recovery project area, and does not account for the built environment transformation, regaining livability for all citizens.

4. Discussion

Based on the last two sections (3-3 and 3-4), it is clear that there are two driving forces for built environment transformation which are the government-driven recovery project and individual housing relocation without planning. Both trigger polarization between people and places making the built environment unsustainable. Bartuska (2007) identifies the built environment as everything human-made, arranged, or maintained; fulfilling human purposes; mediating the overall environment and affecting the environmental context. How could we explain the transformation of the built environment after the GEJE by using this definition? Roughly speaking, the built environment is made by a government-driven recovery project and individuals' self-directive relocation without planning, the human purposes need to finish housing reconstruction quickly and securely for the next tsunami, and robustness by through countermeasures to deal with tsunami risk and protection, shaped by the government's prioritization of reducing tsunami risk. Government planning, such as collective relocation and land use control and, also, peoples' relocation changed the environmental context which was unable to sustain coastal life. The next section describes several findings in this paper.

4.1.Resilience by individuals causes a significant impact on the transformation of the built environment

This paper emphasizes the importance of understanding individual involvement in the transformation of the built environment. This does not refer to citizen's participation in planning but to peoples' resilient actions to relocate without government planning. Resilience by individuals is defined as peoples' rapid housing reconstruction by utilizing their resources without government support and planning intervention. Lizarralde et al. (2015a) explain systems resilience by multiple levels of analysis and intervention, including individuals as a sector of intervention. Prior research has demonstrated individual resilience following a disaster, although, few have studied how this has influenced the transformation of the built environment (Kondo and Karatani 2017). The relationship between people and the built environment has been identified with the multi-scale analysis in this article. It is ironic that peoples' resilience disturbs sustainability, and this leads to decreased mobility because of urban sprawl without public transportation, however, the phenomenon of individuals' actions without planning after a mega disaster must be considered as a positive action which does not depend on government planning.

4.2.The trade-off between resilience and sustainability

Robustness by the government and resilience by the people negatively impacts sustainability. There is a trade-off relationship between resilience and sustainability following a mega disaster. Community-driven resilience might work to tackle this trade-off. Resilience actions by people led to urban sprawl in Rikuzentakata. The scale of government intervention by a coastal levee, collective relocation development, and land embankment is substantial which prioritizes tsunami risk reduction, making people wait for their housing reconstruction. There is a need for downsizing for depopulated societies following a mega disaster. Achieving resilience, sustainability, and livability following a disaster is not easy. A livability index should be redefined after experiencing disaster. Individual relocation triggers urban sprawl, which makes people depend on vehicles to sustain their lifestyle; however, people want to resume their lives as early as possible, feeling secure for the next tsunami. Redefining livability after a disaster is an essential process in recovery.

4.3.Rethinking how human alteration of the environment can mobilize peoples' resilience

The trade-off between resilience and sustainability implies that we should consider how planning for resilience guides people's decision-making and actions to achieve sustainability and redefined livability. Post-disaster recovery planning tends to draw a fixed future vision, preparing projects to implement. However, what we need following a mega disaster is an intervention for resilience, using resilience with minimal government intervention. New interventions might include management or coordination, rather than planning. Understanding phenomena after disaster, such as individual relocation actions, simulate the direction the effects of the built environment takes. What we have to consider next is to where could intervention apply to and how?

The limitation of this paper is that it does not have enough quantitative data to measure resilience, sustainability, and livability. The methodology for this analysis could be a systems approach to clarify the mechanism of the built environment transformation by examining the relationship between planning and peoples, which are not independent elements. Identifying what causes the trade-off between resilience,

sustainability, and livability three abilities and finding how to develop planning for effective recovery will be important. How we should enhance systems resilience to achieve *S* and *L* in the built environment, by what kind of intervention, and by whom must be answered in another research.

5. Conclusion

This paper clarifies the trade-off relationship between resilience, sustainability, and livability after the Great East Japan Earthquake, and shows the importance of intervention as a "management and coordination" role in peoples' resilience such as guiding peoples' relocation area with social infrastructure and services for their lives. Individual resilience has to be evaluated positively, and public intervention needs to understand peoples' resilience. The mechanism of the built environment transformation must be considered with sufficient and quantitative data to develop a more concrete planning approach to achieve *f (S, L, R)* following a mega disaster. We have to reconsider the role and approach of planning, what planning can do, and how planning can be destructive for the built environment to attain the minimum level of government intervention and the relationship between stakeholder's resilience.

Acknowledgments

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Enabling adaptive capacity of urban neighbourhoods through architecture and urban design in the face of human-induced hazards: the case of urban decline

Deniz Ozge Aytac [a,*], Tulin Vural Arslan [b]

[a] Amasya University, Turkey
[b] Uludag University, Turkey

Abstract

The aim of this study is to form a conceptual framework by drawing on qualities of neighbourhood and adaptive capacity in order to strengthen resilience and adaptive capabilities of neighbourhood that will face with stresses or consequences of urban decline. The central arguments of the study are that neighbourhood is a dynamic system (a) which could adapt itself in order to mitigate shocks in the occurrence of urban decline, and (b) which establishes critical connections within the city and is a key for the resilient city. The emphasis is on triggers of urban decline, dynamic and non-linear relations in a neighbourhood, variability in scales (time, space, and context) of adaptive capacity as well as physical and social construct of the neighbourhood that should be considered in an integrative approach. The study concludes that focusing merely on the hazard will present limitations to enable necessary adaptive measures to the system. In this regard, triggering conditions and dynamics should be defined in detail. Also, adaptive capacity of neighbourhoods could be enabled through structural and non-structural measures in advance to urban decline provided that space, size, context, time, and drivers of the dynamics are established.

Keywords: neighbourhood; adaptive capacity; urban decline; urban resilience

1. Introduction

Hazard denotes a process, phenomenon or human activity that results in serious health impacts, property damage, economic or environmental disruption (UNISDR, 2016). In the era of Anthropocene urban environment is critically affected by the human activities which result in human-induced disasters (e.g. structural collapse, economic crises, chemical spill, riot). According to Global Risk Report (2018), trend in rising urbanization is correlated with risks of failure of urban planning, profound social instability, large scale involuntary migration, water crises, and food crises among others. Human-induced hazards (man-made hazard, anthropogenic hazard) are induced entirely or predominantly by human activities which encompasses technological, socio-natural, social, and economic activities (UNISDR 2016). In order to "substantially reduce disaster damage to critical infrastructure and disruption of basic services ... including through developing their resilience by 2030", Sendai Framework for Disaster Risk Reduction presents a process of a focused action by four priorities at local, national, regional, and global scales (UNISDR, 2016). In the scope of this paper we focus on Sendai Framework 'priority 3: investing in disaster risk reduction for resilience' in which outlines necessary actions toward resilience of the communities (UNISDR 2016). UNISDR (2016) suggests a hazardous event classification based on family, sub-family, and hazard classes, human-induced hazards are classified as technological, chemical and radiological, and major transportation accidents.

This classification is based solely on disasters which focus on the results of hazardous events. However, triggering events and stresses could provide valuable information for mitigating efficiently pre and post disaster risk. In the context of Sendai Framework implementation, Lerner (2016) suggests an alternative classification for human-induced hazards which are list format, matrix format, and causal loop diagram format by adding contextual information, addressing causes and triggering and series of events, and social hazards. Among three formats, matrix format presents a detailed informational chart that accommodates triggering events by the interconnection with other types of hazards. According to Lerner (2016), matrix format not only 'reproduce hazard types' but also 'providing the means for drawing connections between hazards.'

* Corresponding author. E-mail address: aytac.ozge@gmail.com

Urban environment is interlinked with physical and non-physical entities and changing in response to external and internal dynamics as well as shocks and stresses in context of resilience concept. Urban population increase leads to housing demand which results in rapid urbanization (e.g. individual or corporate initiated constructions) in urban environment. On the one hand urban land expansion puts pressure on natural habitat and resources, generates urban sprawl and gated communities; on the other hand, existing urban neighbourhoods are threatened with urban renewal, dislocation of communities, gentrification, and decline of existing urban neighbourhood. Urban decline (decay) is deterioration of social and physical characteristics in the urban tissue resulting from economic, social, and political dynamics of cities. Urban decline is under dynamic processes and develops gradually; therefore, the risk assessment for urban neighbourhoods should be carried out in a timely manner (Weaver 2016). Neighbourhoods, a living part of urban system, are dynamic and interconnected systems and form living environments for the society. Once a neighbourhood is subject to decline, it could draw social problems toward itself and repulses economic activities. In other words, it affects other parts of the city and threatens resilience of neighbourhoods. These areas could become visible proof of socio-spatial forces in cities that 'causing unstable conditions and sometimes destruction' (Andersen, 2003).

This paper investigates how to mitigate the effects of urban decline through enabling adaptive capacity of neighbourhood. Leading questions of this study are: (a) what are the components and dynamics of neighbourhoods? (b) what are the drivers of urban decline? (c) how could cities become resilient to urban decline through adaptive capacity? The methodology delineates the following stages through forming conceptual framework: reviewing literature and categorizing the selected data, identifying and deconstructing concepts, and synthesizing.

2. Neighbourhood dynamics and urban decline

Neighbourhoods are dynamic bodies which illustrates a constant change in terms of their structure (physical and non-physical), meaning and connections within their context (Van Ham et al. 2013). Neighbourhood concept in the literature is explained as being both physical and social entity; is about place (context) and people, having varied boundary size, cannot be separated from its context and connections (i.e. closely linked to other neighbourhoods and the city). As much as cities, neighbourhoods are affected by changing urban dynamics which cause neighbourhoods to become vulnerable to unpredicted events. Moreover, 'some neighbourhoods change very quickly as the result of single or multiple external shocks, such as large scale neighbourhood demolition and (re)generation, or more slowly as the patterns of residential mobility change' (Van Ham et al. 2013). Due to economic, social, political and spatial forces, old neighbourhoods lose their vitality and remain deteriorating.

In time, these neighbourhoods lose its attraction and lose its economic value. So that, homeless or residents with lower socio-economic status prefer to live in these neighbourhoods. For example a Syrian refuged family in Istanbul shelters themselves a wooden abandoned house –once it was a mansion- around old Suleymaniye district (Unsal Gulmez 2018). Urban decline is a slowly developed process; however, it could become serious cases that lead to 'sores on the face of the city' or 'places of exclusion' (Andersen 2003). Several theorist and researchers have attempted to explain the drivers of urban decline. Mumford (1968) has drawn attention to physical and social harmful effects that direct to urban decline from an anti-urban perspective, Gutkind (1962) has foresaw urban decline as a result of expansion of mobility and advancing technological culture, and Beauregard (2003) has integrated anti-urban ideology with the concept of decline which is related to urban life insufficiencies and defects of both physical (e.g. slums) and social (e.g. insecurity) elements. If so, how could we sustain core functions and characteristics of neighbourhood in the face of urban decline? In the light of neighbourhood resilience and adaptive capacity how could we reconsider this dynamic nature in terms of architecture and urban design?

In order to systematically approach the issue first, we need to explain core functions of a neighbourhood. Besides ecological and social-ecological perspectives on the neighbourhood, Galster (2001) introduces a spatial perspective by stating that neighbourhoods have spatially based attributes associated with clusters of residences together with other land uses. Moreover, he outlines components of a neighbourhood as, structural characteristics of the buildings, infrastructural characteristics, demographic characteristics, class status of the residents, public service characteristics, environmental characteristics, proximity characteristics, political characteristics, social-interactive characteristics, and sentimental characteristics. These characteristics work together and vary by location, infrastructure, and topography or collective attribute to the space. In other words, every neighbourhood

doesn't display homogenous attributes. As a part of the urban system, working principles of a neighbourhood are triggered by governance networks, metabolic flows, social dynamics, and the built environment.

3. Adaptive capacity: definitions and concepts

Urban environment is an example of social-ecological system that demonstrates three distinct features: the amount of change it can experience while retaining the same controls on its structure and function, the degree to which it is capable of self-organization, and its capacity for learning and adaptation (Resilience Alliance 2008). Acknowledging urban environment is a dynamic system that functions through feedbacks, non-linear dynamics as well as in constant change, adaptations become inevitable for the system to be able to cope with changing conditions. The concept of adaptation have been studied in a broad context as well as in urban and architectural research such as resilience studies, vulnerability and risk management studies, complex systems and non-linear dynamics. Adaptation occurs as a reaction in its surrounding environment due to a system change (Darwin 2005) which requires 'learning and adjustment' (Engle 2011). Adaptation attempts could be a result of an innate capacity as 'reactive or autonomous' (Engle 2011), or anticipating future shocks and taking precautionary measures as 'anticipatory or planned adaptations' (Fankhauser et al., 1999). As emphasized by IPCC (2012) and Pelling and Manuel-Navarrete (2011) adaptation strategy could be carried through 'incremental or transformational' action. Adaptation measures differ by spatial scale from individual household to global scale; by the phenomena from biological, economical, to social; by the scale of time from daily to annually.

Adaptations also could be addressed to one particular subject and stress to a broader group and multiple stresses (Smit& Wandel 2006). Therefore, it can be inferred that adaptive capacity of a system will 'depends critically on the nature of the hazard faced' (Brooks 2003). Adaptive capacity points out generating flexibility so that to enable alterations for the changing contexts in order to maintain crucial functions without having noteworthy declines in the system (IFLA 2012). In time of uncertainty, adaptive capacity shows the ability of responding to concurrent stresses as well as show variation in different contexts and systems (Adger et al., 2007). In order to be prepared for disaster risk, it is important to assess existing adaptive capacity of the neighbourhood. Brooks (2003) asserts that in order to assess existing adaptive capacity, how it is constituted and translated into adaptation process must be perceived. The process could reveal itself in various applications in various scales, for example an adaptation procedure of a plot in the face of a disaster will differ than a neighbourhood's adaptation procedure. Adaptation will take place on various scales as well as depending on how the system is delineated.

4. A conceptual framework for neighbourhood adaptability

Disaster risk reduction for resilience calls for adaptive measurements in order to mitigate shocks and hazardous results. Therefore, it is necessary to develop a holistic framework for neighbourhood adaptability that takes into consideration of defining characteristics and dynamics of neighbourhood, defines urban decline drivers of the case study, defines adaptive capacity on structural and non-structural measures that are related to urban design and architectural studies. Since urban and architectural actions are investigated in the context of adaptive capacity, spatial neighbourhood attributes (Galster, 2001) are taken in to account to address structural or non-structural adaptability measures. Therefore, it is intended to integrate spatial, economic, social, and environmental scales of the neighbourhood within its scales and elements with urban decline (risks and triggering events), and structural and non-structural adaptive capacity measures. As a consequence, a proposal (Table 1 and Table 2) for strengthening adaptive capacity of neighbourhoods that presents with a multi-scale and multi-characteristic qualities. Structural and non-structural measures present an action plan for strengthening adaptive capacity of neighbourhoods.

Table 1: Introducing spatial, economic, social, and environmental scales in the context of a neighbourhood

Scales	Components	Referred Elements
Spatial Scale	Dwelling unit	Structure, facade, interior space
	Plot	Building, open space
	Block	Dwelling clusters, circulation, open space
	Tissue	Transportation, dwelling units, public spaces, businesses, education facilities, health facilities
Economic Scale	Local economy (Neighbourhood level)	Local businesses, local production
	Inter-neighbourhood economy	Interchangeable businesses cultivates the community sources
	Neighbourhood – city economy	Web of businesses
Social Scale	Individual	Identity; socio-economic status; ethnic background ; ageing; social background;
	Community	
	Administrative bodies	
Environmental Scale	Vegetation	Flora, recreational parks
	Water	River, sea, lake
	Land (soil)	Arable land, community garden
	Fauna	Animal species

Table 2: Structural and Non-structural measures in order to enable adaptability capacity suggestions for spatial scales of a neighbourhood facing urban decline (authors) (adapted from Brooks&Adger 2005; Galster 2001)

Type of Measure	Spatial Scale			
	Scale	Characteristics of Neighbourhoods	Risks (Urban Decline)	Adaptive Capacity
Structural Adaptability Measures	Dwelling unit Plot Block Tissue	Structural characteristics	Structure failure ; Failure of connectivity ; Failure of accessibility to environmental sources	Establish monitoring networks Assess historical data and past/existing adaptations (identify successful and unsuccessful adaptations) Disseminate information on successful adaptations Develop long-range forecasting capacity Assess adaptation needs through stakeholder engagement Create "enabling environments" to encourage further adaptation
		Infrastructural characteristics		
		Environmental characteristics		
Non-Structural Adaptability Measures	Dwelling unit Plot Block Tissue	Political characteristics	Failure of political engagement ; failure of interpersonal connectivity ; failure of accessibility to attractions ; failure of have heterogeneous distribution of community	
		Social-interactive characteristics		
		Sentimental characteristics		
		Proximity characteristics		
		Demographic characteristics		
		Class status characteristics		
		Tax/public service package characteristics		

5. Conclusions

Neighbourhood dynamics are in change due to global and local forces that affects social, economic, environmental, and spatial activities. In the era of Anthropocene urban decline, among various human-induced hazards, causes urban environment to fall into disuse. By addressing Sendai Framework for Disaster Risk Reduction Priority 3, to maintain resilience of urban environment, a conceptual framework and action plan for the neighbourhoods that enables adaptive capacity is necessary for pre and post disaster events. Therefore, this study has aimed to form a conceptual framework which assesses neighbourhood characteristics, spatial scales with urban decline risks and suggests adaptive capacity measures. First, neighbourhood characteristics are unfolded, neighbourhood dynamics are studied, and structural and non-structural measures are discussed. Decoding neighbourhood components and characteristics as well as defining risks that neighbourhood might confront in the likelihood of urban decline, and reconstructing adaptive capacity strategies that are customized to urban decline is crucial for maintaining resilience of urban neighbourhoods. Enabling adaptive capacity of neighbourhood will benefit neighbourhoods to better respond to changing dynamics, to become flexible, and to transform its components where is needed.

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Walking as a key factor in the resilient low-carbon city

Thanuja Panawannage [a,*], Alan March [a]

[a] University of Melbourne, Australia

Abstract

Future cities will increasingly face wicked problems relating to climate change and fossil fuel scarcity. Reduced CO2 emissions and planning cities for resilience against fossil fuel scarcity are important tasks for planners and designers. The planning and design of 'resilient walking neighbourhoods' could contribute partial solutions for many issues. In this research, the focus is to improve or reinstate 'resilient walking neighbourhoods' in response to future fossil fuel scarcity. Therefore, the researcher has chosen to undertake two research methods: an in-depth study of urban cases in Melbourne together with an international study in well-established walkable neighbourhoods so as to gain comparative data and the scale of resilience to fossil fuel scarcity in Melbourne compared to the international cities. Methodologically, both qualitative and quantitative methods are used in this study in keeping with a 'convergent parallel mixed method' approach. Data collection was conducted through mapping and field observations of key urban place characteristics, and face to face interviews with residents and users on their walking experience within 400-metre neighbourhoods. The analysis of resilience and walking related values using key literature provided opportunities to reveal the most resilient walkable neighbourhoods in the case studies. The results identify neighbourhoods' key urban place characteristics that commonly contribute to or detract from walking resilient neighbourhoods.

Keywords: Innovation; Resilient; Urban place characteristics; Walkability.

1. Introduction

Imagine the world loses fossil fuel energy. What is the most convenient way of achieving mobility over any stresses or shocks in future cities? Here, the researcher argues that it is walking.

In the 21st century, rapid growth in populations, urban agglomerations, urban sprawl, car usage and massive unscaled developments have resulted in the excessive use of natural resources. Extreme weather conditions together with the depletion of natural resources are alarming, urging people to think about the damage they have made to the environment for their egos (Beattie 2012; Priemus 2016; Bulkeley 2005). In ancient Rome and Greek periods, walkable cities organically grew, and as time passed, these cities transformed into automobile cities. Now the cities are filled with cars, and there is limited space for pedestrians, who are often the last group to be accommodated by planners in the 20th-century, to walk comfortably (Newman 2009).

The world oil demand has been consistently rising from 2013 to 2016 as per the Oil Market report, International Energy Agency (OECD/IEA 2015). It affects all the countries which used automobiles as the primary transport, and Australia is one of them. Transport is the highest power consumption industry in Australia, and it is 27.3% as a share of total energy consumption (Department of Industry and Science 2015). Projected population in Melbourne, 2061 is 8.5 million, Sydney 8.4million, Perth 5.5 million, Brisbane 4.8million and Adelaide 1.9 million as per the actual and projected number of persons by capital cities 2003-2061 (Department of Infrastructure and Regional Development 2015). Growing population with high car usage in Melbourne and the other cities in Australian indicate that Australian cities are in a high-risk of oil shortage (Dodson and Sipe 2008; Newman 1996). In this research, the focus is to improve or redevelop 'resilient walking neighbourhoods' to prepare for fossil fuel scarcity in the future.

2. Walking as a key factor

Some explain walkability as a proxy for better urban places with some paying attention to walkability being multidimensional and measurable (Birch 1980), while others propose that enhancing walkability provides a holistic solution to a variety of urban problems (Forsyth 2015). Walkability is a foundation of the sustainable city; without it, important resource conservation will not be possible. Michel Southworth defines the term of walkability as "the extent to which the built environment supports and encourages walking by providing for

* Corresponding author. E-mail address: t.panawannage@student.unimelb.edu.au

pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network" (Southworth 2005). This study indicates the importance of time and the key characteristics which makes the visual interest between the two destinations. However, the Oxford English Dictionary Online explains walkability in two ways. The first is understood as the route suitable or safe for walking, and the second is a route close enough to be reached by walking.

The term walkable has been in use since the eighteenth century and meaning a route that is safe and reachable by pedestrians. However, these definitions are contentious. Not all safe and reachable routes are walkable. People expect more than simply "reachability in modern cities" as modern cities change to address resilience. Resilience in the walking environment referred to as 'Resilient walking', that is walking of high quality, now includes many key elements that are missing in many neighbourhoods in existing cities. Walking is a key factor in the planning and design of resilient, low carbon cities. It can encourage and support a range of core urban place characteristics of a given location. It is a holistic approach, and the planning and design of built environments suitable for 'resilient walking' associated with day to day activities and needs will help change the fate of future cities.

3. 'Resilience' in the walking context

The word resilience word comes to the discipline of planning and design in urban contexts as urban resilience. When applied to the building of urban resilience capacity, it can be described as multi-functionality, redundancy, modularisation, diversity, multi-scale network connectivity and adaptive planning and design (Ahern, 2011). Accordingly, resilience is now recognised as challenges related to climate change, and disasters occurring in urban contexts (Béné 2017; Leichenko 2011). Arup, Siemans and RPA (Regional Plan Association) explain in the "Toolkit of Resilient Cities" that resilience means the ability of a system to survive and thrive in the face of a complex, uncertain and ever-changing futures. It is a way of thinking about both short-term cycles and long-term trends: minimising disruptions in the face of shocks and stresses recovering rapidly when they do occur, and adapting steadily to become better able to thrive as conditions continue to change (ARUP). The authors of Resilient Cities: Responding to peak oil and climate change "don't believe that oblivion is necessarily the destiny of urban areas. Instead, they believe that intelligent planning and visionary leadership can help cities meet the impending crises, and look to existing initiatives in cities around the world" (Newman 2009, p92).

However, synthesising the definitions of resilience in urban research and policy context Meerow et al. (2016) explained the best way to define urban resilience is as follows "Urban resilience refers to the ability of an urban system and all its constituent social, ecological and socio-technical network across temporal and spatial scale to maintain or rapidly returned to desired functions in the face of a disturbance, to adapt to change and to quickly transform systems that limit current or future adaptive capacity"(Meerow et al., 2016). This concept of urban resilience is suitable in most urban systems in an urban context. As per the urban resilience concept of Meerow et al. (2016), the concept of 'resilient walking' can be defined as "the ability of an urban walking environment and all its constituent (key urban place characteristics) social (people safety and comfort), ecological – (plan and design building facades and landscape attractiveness along the streets) and socio-technical –(planning accessibility, proximity to day today needs and convenient transits) network across temporal and spatial scale continuous maintain, redevelop or retrofit of the desired functions to face the peak fossil fuel scenario, to adapt, to change and to transform that limit current or future adaptive capacity of neighbourhoods".

4. 'Resilient walking' framework

What are the basic people requirements as identified by the originator of the concept of basic needs, Abraham Maslow? Although most needs are inherent, Maslow considered that certain needs are more fundamental than others. His pyramid diagram represents a simplified representation of the relative power of needs. The first is physiological needs (food, water, air and sleep). The second level is safety and security, the third is love and belongingness, and the fourth includes esteem needs and intellect (Litwack 2007). However, whilst this literature explained the basic requirements of the people following Maslow (1954), physiological needs now have been expanded into a wider context with the impact of climate change, technological revolution and cultural changes. Essential people requirements in developed and developing countries have significantly changed. The basic needs in an African country are different in some ways to those in Australia.

As indicated in the hierarchy of walking needs, the first model introduced by Alfonzo (2005) identified feasibility as the most basic need related to personal limits. When this is related to urban form, it includes

accessibility, safety, comfort and pleasure respectively. Alfonzo (2005) states that if a walker is not satisfied with the basic needs in the hierarchical order, s/he will not think about the top level in this order. Although Alfonzo (2005) mentioned the hierarchy of walking needs in the early 20th century, it has changed due to the challenges of climate change and oil vulnerability in the 21st-century. Following a decade of using this five-part hierarchical walking model, Mehta (2016) researched the microscale urban design qualities of the walking environment, especially on the main street. She introduced two additional components to the list. Those are usefulness, the ability to supply basic needs and create place attachment, and the belongingness, which creates many community places. However, Alfonzo (2005) and Mehta (2016) noted hierarchical walking needs in different situations in the urban context, the most important component of which is the location of activities associated with meeting human needs and the built environment; people, buildings, landscape and the supportive infrastructure for walking related to activities that meet human needs, when considered in the context of climate change and oil vulnerability.

Most researchers have studied only one or two aspects of the walking environment (Koohsari 2015; Lamíquiz 2015; Stevenson 2016) disregarding the overall picture of walking when planning and designing neighbourhoods. This is predominant in urban, peri-urban, and suburban residential developments in the 21st century. There is a poorly built environment in some parts of the Melbourne metropolitan region due to a lack of proper planning and building regulations including relevant key urban place characteristics. Therefore, the researchers can see a clear gap in key urban place characteristics and in the planning and building regulations which encourages 'resilient walking' at the neighbourhood level for a resilient future. In the table below the key urban place characteristics that contribute to developing or transforming an entire 'Resilient Walking experience' within a neighbourhood are identified.

Table 1: 'Resilient walking' framework

Key urban place characteristics	Why is it Resilient?	and walkable	
Convenient transits	In a low fossil fuel scenario, people need to move a long distance in public transport. Therefore the availability of convenient transits within (approx. 400m means 5-10 min walking) (Rattan,2012) walkable distance and different transit options such as cycling, electric cars will be resilient for all age's people.	The convenient location of the transits and the transits options are a major link of walkable neighbourhoods in the future less fossil fuel scenario.	 Figure1:Convenient Transits Source. ontheplatform.org.uk
Proximity to activities associated with meeting human needs.	Easy to reach for children, older adults, disabled people and young people if the distance is a maximum (400m) for activities associated with meeting human needs.	Indicative urban fabric can see the direct location, and it makes people feel it is reachable and it encourages walking.	 Figure 2: Proximity to daily activities Source. www.theknot.com
Accessibility	Easy direct access is essential for all ages (children, young and older adults) without diverting pathways away from destinations. Street network and connections are important in future resilient cities.	Access to a place from different points without any disturbance is encouraging walking. If one way is not accessible, people have several other options.	 Figure 3: Accessibility options Source.www.billcaid.com
Safety	The feeling of safe and secure environment cannot be created with the security cameras or other technology. For a 'resilient walking', the environment needs peoples eye contact and a sense of natural surveillance. There are some elements feel people safe along the streets ex. Walls to opening ratio, streets width to height ratio, graffiti in a right way sometimes people feel unsafe if there is graffiti in a bad way, abandon buildings, isolated landscape and parks, no street lighting.	Building elements give a feeling of safe and secure built environment, and that encourage 'resilient walking'.	 Figure 4: Safety features Source.www.google.com

Comfort	Human scale and proportions (Height: width ratio) of the sidewalk, streets widths and heights give an intimate feeling, and resilient walking built environment. Most of the overhanging into human scale Ex. Arcades, verandas, pergolas, and tree canopies keep the sense of comfort from the climate ex. hot, windy and cold climate.	Sometimes people are not in the streets, but the human scale and the proportions of the buildings and trees will give a feeling of comfort to walk "you are not isolated".	 Figure 5: Comfort built form Source.www.google.com
Attractiveness	The attractiveness of the streets makes a pleasant and stimulating feeling in the environment. Ex. Graffiti as an art, colours and textures of the buildings, landscape, paving patterns and the quality of paving, type of building materials make a resilient built environment.	Colours & Textures building materials, paving attract people and heal people mind, give a sense of walking up to the end and cheerful mood to walk.	 Figure 6: Attractive streets Source: the culturetrip.com

5. Method, data and approach

This research aims to improve or develop resilient walking neighbourhoods given the lower fossil fuel scenario and the impact of climate change. The approach provides an in-depth study of cases in urban Melbourne in the local government municipalities of Port Philip, Moreland and Hume Cities and international cases in well-established walkable neighbourhoods, Freiburg, Germany and Malmo, Sweden, to gain richer data so as to compare the scale of resilience to fossil fuel scarcity in the Melbourne and international cities (Yin 2011). Therefore, the research adopts a combination of qualitative and quantitative methods that can be used to understand complex problems (Creswell 2014). A mixed methods approach also allows for different ways of seeing, knowing and valuing the aspects of the research. (Williamson and Johanson 2013).

The data collection has been undertaken by mapping through observation and a letterbox survey of residents for each of the case studies. The main data collection method, mapping and observation, has been undertaken using key urban place characteristics in the five randomly selected 400m radius sample neighbourhoods in each municipal area. Here the 400m distance has taken as comfortable distance to walk any age group in a low fossil fuel scenario. The secondary data collection method, a letterbox survey, followed face to face interviews or interviews of people on the streets. Eight to ten people in each randomly selected in a 400m radius neighbourhood area were chosen for face to face interviews. The questions included both open-ended and yes/no responses and data were recorded. Participants 18 years and over were selected for the interviews each taking approximately 15-20 minutes. Interviews were carried out on two designated streets in the neighbourhoods. Sample questionnaires were prepared in parallel to the empirical research data. These questionnaires gathered the perspective of local people about the built environment and their response to the application of the 'resilient walking' framework in their neighbourhood and their overall views on how their neighbourhood could be improved to encourage walking. The results of the mapping, observations and the interviews will triangulate to confirm the results of the total research.

6. Results and findings

The qualitative and quantitative data collected and assessed in the case studies reveal the existing resilience levels of neighbourhoods to fossil fuel scarcity and climate change impacts. Therefore, the key urban place characteristics which represent the most 'resilient walkable neighbourhood' can be taken as an example to improve neighbourhoods towards less fossil-fuel dependency scenarios. The results assist us to identify a neighbourhoods' key urban place characteristics that commonly contribute to or detract from resilient walking neighbourhoods.

It reveals that the findings could provide direction for to improved neighbourhood planning and design over time as development occurs. It will contribute to the city's capacity to be more resilient to fossil fuel scarcity, the impacts of climate change and could also lead to low carbon options.

Here the researchers propose four future scenarios;

1. If most of the neighbourhoods are walkable and activities associated with meeting human needs are within walkable distance, those neighbourhoods are resilient in low fossil fuel scenarios.

2. If most of the neighbourhoods are not walkable, but the activities associated with meeting human needs are within walkable distance, those neighbourhoods have lower resilient to less fossil fuel scenarios.

3. If most of the neighbourhoods are walkable, but the activities associated with meeting human needs are not within walkable distance, those neighbourhoods are less resilient to less fossil fuel scenarios.

4. If most neighbourhoods are not walkable and no activities associated with meeting human needs within walkable distance, those neighbourhoods are not resilient to less fossil fuel scenarios.

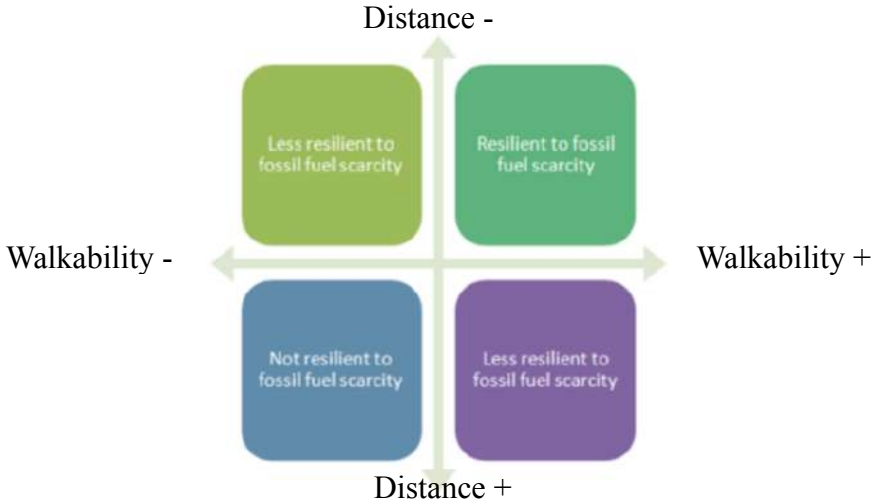

Figure 7: Proposed four future scenarios

7. Conclusion

The need to build resilient cities is a growing awareness in an increasing number of cities around the world. It is therefore difficult to identify an exemplary city. However, the literature tells us that resilient cities are cities that are more organised and have distributed and integrated systems. If one system fails due to any systems failure, there is the option to recover and continue. Modern cities have become car dependent and today's planners and designers, are searching for a better environment for a resilient future. If resilient cities are to emerge as a result of the impact of climate change and fossil fuel scarcity, resilient walking neighbourhoods will play a key role in the planning and design of cities.

In a fossil fuel scarce world, one of the most important key urban design characteristics will be walkability to meet daily needs. If this can be achieved, it will reduce the car usage. Neighbourhoods that can achieve a walkable environment through good urban place characteristics to meet daily needs will be resilient to fossil fuel scarcity and climate change impacts. Therefore, the planning and design of our neighbourhoods with good urban place characteristics is vital for low carbon and resilient city.

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Building resilience: an adaptive framework for Greater Bay Area sustainable development

Matthew Cheuk Fai Lee [a,*], Wilson W.Y. Yik [a], Ivy S. W. Lee [a], Alex Yueng [a]

[a] Leigh & Orange Ltd., China

Abstract

Resilience as a goal of climate-responsive design presents challenges and opportunities to architects. Their responsibilities for the increasingly risk-prone Greater Bay Area (GBA) are critical. The concept of resilience is coined in post-hazard protocols evaluating the capacity of cities to persist. However, debate arises between ecological and engineering resilience. Canadian ecologist, C.S. Holling, argued from an ecological perspective that resilience as the "ability of a system to return to equilibrium after a temporary disturbance." Adaptive resilience is not bound to the ability to 'spring back', but to absorb shock, and change through renewal, reorganization, and adaptation. The objective is to investigate how the network between buildings and neighbourhoods integrate adaptive resilience design in the creation of Chinese Silicon Valley. Analysis of the impact on regional framework reveals the resiliency of the area. Firstly, in the context of this mega-city, risky locations such as seacoast and floodplains confer important economic benefits. The buildable land, well-appointed sites for collection, and transhipment of goods set apart from land-locked regions for technological growth. Secondly, mega-city escalates the disaster potential by concentrating people and investments. The disproportionate amount of material wealth is bound up in the built environment. Historic typhoons inflicted billions of properties damage which took weeks to resume challenges social resilience. Lastly, new development without environmental resilience consideration paving over water-sheds reduces infiltration, speeds runoff, and increases flood volumes. The impacts of creating conditions for disaster are also opportunities to enhance resilience by implementing adaptive strategies, like blue-green infrastructure. In conclusion, this paper would demonstrate how resilience as a dynamic design strategy can tackle the geographical characteristics of GBA socially, environmentally, and economically for a sustainable future.

Keywords: Communities, Ecological Resilience, Governance and Leadership, Integrative Design Framework, Mega-cities.

1. Introduction

The concept of resilience applies in multi-disciplines to evaluate the ability of persons, object, entity, or system to persist in the face of disruptions (Gunderson 2000; Bruneau et. al. 2003). Resiliency in adaptation planning, policy development, and implementation, is different in scales (Vanham et.al. 2017). Resilience is still an emerging concept in urban development policies (Zhao 2010). Rockefeller Foundation's 100 Resilient Cities and United Nation International Strategy for Disaster Reduction (UNISDR) campaign on Making Resilient Cities (UNISDR 2012; Rockefeller 2016). A resilient city is defined as 'developing systems and capacities to be able to absorb future shocks and stresses over time to maintain essentially the same functions… while at the same time working to mitigate the present causes of future shocks and stresses (Holling 1973; Bruneau et. al. 2003)."Resilient Cities Laboratory, (Laboy & Fannon 2016), echoed that "architecture is neither stable nor resilient, washed by tides of ecological deterioration, cultural devaluation, and economic disinvestment." However, the absent of clear conceptual framework elucidating the basic implication of design for uncertainty and risks are problematic (Holling 1973; Luthar et.al. 2000).

This paper would first introduce the Greater Bay Area and highlight the economic and geographical significance as field of study for adaptive resilience. Secondly, we would discuss how Building Adaptive Resilience as conceptual framework address both on the stability of shifting system and adaptability to climate change. Furthermore, we contrast Socio-economic and Socio-environmental Resilience of GBA touching on the 6Rs. Robustness, Redundancy, and Resourcefulness in the engineering perspective are basic, yet limited to the water access in GBA. Additionally, ecological dimension of Risk Avoidance, Rapidity, and Recovery prior to and after the event, thus, are keys to Blue-green infrastructure and Transit-oriented development in transferring the

* Corresponding author. E-mail address: matthew.lee@leighorange.com

state of equilibria in creating opportunities and advancing preparation. Lastly, the paper concludes that through renewal, reorganization, and adaptation, this integrative framework is determinate to address urban vulnerability.

2. Greater Bay Area as field of study

GBA sits in three major urban economic circles and China's two international outlooks in the Southern coastal region in the country shown in Figure 1 (Puente 1999; CLSA 2018; Ng et. al. 2018). The 9+2 city cluster comprises Guangzhou, Shenzhen, Dongguan, Huizhou, Foshan, Jiangmen, Zhongshan, Zhuhai Zhaoqing and two special administrative regions, Hong Kong and Macau (Shenzhen Municipal Government 2007; HKTDC 2018; KPMG 2018). This bay-area economy is marketed to have both **more** advancement for an export-oriented economy and natural advantage of a close relationship with mainland economy (Guangdong Government 2010; CLSA 2018; HKTDC 2018). The unique geographical location is perceived as rival to world's three incumbent bay areas of San Francisco, New York, and Tokyo. GBA covers 56,500km^2, accounting for 0.58% of the country total (HKTDC 2018). According to CITICS research (2017), the virtue of GBA economic and growth potential, yet, shows in the GDP of over RMB1tn covering three cities, Shenzhen (RMB 2.2tn), Guangzhou (RMB 2.15tn), and Hong Kong (RMB 2.12tn). Huawei, ZTE, Kuang-Chi Technologies, DJI, and Royole are examples of emerging innovative advanced manufacturing enterprise with international influence (Shenzhen Municipal Government 2007; KPMG 2018). Socio-environmental resilience is matured by using cheap land to attract technology companies to settle in the region (Luthar et.al. 2000; Laboy & Fannon 2016). Moreover, the unique advantage for shipping port development allows a dense network of waterways and natural ports along the Yangtze River (Vanham 2017; Sweya et.al. 2018). The physical planning of the networked cities is important for China resilience development in short term, while policy in building social capacity to resolute from development is vital for long term.

Figure 1: Location of Greater Bay Area in Southern China.

The interconnectivity is much as opportunities as threats (Wei et. al. 2017). The agglomeration in GBA is prone to flooding from extreme storms anticipated (Stern 2006; Herath 2018). Moreover, rising sea levels affects built-up areas from reclamations (Wilde & Coley 2012; Herath et. al. 2018). The mega-city network complicates the potential of failure in one system leading to domino effect (Puente 1999). Accelerated urbanisation caused rapids expansion of cities in size, density, and complexity climate-adaption is essential to resilient (Sweya et.al. 2018; Perera 2018). Without risk avoidance consideration, initial developments build on available safe sites sub-sequentially spill over to high-risk areas. In alignment with the *Sendai Framework for Disaster Risk Reduction 2015-2030*, sustainable urban development is vital in reducing exposure and vulnerability (Assembly UN General 2015). Harnessing resources to prepare back-ups and enhance restoration is vital (Puente 1999). Investigating hazard-prone areas in GBA such as floodplains and coastal areas amplify the vulnerability subject to seasonal cyclone and sea level rising (Reid & Vogel, 2006; Chong et.al. 2018). Underlying risk driver like poverty, inequality, unplanned urbanization, poor land management, and compounding factors like demographic changes and non-risk-informed policies are at stake. Hence, evaluations on adaptive resilience embedding in the regional infrastructural network are important in hazard-prone areas (Adger 2006; Nielsen & Vigh 2012).

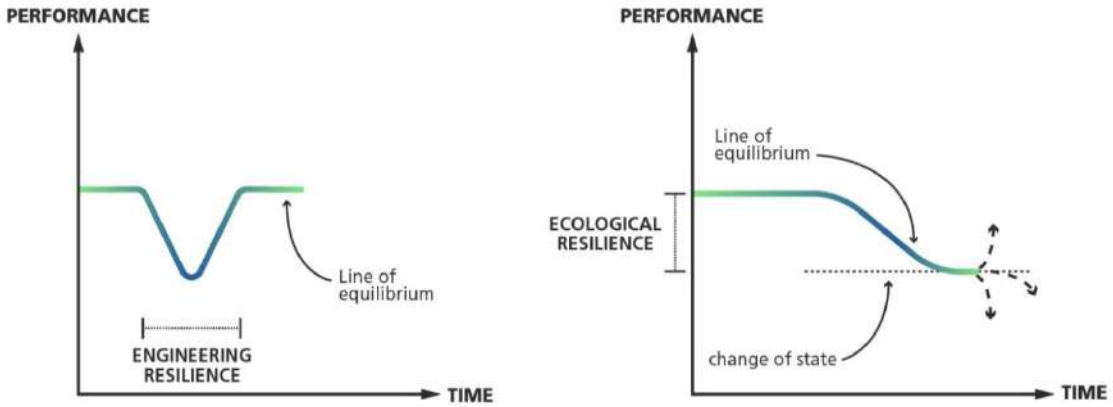


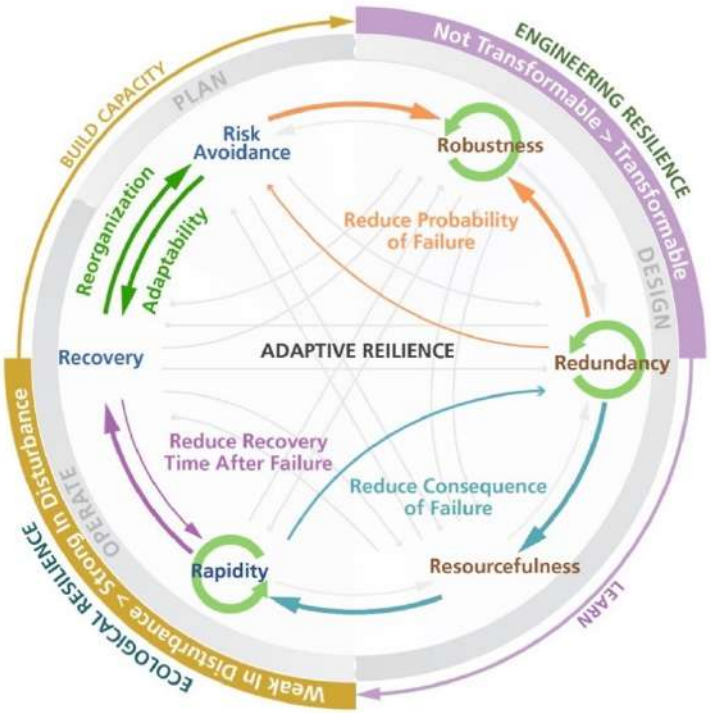
Figure 2A: System behaviour under ecological and engineering resilience is different responding to time for recovery and the magnitude of change in performance (Holling, 1973, 1996; Bruneau et. al. 2003).

3. Building Adaptive Resilience: A Conceptual Framework

Building adaptive resilience is introduced as conceptual framework on both the stability of shifting system and adaptability to climate change (Bruneau et. al. 2003). We argue that the duos are complementary in the economic, social, and environmental resilience of GBA. Gunderson (2000) noted that the engineering perspective is inadequate due to the assumption on equilibrium systems, although ecosystems do not have single equilibrium monitored at proximity. Contrastingly, adoption of a socio-ecological approach defines resilience as the "ability of a system to return to equilibrium after a temporary disturbance (Holling 1973)." Integrative conceptual framework addresses urban vulnerability as a system behaviour responding to recovery time and the magnitude of change in performance (Holling, 1996). In Figure 2A, the system behaviour under ecological and engineering resilience is different responding to time for recovery and the magnitude of change in performance (Holling, 1973, 1996; Bruneau et. al. 2003; Connerly 2016). Ecological Resilience challenges the assumption in Engineering Resilience on equilibrium notion and attempts to address the interoperability and integration of diverse disciplines (Reid & Vogel, 2006; Biesbroek 2009). The distinctions lead to three distinctive stability levels (Gallopin 2006). They are (1) equilibrium capability, (2) shift of state within the same stability landscape, and (3) the change of landscape stability while the structure remains the same, respectively (Laboy & Fannon 2016). The use of term resilient to describe cities, like ecosystems, acknowledges its dynamic nature (Puente 1999; Adger 2000). This paper reviewed literatures on adaptive resilience through both lenses and discusses how adaptation in design thinking would anticipate shock in the design process.

A conceptual framework in Figure 2B is established evaluating the regional resiliency in GBA. Adaptive resilience is the interplay of disturbance and reorganization with social intent (Hettige et.al. 2018). This socio-ecological framework focuses on the adaptability, transformability, learning, and recovery (Gallopin 2006). Resources, transportation, human capital, and communication are four key aspects in the TOSE model (Technological, organizational, social, and economical) for ecological resilience in architecture (Laboy & Fannon 2016). They refer to the artefacts in the technical-ecological, economic, social and organizational domains (Luthar et.al. 2000; Vanham 2017). Adaptive models embrace dynamic system transiting to new normal (Gunderson 2000; Reid & Vogel, 2006; Chang et.al. 2018). The six interrelated dimensions are (a) Risk avoidance, (b) Robustness, (c) Redundancy, (d) Resourcefulness, (e) Rapidity, and (f) Recovery, respectively. These stages are contextualized to the phases of architectural practice, planning, design, and operation integrated with reorganization in Figure 2. Firstly, Risk avoidance, robustness and redundancy can reduce the probability of failure. Secondly, the combination of redundancy, resourcefulness and rapidity minimize the consequences. Thirdly, the synergy of rapidity can reduce the recovery time after failure. Lastly, reorganization and adaptability of the post-recovery process is determinate to reinforce resilience for short or long terms.

Figure 2B: Adaptive Resilience: the application of the resilient model as adapted to the phases of architecture practice considers early planning decisions and late recovery and reorganization strategies.



4. Socio-economic Resilience in GBA: Robustness, Redundancy, & Resourcefulness

4.1.Dongjiang: Access to Water

Clean water is vital for agriculture, food production, industry, and daily living (Stern 2006; Jenkins et. al. 2009; Laukkonen et. al. 2009). Dongjiang, in the main tributary of the Pearl River, provides for the majority of Pearl River Delta (PRD) cities in GBA (HKTDC 2018; KPMG 2018). The tight integration of cities is widely viewed as a threat to self-reliance (CLSA 2018). The greater integration of water and electricity networks with Guangdong, specifically, is under an impression on over dependency of external resources (Shamsuzzoha et. al. 2018). For example, Hong Kong indeed, relied on importing water from the Donjiang River following a severe drought in the 1960s (Ng & Cook 1997; Zacharias & Tang 2010). Despite rich water resources from the PRD, shortages of clean water are the concern as infrastructure struggle to keep up with the regional rapid urbanisation since the 1980s (Shenzhen Government 1986; Yeh 1996; Hu 2005). Beyond water shortage, Hong Kong also anticipates great integration to deal with too much water as a coastal city due to sea-level-raises (Zacharias & Tang 2010). Hence, flood defences, such as sea walls and water-catchment system, are examples for robustness strategies for resilience (Gersonius et. al. 2008; Lai et. al. 2016). Sponge City concept, as a regional resilient strategy, is applied in the vast urban development in GBA (Guangdong Government 2010; Chan et. al. 2018). This concept is similar to the Low Impact Developments (LID) approach in the United States (Pyke et al., 2011); Sustainable Urban Drainage Systems (SuDs) (Griffiths, 2017; Mitchell, 2005) and the Blue-Green Cities (BGCs) approach (Thorne et al., 2015) in the United Kingdom. In GBA, historic typhoons inflicted billions of properties damage which took weeks to resume (Geels & René. 2007; Delmastro et.al. 2016; PD 2016). A system-based approach redefines performance for measuring flood resilience (Luthar et.al. 2000; Laboy & Fannon 2016).

From the complex system perspective, GBA is represented as multi-level integrating systems in Figure 3 (Zacharias & Tang 2010; Romero-Lankao 2012). The megacity system is composed of input-output units, including positive and negative feedback loops (Zhao 2010; Leung et. al. 2017; Wei et. al. 2017). The neighbourhood level is composed of interacting subsystems such as buildings, roads, and civic places to support the inhabitants (Gallopin 2006; Young et. al. 2006). All regions are part of the catchment system, PRD. There are three steps of measures at each stage to reduce the overall system's flood vulnerability (Luthar et.al. 2000). Reducing exposure and sensitivity by mitigating recovery are keys. GBA Port development underlying the flood propagation through the catchment system is important (Geels & René. 2007). The propagation of a flood wave in the neighbourhood is buffered by thresholds at each level in Figure 3, i.e. flood barrier protects the catchment (Guangdong Government 2010; PD 2016). Flood exposes at one level depends on the interventions implemented at its prior (Luthar et.al. 2000). In other words, top-down initiated feedback process manages the flood exposure. Meanwhile, Robustness is enhanced from the bottom-up (Laboy & Fannon 2016). For example, designing flood

proof building can grantee survival to the home owner at critical time (Geels & René 2007; PD 2016). A network of support enhances the city robustness and reduces dependency (Shenzhen Municipal Government 2007). Individual flood resilience at street and building level are important to urban resilience, waterfront real-estate, (Guangdong Government 2010; PD 2016). Neighbourhood strategies are economically efficient because of structural responses in managing flood losses (Abunyewah et. al. 2018; CLSA 2018). Achieving Gallopin's third level of stability with the change of landscape stability while the structure remains the same (Gallopin 2006). All in all, urban flood resilience involves multiple levels, and understanding the interaction of the established ecosystem ensures liveability.

5. Socio-environmental Resilience in GBA: Risk avoidance, Rapidity & Recovery

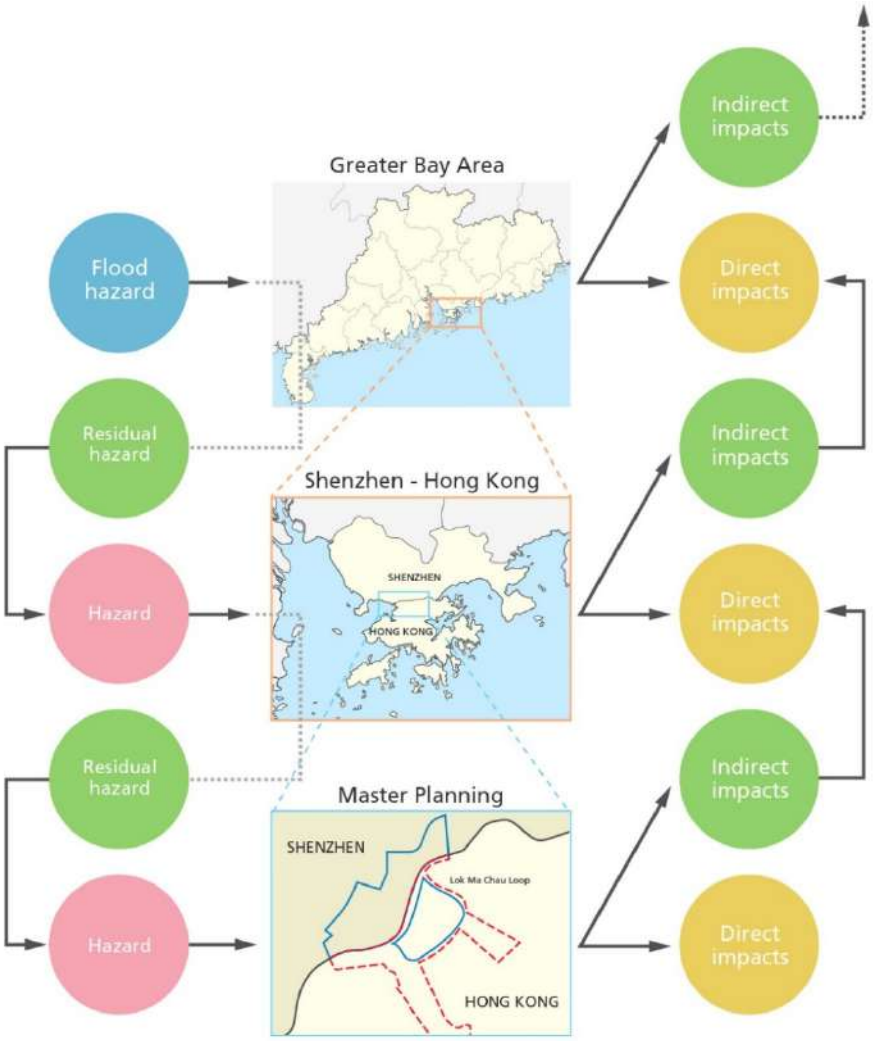
5.1.Transit-oriented developments with Blue-Green Infrastructure

Transit-oriented developments (TODs) are identified as the most socio-environmental resilient strategy (Cervero & Day 2008; Harvey 2014; Black et. al. 2016). TODs refer to the high-density housings with complementary retail and services around transit stations (Calthorpe 1993; Li et. al. 2013; Guthrie et. al. 2016). TODs are significant avenue for sustainable urban development model in Guangzhou, Shenzhen, and Wuhan (Lai et. al. 2007; Li et. al. 2013). The intercity connection and regional integration with connections between counties are taking shape (Luthar et.al. 2000). Redundancy and resourcefulness enhance the high-tech product export bases, free trade zone, cross-border e-commerce pivot zones and national university Technology Park (Lai et. al. 2016; CLSA 2018). The synergy of bay-area economy is coupled with high mobility and connectivity network. For example, the construction of Daqing-Guangzhou Expressway, Lechang-Guangzhou Expressway, Guangzhou-Shenzhen-Hong Kong Express Rail Link, Xiamen-Shenzhen Railway, Guiyang-Guangzhou High-Speed Railway and Nanning-Guangzhou High-Speed Railway are rapidly completed to achieve this goal (Guangdong Government 2010; Qihu 2016; CLSA 2018).

HK-Shenzhen Innovation and Technology Park, for example, is a TOD project responding to socio-environmental resilience (HKTDC 2018; KPMG 2018). An 87-hecttare area in Lok Ma Chau Loop in Figure 2 at the border between Hong Kong and Shenzhen is destined for new innovation hub signed with the memorandum of understanding (MoU) in January 2017 (CLSA 2018). This wetland region with a sensitive ecological reserved zone is developed to be home for robotics, biological medical, smart, and financial technology (Guangdong Government 2010; PD 2016). Flood resilient design strategies are vital since the water table in low lining area is high (Gunderson 2000; Chang et.al. 2018). Careful planning of Blue-Green infrastructure delivers multiple benefits to the public by creating recreational space and improving the amenity of a district (Wang et al., 2017; Chan et. al. 2018). Embracing the flood retention nature, adaptive resiliency can enhance ecological value (Schroeder et.al. 2008). Adopting blue-green infrastructure for flood control is an emerging trend (Ahern 2013; Oldham & Astury 2018). By infiltration, rainwater and storm water can be discharge to trunk system slowly (Sweya et.al. 2018; Perera 2018). By absorbing urban storm water through soil infiltration, retention, storage, purification, recharge groundwater and improving water quality of the runoff (Everett et al., 2015; Chan et. al. 2018). Nevertheless, risk avoidance with appropriate site selection cannot compensate the loss of carbon sinks. Top-down governance at macro scale also led to forced eviction, cultural assimilation, efficient urbanization, by pressing for modern infrastructure (Puente 1999; Pollice 2016). Therefore, the near future of GBA development is subject to a high vulnerability in disaster risk by compromising resilience design for economic growth.

6. Conclusion

Based on building adaptive resilience framework, this paper investigated whether GBA has developed the systems and capacities to be able to absorb future shocks over time to maintain the fundamental functions while mitigating the present causes of future stresses. Applying resiliency in design thinking in an integrative manner engages designers meaningfully by anticipating potential shock in planning for short-term. Meanwhile, policy makers can use adaptive strategies in evaluating the magnitude of disaster risks in building long-term policy by enhance accountability at the regional, city, and neighbourhood level. At the regional level, fresh water is a scarce resource, but Dongjiang in the only tributary of the Pearl River rises. This creates a negative feedback loop at the catchment level. Hence, Sponge City Concept is proposed as a resilient strategy to improve self-reliance. Contrasting to conventional flood-risk management policies, adaptive resilience involves multiple spatial levels based on an understanding of the established ecosystem to the sure liveability of post-hazard GBA. Although GBA perform well in building redundancy at the inter-city level with the rapid development of the



local transport networks and major national passageway projects, TODs and technology hubs on risk prone area is a highly vulnerable neighbourhood. Nevertheless, building a global technology and innovation hub is high on the regional government's agenda. However, inappropriate site selection exposes development to a high vulnerability in disaster risk and compromising city resilience. It is alarming that developments are not in alignment with the *Sendai Framework for Disaster Risk Reduction 2015-2030.* When available safe sites are saturated, subsequent growth spills over to high-risk areas. Top-down governance is under positive light as strategies for progress, and pressing for modern development. Understanding that the six elements of adaptive resilience are interrelated, the weak link in one aspect would be detrimental to another. GBA is lacking behind on policy addressing risk avoidance and recovery strategies for long term at this dynamic stability system. Therefore, it is critical for architects and policy makers to apply this conceptual framework in preparing extreme event from climate change and building a sustainable future.

Figure 3: Flood Resilience: traveling across spatial levels; this figure depicts the propagation of flood wave through the catchment system in case of a failure or overtopping of the primary flood-protection system.

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Teaching resilience for urban planners and architects

Konstantinos Lalenis [a,*], Balkiz Yapicioglu [b]

[a] University of Thessaly, Greece
[b] Arkin University of Creative Arts and Design, Cyprus

Abstract

Collaborative lecture series were designed to teach a graduate course called 'Resilience', where two different student groups from two different countries (and cities) explored the concept of city resilience as their project in their course and explored the concept of city resilience in their local cities. One of the groups was based in Greece and were Regional and Urban Planning graduate students. The other group was based in Cyprus and were graduate students in Architecture. The two programs were shaped in such a way, as to have a common theoretical origin, based on the framework for resilience researched about globally, and were further specialized, being adapted in the equivalent local specificities. Parts of the programs were common lectures, presentations, and progress reports. This paper, not only discusses the approach used by the authors to teach the concept, but also focuses on how the students used the existing resilience concepts in their project and discusses the challenges and the learning outcomes from the course.

Keywords: Resilience; urban planning; architecture; teaching

1. Introduction

Resilience has been widely discussed about in the last decade, and one of its definitional characteristics is its fuzziness. Different approaches have been adopted in academic and policy literature, with different applications of the term in every aspect of our lives as explained in detail and as depicted chronologically (Figure 1) by Alexander (2013). Urban resilience, in particular, has been defined by Arup and Rockefeller foundation as "the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience".

Furthermore, several researches consider urban environment as a complex, able to self-organized and learning system in constant change, moving forward from a disturbance and they argue that urban adaptation/ transformation is the key feature of urban resilience. In general, the approach of resilience used in urban planning, and the means and practices of its implementation in cities, has always its challenges. One of the biggest challenges of the concept is that, it is local and diverse, and not standardized which deals with countless interactions.

Moreover, cities are very dynamic, and their ever-changing circumstances can cause challenges in adaptation, but is also a concept that greatly benefits the cities to come to the terms with their vulnerabilities, whether it be infrastructure, natural disasters or human caused stresses. However, there is also the challenge of how to connect theory to practice with concept of resilience and over the years the authors of this article have found this to be a challenge in their research and teaching. Consequently, the authors had planned to undertake the challenge to teach a master course for their graduate students where the resilience was the main core of the course from the perspective of 'city planning' and by the development/improvement of spatial policies related to city planning.

* Corresponding author. E-mail address: klalenis@uth.gr

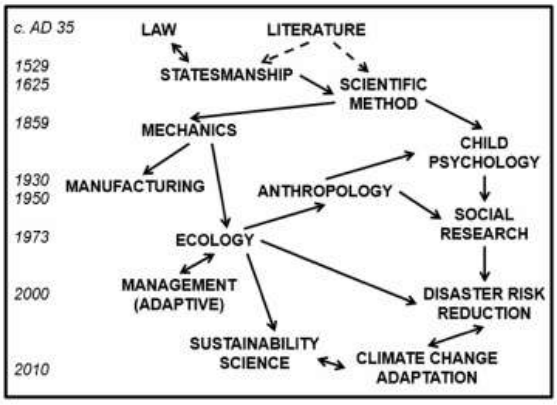


Figure 1: Schematic diagram of the evolution of the term "resilience (Alexander, 2013)

How different subjects seek to establish resilience and the kind of effects this produces, in terms of politics, society, and the ontology of the subject itself, however, might take different forms (Cavelty et al., 2015). Within the rhetoric of 'City Resilience', resilience has been most commonly discussed as a normative concept to build capacity to manage specific risks, including climate change, terrorism, and economic and regional profound implications, leaving much existing governance and practice uncontested. It is mostly concerned about the ability of a system to return to equilibrium after being disturbed temporarily creating an ideological trope that argues for the citizen to merely adapt to the normal demands of capital and the state, rather than via more transformative measures (White and O'Hare, 2014) and it is usually more about the preventive measures in the face of certain disturbances.

However, when the course was designed, we did not want to concentrate just on the measures taken in the face of disturbances but wanted the students to understand how they could approach resilience in cities where change could be initiated by altering the nature of a system (in this case the cities), and therefore 'evolutionary resilience'. This view of resilience does not see the world as orderly, mechanical and reasonably predictable, but sees it as chaotic, complex, uncertain, and unpredictable. Simmie and Martin (2010), similarly, look into this dimension of resilience that advocates a new form and function, better equipped to accommodate shocks or stresses and the focus is on the long-term capacity. Knowing that fourteen weeks might be a short period to achieve this, the objectives and the aim of the course, as defined below, were designed as introductory statements where students would have the opportunity to develop their own interpretation of resilience working with a real-life situation.

2. Learning objectives and the structure of the course

The "Resilience in Spatial Planning" was a joint initiative of the planning departments of the Thessaly University of Greece and the Girne American University of Cyprus. Both universities were the creative leaders, being responsible for the idea development, set up and implementation of the course. A similar course was delivered at the PhD level two years back at Girne American University, however the content was more based on the concept of resilience (mostly theoretical) and did not necessarily address city resilience and did not have a research focus. Therefore, the content for this particular course, firstly provided an international-comparative perspective on spatial planning, not only from a theoretical perspective but also from practice-oriented perspective. The course introduced Resilience, the underlying theories, concepts, and frameworks, spanning from: (1) micro- to macro-scale, (2) past to the future, (3) generic to specific, and (4) material, organizational, and institutional level. Each University represents a specific institutional background, and therefore would provide an overview of its country practice specificities.

From the very beginning of the course it was a challenge how to introduce the concept of resilience to the students since none of the students had previous exposure to the concept of resilience in spatial planning. The course in both countries had similar formats where each course lasted 14 weeks and held once a week for 3 consecutive hours. Because of the concepts complexity and its different applications in different cities, it was agreed that students initially introduced the theory of resilience which was based on the concept on the ecological resilience.

Like many of the other master courses in both institutions (Thessaly University and Girne American University), self-learning was one of the main structure how the course was designed. However, the initial couple of weeks were based on class lectures where different concepts of resilience was introduced by the

lecturers. Even though the students had planning and architecture background, city resilience or urban resilience were not the main focus of the lectures but how the concept was evolved and how the concept was integrated into different disciplines. Students were then asked to research the concept of the resilience where they were scheduled to present their findings via classroom presentations. The students then were assigned to realize the concept of resilience by assessing the resiliency of city of Volos (Greece) and city of Kyrenia (Cyprus), using the knowledge and the methods they would choose. Both students in Greece and Cyprus worked in groups for their project.

Knowing that fourteen weeks might have been a short period to achieve a deep understanding of city resilience within the framework of systems theory, the objectives and the aim of the course, as defined below, were designed as introductory statements where students would have the opportunity to develop their own interpretation of resilience working with a real-life situation.

Main objectives of the course:

1. An understanding of the breadth of factors that give rise to urban vulnerability (for example building construction, urban planning, infrastructure provision or transportation and human); and
2. A foundation for assessing indicators to measure resilience

Aim of the course:

1. Evaluate the environmental, social and economic inputs and the ways that it may contribute to vulnerability/ resilience.
2. Understand what and who makes a city resilient
3. Learn man-made and natural factors' influence on the built environment and develop responsive planning schemes for more resilient cities.
4. Understand that, most planning solutions are found on the local level, embedded in institutional frameworks on the national scale.

Accordingly, the course was structured into 4 different components:

A) Knowledge Component: The first component of the course covered the structure of the course where students were given a brief definition of the concept resilience, subject of focus and research the students were expected to undertake during the course. During this component of the course, students were also given the task to research of bibliography and reference on the subject, where this collection of bibliography and references were collected in a pool. This was achieved by separating students in groups of two or three with each group having a coordinator to compile and organize the notions and definitions on resilience. Eventually, the students presented their bibliography and references in a classroom discussion at the end of the third week of the course.

B) Assessment Component: The second component of the course focused on research on master plan of their cities (Volos and Kyrenia) where students had the opportunity to meet with local governance and got acquainted with their cities. During this component students explored, and defined points and sectors related to resilience in their cities, both internal and external. Moreover, students explored how the resilience of cities are related to vulnerabilities, using tools, like SWOT analysis, and other tools they had come across during their research of the existing literature. This component was intended to lead the students to recognize that assessing the vulnerabilities and the capacities of a system plays an important role in resilience measurement and touches upon many disciplines. Furthermore, resilience can only be understood in a truly interdisciplinary fashion and this is how contribution to the successful inclusion of vulnerability assessment in planning and development can be created.

C) Deliveries Component: This component was about presenting the initial assessment and analyses outcomes for both short-term and long-terms. At this component the intention was to evaluate the capacity of the cities according to the assessment results, where the measures to increase resiliency was presented to the lecturers for further comments for final presentation. Grasping the idea that resilience is also affiliated with other combinations of relationships, such as vulnerability, persistence, change and transformations was the intended outcome of this components and this was achieved by the support of the comments from the class lecturers. The idea of Panarchy of nested adapted cycles of evolutionary resilience by Gunderson (2001) was introduced at the end of this component.

D) Modelling Component: This component was the final presentation on the models that groups sought to create resilience. Before the presentation of their final models for creating resiliency, the groups from the two different cities (Volos and Kyrenia) were given the opportunity to exchange ideas for their final models. This had been initiated so that it is clear to the students that resilience is contextual and that resilience also posits that the relationships between the agents of the system are more important than the agents themselves.

3. Discussion on the class progress and outcomes

In the preliminary stage that the idea of "parallel" graduate courses about resilience was explored, it was thought that it would be interesting that two different groups of students from the two universities should study urban resilience of the same place, this being either Volos or Kyrenia, or another city. Soon, though, the idea was abandoned due to financial restrictions, and it was decided that each group would study resilience in its own home city, with a common theoretical origin and a broad common methodology.

The course was conducted without the two groups of students being able to acquire a first-hand knowledge of the other group's case study. In the initial programme, two visits were scheduled, one in Volos and one in Kyrenia, where the two groups would have the opportunity to work together, and comprehend the equivalent/ mutual social structures of local environments and perceptions on urban resilience. Unfortunately, the financial restrictions proved to be impossible to overcome, given the inabilities of many students to pay for their trip and the lack of other possible sources of funding. As a result, evaluations and risk assessment of each group were based on perceptions of local specificities, which the other group did not have the chance to grasp. This was particularly obvious in the SWOT analyses, and in composing the City Resilient Index (CRI-Arup) for each city. This problem was tackled by organizing tele-conference presentations about the two cities, firstly at the beginning of the Assessment component –in parallel with the presentations of the equivalent Master Plans- and secondly, during the modelling component, at the time that the two groups were exchanging ideas about their final models.

The final modelling of resilience in both groups showed that students were initially more comfortable in working according to the approach of City Resilience Index, with reasonably good quality results. They studied resilience in four dimensions: leadership and strategy, health and quality of life, environment and infrastructure, and society and economy. While these dimensions were the same for both groups, further analysis in specific targets and implementation measures differed, obviously reflecting the different local characteristics and specificities of the equivalent cities. The two groups further attempted to analyse resilience through the approach of adaptive cycles, focusing on the previous four dimensions. The justification of the structure of the produced diagrams was mostly based on the CRI that had been previously conducted, and they were adequately sufficient. The attempt for further generalization of adaptive cycles, though, seemed to be often oversimplified as shown in the following two examples of outcomes one from Kyrenia showing the final outcome, and one from Volos, which shows progress during research (see Figures 2 and 3).

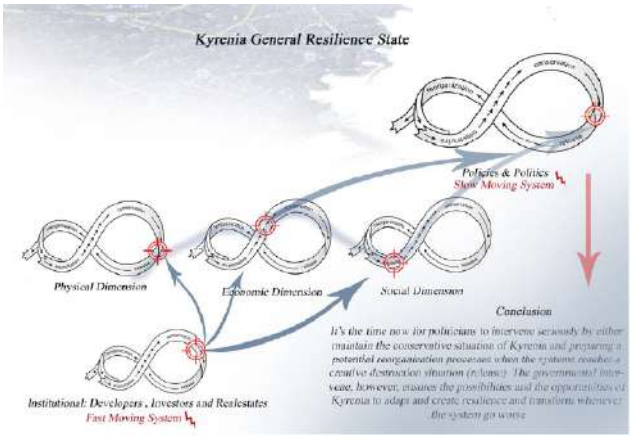
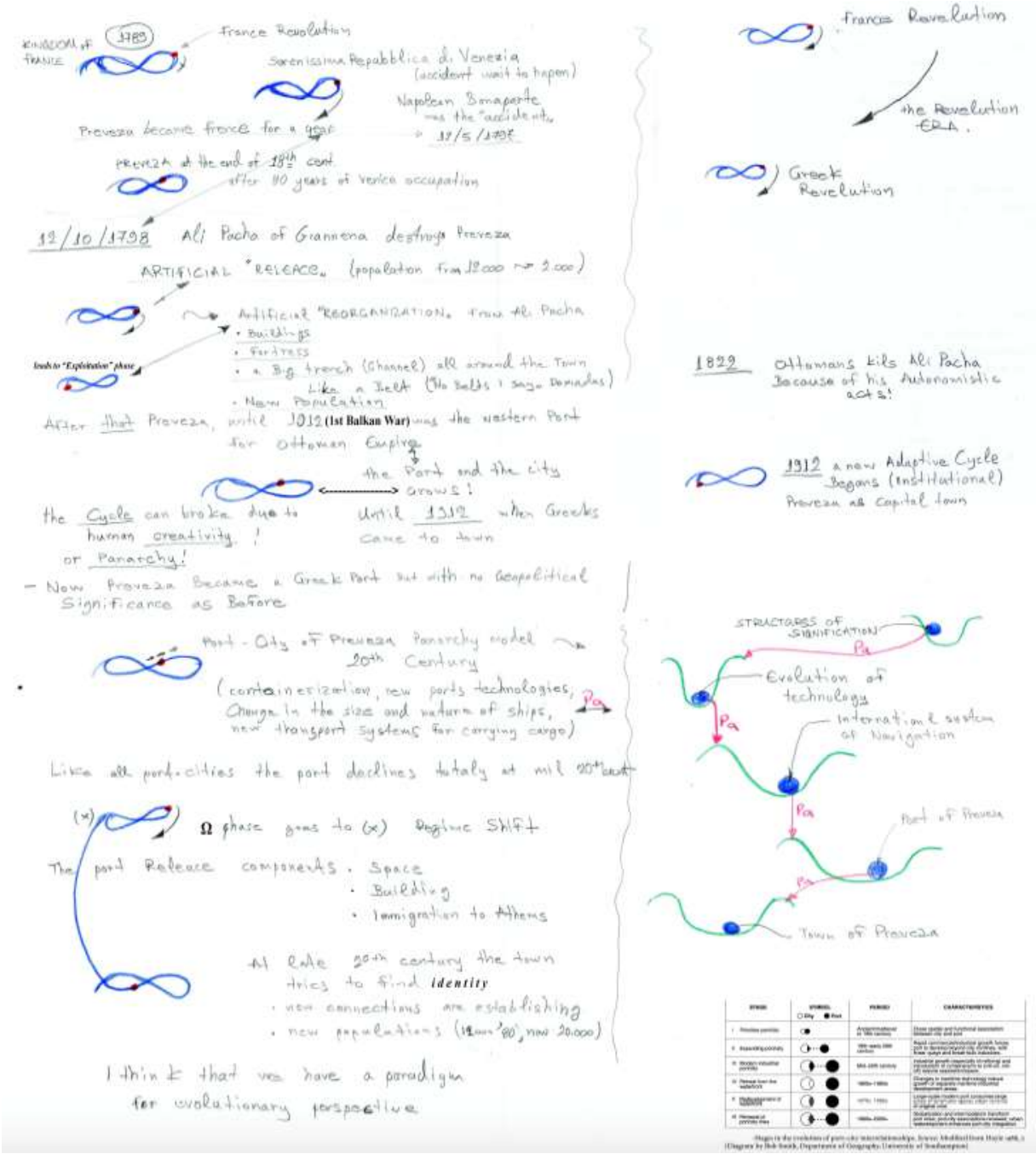


Figure 2: The interaction of slow and fast-moving systems in Kyrenia forming the current general resilient state of the city:by Ma'in Abushaikha, 2017, student from Kyrenia.

Both sketches show that the students were comfortable using SWOT analysis to create their own understanding of resilience and representing their findings using the adaptive cycle for each four dimensions to measure the resilience of Volos and Kyrenia, while some students used different time scales to reach their final measurement of resilience.

Figure 3: Progress of research during the course from Volos. by: Kotsinis Christos, 2017, student from Volos.

The approach was aimed to be creative, as the organization of the module was open-ended and continually challenging. In a background of theory and knowledge offered by the lectures delivered, learners were in a continuous pursuit to arrive at a consensus concerning the best possible way in which the required resilience analysis and assessment would be organized. From the very beginning, learners were challenged to choose by



themselves the questions they needed to explore in their approach. Evidence has shown that the approach of both groups has been imaginative and creative while most criticism has been constructive. The involvement of stakeholders and the organization of participation processes during the course, also added to the creativity of the approach.

Relating theory to practice was also the major concern for the specific course. Apart from specific examples of resilience studies given whenever this was essential, this was also achieved through the presentation and analysis of cases out of the 100 Resilient Cities projects.

4. Conclusions

The type of "parallel learning" and cooperation of two groups of graduate students with relative professional backgrounds, but from different institutions and countries proved to be fruitful and exciting. It was flexible, it kept students' interest on high levels all during the course, it helped students acquire knowledge and skills in a subject that currently is at the forefront of planning research and practice, and most of all, it gave them the opportunity to understand the impact of natural, cultural, legal, and local differentiations on a common theoretical origin.

The notion of resilience seemed to be better understood through the elaboration of the City Resilient Index (Arup) and the subsequent analysis of case studies conducted within this framework (100 Resilient Cities). The Adaptive Cycles approach attracted the students' interest, but the final outcomes in the implementations in Volos and Kyrenia remained somehow static, possibly because of the heavier and more "dense" theoretical requirements that the particular approach presupposed. Nevertheless, there were students of both groups who chose to grasp deeper in the resilience issue, and went on working on it for their Master thesis (or a PhD in one occasion). Interestingly, in all these cases, the adaptive cycles approach was the adopted approach.

In retrospect of the Resilience graduate course, an obvious conclusion is that the "parallel" way of conducting it in groups of students of different institutions, in different countries, presented exciting perspectives as well as inherent difficulties and problems of various natures. But this is also the dynamism and one of the most important virtues of education: attracting interest, raising questions, provoking debates, and constantly providing space for further improvements. Furthermore, the course was successful where it provided a platform to foster cooperation with colleagues from different parts of the world.

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Urban ecological planning as a long-term instrument for risk governance in Guangzhou

Jieling Liu [a,*]

[a] University of Lisbon, Portugal

Abstract

Urban ecological planning has been adopted in many Chinese cities for reducing climate risks and restoring degraded ecosystems. It is aligned with the Sendai Framework to manage the changing dynamics of human-nature linkages in cities to stay resilient within planetary boundaries, as urban ecological systems provide multiple ecosystem services essential for urban environments to rebound from climate change impacts, pollution and degradation, hence building ecological resilience and benefiting health and well-being. How exactly does urban ecological planning help govern risks and make Guangzhou more resilient? This key question leads to an in-depth analysis of current ecological planning policies and governance model. The main objectives are to verify the contribution of ecological planning to risk governance in cities within the Chinese system and to propose ways forward for resilience thinking in risk governance. Building on relevant theories and concepts including risks and resilience, governance and urban planning, a throughout policy analysis is conducted. The paper finds that urban ecological planning contributes constructively to risk governance in Guangzhou and reflects a long-term vision and value for human-nature harmony. Although the current top-down approach and the one-sided technical focus of risk governance need to be addressed with more systemic and socio-economically inclusive approaches.

Keywords: Urban ecological planning (UEP); risk governance; resilience; sustainable socio-economic development.

1. Introduction

Today and globally, human beings are increasingly exposed to risks. Just in 2018 alone, we have experienced heatwaves across much of Europe and Asia, wildfires across the U.S. and droughts that preoccupied Australian farmers. Such ecologically devastating risks implied the absence of respect that human beings have long indebted to the natural environment (Friedmann, 2011). Many global risks are concentrated in urban areas and they have become more complex and uncertain due to climate change, dense population and ecological degradation which jeopardised the self-maintenance and carrying capacity of the natural systems (IPCC, 2014). Such is the case of Guangzhou, a megacity located on the low-laying estuary of the Pearl River Delta with 14 million urban population. It is ranked as the city at the greatest risk facing climate change in the world in terms of the overall cost of damage by flooding as sea level rises (Worldbank, 2013) and No. 4 at risk in terms of population exposed to flooding (Hanson et al, 2011). Indeed, rising sea levels, storm surges, floods and heatwaves are dangerous for Guangzhou as they imply risks of death, injury, ill-health or disrupted livelihoods, breakdown of infrastructure networks and critical services and are likely to intensify in the coming decades (IPCC, 2014; C40). It is critical that these risks are governed for cities to stay resilient and that residents' health and wellbeing are protected. Governing risks and protecting Guangzhou in the future facing climate change require considerable improvement in current planning (Worldbank, 2013).

Conventionally, risk governance has mostly focused on delivering basic services, typically involving institutions such as departments of public health, security, police and fire. Conventional risk governance has largely been reactive, short-term and working in sectoral silos, challenging institutions across the world to deliver effective and comprehensive management towards increasingly complex and uncertain risks. Urban planning deals with anticipated changes often of years to come in the natural and built environments, therefore is more preventative and long-term. Urban ecological planning is based on the ecological principle of pursuing human-nature harmony and it recognises and makes use of the multiple ecosystem services of natural ecological systems, therefore is capable of reducing these life-threatening risks and build resilience. Therefore, urban ecological planning is also aligned with the Sendai Framework's aim to manage the changing dynamics of

* Corresponding author. E-mail address: jielingliu@campus.ul.pt

human-nature linkages in cities to stay resilient within planetary boundaries. Under the guidance of the national development paradigm and environmental policy framework *Ecological Civilisation*, Guangzhou applied a set of planning policies for urban environmental risk governance which seem to be more ecological, preventative and long-term. How exactly do these planning policies help govern risks and make Guangzhou more resilient? This key question lead to a mapping of current ecological planning policies in Guangzhou and actual governance model, from which lessons learned are drawn and recommendations for improving risk governance in Guangzhou is made.

2. Objectives and methodology

The paper has three-fold objectives. The first is to verify the contribution of planning, in particular, urban ecological planning, to risk governance in cities. The second is to enrich the field of research of urban environmental risk governance within the Chinese governance system. The third is to propose ways forward for resilience thinking in risk governance. Building on the summary of relevant theories and concepts including risk and resilience, sustainable development, environmental governance and urban planning, several ecological planning policies are carefully selected and analysed.

3. Conceptual framework

Risks appear generally in the contexts of human taking actions to transform the natural into a cultural environment with the aim of fulfilling certain needs (Turner et al., 1990). Indeed, risks emerge in any social-ecological systems where human activities are connected to an ecological setting. But risks do not only appear when humans take certain actions, as Renn (2008) further defines: risks appear at any time when any human individual or groups face several options for taking action, or not taking any, and each of these options is associated with potential consequences. Since the nature of these consequences are human experiences, risk is not merely a mental perception but that it can be transformed into reality depending on the options and actions taken.

When it comes to governing risks, Gunningham et al (1998) defines it as a process involving the ‘translation’ of the substance and core principles of governance to the context of risks. In a risk-related decision-making process, a critical moment when a risky incident occurrs defines the actions (or non-actions) towards the risks as either preventative or reactive. In general, risk governance models evolved from simpler reactive models to more preventative and more inclusive ones. Take three theoretical risk governance models (NRC, 1996; Omenn, 2003; Millstone et al, 2004; Renn, 2008) as examples: the ‘technocratic’ model, the ‘decisionistic’ model and the ‘transparent (inclusive) governance’ model. While the ‘technocratic’ model focuses on directing objective scientific findings of risks into policy-making, the ‘decisionistic’ model also considers other legitimate factors, and finally, the ‘transparent (inclusive) governance’ model stresses the participation of the science, politics, economic actors and representatives of civil society in both risk assessment and management. Scholars like Renn (2008) emphasises the inclusion of both the ‘physical’ and ‘social’ dimensions of risk and deems public values, concerns and perceptions of risk equally important for risks governance.

Urban planning is potentially a useful tool for improving the quality of urban environment. From a physical planning perspective, it is about improving the spatial functionality of urban infrastructures in order to accommodate the anticipated population and activities. Urban planning theories gained ecological thinking in the late 1960s when McLoughlin (1969) was inspired by the natural phenomena in 'ecosystems' and viewed urban natural and built environments as a system of interconnected parts. In the 1980s and 1990s appeared more theoretical quest on planning for environmentally 'sustainable' cities (e.g. EU Expert Group, 1994; Barton et al., 1995). One issue of particular relevance for today was whether the 'compact city' might, in general, be environmentally more sustainable than the dispersed cities.

Resilience penetrated into the field of environmental and urban sustainability science from other disciplines like psychology and mathematics rather recently (Olsson et al., 2015). The term in urban processes refers to the adaptive capacity to maintain dynamic equilibria and transformation to desired social-ecological states (Simon et al., 2018). In urban planning, resilience can be defined both as a process and a goal, or the desired outcome. Risk and resilience are in a systole-and-diastole relationship in theoretical terms, as risks challenge to destabilise the dynamic equilibria of a social-ecological system by associating potential positive or negative consequences. Therefore, governance of risks means enhancing resilience. Since risks are complex and uncertain, resilience as the result of governing risks is therefore also fuzzy and difficult to be evaluated with clear metrics (Simon et al.,

2018). These characteristics of risk and resilience explain why most of the technical, piecemeal approach of risk management failed to reduce risks and protect the health and wellbeing of urban residents.

In summary, risks emerge in social-ecological systems and challenge the systems' dynamic equilibria with potential consequences on humans and their ecological environment. The system's adaptive capacity to rebound from such consequences back to equilibria is referred as resilience, a concept increasingly applied in urban planning which aim to improve the quality of the environment, especially the ecological quality of environment – an aspect of particular relevance for today.

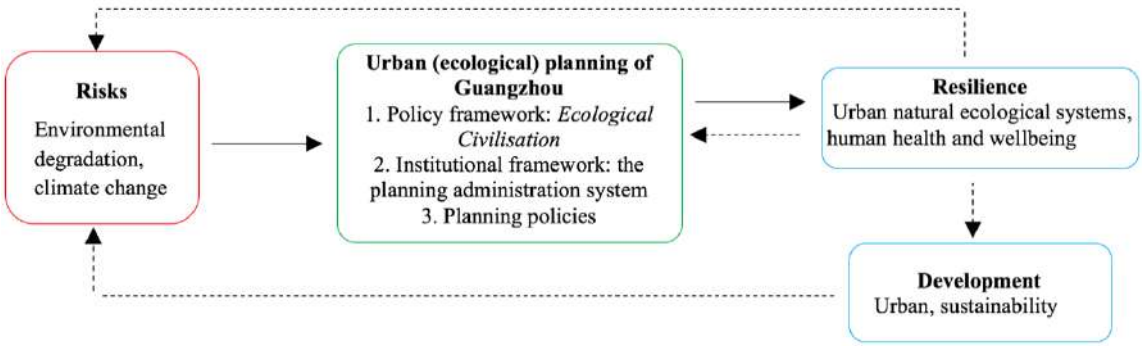

Figure 1. Conceptual framework: urban ecological planning as an instrument for risk governance in Guangzhou.

4. Urban ecological planning in Guangzhou

4.1.Ecological Civilisation as a national environmental policy framework

The concept *Ecological Civilisation* was raised for the first time by the former Chinese president Hu Jintao in 2005 as a potential new development paradigm, in order to address the environmental degradation across the country after three decades of rapid economic growth driven by manufacturing and industrialisation. The concept was officially written into the National Party Congress Report in 2007 as a "strategic goal" of China's modernisation construction. *Ecological Civilisation* values the integrity of human and nature – meaning human respecting nature and coexisting and co-prospering with nature, with an ultimate objective to develop and secure comprehensively a quality life for people (Pan, 2015). While it appears abstract and gestures political ambition as a development paradigm, *Ecological Civilisation* does possess a concrete facet with specific action indications as the national environmental policy framework. For instance, *Ecological Civilisation* has been promoted by the successive central government leaders to conduct reforms on ecological environment governance institutions (Wang and Su, 2015). In 2015, the State Council published the *Integrated Reform Plan for Promoting Ecological Progress*, outlining the need to improve the natural ecosystem and do so through more systematic, holistic and better-coordinated governance systems.

4.2.Institutional framework of urban ecological planning in Guangzhou

China's strong central government and its traditional top-down governance approach defined the institutional framework of urban ecological planning in Guangzhou, which is conformed in a vertical organisational structure. As illustrated in Figure 2, urban ecological planning in Guangzhou primarily involves the Bureau of Environmental Protection (BEP), the Development and Reform Commission (DRC), the Housing and Urban-Rural Construction Committee (HURCC), the Land Resources and Planning Commission (LRPC), the Bureau of Water Resources (BWR) and the Administration of Forestry and Landscaping (AFL). In general, these institutions report to their superior authorities – the provincial departments. In March 2018, a major reshuffle of institutions at the ministry level changed the way original individual ministries direct environmental policies downwards to the city level. Among them, two new ministries – the Ministry of Ecology and Environment and the Ministry of Natural Resources encompassed the functions of natural resources protection and management, urban and rural development, planning and ecological restoration.

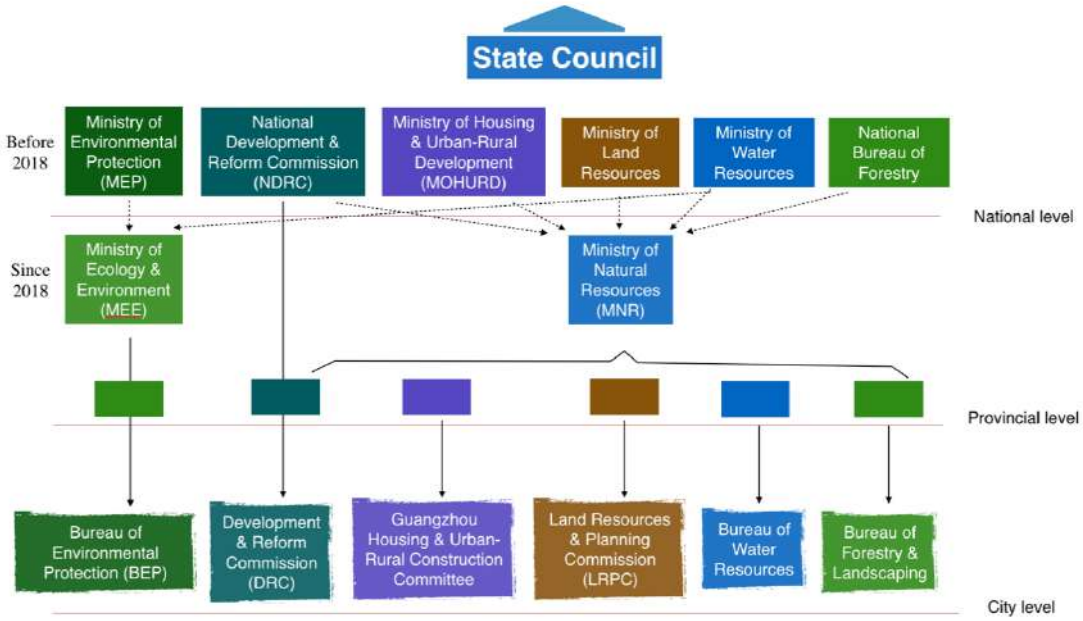

Figure 2: Institutional framework of urban ecological planning and governance in Guangzhou.

4.3.Ecological planning policies of Guangzhou

Under the guidance of the national environmental policy framework *Ecological Civilisation*, a series of plans and policies were introduced for Guangzhou to reduce the risks of climate change and environmental degradation. Table 1 lists six major ongoing ecological planning policies in Guangzhou, each one led by one of the departments at the city level and coordinated among the rests, as illustrated in Figure 2. The ecological planning policies listed are: Plan of Sponge City Construction, Plan of Guangzhou Urban Green Space System, Ecological Red Line System (highlighted in the *Master Plan of Urban Environment of Guangzhou 2014-2030*), Demonstration city of Water-Ecological Civilisation, Construction of Ecological Corridor Networks and the 13rd Five-Year-Plan of Ecological Civilisation Construction of Guangzhou.

The concept of *sponge city* takes the resilient characteristic of sponges to refer to the adaptive capacity of cities to cope with and rebound from environmental changes and natural hazards. The initiative aims to build cities which can absorb, reserve, purify and release water according to needs and improve cities' capacity for flood control, drainage and risk reduction. The Plan of Sponge City Construction is crucial for Guangzhou given the city's high susceptibility to water-related risks. Urban green spaces are essential components for building a sponge city as their ecosystem regulation service – flood prevention - forms the ecological functions necessary for processing water. Meanwhile, green spaces, if planned systematically for ideal quantity, quality and accessibility, can regulate local climate, hence reduce the risks of urban-heat-island effect and heatwaves. Green spaces can also ameliorate urban pollutions and foster biodiversity.

Building ecological corridor networks serve similar purposes of reducing urban-heat-island effect, fostering biodiversity and improving the quality of ecological environment. The ecological red line is a spatial baseline that must be maintained to improve the ecosystem functions of certain areas, which, once protected, could require ecological compensation or payment for resource use. Second lastly, Guangzhou sets out to be a pilot city to demonstrate "water-ecological civilisation" – an initiative led by the Bureau of Water Resources to pursue comprehensive urban water governance. Finally, *the 13rd Five-Year-Plan* sets the overall goal and provides comprehensive guidance for ecological governance in Guangzhou during 2016-2020.

Table 1: List of ecological planning policies of Guangzhou.

Ecological plans and policies	Year of introduction	Targeted risks	Leading city department	Goals
Plan of Sponge City Construction	2014	Storm floods, inundation, water pollution, water shortage, damages of ecological functions of river and lake systems, urban-heat-island effects	HURCC	Impact of urban development on ecological environment will be dramatically reduced, > 70% of rainfalls will be absorbed and recycled. > 20% of planned sponge areas will be built by 2020, > 80% by 2030. Flood management will be improved greatly and urban inundation will be mostly resolved, ecological spaces will be protected
Plan of Guangzhou Urban Green Space System	2010	Degradation of urban natural ecological system, loss of biodiversity, heatwaves, air and water pollution	BFL	Green space system will be established, carbon sequestration capacity will be increased. The urban central area will gain green landscape, green paths and community parks. Atmospheric and water quality will be improved. The city will lead in greening, water management and urban natural landscape.
Construction of Ecological Corridor Networks	2009, 2015	Degradation of urban natural ecological system, loss of biodiversity, heatwaves	LRPC	Urban-heat-island effect will be effectively reduced. Water and air quality will be greatly improved.
Ecological Red Line System (Master Plan of Urban Environment of Guangzhou 2014-2030)	2014	Degradation and vulnerability of urban natural ecological system	BEP	Ecological functions of nature will be secured, degraded areas will be restored, sensitive and vulnerable areas will be protected.
Demonstration of water-ecological civilisation	2013	Damages of ecological functions of river and lake systems, water pollution	BWR	Water resource management will be effectively implemented, total usage will be under control, while consumption efficiency and quality will be improved. Flood management, water provision and carrying capacity will be improved. Ecologically vulnerable river and water bodies will be restored effectively.
Outline of the 13rd Five-Year-Plan of Ecological Civilisation Construction of Guangzhou (2016-2020)	2016	All the risks mentioned above.	DRC	Ecological red line and spatial control will be established to reduce environmental risks. Healthier environment: 86% of days with good air quality with a yearly average of PM2.5 < 30μg/ m³. A more comprehensive institutional system for ecological civilisation construction. Carbon emission will peak around 2020.

Data sources: Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), Guangzhou Land Resources and Planning Commission, Guangzhou Bureau of Environmental Protection, Guangdong Provincial Development and Reform Commission, Guangzhou Bureau of Water Resources and Guangzhou Bureau of Forestry and Landscaping, Yearbook of China's Ecological Civilization Construction and Xinhuanet.

5. Results and discussion

Departing from ecology and urban planning perspectives, the urban ecological planning policies listed above possess a clear aim to restore the urban ecosystems and reduce the risks threatening the health and wellbeing of the residents and the infrastructure of Guangzhou. Comparing to conventional contingent plans for risk reduction, ecological planning and the guiding policy framework *Ecological Civilisation* provide a more preventative-than-reactive approach for risk governance with a macro and long-term vision of seeking human-nature integrity. Although, despite the "people-centred" ecological thinking and ambitious goals, risks in Guangzhou are governed primarily through the vertical, top-down government structure. In addition, urban ecological planning in Guangzhou treats risks mainly on the technical level and does not include the 'social' dimensions of risk sufficiently.

6. Conclusions

The fact that urban ecological planning is applied in Guangzhou to reduce risks of climate change and environmental degradation reflects the government's long-term vision for risk governance and value for human-nature integrity. The national environmental policy framework *Ecological Civilisation* is powered by the central government's political ambition and is effective in guiding the making and implementation of urban ecological planning policies. However, public values, concerns and perceptions of risk are not properly included in this approach for identifying, understanding and managing risks. Urban ecological planning as an instrument for risk governance in Guangzhou is hence long-term and ecological but not inclusive, which the government needs to address, in order to make risk governance truly comprehensive and could build long-term resilience. The way forward for urban ecological planning as an instrument of risk governance in Guangzhou, therefore, is to enrich resilience thinking in urban ecological planning with systems thinking, and that is not only about viewing urban natural and built environments as a system of interconnected parts, but also, viewing ecological and socio-economic factors as interactional. To that end, adding systems thinking in urban ecological planning requires including social-economic actors: science, politics, economic actors and representatives of civil society to participate and incorporating their values, concerns and perceptions of risk in the making and implementation of ecological planning policies for risk governance.

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A risky business: the impacts of hazards on traders located in different marketplaces in Port-au-Prince, Haiti

David Smith [a,*]

[a] Department of Architecture and Planning, Norwegian University of Science and Technology, Norway

Abstract

Overlooked in urban resilience and petty trade studies as well as in urban planning and humanitarian practice, this paper demonstrates that marketplaces are indeed important urban infrastructure in low- and middle-income cities. Based on the analysis of 125 trader interviews conducted in four distinct marketplaces in the Haitian capital, Port-au-Prince, this paper explores the influence of marketplace environments on traders' capacities to fulfill their needs and to maintain or rapidly return to trade after hazardous events. Findings suggest that traders located in a covered market that withstood shocks were better able than their counterparts in other markets to sustain their household needs and were able to restart trade relatively quickly. In contrast, traders in covered markets that collapsed were impacted the most. For these, the loss of market assets, absorbed within the domestic sphere and by their capacity to borrow, hindered their ability to meet household needs and induced longer recovery time. Findings also suggest that traders in open-air markets were less affected by the earthquake but endure worse working conditions and exposure to meteorological hazards. The results in this paper therefore provide evidence to better engage marketplace environments in urban resilience research and in strategies to build resilience for low-income citizens.

Keywords: marketplaces; traders; resilience; hazards; urban infrastructure

1. Introduction

On February 13, 2018, a fire ravaged the Iron Market, the most iconic marketplace of Haiti's capital, Port-au-Prince. The event, symptomatic of the vulnerability of marketplaces in many low- and middle-income cities across the world, impacted hundreds of petty traders. While the informal retail sector contributes significantly to urban employment in low-income cities across the globe (ILO, 2018), it often occurs in public spaces without basic infrastructure, services and legal protection (Chen and Beard, 2018). When such infrastructure exists, as in the case of the Iron Market, the marketplace can itself be exposed to hazards and its destruction has disastrous consequences on its users. Yet, marketplaces – defined here as covered markets and other open public spaces hosting primarily petty trade activities – have to date been disregarded in research on city infrastructure (see Ferrer et al., 2018, Choguill, 1999), despite their importance as a source of income, food and other affordable commodities for low-income dwellers (ILO, 2018). Due to the role infrastructure plays in urban resilience (see Meerow et al., 2016), it is essential to better understand the impact of hazards on marketplaces and their users.

Precisely, current research on petty trade focusses mainly on harassment and evictions (e.g. Roever and Skinner, 2016) and rarely considers other hazards by which traders may also be affected. The spatial and physical characteristics of the market *place* and its infrastructure are also rarely taken into account in the literature despite their potential impact on protecting trade in times of crises (Alfers et al., 2016, Chen and Beard, 2018). Current research also neglects the indirect impacts of hazards in marketplaces and yet, the failure or interruption of an urban infrastructure could also indirectly affect a significant number of people far from the vicinity (da Silva et al., 2012).

This paper, in response, aims to explore the influence of marketplace infrastructure and environment on traders' capacities to fulfill their needs and to maintain or rapidly return to trade after facing hazardous events.

2. Methods

The paper is primarily based on the analysis of 125 structured interviews with traders conducted in 2017 in the Iron Market as well as in Lalue, Canapé-Vert and La Coupe markets in metropolitan Port-au-Prince (see Figure 1). All marketplaces host the retail trade of basic daily commodities (i.e. perishable and non-perishable food, as well as charcoal) and present different architectural characteristics. The comparison of the four cases

* Corresponding author. E-mail address: david.smith@ntnu.no

allows the distinction between hazards and impacts that occur across different built environments from those that are market-specific. The study targeted fixed adult traders and covered a variety of commodity and stand typologies across the different markets. Questionnaires were designed based on a literature review of the risks faced by petty traders in low- and middle-income countries and on preliminary field work in 2016, and consisted of a mix of closed- and open-ended questions. Interviews were held in Creole and transcribed into French by four students attending the Université d'État under the direct supervision of the author. The responses were then analyzed using qualitative data analysis software for content analyses and quantitative data analysis software for frequency and descriptive analyses.

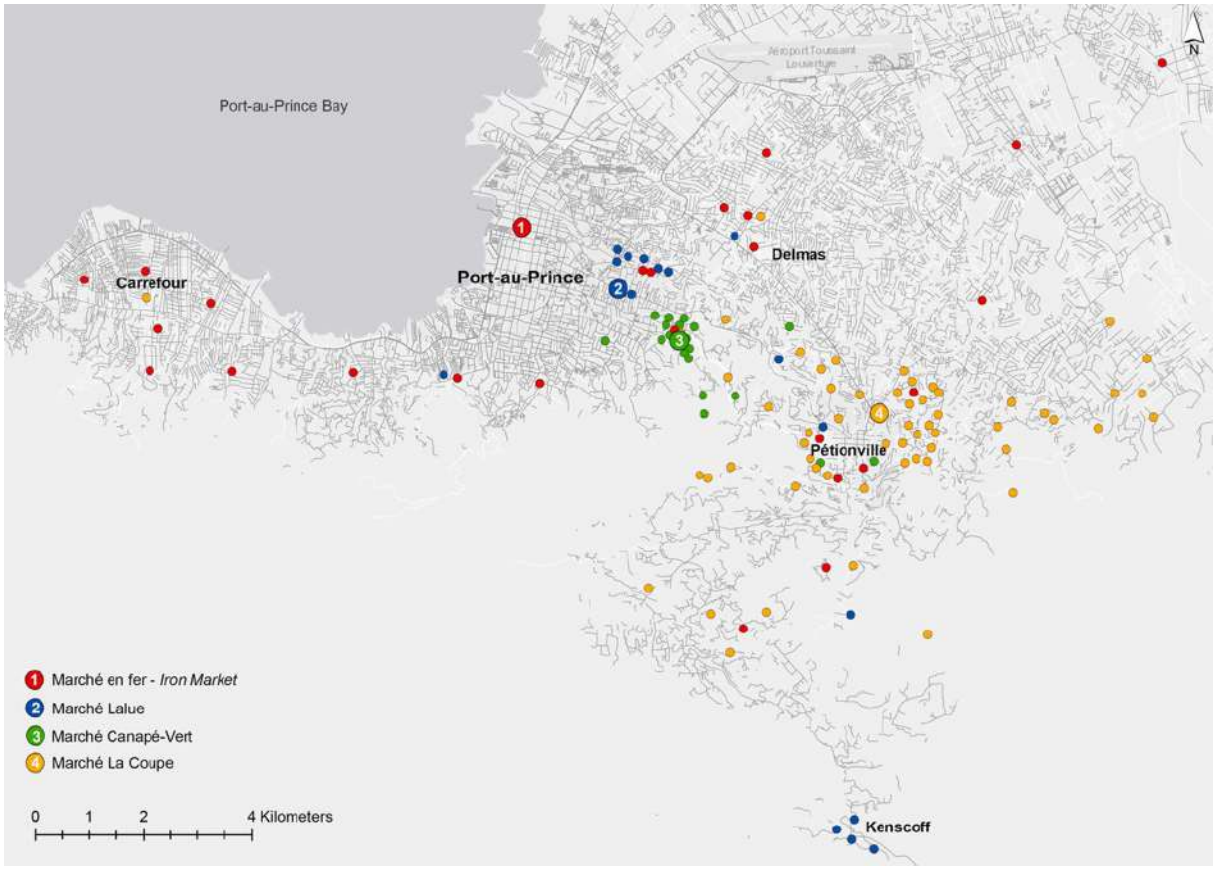

Figure 1: Location of marketplaces and place of residence of petty traders

3. Setting the scene: traders and their marketplace environments

In Haiti, where "70% of the population are either poor or vulnerable to poverty" (Herrera et al., 2014, own translation), petty trade is generally a response to the lack of formal jobs and the need to earn an income to survive and fulfill households needs (Lamaute-Brisson, 2002, Neiburg et al., 2012). In the metropolitan Port-au-Prince, 77.1% of employment is informal (Herrera et al., 2014) and in Haitian cities, "40 percent of the workers are employed in wholesale and retail trade—a large part of them in 'petty trade'" (Scot and Rodella, 2016, p. 19). Several studies have documented how petty trade is dominated by women in Haiti (Lamaute-Brisson, 2002, Blanc, 1997, Neiburg et al., 2012, Mintz, 1960).

Such documented role of trade and traders' gender predominance were confirmed in the study (Table 1). The research shows that besides the necessary maintenance of stock, traders – of which 81% were women – allocate most trade income to food, school fees, transport costs and other items and services for the household. These findings, confirmed by other studies (Thérasmé, 2011, Lamaute-Brisson, 2002), show that capital accumulation does not materialize in the streets but instead in the improvement of household conditions and human capital. In fact, because traders do not necessarily live in the neighborhood of the marketplace where they work (see Figure 1), income generated in the market can influence living conditions far away from the market location. Moreover, the continuity in traders' places of residence and work suggest a stability in their environments.

In Haiti, petty traders practice their activities in various environments and in various ways (Bazabas, 1997). The four selected marketplaces, despite selling similar products and being predominantly constituted of fixed

traders, present substantial differences in the type and quality of the infrastructure (see Table 2), as well as in relation to the surrounding context. Of particular relevance for this paper are the distinctions between a covered market that withstood major hazards, a covered market that collapsed and an open-air marketplace of individual structures.

Table 1: Trader profile

	Marché en fer (South hall)		Marché Lalue		Marché Canapé-Vert		Marché La Coupe (covered)		Marché La Coupe (open-air)		Total	
	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*
Female	85.2	23	82.4	14	81.8	18	92.9	13	73.9	34	81.0	102
Trade in basic daily commodities	55.6	15	88.2	15	72.7	16	46.7	7	65.3	32	63.3	81
Sole or main breadwinner	84.6	22	82.4	14	75.0	15	92.9	13	81.3	39	82.4	103
≥ 5 members in household	56.0	14	60.0	9	61.9	13	42.9	6	72.3	34	62.3	76
Live in the same neighbourhood since 2009	84.6	22	82.4	14	95.2	20	85.7	12	76.6	36	83.2	104
Work in the same marketplace since 2009	84.6	22	76.5	13	85.7	18	85.7	12	78.7	37	81.6	102

Table 2: Overview of the marketplace characteristics

	Marché en fer (South hall)	Marché Lalue	Marché Canapé-Vert	Marché La Coupe (covered)	Marché La Coupe (open-air)
Population (approx.)	220	110	140	280	1080
Area (approx. sqm)	2040	1920	2130	2940	8060
Proportion of traders in basic commodities	29%	91%	70%	51%	63%
Date of original construction	1890	N.A.	2004	2008	
Type	city market (retail and semi-wholesale)	local market (retail)	local market (retail)	city market (retail)	
Management	private company	self-managed	municipality of Port-au-Prince	municipality of Pétionville	
Infrastructure	market hall, integrated concrete stalls	wooden tables and tarps	market hall, integrated concrete stalls	market hall, wooden stalls	wooden stalls, parasols, tarps and metal sheets
Recent documented hazards	fires (2008, 2018) earthquake (2010)	N.A.	N.A.	earthquake (2010)	fires (2011, 2016)

Figure 2: The four marketplaces

The *Iron Market* is a historical covered market located in the business district of downtown Port-au-Prince, where street markets dominate the urban landscape. The market is constituted of two halls on each side of a central open space. The South traditionally hosted food traders but now predominantly hosts traders of non-food items for retail and semi-wholesale. Trading spaces consist of a dedicated concrete stall. Traders of non-food items often add wooden doors, shelves or panels. The North hall, excluded from this study, specializes in arts and crafts. The North hall was destroyed by a fire in 2008 and the remaining market area was severely damaged by the 2010 earthquake. Through the financial backing of the owner of a telecommunications company, the market was reconstructed in 2011 and has remained under the company's management since that time.

Lalue Market (or *Ravine-Pintade*) occupies an undeveloped plot in a mixed neighbourhood and close to an informal residential settlement. Most traders display their commodities on individual wooden tables or in baskets or on blankets laid directly on the ground. Tarps are strung to offer protection from the sun. This market is self-managed. No significant damage was reported following the earthquake and no fire has ever been reported.

Canapé-Vert Market is a covered market built in 2004, located in a mixed neighbourhood and close to several informal residential settlements. The western part of the market hosts mostly food vendors. In the eastern part, the lower floor hosts mostly charcoal and food vendors and the upper floor hosts mainly cosmetic and clothing vendors. Trading spaces consist of concrete tables that offer integrated storage space underneath. Several traders extend their stands by adding wooden structures, but many traders display their commodities directly on the tables, or in baskets or on blankets on the floor. The market structure withstood the earthquake and no fire has ever been reported.

La Coupe Market was inaugurated in 2008 with the aim to relocate traders from the business center of Pétionville to its vinicity, a mixed neighborhood close to informal residential settlements. The three-storey covered market built in a ravine collapsed two years later and was rebuilt as a two-storey building. Today, the majority of traders are located outside the covered market, on the different plateaus and alleys that link the market to the road above the slope. Most stands within the halls and on the plateaus are made of wood and, when appropriate, a metal roof is mounted. Traders located in the alleys generally display their goods on wooden tables or in baskets placed directly on the ground. Tarps and parasols create protection from the sun. Fires swept through the marketplace plateaus in 2011 and 2016.

4. Shocks and stresses across different marketplace environments

Trader reports of shocks and stresses vary between marketplaces and consist of various events and conditions that are marketplace-specific (i.e fires, poor environmental conditions, forced displacement or harassment, quarrels with traders and clients and poor market management) or that are experienced over a larger area (i.e. earthquakes, tropical storms, instability and insecurity).

The 2010 earthquake caused the collapses of the Iron Market and La Coupe, and nearly all traders lost their commodities as well as their trading spot. Despite the market halls of Canapé-Vert withstanding the earthquake and Lalue evading serious damage, many traders in these markets (54.5% and 41.2% respectively) reported that they were affected by the earthquake. The main reasons given were that the earthquake imposed financial constraints on clients as well as on traders who lost relatives and homes. Many traders reported that "people got poorer" after the earthquake, thus the trade economy was impacted negatively.

Fires also broke out at the Iron Market in 2008 and at La Coupe in 2011 and in 2016 – both large markets located in or close to business districts. Traders and experts, similarly to Neiburg et al. (2012), mentioned that fires, as well as thefts and assassinations, often occur in marketplaces as a result of non-payment of dept, gang wars and political rivalry. The case of the Iron Market, located in an area renowned for such incidents (Neiburg et al., 2012), shows that its surrounding environment influences traders' perception of risk, despite numerous security measures and available fire extinguishers. The armed robbery that caused one fatality in 2017 and the fire in 2018 give reason to the traders who fear such events. At La Coupe, where feelings of insecurity were also high, the fires destroyed many stands and commodities localized on the plateaus. Many traders that were not directly affected by the fires reported that their sales diminished following the events, as clients tend to avoid the area for some time after episodes involving fire and insecurity occur.

Less traders reported problems related to their working conditions in the covered markets of the Iron Market (4%) and Canapé-Vert (9.1%) than in the open-air markets of Lalue (23.5%) and La Coupe (46.8%). Traders were also more affected by meteorological events in uncovered markets, especially at Lalue and in the alleys of La Coupe. At La Coupe, the poor location, design and management were often mentioned as it generated a competitive disadvantage over other street markets in the area. Such findings therefore suggest that traders are exposed to different hazards and conditions according to the type of market environment they occupy.

5. Financial impact, self-recovery and time-to-return

The earthquake and fires impose a considerable financial burden on traders due to the loss of commodities and structures. Trader accounts of the value of their commodities varies significantly, from 500 to 50,000 gourdes (approx. 7.50 to 750 USD) in the case of traders of basic commodities, 69% of whom have a weekly turnover of more than 5,000 gourdes (approx. 75 USD). When uncovered by a market hall, the same trader spends 2,900 gourdes on average (approx. 45 USD) for his stand structure. The value of the loss of commodities or market structure is therefore substantial, as the average monthly income is of 7,620 gourdes (approx. 115 USD) for informal workers of the metropolitan area (Herrera et al., 2014).

When questioned about the aftermath of the 2010 earthquake, nearly half of respondents reported that they received no support, stayed home, or 'did nothing'. The others borrowed money from a bank, a micro-credit organization or a pawnbroker (22.8%) or received support from family (18.8%) or friends (9.9%). Other actions or sources of support were mentioned but reported only by a handful of traders, and for most, remained within the domestic sphere (e.g. selling household assets). In the case of fires in municipal markets, traders may also form associations to pressure authorities for financial compensations. However, very few interviewed traders mentioned they personally received money from the State (from 2,500 to 10,000 gourdes, approx. 40 to 150 USD) and most mentioned that they were for a limited number of traders.

These findings suggest that the financial shock caused by the destruction of market assets – particularly evident at the Iron Market and at La Coupe – is mostly absorbed through traders' productive capacities and by making compromises within their domestic environments. For instance, a few vendors mentioned they had to reduce food expenditure and stop sending children to school in order to cope with the drop in income. Several traders reported that the impact on some traders was so substantial that many "did not come back."

Moreover, recovery times following the 2010 earthquake also varied among marketplaces. Due to the inaccessibility of the marketplaces during reconstruction (twelve months in the case of the Iron Market) and the loss of market assets, time-to-return was longer in the markets severely affected by the shocks (Iron Market and La Coupe) than those in the least affected (Canapé-Vert and Lalue). There is also a difference in the pace of return between Canapé-Vert and Lalue. While the covered marketplace of Canapé-vert, which withstood the earthquake, was not used in the following month, as residents feared aftershocks, nearly all traders (92.3%) returned within three months. At Lalue, more traders were able to return within a month (58.4%). The numbers of traders increased over time, reaching 75% after three months and 83.4% returning after twelve months. These findings suggest that when commodities and infrastructure successfully withstand shocks, traders are able to return to trade relatively faster than traders in open-air markets.

6. Discussion and conclusion

This paper aimed to explore the influence of marketplace infrastructure on traders' capacities to fulfill their needs and to maintain or rapidly return to trade when facing hazardous events. Due to the exploratory nature of the study, primarily based on perceptions of a non-representative sample of 125 traders, the patterns highlighted

in the analysis are indicative and should therefore be treated with caution. Other aspects explored in the research relating to working conditions and governance are also missing in the paper. Nevertheless, the study uncovered several ways in which the marketplace infrastructure may influence traders' capacities to face crises.

The study indicates that traders located in a covered market that withstand shocks were better positioned than counterparts in other markets to sustain their household needs, as they were able to restart trade relatively quickly. In contrast, traders who had stands and commodities in covered market that collapsed during the earthquake were impacted the most. Due to the lack of safety net, the financial shock was absorbed within the domestic sphere and the ability of traders to obtain and payback an essential loan. Time taken to return to the market was also the longest in the covered markets that collapsed, due to the time needed to refinance their commodities and to rebuild the infrastructure. In many cases, this resulted in the reduction of traders' capacity to direct income into meeting household needs. The influence of the marketplace infrastructure however can be limited as other risks and threats come from the surrounding urban context.

These findings have implications for humanitarian and urban planning practices in low- and middle-income cities. The paper provides additional evidence suggesting the need for making immediate financial support available for traders, who may reside out of affected areas, following the collapse of marketplace infrastructure, as well as on the need for upgrading existing marketplace infrastructure, so as to increase their capacities to resume operation and to reduce their vulnerability to shocks and stresses. However, the aforementioned projects must fully engage traders in order to address their most pressing needs, as they can vary according to marketplace, and to reduce trade risks that may result from the changes. Marketplace management must also be carefully considered and supported to ensure appropriate maintenance over the long term. Furthermore, due to the links between traders' marketplace and household conditions, the paper challenges traditional levels of analysis and programming, focused mainly on households and their immediate environments (Earle, 2016). It calls, for instance, for including the main income providers' assets and workplace infrastructural conditions in assessments and projects aiming to reduce households' vulnerability and enhance their resilience.

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Social cohesion through urban planning: strengthening community resilience in multi-ethnic urban neighbourhoods

Bo Tackenberg [a,*], Tim Lukas [a], Frank Fiedrich [a]

[a] University of Wuppertal, Germany

Abstract

The social infrastructure of a city plays a crucial role in the prevention and mitigation of serious damage in times of crises or rapid social change. Similarly, post-catastrophe recovery is based on a sense of community that connects the members in disaster-struck neighbourhoods. However, trusting neighbourhood relations and an active participation in social life are often questioned in multi-ethnic societies. Experiences of past catastrophes show that organisations contributing to the reduction of vulnerability relate very differently to social cohesion. Against this background, we focus on the question of how social cohesion in multi-ethnic neighbourhoods can be strengthened by the (cooperative) work of organisations in the field of neighbourhood work and urban development. Theoretically rooted in Robert J. Sampson's "collective efficacy"-approach the article is based on an extensive review of policy papers and practical guidelines from a broad variety of organisations in the fields of district development and neighbourhood work. Furthermore, a theoretical but practice-oriented model will be introduced comprising different dimensions and interdependences of social cohesion and community resilience, proposing future directions of supporting urban planning and neighbourhood work in the face of crises and rapid social change.

Keywords: Urban planning; social cohesion; collective efficacy; community resilience; ethnic heterogeneity.

1. Introduction

In recent years, the concept of resilience has received particular attention in the (security) political domain, in various fields of practice (including civil protection and development aid) and in numerous academic disciplines. The idea is that resilience plays a crucial part in minimising risks and threats and in limiting – ideally even preventing – damaging events. Based on the awareness that absolute security is unachievable in a highly interlinked and increasingly complex world, the focus is less on safeguarding against (in terms of) possible risks than on the creation of general resistance in case of disaster despite all precautions. Resilience designates the capability of a system to flexibly absorb, balance and overcome stressful influences in such a way that the capacity to (re-)act appropriately remains preserved.

As part of our research project "Resilience through social cohesion - The role of organisations (ResOrt)", we focus on the concept of community resilience that locates the coping potentials of society in social processes and the personal and collective skills of society members (Ross & Berkes 2014, p. 788). Referring to theories of social capital, social disorganisation and collective efficacy (Sampson 2012) we will outline the functions and contexts of community resilience in a theoretical and multidimensional model comprising aspects of social trust, shared values and norms, reciprocity, participation and social networks. Based on an extensive review of policy papers and practical guidelines, we will highlight the essential role of neighbourhood work and urban planning in fostering and promoting social cohesion in multi-ethnic communities. Furthermore, we will discuss both the potentials as well as the challenges of integrating both urban planning and neighbourhood work into urban management and coordination.

2. Social cohesion and collective efficacy in multi-ethnic communities

Rooted in the field of criminology, the collective efficacy approach (Sampson et al. 1997) is based on an advancement of social disorganisation theories, which were originally developed (in the context of) to explain different crime-rates in urban districts and neighbourhoods. The theory of collective efficacy assumes, that residents engage successfully in the common good of their neighbourhood, if there is a basis of mutual trust, shared values and norms, and social cohesion among neighbours (Sampson 2012). Social cohesion exists if people know each other, trust each other and share a common set of norms and values. Similar to the concept of social capital collective efficacy is a group-based social resource; however, unlike social capital it is merely of

* Corresponding author. E-mail address: tackenberg@uni-wuppertal.de

episodic nature (Mennis et al. 2013, p. 2177). While social capital can be used to achieve collective goals, collective efficacy is per definition oriented to a common effort. Therefore, collective efficacy includes especially those social relations within a community that lead to participation and mobilisation towards a particular common goal or action, thereby influencing informal social control in a community (Sampson et al. 1997).

According to Putnam (2007), social capital is a resource derived from social networks and the associated validity of reciprocity norms and social trust. Neighbourhoods that are characterised by a lack of social capital are supposed to be less capable of creating common values and thus maintaining informal social control. Against this background, social capital in residential neighbourhoods relies less on the individual characteristics of the inhabitants but rather on the local structure of social organisation. In his seminal article "E Pluribus Unum" Putnam (2007, p. 137) argues that: "in ethnically diverse neighbourhoods residents of all races tend to 'hunker down'. Trust (even of one's own race) is lower, altruism and community cooperation rarer, friends fewer." He postulates that in long- or even short-term all modern societies tend to be more ethnically heterogeneous, which in turn leads to a continuous decrease of social solidarity and participation, weak social networks, limited social trust and thus to a reduction of social capital and cohesion. Also Sampson et al. (1997) assume that ethnic diversity in a neighbourhood contributes to mutual mistrust. That is, social capital and ethnic heterogeneity seem to be negatively correlated as diversity may undermine the underlying structure of shared values and norms in a community.

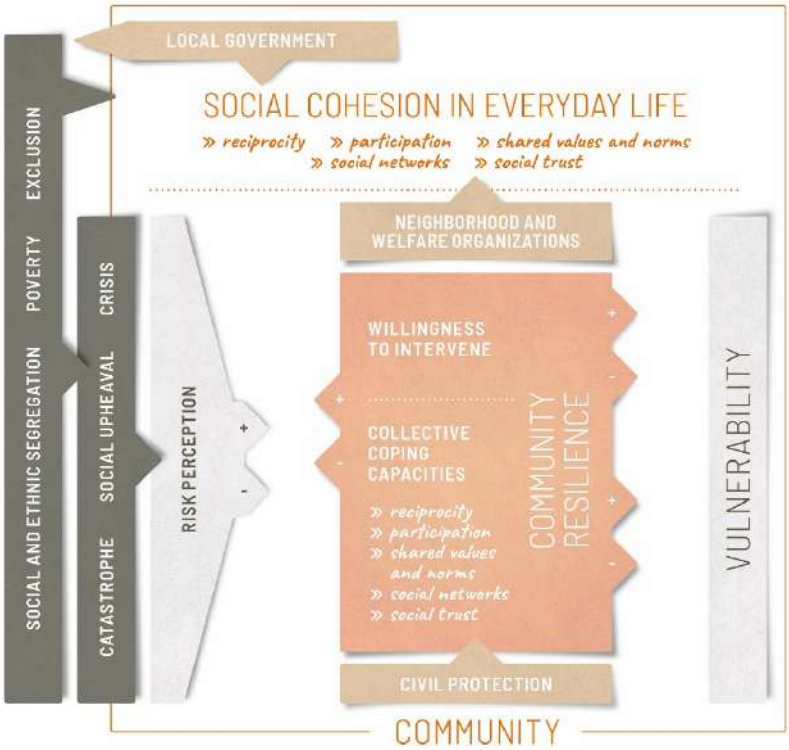
Putnam's pioneering "hunkering down"-thesis initiated an ongoing debate on the impact of ethnic diversity on social capital, followed by numerous international studies which analysed the influence of ethnic diversity on social cohesion and empirically examined Putnam's hypothesis. While some studies found significant empirical evidence emphasising a negative effect of ethnic diversity on social cohesion and social capital (e.g. Alesina & La Ferrara 2000; Costa & Kahn 2003; Leigh 2006; Tolsma et al. 2009; Fieldhouse & Cutts 2010; Portes & Vickstrom 2011; Koopmans & Schaeffer 2015), other studies however found a clearly positive effect (e.g. Marschall & Stolle 2004; Pendakur & Mata 2012; Gundelach 2014). According to Portes and Vickstrom (2011) a possible reason for the inconsistency of empirical findings could be the very different conceptualisation and definitions of social cohesion. In many studies, there was either a different understanding of social cohesion or certain sub-components were operationalised differently (Ariely 2014, p. 578). In addition, scientific literature often lacks a clear distinction of social capital and social cohesion.

3. A theoretical model of social cohesion, collective efficacy and community resilience

Modern societies are characterised by continuous processes of change and thus permanently face various risks of being affected by a multitude of potential threats. By referring to crises, catastrophes and social upheavals, our model (Figure 1) deliberately comprises not only external, unpredictable disturbances, but also includes those 'man-made' disruptions, which can be foreseen to some extent. Moreover, we argue that the risk perceptions of community members are not necessarily oriented to the 'objective' or formal risk. We rather consider risk perception as a product of common values, which are based on respective group affiliations. That is, risks are socially constructed and thus influence the action and behaviour of individuals on the level of a constructed reality (Renn 1989, p. 168). Although risks factually exist, human actions are usually determined by perceived risk characteristics. For example, if a risk is perceived as very high, it may individually lead citizens to better prepare for a potential incident (by i.e. storing food, etc.). With an increase of emergency preparedness, the individual vulnerability to external disruptions or challenges declines.

However, the focus of our research is less concentrated on the individual resources of emergency planning, but rather on the willingness of actors to engage in community welfare as well as social resources that emerge in everyday coexistence of community members, such as reciprocity, participation, shared values, social networks and trust. That is, factors that form the social cohesion in a community and, in parallel, represent collective coping capacities in dealing with external disruptions and challenges. We assume that people who have access to collective coping capacities are less vulnerable (e.g. Klinenberg 2015, Lumbroso et al. 2017) and therefore exhibit a lower risk perception. This, in turn, would mean that with an increase of collective coping capacities, the degree of resilience in a given neighbourhood expands – and vice versa. On the other hand, people who have neither access to collective coping capacities nor prepare for emergencies would be much more vulnerable.

In order to foster social cohesion, we believe that individuals need to be actively involved in a functioning network that goes beyond close friendship ties or binding social capital. In this context, reciprocity and trust norms are necessary to ensure a better coordination of actions in social networks of a society (Adloff & Mau



2005). In our research, we focus on generalised reciprocity as it arises in the context of group affiliation. Group affiliation can mean both a specific group in which close contacts are maintained and a group that does not even communicate with each other or only keeps formal contacts. In contrast to direct reciprocity, generalised reciprocity enhances bridging social capital and thus meets the demands of modern societies, in particular the anonymity and informal social contacts of their respective members. In our understanding, social trust is a logical consequence of the relationships between individuals. It represents an elementary conceptual component of social capital and is essential for the formation of social cohesion (Gundelach 2014, p. 19; Gundelach & Freitag 2014, p.19) as well as for collective efficacy (Sampson et al. 1997). Social trust can be conceptualised as a result of an individual affiliation to social networks and its reciprocity norms (Zmerli 2013, p. 135). Shared expectations and a common understanding of values and norms (Sampson 2012, p. 135) foster a sense of belonging and trustworthiness in a community, and feed into the expectation that others act on behalf of the common good. As a productive component of social capital social trust is a pre-condition for social cooperation; it enhances the inclusion of social interaction and the development of social networks. Social trust exists apart from close family and friendship bonds and is therefore an effective resource in building social cohesion among neighbours without requiring close relationships.

Figure 1: A theoretical model of social cohesion, collective efficacy and community resilience.

4. The role of neighbourhood work and urban development in multi-ethnic societies

Organisations that contribute to the reduction of vulnerability in society have recently recognised the fundamental significance of social cohesion and thus try to improve (their knowledge on) the social infrastructure of communities. This is especially true for local governments that try to address social problems like segregation, poverty and exclusion by implementing policies that are directed to disadvantaged multi-ethnic urban neighbourhoods. In contrast, neighbourhood and welfare organisations have a long tradition in fostering social cohesion, providing practice-oriented knowledge in enhancing civil and voluntary engagement and creating social networks among neighbours. From a resilience perspective, it is particularly important to promote the knowledge exchange between those organisations that shape the social infrastructure of cities and those organisations which try to immediately influence the degree of social vulnerability. Municipal as well as neighbourhood organisations help to develop collective resources, which can be exploited in crises, catastrophes or in times of rapid social change. However, what is important is not the existence of a particular type of organisation, but the entire organisational infrastructure of a community and the overlapping networks between various organisations.

The overall goal of community work is to support local actors developing and organising their communities. By taking into account the complexity of life-realities in urban areas, community work tries to improve the material, infrastructural and social conditions of local residents. Community work is usually directed to disadvantaged residential areas trying to give unprivileged groups the possibility to participate in restructuring and improving their local living conditions (Riede, 2017, p. 181). That is, community work aims at the collective organisation of individual interests; it strives for building social capital and social cohesion in urban disadvantaged multi-ethnic neighbourhoods. Similarly neighbourhood work fosters interpersonal contact, a sense of community and the individual's abilities to self-help. Neighbourhood work thus interlinks unconnected institutions in a way that various fields of action are integrated (e.g. housing, health, youth, work, culture, social issues, education, etc.) and interdisciplinary cooperation between different professions and institutions will be fostered. Organised neighbourhood activities promote the development and strengthening of networks of residents, professional actors and cross-border networks. Neighbourhood work combines diverse residential activities with aspects of social and urban planning (VskA, 2018).

Urban planning contributes significantly to the promotion and organisation of public life. Particularly the public space is an important place of communication for which strategies of urban planning create offerings to connect people and to actively experience social participation – particularly in disadvantaged multi-ethnic urban areas. Thus, urban planning faces the challenge of developing convivial neighbourhoods that promote and foster social cohesion and strengthens a sense of community in an increasingly heterogeneous context that enables diverse communities to pursue collective-action efforts and to provide for collective goods. Community organisations and relief agencies have developed a variety of urban planning strategies for strengthening social cohesion in ethnically diverse neighbourhoods. A prominent example of socio-political efforts to stabilise and revaluate disadvantaged neighbourhoods is the German urban redevelopment programme "The socially integrative city" which combines structural investments of urban renewal with measures to improve the living conditions in "districts with special development needs" (BMI, 2018). Funded jointly by the federal government and the federal states the programme particularly aims at developing lively neighbourhoods and fostering the local social cohesion. The objectives of the programme are to improve the actual housing and living conditions (predominantly through investment in construction measures and projects), to increase the residents' personal opportunities (by imparting qualifications, skills and knowledge, creating openings in the labour market and helping people to help themselves) and to upgrade the district's image, local profile and neighbourhood identification (through stabilisation and revitalisation measures).

Since 1999, the large-scale initiative allows the linkage of structural urban renewal with socio-political objectives and initiation of cooperative collaboration between various domains (Altrock & Kunze, 2017, p. 5). The programme is based on a socially integrative approach that emphasises the fundamental significance of a collaboration between economic development, urban planning, and socio-cultural neighbourhood work (BMI, 2018). Coordinated by a local neighbourhood management team, the programme seeks to activate people and local business owners to participate in the economic and social development of disadvantaged urban neighbourhoods. The neighbourhood management team attempts to connect local actors by coordinating and organising cooperation between diverse institutions such as schools, the police or housing companies. Since community activation is a central issue in the programme, the neighbourhood management team is structurally linked to a resident council, which provides advice regarding the development of projects in different categories like e.g. construction measures or social activities in public spaces. In collaboration with local actors, the neighbourhood management team arranges public meetings and organises working groups, workshops and planning processes. Aiming at the promotion of interpersonal contacts and communication among local residents from various ethnic origins "The socially integrative city" thus takes a key role in bringing together urban planning and neighbourhood work.

However, organisations which contribute to the promotion of resilience in society pay very different attention to social cohesion as a coping capacity. Particularly in the field of civil protection, the promotion and knowledge of social cohesion has so far played only a minor role. In our theoretical model, however, we assume that social cohesion is an essential resource for better coping with crises and disasters of all kinds (including natural disasters). Against this background, the "Socially Integrative City" programme is a good practical example of how the self-help capacities of the population can be strengthened through a cross-sectoral coordination of social, everyday interactions and the improvement of local infrastructures. Civil protection organisations should therefore be more open to neighbourhood work and urban planning organisations and seek mutual exchange. Civil protection can benefit greatly as these organisations have a knowledge that is essential for building community resilience in multi-ethnic societies.

5. Conclusion

In light of rapid social change, modern societies are challenged by a multitude of urgent problems, which cannot be fully addressed only by state-run hazard management. It therefore seems only plausible, that new resilience strategies are increasingly demanded that fill the gap and strengthen the self-help capabilities of citizens. In that regard, we believe that greater attention should be paid to foster the social cohesion of communities. Social cohesion represents a collective coping capacity that can be exploited in crises and catastrophes, however, the foundations of cohesion are laid in everyday life through the interaction and cooperative action of citizens. Until now, very little is known about the socio-spatial preconditions of social cohesion and the ways in which organisations can stimulate them. We assume that organisations which focus on the reduction of vulnerability "provide more than advice and material resources – shared expectations and trust are strengthened through coordinated activities" (Sampson, 2013). Organisations form a network of associations and routine activities that promote collective action. Against this background, urban planning and neighbourhood work play a key role as both strengthen the community's social cohesion by creating spaces of opportunity for everyday encounters. The German federal-state programme "The socially integrative city" combines both approaches in a two-layered inter-organisational concept. Concerning the field of urban development and planning, physical spaces for encounters and participation are created as a fundament for subsequent socially integrative measures and instruments of neighbourhood and community work. Thus, "The socially integrative city" provides a striking practical example of how urban planning and neighbourhood work interact organisationally for a higher purpose: The development of a sense of community, which constitutes not only the basis for a peaceful coexistence in everyday life of multi-ethnic societies but also for coping with extra-ordinary occurrences like crises and catastrophes.

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Improving Disaster Risk Reduction education for Australian construction professionals

Helen Giggins [a,*], Anthony Fuller [a]

[a] University of Newcastle, Australia

Abstract

There is an increasing push from governments and agencies around the world to mainstream Disaster Risk Reduction (DRR). The built environment is a major stakeholder when it comes to DRR and the associated construction professionals have a responsibility to help mainstream DRR within the built environment. This research paper explores how DRR practices and knowledge can be disseminated among construction professionals. The purpose of the research was to identify the core DRR knowledge, skills and requirements and determine if the current Construction Management (CM) Curriculum includes these within their degree programs. This research paper adopted a qualitative research method involving an assessment of current CM Curriculum and a gap analysis against the previously identified core DRR knowledge, skills and requirements. The curriculum of four major universities within New South Wales, Australia, were examined and it was found that only roughly half of the core DRR knowledge, skills and requirements were covered within the current CM Curriculum. As such, recommendations to bodies responsible for accrediting the CM related degree programs have been given, since more needs to be done in relation to the implementation of the core DRR knowledge, skills and requirements within the CM Curriculum within Australia.

Keywords: Disaster Risk Reduction; Construction Practitioners; Curriculum; Mainstreaming, Australia

1. Introduction and background

Disasters continually effect millions of people globally and have a large impact on lives and the built environment, including buildings and infrastructure (Bosher and Chmutina, 2017, Bosher et al., 2016). As such, there is a continued push from agencies and governments around the world to improve the understanding of disaster risk (UNISDR, 2015). Disaster Risk Reduction (DRR) is a key concept when it comes to reducing the risks associated with disaster events, with an aim to reduce the social and economic impacts caused by hazards and disaster events on both communities and the built environment (UNISDR, 2015). The construction industry and associated construction professionals are major stakeholders when it comes to promoting and mainstreaming DRR within the built environment (Amaratunga et al., 2017). The ultimate goal of mainstreaming DRR within the built environment is to "make DRR part of the development DNA" (Bosher and Chmutina, 2017). However, Amaratunga et al. (2017), Bosher, Chmutina and von Meding (2016) have all indicated that construction professionals do not have the appropriate DRR related knowledge, and that there is a need for the integration of DRR in the higher education of construction professionals.

The concept of DRR goes further than only addressing the reduction of the impact of disaster events, DRR essentially acts as a framework for addressing key issues such as vulnerability, mitigating hazards, reducing exposure and improving resilience (Nassopoulos et al., 2015). The Sendai Framework for Disaster Risk Reduction has an expected outcome to reduce the impact of disaster events on both a social and economic level with the main goal of preventing and reducing new and existing disaster risk (UNISDR, 2015). To achieve this, the Sendai Framework for Disaster Risk Reduction has implemented seven global targets and four priorities for actions that will assist in guiding all levels of government and relevant stakeholders in reducing the risk of disasters by implementing and integrating at all levels of government appropriate economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures (UNISDR, 2015). The framework is designed to implement core DRR skills among all communities and provides an opportunity for all members of communities including women, the elderly, and people with disabilities to engage in DRR activities and practices. Priority action four highlights the 'Build Back Better' goal and emphasises that through appropriate planning of recovery, response and reconstruction is an opportunity to 'Build Back Better' as DRR principles and requirements can in integrated into the development measures thus making the affected communities more resilient to disasters (UNISDR, 2015).

* Corresponding author. E-mail address: helen.giggins@newcastle.edu.au

In addition to the United Nations, global communities such as the European Union are funding studies such as the Collaboration Action towards Disaster Resilience Education (CARDE) Report, which sets out to identify ways to mainstream disaster resilience into the construction process (Amaratunga et al., 2017). To achieve this goal of mainstreaming DRR in all levels of governments and within the built environment it is important for all the relevant stakeholders including national and local government, communities and the built environment to understand the core skills and requirements for DRR. It is argued by Bosher et al. (2016) that the development and integration of core DRR skills and requirements as a mechanism to better understand the requirements of DRR within the built environment.

For DRR to be mainstreamed within the Built Environment, buildings and infrastructure should be designed, built, located, operated and maintained in an appropriate way that to ensure that the people who live and work in these buildings have the ability to withstand, mitigate and recover from extreme disaster events, this is also known as 'built in resilience'(Bosher and Dainty, 2011). As such, DRR measures should be considered in all components of the development process including building regulations, design processes, procurement practices, development control and construction and operation of the built asset (Bosher and Dainty, 2011). However, this approach is not without challenge due to the nature of the construction industry. The varying skill sets of project participants, large capital investment required, and uniqueness of the product all make any change to the culture of the industry difficult (Bosher and Dainty, 2011).

Engaging construction professionals from the private sector within the DRR process can create an opportunity for DRR measures to be addressed. However, without the necessary understanding of DRR principles their input would be less effective. It is considered that these construction professionals are lacking the required training relating to DRR therefore more needs to be done to ensure that built environment professionals receive the appropriate DRR training (Bosher et al., 2016).

To overcome the issues highlighted above, appropriate training is necessary for construction professionals and current research states that professional DRR related competencies need to be integrated into the higher education curriculum of construction professionals (Bosher et al., 2016, Amaratunga et al., 2017, Thayaparan et al., 2014). Although higher education institutes in both the UK and Australia have some DRR related modules available for construction professionals it is clear that is it still not a priority (Bosher et al., 2016). A recent report in Europe focusing of mainstreaming disaster resilience into the construction process has identified 13 knowledge gaps among construction professionals in relation to disaster resilience, as shown below:

- "Governance, legal frameworks and compliance
- Sustainability and resilience
- Business continuity management
- Ethics and human rights
- Disaster response
- Innovative financing mechanisms
- Contracts and procurement
- Resilience technologies, engineering and infrastructure
- Multi-stakeholder approach, inclusion and empowerment
- Knowledge management
- Social and cultural awareness
- Post disaster project management
- Multi-hazard risk assessment" (Amaratunga et al., 2017)

Construction Management (CM) as a degree program is currently offered at 12 universities within Australia. CM as a discipline is also widely recognised in the United Kingdom (UK) and the United States (StartClass, 2017). Professional bodies, such as the Charted Institute of Building (CIOB), are responsible for accrediting the degree in both the UK and Australia (CIOB, 2017). The Australian Institute of Building (AIB), an Australian accreditation body, provides curriculum benchmarks that are expected to be met in the CM degree program (Australian Institute of Building, 2017). The curriculum benchmark guidelines address 4 main areas including Technical, Legal, Management and Economics**.** Table 1 below outlines the required skills and knowledge area that is the standard for the CM curriculum in Australia.

Table 1: CM Curriculum Guidelines – Australian Institute of Building (AIB, 2017)

Knowledge Domain	Skills & Knowledge	Knowledge Domain	Skills & Knowledge
Knowledge Domain – Technical	Construction Process & Structures	Knowledge Domain – Management	Construction Site Operations
	Surveying		Project Management
	Building Services		Business Management
	Building & Material Science		Industrial Relations Management
	Environmental Science		OH&S
	Building Documentation		Human Relations Resource
			Risk Management
Knowledge Domain – Legal	Legal System	Knowledge Domain – Construction Economics	Marco Economic Theory
	Sources of Law		Micro Economic Theory
	Building Related Law		Economic Feasibility Study
	Contract Law		Estimating
	Dispute Resolution		Cost Planning & Management
	Building Requirements		Project & Development Financing

Bosher et al. (2016) argue that the current building professionals, including Construction Managers, have not received appropriate training when it comes to dealing with DRR, and the requirements of DRR should be better integrated in the education of construction professionals (Bosher et al., 2016). The current trends in CM curriculum and the accreditation guidelines for CM degree programs do not appear to be including any pedagogy related to DRR core skills and content for construction professionals. This leads us to pose the following research problem question. *How can DRR practices and knowledge be disseminated among construction professionals?*

2. Research method

The aim of this paper is to identify the gaps in current curriculum for construction management professionals in relation the required DRR training and education. This research paper has the following research objectives in response to the proposed research question and aim.

- To conduct an assessment review of current Construction Management (CM) Curriculum in New South Wales (NSW) Australia focusing on universities that deliver well known CM degree programs.
- Conduct a gap analysis to identify current deficits within the CM curriculum in relation DRR.
- To develop a list of recommendations on how DRR could be better disseminated to construction professionals through the construction management curriculum.

Note that an initial systematic literature review, and thematic analysis was conducted to disseminate the core knowledge and skills required by construction management professionals to best meet the current DRR skills gap. This component of the research is outside of the scope of this paper. However, the results from this review form an input to the research conducted here. In this paper we first undertook an Assessment Analysis to map the current CM Curriculum against the core requirement and skills that are applicable to allow DRR to be mainstreamed within the built environment and among construction professionals. Four universities were selected in New South Wales (NSW), Australia, namely, The University of Newcastle (Australia), University of New South Wales, Western Sydney University and University of Technology (Sydney). Theses universities have been selected as they are prominent universities that are well known for providing tertiary education in CM and are well accredited. To analyse the CM Curriculum of the selected universities against the core DRR skills and requirements the researchers analysed the Program Handbooks of the relevant CM (or equivalent) degree program including the course description of each of the courses that form the degree.

Next, a Gap Analysis study was undertaken to identify the core DRR knowledge, skills and requirements that are missing from the CM Curriculum of the targeted degree programs. These results informed the development of a list of recommendations on how DRR could be better disseminated to construction professionals through the CM Curriculum.

3. Results and discussion

Through the process of the systematic literature review and the thematic analysis (Fuller, 2017) we previously identified 11 core DRR knowledge, skills and requirements as shown in Table 2 below.

Table 2: Core Knowledge, Skills & Requirements of Disaster Risk Reduction (Fuller, 2017)

Number	Description
1	Vulnerability
2	Reduction of Hazard Exposure
3	Disaster Preparedness
4	Response and Recovery
5	Build Back Better (BBB)
6	Capacity Development
7	Multiple Stakeholder Approach
8	Equality
9	Structural and Non-Structural Measures
10	Hazard Mitigation
11	Sustainable Development

The assessment of the CM Curriculum at 4 of the major universities delivering Construction Management related degrees was undertaken to establish if the core DRR knowledge, skills and requirements that have been outlined in Table 2 above are being implemented in the current CM Curriculum at the nominated universities. Every course from each of the CM related degree programs was tabled and assessed against the core DRR knowledge, skills and requirements. The summary results of this assessment have been outlined in Table 3 below.

Table 3: Comparison between CM Curriculum and DRR Skills & Requirements

ID	DRR Core Knowledge, Skills & Requirements	UON	UNSW	WSU	UTS
1	Vulnerability				
2	Reduction of Hazard Exposure				
3	Disaster Preparedness				
4	Response and Recovery	✅			
5	Build Back Better				
6	Capacity Development	✅			
7	Multiple Stakeholder Approach	✅			
8	Equality				
9	Structural and Non-Structural Measures	✅	✅	✅	
10	Hazard Mitigation	✅			
11	Sustainable Development	✅			✅

The next stage of the research as to analyse the current CM Curriculum against the core DRR knowledge, skills and requirements and then identify the major gaps that exist between the current CM Curriculum that is being delivered and the identified core DRR knowledge, skills and requirements. As shown in Figure 1, out of the 11, identified core DRR knowledge, skills and requirements 5 of these are not being addresses at any of the

nominated Universities. Structural and Non-structural Measures are implemented at 3 out of the 4 universities, Sustainable Development 2 out of the 4 and Response and Recovery, Capacity Development and Hazard Mitigation are included in 1 out of the 4 universities.

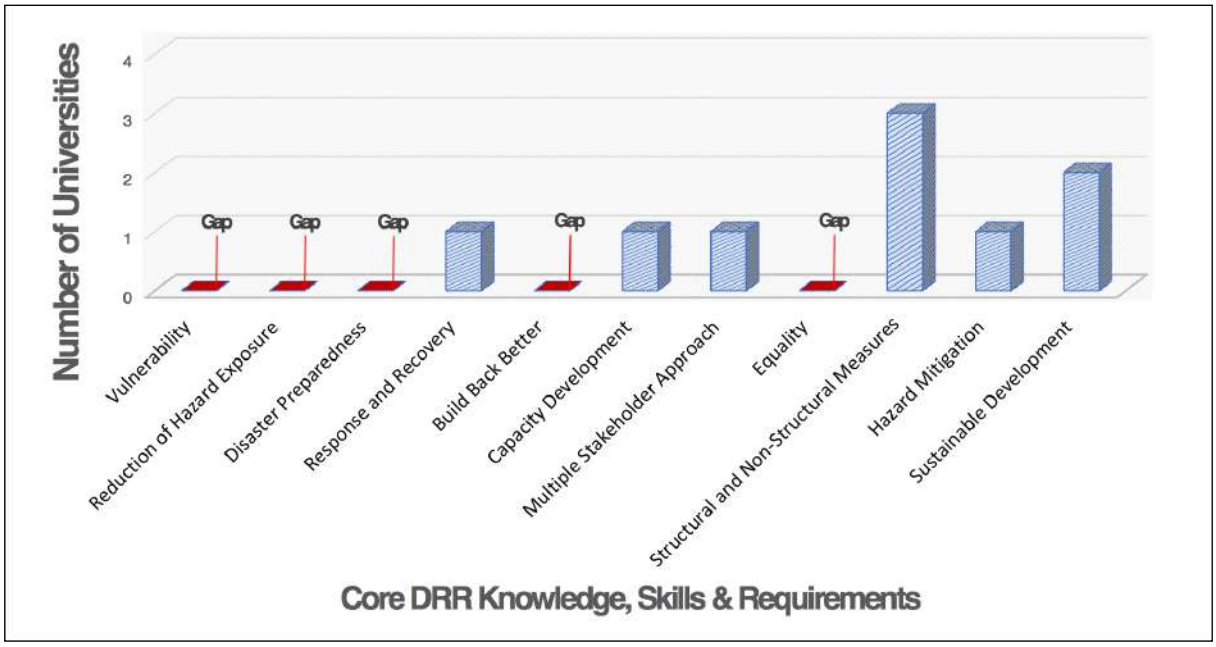

Figure 1:Curriculum Gap Analysis Results

The University of Newcastle (UON) is by far the best performing university when it comes to the inclusion of DRR knowledge, skills and requirements within the course curriculum. University of New South Wales (UNSW), University of Western Sydney (UWS) and University of Technology (UTS) have considerably less DRR knowledge, skills and requirements included in their CM curriculum, with each of the 3 universities from Sydney including only 1 of the 11 DRR knowledge, skills and requirements in the respective degree programs as shown above in Table 3.

Taking into account the above results shown in Figure 1, consideration must be given to the structure of the degree programs in regard to core (compulsory) courses and directed/elective courses. Whilst it appears UON is leading the way with the inclusion of 6 out of the 11 core DRR knowledge, skills and requirements, 4 of these come from a single directed (non-compulsory) course. However, with this in mind the UON course, Disaster Management and Resilience within the Built Environment, is the most appropriate course on offer across all of the universities subject to the analysis of this research.

The purpose of the following recommendation is to provide guidance to the relevant stakeholders responsible for the higher education of construction professionals and ultimately provide a solution to the proposed research question outlined at the end of Section 1.

Recommendation 1 - The Australian Institute of Building (AIB) is one of the accreditation bodies responsible for providing requirements to universities in relation to CM Curriculum within Australia. As such, the accreditation body has influence over the current and future direction of university curriculum. It is recommended that the AIB upgrade their current *Standards for the Accreditation of Building & Construction Management Programs* including the *Curriculum Benchmark Guidelines* to include the core DRR, knowledge, skills and requirements, as outlined in Table 2.

Recommendation 2 - It has been highlighted within this research paper that there is a current push from governments and agencies around the world to mainstream DRR within the built environment. A key way to achieve this is to ensure that construction professionals receive appropriate training, so they understand what is required to achieve DRR and implement this within the built environment. It is therefore recommended that the gaps identified in Figure 1 are included in future CM Curriculum to ensure that the construction professionals of the future have a holistic understanding of the core DRR Knowledge, Skills & Requirements**.**

Recommendation 3 - As highlighted throughout this research paper, construction professionals are a major stakeholder of the built environment and, as such are an important stakeholder when it comes to mainstreaming DRR within the built environment. The appropriate training and education of construction professionals in

relation to DRR is vital when it comes to mainstreaming DRR within the built environment. As demonstrated in Table 3 universities, such as The University of Newcastle, are beginning to implement relevant DRR related courses within the CM curriculum. However, more still needs to be done. Hence, it is recommended that key DRR related courses become part of the core course list within CM degree programs, rather than as elective courses. This will likely increase the possibility of mainstreaming DRR within the built environment.

4. Concluding remarks

This research identified the core DRR knowledge, skills and requirements for the built environment, as well as an analysis of the current CM Curriculum at four universities within New South Wales (NSW), Australia. As highlighted in this paper it is considered that construction professionals have not received the appropriate training in relation to DRR and it is argued that through the inclusion of the core DRR knowledge, skills and requirements in the CM Curriculum at universities, construction professionals will be better educated and equipped when it comes to understanding the requirements of DRR. It is recommended that the accreditation bodies and the universities who are responsible for the development of CM Curriculum embed the 11 identified core DRR knowledge, skills and requirements within the CM curriculum. Through the appropriate education of construction professionals DRR knowledge and practices will be better disseminated among construction professionals.

Additional further research in this area could provide a greater understanding of the current CM curriculum in relation to DRR. The curriculum of universities outside NSW could also be assessed in relation to the core DRR knowledge, skills and requirements including Australia wide and across the world. Research at this level would need participation from multiple individuals, universities, governments, nations and would be beneficial to the global push of mainstreaming DRR within the built environment. Furthermore, additional research could be conducted that assesses a wider range of the accreditation bodies responsible for CM curriculum to obtain a better understanding of what curriculum content is being recommended beyond NSW and Australia and where the core DRR knowledge, skills and requirements could best fit within the curriculum structure. Finally, it is also recommended that a longitudinal study is developed and implemented to assess the success of mainstreaming DRR within CM curriculum and also assess the success or failure of the recommendations made within this research paper.

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Disaster Risk Reduction improvement suggestions for a renewal area in Istanbul

Seda Serbest Yenidünya [a,*], Sevgül Limoncu [a]

[a] Yıldız Technical University, Turkey

Abstract

Major causes for losses from natural hazards in Turkey are earthquakes and flood events. After the Marmara Earthquake in 1999, the Turkish government has intended to take precautions against disasters with disaster management plans. Although disaster management plans exist on national level, local plans on neighborhood scale are needed, since Istanbul is a metropolitan city with a population of 15 million which is located mostly in earthquake zone and also faces risk of floods. The study proposes to examine the city on neighborhood scale to be able to fully understand the challenges on disaster risk reduction. In this study, a neighborhood of Kadıköy district in Istanbul is analyzed as fieldwork due to numerous practices of building renewals in the area. It is aimed to establish Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis in the selected field and to develop disaster risk reduction recommendations according to the conducted analysis. The SWOT analysis reveals that there are gaps in the legal framework, risks arise in the physical environment and there are social groups which require special attention in disaster management plans. The findings of the research highlight the importance of local analyses for identifying disaster risks and verify the need for disaster risk reduction improvement at local levels.

Keywords: Disaster risk reduction; SWOT analysis; urban renewal

1. Introduction

Cities need transformation, improvement and renewal over time due to economic and social reasons as well as disasters. Urban regeneration is applied all over the world to meet different needs of cities. Like many, Istanbul also faces urban regeneration practices since 1980s on illegal or unhealthy areas. After the Marmara Earthquake in 1999, the Turkish government has intended to take precautions against disaster risk in the built environment. One way to implement the new strategy is to renew old buildings in order to provide earthquake safety. Renewal became the main type of urban regeneration implemented in the country. After the Law of Transformation of Areas under Disaster Risks No. 6306 in 2012, renewal gained speed on urban and also on building scale. Renewal on building scale is very common, so much so that even though they are single practices, they have urban-scale effects due to their high numbers.

On the other hand, three major causes for losses from disasters in Turkey are earthquakes, landslides and flood events. 66 percent of country's lands are located in the 1st and 2nd degree earthquake zones. A major earthquake is highly anticipated in 11 large cities with populations over one million, in regions where 70 percent of the whole country's population reside and in industrial areas where 75 percent of large industrial plants have been established. Despite these possible disasters, disaster management is still premature in Turkey. There are many deficiencies in existing disaster management plans. There are gaps in legislations related to the subject, lack of appropriate organization plans for management and lack of consideration of different approaches. The lack of adequate scientific work has created problems in the creation and development of disaster culture in the community. Urban renewal in Istanbul is an opportunity to implement all the missing aspects of disaster management plans since many buildings are being rebuild. It is important to take the steps to identify the deficiencies and to fill the gaps in management in order to reduce disaster risks in the new built environment.

Disaster risk reduction practice reduces disaster risks by analyzing the existing situation and previous impacts of disasters. In order to successfully carry out the risk mitigation under the disaster management, the current situation needs to be analyzed in detail. In this study, it is aimed to establish Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis in the selected field and to develop disaster risk reduction recommendations according to the conducted analysis. A neighborhood of Kadıköy district in Istanbul is analyzed as fieldwork due to its central location and numerous practices of building renewals in the area.

* Corresponding author. E-mail address: serbestseda@yahoo.com

The research is structured in two parts. First part introduces the research subject and identifies the theoretical basis of the research by conducting a literature study. The second part is the case study in a neighborhood in which building renewal is very common. Finally the findings and recommendations are presented.

2. Disaster risk reduction

United Nations Office for Disaster Risk Reduction (UNISDR) defines disaster as "a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts." Disasters are caused by natural or human driven hazards and their impacts are dependent to vulnerabilities and capacities of the affected society. Disaster management is a series of processes designated to cope with disasters which involve reducing vulnerabilities to hazards (FEMA) and comprise of four main steps (Figure 1):

- Mitigation
- Preparedness
- Response
- Recovery

Figure 1: Disaster management cycle

The process involving mitigation, preparedness, prediction and early warning is called risk management while actions after disaster like response, impact analysis, recovery and reconstruction/rehabilitation is named as crisis management (Kadıoğlu, 2008). These actions create the disaster management cycle by repeating each time a disaster occurs. Another model for disaster management suggests that these actions should shape a spiral by unfolding and create a chance for sustainable development (Figure 2) (RICS, et al. 1999). The spiral model contains the enhancement of pre-disaster conditions.

Risk management consists of identifying, analyzing, evaluating and treating risk as well as monitoring the results and reviewing the process (Standards Australia, 1999). The concept of resilience is closely related to risk reduction (Sharma, et al. 2011). In order to reduce risks, a risk analysis should be conducted. Since risk is a result of hazards, vulnerabilities and capacities, possible hazards and vulnerabilities should be determined primarily as well as the capacities that would be affected.

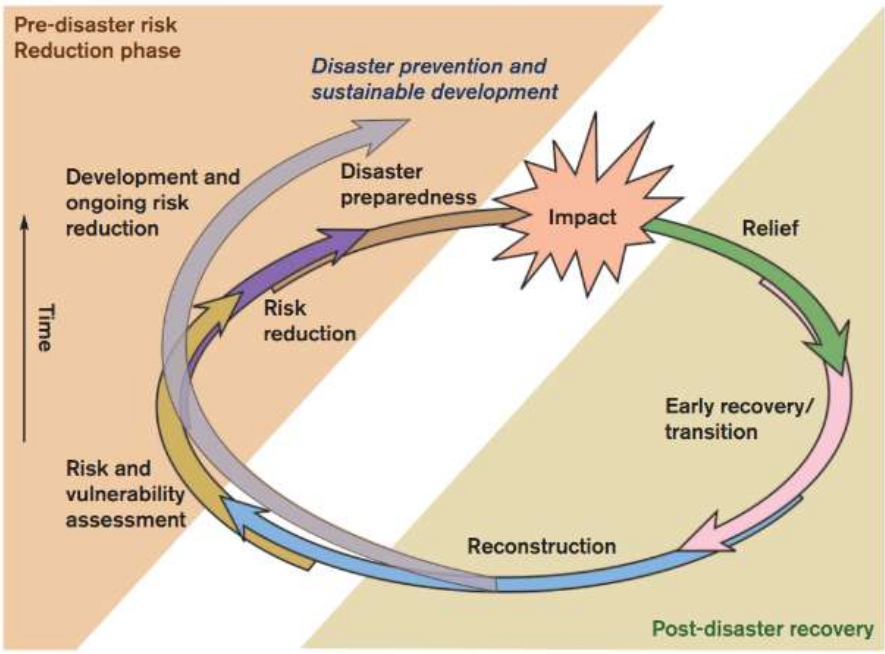

Figure 2: Disaster Management Spiral (RICS, et al.,2009)

According to Baas et al. "disaster risk reduction (DRR) refers to the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards" (p.5). In the case of natural hazards, vulnerabilities should be analyzed in detail for disaster risk reduction since preventing a natural hazard is mostly not possible. Vulnerabilities of a society may be categorized into five groups (Bosher, Chmutina, 2017):

- Physical vulnerability
- Social vulnerability
- Economic vulnerability
- Environmental vulnerability
- Governance vulnerability

Mitigation strategies vary according to type and properties of a hazard. Mitigation actions for local governments should cover all hazards threatening the area. Therefore risk analysis on which the risk reduction plan is based should be prepared covering all risks. (Kadıoğlu, Özdamar, 2008)

As stated in Sendai Framework for Disaster Risk Reduction, in order to effectively manage disaster risk, it is highly important to implement policies at the national, regional and global levels (UNISDR, 2015). However, Turkey's disaster management system is a centralized structure and lack of coordination among central and local governments has still not been resolved. Furthermore, it is an organization based entirely on public institutions, not defining roles for CSOs, the private sector and voluntary citizens, which are crucial components that cannot be ignored in an effective risk and disaster management system.

3. Disaster risk in Turkey

Turkey is exposed to many natural hazards like earthquake, storms, flood, and landslide but the most discussed hazard is earthquake due to high losses caused by earthquakes. 66% of country's land is located on first and second degree earthquake zones in other words active fault zones and 71% of population lives on these areas (Ergünay, 2007). Turkey experienced many earthquakes along the years (Table 1). However, Marmara Earthquake which occurred in 1999 resulted in the greatest losses of recent years causing about 17000 deaths, over 75000 demolished buildings and an economic loss over 12 billion dollars (Kadıoğlu, Özdamar, 2008).

Table 1: Recent Earthquakes in Turkey (Kadıoğlu, Özalp et al., Şahin and Kılınç)

Year	Location	Magnitude	Losses
1992	Erzincan	6.4	653 deaths, 3850 injured
1995	Dinar	6.2	90 deaths, 200 injured
1998	Ceyhan	5.9	145 deaths, 1113 buildings
1999	Kocaeli	7.4	17127 deaths, 23781 injured 75000 buildings
1999	Düzce	7.2	845 deaths, 5000 injured
2011	Van	7.2	604 deaths, 1301 injured, 48600 buildings
2011	Van- Edremit	5.7	40 deaths

In addition to earthquakes, flood is most often occurring hazard in Turkey, which cause high economic losses (Ergünay, 2007). City floods can occur in all kinds of places within the city. Especially in the urban areas where the natural vegetation is destroyed by building of parks for buildings, roads and automobiles, and therefore, the sudden floods frequently occur.

According to Kadıoğlu the common understanding of disaster management in Turkey is limited to activities after the disaster occurs (2008). It is very important to change the view of society on disaster management by engaging communities on disaster mitigation and preparedness activities.

Dodman et al. suggests that the municipal governments should regulate land use, construct and maintain public buildings also provide infrastructure like roads, sanitation and drainage, and services like fire protection, healthcare and transport for disaster protection and response (2013). There are some activities in Turkey for disaster risk reduction such as mapping earthquake zones of Turkey, regulation on buildings to be constructed in disaster areas and building inspection to reduce physical vulnerability Center for Earthquake Mitigation to coordinate activities for earthquake management, disaster insurance to decrease economic vulnerability. However, these actions are not sufficient and mostly not embraced by the community.

The approach to disaster management evolves all over the world in time. Turkey uses mostly disaster management cycle as a model, however the spiral would be more suited since it suggests enhancing circumstances that existed before the disaster. In many cities of the country, the built environment is being rebuild and many aspects such as earthquake safety, urban regeneration and sustainability should be considered at the same time. As a developing country, Turkey needs to take conceived yet quick steps as a country relatively new to disaster management plans.

4. Methodology

The selected neighborhood is located in Istanbul. Therefore, possible natural hazards in İstanbul have been researched in the first place. The hazards affecting Istanbul are accepted to be affecting the selected neighborhood as well. Secondly, quantitative data about case study area is collected from governmental organizations, statistics office of Turkey, municipality of the district and an academic research on neighborhoods of Istanbul. Qualitative data is gathered from unstructured interviews, visual survey and literature. Then, a strengths, weaknesses, opportunities and threats (SWOT) analysis is conducted with collected data in order to understand the existing situation of the neighborhood and to receive inputs for disaster risk reduction plans. In this study the items under SWOT analysis are grouped as institutional, physical, and social in order to create a better understanding on the analysis table.

5. Case study

Istanbul is a very old city that grew very rapidly. Population of Istanbul increased from 1 million in 1950s to 15 million as of 2017 (TÜİK). As a consequence of population growth, there was a need for rapid urbanization and it resulted mostly in questionable building stock regarding earthquake safety, since Istanbul is located mostly in first and second degree earthquake zones (Ergünay, 2007). After the enormous impact of Marmara Earthquake on built environment, the government published the Law of Transformation of Areas under Disaster Risks No. 6306 in 2012 for encouraging renewal of indurable buildings. As a result, renewal applications on urban as well as building scale accelerated all over the city.

Beside earthquakes, flood is a natural hazard which may occur in Istanbul. As the city develops, many areas are being covered with buildings and roads, and the water absorption capacity of the land decreases and the flow rate of rain increases. The inadequacy or lack of rainwater drainage systems in the city increases the risk of sudden floods (Kadıoğlu, 2008). Global climate change is another cause of unexpected possible floods. It also may have direct and indirect impacts on urban areas like disruption of livelihood and city economies, damage to infrastructure and displacement of urban population (Dodman et al., 2013)

Figure 3: Suadiye Neighborhood

Istanbul is divided in 39 districts and 961 neighborhoods. The case study is located in Kadıköy District that lies on the Asian side of the city and consists of 21 neighborhoods (Ministry of the Interior). Suadiye neighborhood is selected as case study since the buildings are being renewed in the area as a disaster mitigation policy (Figure 3). The neighborhood was a summer village of Istanbul till the 70s. Therefore the layout is very different from other parts of Istanbul by the amount of greenery and density of buildings. The neighborhood covers an area of 1.48 km² hosting 1162 buildings and 21909 people (Table 2) (Kadıköy Municipality, 2015, Mahallem-İstanbul). 42.9% of the population is male whereas 57.1% is female. Average age of the neighborhood is 45.57 and 44% of population has a university degree. There are 10840 dwellings on the area as of 2017(Kadıköy Municipality). However, this number increases constantly due to urban renewal projects.

Table 2: Population according to age groups (Mahallem İstanbul Project)

Age group	Number of people
0-19	3039
20-39	5532
40-64	8008
Over 65	2083

The neighborhood accommodates several public facilities including a primary care clinic and three schools. The only open public space is the park on the coast along the district. There is no fully-equipped health facility on the area but there are two hospitals in the adjacent neighborhoods.

The neighborhood has many transportation opportunities like railway and seaway. Railway connects the area to the district center and to Anatolia. A functioning pier is present very close to the area and there are three main roads connecting the neighborhood to other parts of the city, also highway is very close to the area.

Considering these data and observations on site SWOT analysis of the neighborhood is given on Table 3.

Table 3: SWOT Analysis of Suadiye Neighborhood

Strengths	Weaknesses
Institutional A legal disaster management policy is completed providing a framework on general issues. Municipality of the district is open minded on providing policies and integrating different stakeholders. Several public facilities exist on the neighborhood. **Physical** Neighborhood is on a central location in the city. Several transportation options are accessible including railway and seaway. Old buildings in the neighborhood are being renewed. The neighbourhood has low density urbanization compared to other central parts of the city. Soil structure of the area is fairly good. **Social** Level of income of the population is high. Education level of population is high. The majority of the population is young which offers an opportunity to educate young people on disasters.	**Institutional** Research that studies disaster management on local scale misses. A common action plan at national, city and neighborhood level lacks. Research studies are mainly theoretical rather than applied. Risk scenarios do not consider climate change, they generally focus on earthquake risk. Education on disaster issues is not continuous. Disaster management on district level is not sufficient. Management plans focus on crisis management rather than risk management. **Physical** Neighborhood is located on first degree earthquake zone. Existing infrastructure does not meet the needs of increasing urbanization and population. The number of health facilities in the neighbourhood is low. Disaster resilience of critical infrastructure is questionable. There is no high quality training institution for disaster management. There is low synergy between the academic institutions and politic authorities. At neighbourhood level, there is no institutional mechanism for advancing disaster risk reduction. Earthquake safety of school buildings is uncertain. **Social** Rapid population growth occurs as a result of newly added dwellings. There is a high number of elderly people on the area.
Opportunities	**Threats**
Institutional Urban renewal is promoted by a law that encourages stakeholders **Physical** The district municipality offers an education center on disasters. Public facilities are being reinforced or renewed for earthquake safety. **Social** Working groups on various topics are created in the district such as health, climate change and environment.	**Institutional** The number of professionals with knowledge and expertise in disaster risk mitigation is low. There are few educational institutions that offer disaster management degrees or courses. **Physical** High-rise buildings are constructed on the neighborhood resulting in changes in air movement. There is a decrease in the amount of green areas in the whole district. Climate change occurs on local level as well due to dense urbanization in the city. **Social** The user profile changes as a result of increasing population.

6. Results and discussion

Istanbul is a crowded and large city and as a result, analyzing the whole city deeply is a challenging task. This study offers to analyze Istanbul on neighborhood scale in order to understand the existing situation and to create inputs for disaster risk reduction.

The SWOT analysis reveals the major issues on institutional, physical and social aspects of the neighborhood. When approaching institutional subjects, lack of policies involving every scale and stakeholders as well as integration between different levels of management are showing up as prominent issues. Considering

the physical matters, renewal focusing solely on earthquake risk which may create flood risks and vulnerabilities in infrastructure seems to be a major problem. Social issues should be carefully handled due to the existence of more vulnerable groups in particular the elderly population, high number of children and females. On the other hand, high number of young people and high level of education offer a chance to create a community aware of disaster risks and well educated on mitigation and preparedness.

Considering the disaster risk reduction needed for the area the following measures are suggested:

- Integration and data sharing between local and national governance
- Using local advantages like young and educated population
- Reducing physical risks by monitoring building renewal process adequately
- Organizing available resources
- Defining objectives and strategies for disaster risk reduction at local levels
- Conducting a proper risk analysis
- Improving infrastructure for future density and flood risk of the area
- Monitoring and revising plans for land use in order to reduce flood risk
- Updating and improving existing management plans
- Defining the necessary research topics and planning research activities

This study is an introductory work on examining the ways of analyzing neighborhoods for disaster risk reduction planning. The future studies require multidisciplinary research including architects, urban planners, academics, and experts from public institutions and detailed analysis from upper scale to lower scale. Data gathered from such a detailed analysis would not only create an input for disaster risk reduction but also support the planning of crisis management. In addition detailed analysis should be supported by the governments and should be integrated in every level of governance.

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Exploration of the impact on environment and land use in case of Rohingya influx in Bangladesh: guideline for sustainable survival

Hridita Siddiquee [a,*], Dewan Nurul Huda [a], Abu Naser Babar [a,*], Mohammad Abu Taher Chowdhury [a]

[a] BRAC University, Bangladesh

Abstract

Myanmar, as situated at the south-western direction of Bangladesh, is a country which contains about one third minority group of people in comparison to the total population. Rakhine Muslims (known as 'Rohingya') people are one of the seven minorities of the country. Because of huge cultural and religious difference in many aspects the Muslims are overlooked by the Government of Myanmar since 1982. As the aftermath of 'Ethnic Cleansing' in Myanmar, a huge number of (approximately 6,07,000 within August, 2017 to October, 2017) Rohingya people has taken shelter in Teknaf, Ukhiya, Bandarban areas in Bangladesh. This influx has caused a humanitarian crisis and since this large number of people cannot be returned for humanitarian reasons, Government of Bangladesh is making effort to accommodate this people for short time period. But Bangladesh is paying high price for Rohingya influx and the attempt to accommodate this much people. The negative impacts include environmental and spatial concerns as well as social and economic issues. The area, the displaced citizens of Myanmar are living in is being imposed of a rise in temperature and change in land use pattern. Because of deforestation and cutting hills is causing a drastic change in land-use. This change is affecting environmental degradation too. The goal of this study is to explore the amount of environmental degradation focusing on the temperature rise and the land use before and after Rohingya influx comparing between the Rohingya camp and surrounding areas. The methodology includes quantitative and qualitative research methods. After selecting the site, the time selection, weather temperature readings have been used. and Key Informant Interview are going to be held. Both primary, secondary data, hygrometer readings, are going to be used. The outcome of the research would answer the queries about the negative impacts on the climate of the focused area because of Rohingya influx, the spatial impacts on land use pattern and how the effects can be minimized by architectural interventions through practice of sustainability.

Keywords: Environment; Land use; Rohingya Influx; Sustainable Survival.

1. Introduction

Myanmar, a Buddhist-majority country of southwestern Asia, holds seven ethnic minorities, which is approximately one third of the total population of the country. Rakhaine Muslims are one of this seven minorities, who are also known as 'Rohingya's. This huge number of Rohingyas abide in Rakhaine state, which is geographically isolated from western Myanmar and naturally rich with coastal plains, streams, rivers and mountain range separating it from central Myanmar. The Border between Bangladesh and Myanmar is marked by Naaf river[2].According to Amnesty International and other human rights groups, the Rohingyas have been subjected to decades of state-sponsored discrimination and persecution[1]. Being formed by the constitution of 1974, the Rohingyas have lost their citizenship rights, particularly, because of the Citizenship Law of 1982, which was discriminatory and this law also violated their civil, political, economic and social rights [2].

This situation got bad turn significantly after waves of violence of Rakhaine Buddhists upon the Rakhaine Muslims in 2012.Thousands of Rohingya Muslims were killed and millions of homes were destroyed. This caused a massive displacement. After four years, about 120,000 people continued to live in Internally Displaced Person (IDP) camps and unofficial settlements [8].

Rohingya and other Muslims living outside displacement camps also face severe restrictions on their freedom of movement, limiting their access to livelihoods, healthcare, food and education. Rohingyas were not allowed to main towns and most importantly they had to travel the Muslim villages by waterways [13]. BGP conducted

* Corresponding author. E-mail address: siddiquee.hriditasiddiquee@gmail.com

* Corresponding author. E-mail address: anmbabar@gmail.com

arbitrary arrests, extortion, torture and other ill-treatment of the Rohingya community, international and other organizations documented [13].

In the report on crimes against humanity and Ethnic cleansing of Rohingya Muslims in Burma's Arakan state by Human Rights Watch named 'All you can do is pray' (ISBN: 978-1-62313-0053) in April 2013, Human Rights Watch stated that the following activities was happened as the name of 'Ethnic Cleansing' [10].

- Forcible displacement of more than 125000 Rohingya and other Muslims
- Co-ordinated attacks conducted on Muslim neighbourhood and villages by Burmese officials, community leaders and Buddhist monks
- Forcibly relocating the population
- Destroying mosques, blocking aids to displaced Muslims
- Time to time killing and displacing Muslims.
- Denying the existence of Rohingya ethnicity, demonizing them and calling for their removal by the Buddhist monks and Rakhaine nationalities Development Party (RNDP).

With the consequences of 'ethnic cleansing' the Rohingya people started arriving in Bangladesh since 1970's. The violence continued time to time resulted to the illegal influx in 1978 and 1991.During this short space of time 10000 Rohingya people poured across the border. With the sequential occurrence, again in 1992, about 300000 to 500000 people entered through the border [13]. In 2017 and very recently,602000 more Rohingya people has arrived to get just a safe place to live [10].

According to these circumstances, Bangladesh started facing a new crisis to deal with apart from terrorism and corruption: the Rohingya Refugee Crisis. According to BIPSS special report,

"Bangladesh has (unwillingly) provided refuge to several Rohingyas since 1978, when the first riot broke out in the Rakhine (then Arakan) state in the west of Myanmar. Although both during 1978 and 1992 UN intervention led to repatriation of a significant number of Rohingyas back to Myanmar, there are several who stayed back. The total number of Rohingya presently in Bangladesh is unknown as only 32,000 of them are registered with UNHCR and the Bangladesh government." [3]

The rapid influx has severe effect on the land-use, therefore, environment of Bangladesh, specially, where they are deciding to encroach land as well as society, polity and economy. The refugee camps are being built up destroying the agricultural fields and natural habitat of the area to accommodate Rohingya people [3].

This change of land-use is affecting the environment, to be specific, the climate of Bangladesh. This study aims to explore the amount and type of spatial changes and the effect on environment, occurred because of the creation of shelters, which caused by deforestation in the areas, where Rohingya refugees are living in.

The study aims to explore the change in land-use and temperature as apart of climate change in the context of the area occupied by the Rohingya refugee communities.

2. Methodology

The methodology includes quantitative and qualitative research methods. After selecting the site, focused group discussion, questionnaire survey, In Depth Interview and Key Informant Interview are going to be held. Both primary, secondary data, hygrometer readings are going to be used.

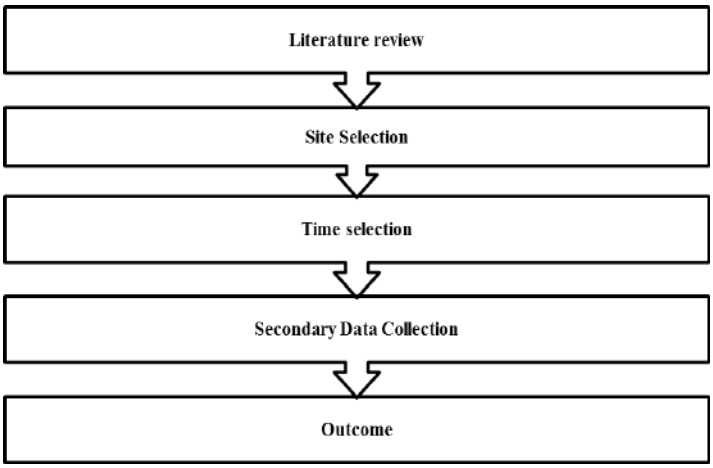


Figure 1: Methodological Framework

3. Literature review

3.1.History

The Rohingya people has a history full of sorrows. According to the Wall street Journal, with a glorious past as far known from the 8th century, the Rohingya people, who are supposed to be from south Asian origin, used to dwell in their own independent kingdom in Arakan (now known as Rakhaine). Since the Muslim conquerors invaded Arakan, while ruling in Bengal, the Rohingya people started to flee to Bengal. This Rohingya people were sheltered even in the reign of Hiram Cox in 1790. The British rulers, when captured Burma, the steps taken for infrastructure development made people migrate to Burma. After the invasion by Japan, the history of oppression got started. As the Rohingyas were retreated by the British rulers, Burmese nationalists attacked the Muslim communities. After reoccupying Burma from Japan, British rulers failed to fulfil the promise of autonomy of Arakan. As many of the people of Arakan wanted to join Muslim majority Pakistan, tension increased. The back and back attack and protests since now, caused the Rohingya community to leave their villages and search a safe place to live. Being at the close proximity of Rakhaine, Bangladesh seemed to be the place they can live. And they started to settle their lives here, overlooking the rules and risks of migration.

3.2.Role of Bangladesh

Bangladesh is handling the Rohingya situation for humanitarian reasons, even if they have severe problems to handle. Bangladesh is a developing country with a population of nearly 160 million and annual GDP of 246 million. Moreover, a rising number of refugees created an emergency, that Bangladesh is facing problems to deal with. Still Bangladesh handles the situation as and when it comes [3]. The exact number of Rohingya people got entered in Bangladesh is unknown. But the approximate numbers are as following:

Table 1: Number of Rohingya people entered (timewise)

Time and place	Number of Rohingya people
August,25 to October 25,2017	605,000
July, 2005 to 24th August,2017	203,431
Except Ukhiya and Teknaf	200,000
Relocated in Thengar Char	232,000

Source: Dealing with Rohingya Crisis, 23 November, 2017, The Daily Sun

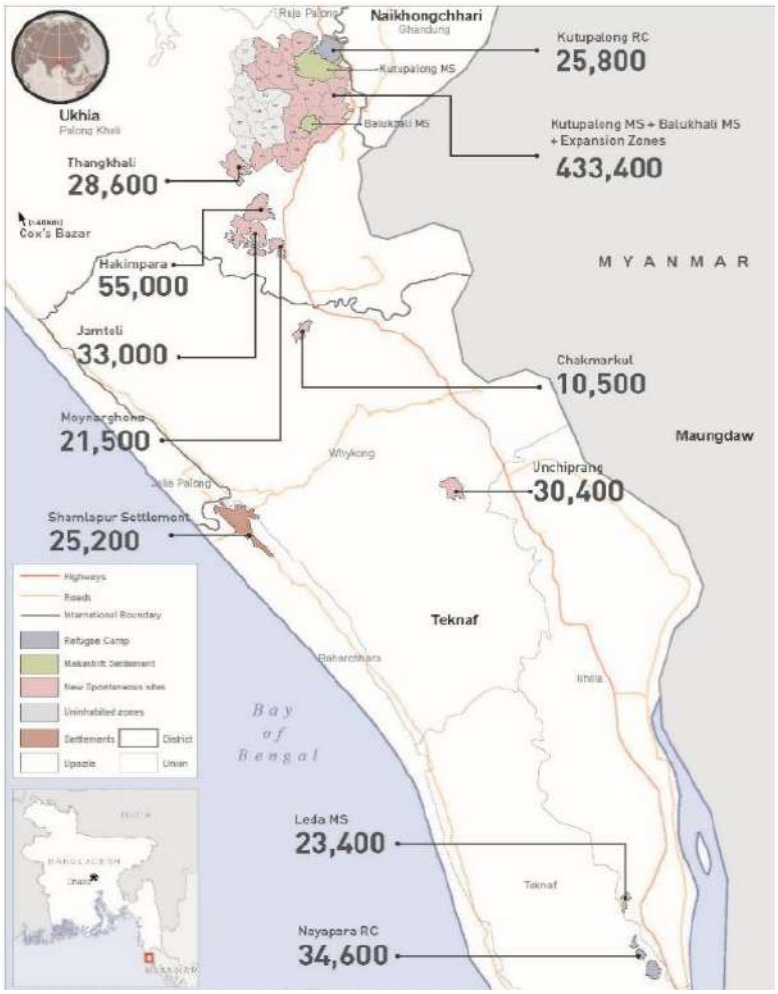
3.3.Change of Land-use: As recoded

According to Arab news, and referred from UNDP report, “The establishment of makeshift camps in Ukhia and Teknaf sub-districts, close to several unique environmentally sensitive areas, threatens global biodiversity and causes the degradation of critical natural habitats.”

The report by UNDP on rapid environmental assessment of the Rohingya Refugee influx into Bangladesh (published on 12th December, 2017) has identified 28 risk factors and rated them from critical to low. The following table shows the issues and aftermaths of deforestation [2]:

Table 2: impact level and amount of deforestation

Issue	Impact level	People Concerned
Degradation of forests	Critical Short term	Host Communities and refugee’s population 1.2 M as of 26 Nov 2017
	Short term Medium Term Long Term	Potentially more than 50% (10,000- 25,000 ha) of remaining forest degraded in the area.



Source: ISCG (Inter Sector Coordination Group)

Figure 2: Locations and numbers of Rohingya people living in Bangladesh (as of 7th November, 2017)

"It was like a jungle, all of this. There were trees and fruit plantations," said Rehana Begum, a local Bangladeshi whose home now lies in the middle of the mega-camp. "Now there are so many homes here but they only appeared over the last two or three months." [6]

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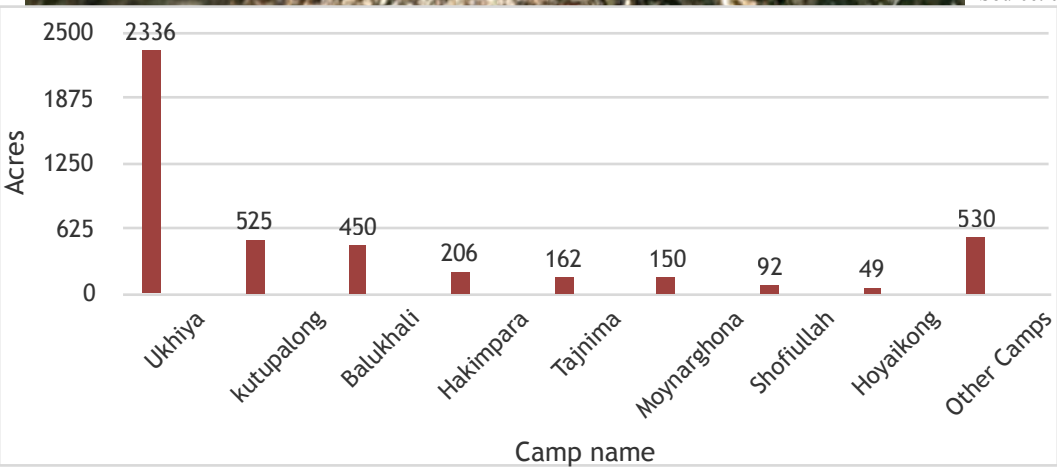
Source: comperative



Source: Department of Forestry, GoB.

According to CPD (Centre for Policy Dialogues),

- Total Forest Area in Cox's Bazar (2016):2,092,016acres
- Due to Rohingya influx, initial loss of forest area:3,500acres
- Which is equivalent to 1.67% loss in Cox's bazar forest area and 0.05% loss in total national forest area.
- The value of forestland occupied by the Rohingyas has been estimated to be BDT 500 crore.

President of Cox's Bazar Forest and Environment Conservation Council Dipak Sharma Dipu said, "It is not an easy matter to provide the firewood for the huge number of Rohingya entrants as there is a lot of demand of firewood which is increasing day by day. They are regularly meeting their needs of the firewood by cutting forests and social forestry trees."

"The government and the administration should plan to provide firewood for Rohingyas including the relief. Otherwise, the way they start damaging forests, there will be an environmental disaster very soon." He added.

on October 25, Environment and Forest Minister Anwar Hossain Manju Ignored the environmental disaster and said that 1000 acre more land will be allocated if it needed after his visit to the Kutupalong Rohingya camp in Cox's Bazar's Ukhiya Upazila. "Some partial damage to the environment needed to be accepted and compromised for the sake of the Rohingya refugees."

4. Site selection

The study area, Kutupalong Camp, is the biggest among the three Rohingya Camps, although there are almost 100 spontaneous refugee camps. This camp expansion has a population density of 533 refugee per hector and the total population is 713000 Rohingya people. The Kutupalong - Balukhali camp expansion is situated at the latitude of Latitude: 21°12′36.70″N and Longitude: 92°9′52.41″E. The average elevation in buffer zone is 23 m [7].

According to [7],

The area, as a part of teknaf-Coxs' Bazar conjuctory area, is situated under a subtropical climate state.

- The average annual rainfall is 4000 mm.
- The most rain occurring in July (1029 mm), and the least rain occurring in January (2 mm).
- The average annual temperature is 78.98 °F (26.1 °C).
- The warmest month is May (32.2 °C) and the coolest month is January, with an average temperature of 58.82 °F (14.9 °C).

41% of the area was covered with forest but the number has decreased over time due to extensive anthropogenic activities in recent decades.

- The site is selected for the study because of the following reasons:
- Mostly populated among all of the camps
- Mostly damaged (in terms of deforestation)

Among the three Rohingya Camps, Ukhiya-Kutupalong – Balukhali camp has been subjected to largest loss of forests. According to Table 3. Hence, the difference between temperature would be clearer to identify if the area is taken as the site for this study.

5. Time selection

As the biggest influx happened after 25th August, 2017 and the huge amount of forest have been destroyed to shelter them. So, the time period for the study was taken related to the execution date.

The matters which were taken in concern when picking the study time, are as follows:

- The time of influx (25th August)
- The rotation of one year (to take record of the same time of the year)
- The hottest month of the year (to get the maximum temperature)

So, the month May, 2017 and May,2018 is selected to show the maximum and minimum temperature data. The historical temperature data average of the particular month for the particular area was collected and compared to the after-influx or after expansion temperature of the camp.

6. Change of temperature according to time

According to BMD and BWDB of Cox's Bazar, the Average temperature of the years 1985- 2013 of month 'May' was 34.79 degree Celsius. According to World Weather Online, the maximum and minimum temperature list of May per year is as following:

Table 3: Average minimum and maximum temperature for May per year

Year	Maximum Temperature (deg. Celsius) of May	Minimum Temperature (deg. Celsius) of May
2017	36	28
2016	35	28
2015	35	28
2014	33	28
2013	31	27
2012	31	27

2011	31	27
2010	33	28
2009	33	27

The day-wise temperature records of May,2017 and May, 2018 represents a huge difference, which does not match to the fluctuation history of the temperature of Ukhiya, Coxs' Bazar in general:

Table 4: Day-wise Maximum Temperature record of May, 2017.

Date	Maximum Temperature	Minimum Temperature
1	33	24
2	34	23
3	33	26
4	34	27
5	33	26
6	33	26
7	34	26
8	33	27
9	34	26
10	34	25
11	34	26
12	34	28
13	34	28
14	35	29
15	32	26
16	32	23
17	34	26
18	34	23

Table 5: Day-wise Maximum Temperature record of May, 2018.

Date	Maximum Temperature	Minimum Temperature
1	33	22
2	33	24
3	34	23
4	31	22
5	32	26
6	33	24
7	32	22
8	32	22
9	41	25
10	34	24
11	33	23
12	33	22
13	33	24
14	33	23
15	33	24
16	31	25
17	33	23
18	33	24

19	34	28
20	35	28
21	35	29
22	35	28
23	35	28
24	35	29
25	35	20
26	34	28
27	36	27
28	36	26
29	32	27
30	29	25
31	30	24

19	32	25
20	32	26
21	32	26
22	32	26
23	32	25
24	31	27
25	33	26
26	34	26
27	34	27
28	35	27
29	35	26
30	34	27
31	33	28

Chart 2: Percentage of Maximum Temperature amounts of May, 2017

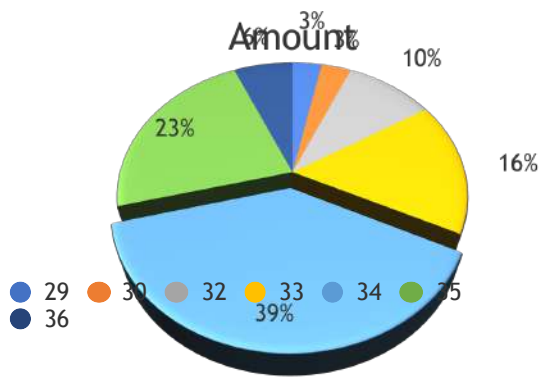


Chart 4: Percentage of Maximum Temperature amounts of May, 2018

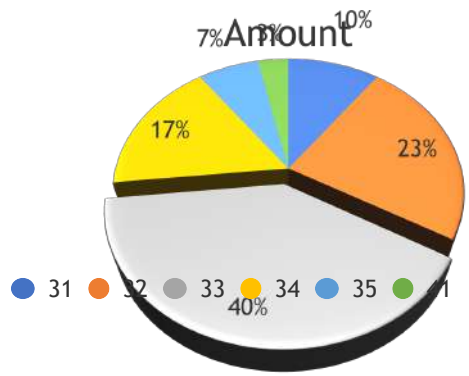


Chart 3: Percentage of Minimum Temperature amounts of May, 2017

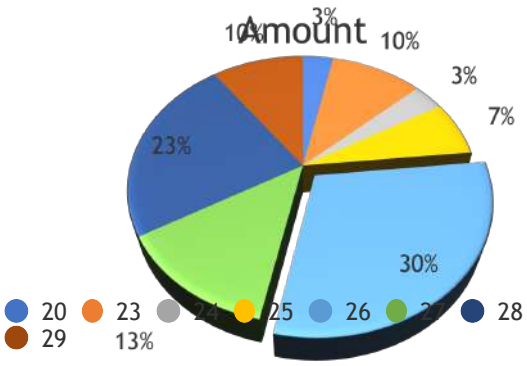
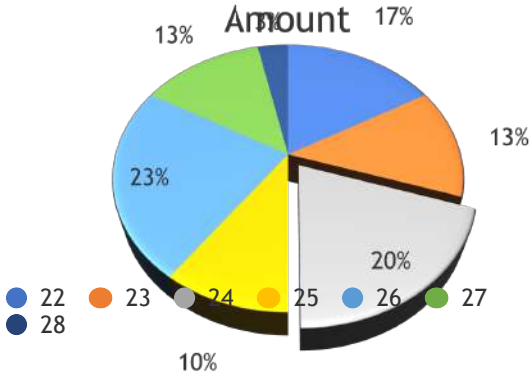


Chart 5: Percentage of Minimum Temperature amounts of May, 2018



The result shows that, the day wise temperature list of 2017 got a jump in 2018, as a big amount of vegetation was vanished and there was nothing to maintain the past consistency of temperature. In 2017, the maximum temperature was 36 deg. Celcius and existed 3% days of the month. The least of the maximum temperature was 29 deg. Celcius.

On the other hand, in 2018, the maximum temperature got a boost and had been recorded to 41 deg. centigrade and that existed 3% days of the month. And this year, the least maximum temperature was 31 deg. Celcius. On the contrary, the minima of minimum temperature was 20 deg. Celcius in 2017. And the maxima of minimum temperature was 29 deg. celcius. Again, the minima of minimum temperature in 2018 was 22 deg. Celcius. And the maxima of minimum temperature was 28 deg. Celcius. In comparison to the previous years, the differences of temperature rise between 2017 and 2018 is quite big.

7. Limitations

The study is not complete yet, as the decisions about environment is a long-term phenomenon. The temperature was taken as a contextual average, so the temperature at an exact situation lost its accuracy. The camps are still growing every day, so it's hard to predict the exact temperature of an area in such a dynamic situation.

8. Conclusion

The loss Bangladesh is facing to save the Rohingya people, is irreplaceable. The area Rohingya people are being sheltered, is mostly a disaster-prone area, and the change of land-use is already replying itself, with a heartless consequence of 'Landslide'.

Though the Government of Bangladesh has taken initiatives to save amount of green those were before Rohingya influx., but it would take time to provide the result to nature.

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Transformation of shelters of the displaced citizens of Myanmar in Bangladesh

Hridita Siddiquee [a], Md. Abdur Rahman [a,*], Jakir Hossain Sarker [a,*], Md. Istiak Hossain Uzzal [a]

[a] Bangladesh University of Engineering & Technology (BUET), Bangladesh

Abstract

'Rohingya Influx', as one of the most alarming humanitarian disasters in recent world, is creating a worse situation day by day. Bangladesh makes effort to accommodate the huge number of Rohingya people coming from Myanmar from humanitarian point of view. Before this much influx, Bangladesh has been facing illegal influx and land encroachment by Rohingyas from a very long time. These people are cutting hills creating their spaces to live with temporary materials first. and then transforming the spaces sequentially, somehow, by encroaching and to shelter new Rohingya people coming from Myanmar. They are transforming not only the place they are living, but also their identity and nationality by the owned lands in Bangladesh, which is alarming and frightening too. The way they start their life here and the way they transform these spaces day by day, is a matter of concern for the existing authority. This study aims to find the type of their settling spaces and the process of progressing the transformation of the abiding spaces. To identify the phasing steps of the shelters they use is the outcome of this research. The methodology includes both quantitative and qualitative research methods. Observation, primary & secondary data and drawing software are going to be used. Key informant interview, In Depth Interview are done to get primary data. After selection of the site, Simple random sampling method has been done to bring out the different case studies. Case study survey and questionnaire survey was done to study the details. The outcome focuses basically on the type of dwelling and the transformation process of the dwellings in Bangladesh by the displaced citizen of Myanmar.

Keywords: Transformation; Shelters; Rohingya influx; Encroachment.

1. Introduction

Myanmar's westernmost state, Rakhaine (Historically known as 'Arakan' [2]), stands with a long coastline along the Bay of Bengal to the west and shares a shorter border with the Chittagong Division of Bangladesh to the northwest [11]. Rakhaine is rich with coastal plains, streams, rivers and mountain range, the 'Rakhaine yoma' which is 3000 in height and separates it from central Myanmar [2]. Rakhaine has only three roads to connect to the rest of the country and neighbour states: Magway to Ann, Pyay to Toungup and Yegwi to Gwa. And this remarks a poor connection to be [11].

With a glorious past to be ruled and hence enriched by the Muslim conquerors, the people of Arakan has been subject to state -sponsored discrimination and persecution since 1982 [11]. According to Amnesty International perpetrating human rights abuses by the state security forces resulted in massive displacement.120,000 people in four years, who are basically Rohingya, continued their life in Internally Displaced Person (IDP) camps and unofficial settlements. Denying fundamental rights, the Government of Myanmar, even created barriers for humanitarian organizations to access the affected communities.

"All You Can Do Is Pray", publication by Human Rights Watch, claims that forcible displacement, co-ordinated attacks, forcible relocation, destroying mosques, blocking aids, killing and denial of existence of Rohingya ethnicity, this al happened under the active supervision of local Buddhist monks and Rakhaine Nationality Development Party (RNDP).Even if not being a formal legal term, 'Ethnic Cleansing' is being used to define the purposeful policy by an ethnic or religious group to remove by violent and terror inspiring means the civilian population of another ethnic or religious group from certain geographic areas. This is exactly what is happening to Rohingyas in Myanmar [12].

Rohingyas started to flee to Bangladesh when they faced this violence in Myanmar in search of safety. Though the policy of closing the border and pushing back those trying to cross is strengthened, they somehow managed to cross the border since August,2017 and later on [8].

* Corresponding author. E-mail address: engr_rahman_2002@yahoo.com

* Corresponding author. E-mail address: sarkerjakir@gmail.com

About 6,22,000 Rohingya people has arrived to Bangladesh since 25th August,2017 [18]. Though Government of Bangladesh is already facing the cost of a population upsurge, it has received the Rohingyas (though unwillingly) for humanitarian reasons and this is a burden on Bangladesh [10]. The influx guides to shelter and this huge number of Rohingya people got shelter here, in Bangladesh. Many of them, started the new life from the relative's house in camp or forest or nearly villages in Bangladesh [8].

According to the report of UNHCR lastly updated on 15th July, 2018, 204,788 households are built in the Kutupalong refugee camp and Nayapara refugee camp [20].

This study aims to enlighten this journey focusing on the "Shelters", Rohingya people lived in Bangladesh. The phases of the transformation, particularly, after 25th August,2017, is the objective of the study.

The study is being run through a pilot study, which consists of qualitative, quantitative research methods. Surveys helped for conducting observation, KII (Key Informant Interview), IDI (In Depth Interview) to know about the transformation.

The outcome of the study will emphasize the process of change of the shelters and documentation of the built environment in which Rohingyas are living in Bangladesh.

2. Objective

The objective is to explore the transformation of shelters in a household level.

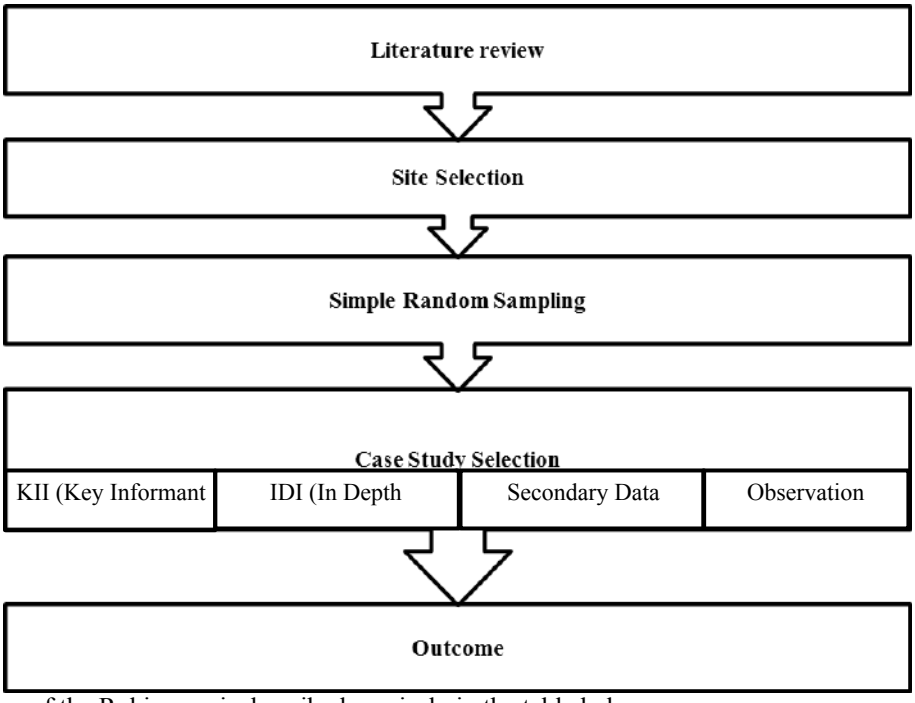
3. Methodology

The study represents the existing situation, process, phasing and findings of the lived spaces of Rohingyas in Bangladesh through a survey method inside the Rohingya camp. Simple Random Sampling method is being used to know the existing condition. Qualitative and quantitative research methods, KII (Key Informant Interview), IDI (In Depth Interview), Secondary Data Collection and Observation is used to know the phasing.

Figure 1: Methodological Framework

4. Literature review

4.1.Background



The history of the Rohingyas is described precisely in the table below:

Table 1: History of Rohingya people

Time	History
8th Century	Rakhaine, independent kingdom in Arakan.
9th to 14th Century	Rohingya came into contact with Islam through Arab traders Close ties were forged between Arakan and Bengal.
1784	The Burman King Bodawpaya conquered Arakan thousands of refugees fled to Bengal.
1790	Hiram Cox established the town of Cox's Bazar in Bangladesh to assist refugees.
1824 to 1942	Britain captured Burma Workers were migrated to Burma
1942	Japan invaded Burma. Burmese nationalists attacked Muslim communities.
1945	Britain liberated Burma from Japanese occupation the British didn't fulfil a promise of autonomy for Arakan.
1948	wanted Arakan to join Muslim-majority Pakistan The government retaliated by ostracizing the Rohingya, including removing Rohingya civil servants.
1950	Some Rohingya resisted the government
1962	General Ne Win seized power and took a hard line against the Rohingya.
1977	The junta began Operation Nagamin. More than 200,000 Rohingya fled to Bangladesh. The army denied any wrongdoing.
1978	Bangladesh struck a U.N.-brokered deal with Burma for the repatriation of refugees.
1982	A new immigration law redefined people who migrated during British rule as illegal immigrants. The government applied this to all Rohingya.
1989	The army changed the name of Burma to Myanmar.
1991	Around 230,000 Rohingya returned to Arakan, now known as Rakhine, under another repatriation agreement.
1992 to 1997	Around 230,000 Rohingya returned to Arakan, now known as Rakhine, under another repatriation agreement.
2012	Rioting between Rohingya and Rakhine Buddhists killed more than 100 people, mostly Rohingya. Tens of thousands of people were driven into Bangladesh. Nearly 150,000 were forced into camps in Rakhine.
2016	Rohingya militant group Harakah al-Yaqin attacked border guard posts, killing nine soldiers. The army retaliated. More than 25,000 people fled Rakhine to Bangladesh, bringing accounts of killing, rape and arson. Aung San Suu Kyi's government denied the atrocities.

Source: Timeline: A Short History of Myanmar's Rohingya Minority

4.2.Rohingya influx in Bangladesh

Though shutting the border from august, Bangladeshi authorities started to allow the refugees in Bangladesh observing the vulnerables and that is even very unofficially since the late November [8]. Information from the office of Coxs' Bazar District Commissioner, Dhaka:

- After 25th August, about 6,05,000 Rohingya people arrived Bangladesh
- Within July,2005 to August,2017, around 2,03,431Rohingya people entered Bangladesh.

- About 2,00,000 Rohingya people are living in the adjacent area of Ramu, Coxs' Bazar, Bandarban, Chittagong and other areas of Chittagong district.

4.3. Role of Bangladesh

According to JRP, the role of GoB, acting through multiple departments is admirable. The Ministry of Disaster Management and Relief, represented by Refugee Relief and Repatriation Commissioner (RRRC) has taken responsibility of operational co-ordination of the response. The DC office and Forestry department worked as key initial responders and actioned quickly by allocating 2000 acres of forestry to allocate the refugees. The Military was involved from September for grand support, distribution of substantial relief items received from civil society and private sector through district authorities. Construction of roads and WASH facilities were also ensured by the Military.

The JRP (Joint Response Plan) brings together over 130 partners, of which 127 are international and national NGOs supporting Government of Bangladesh in responding the crisis. Among them,13 are local, 45 are national and 69 are international NGOs. In the issue of 'Shelter' 8 of the partners are working in host communities, 23 are working for the shelter of refugees in camps and settlements, 7 are working for refugees in host communities and 23 are working for refugees not specifically of anywhere.

The total unit working for Rohingya people represents the authorities included in the response [13].

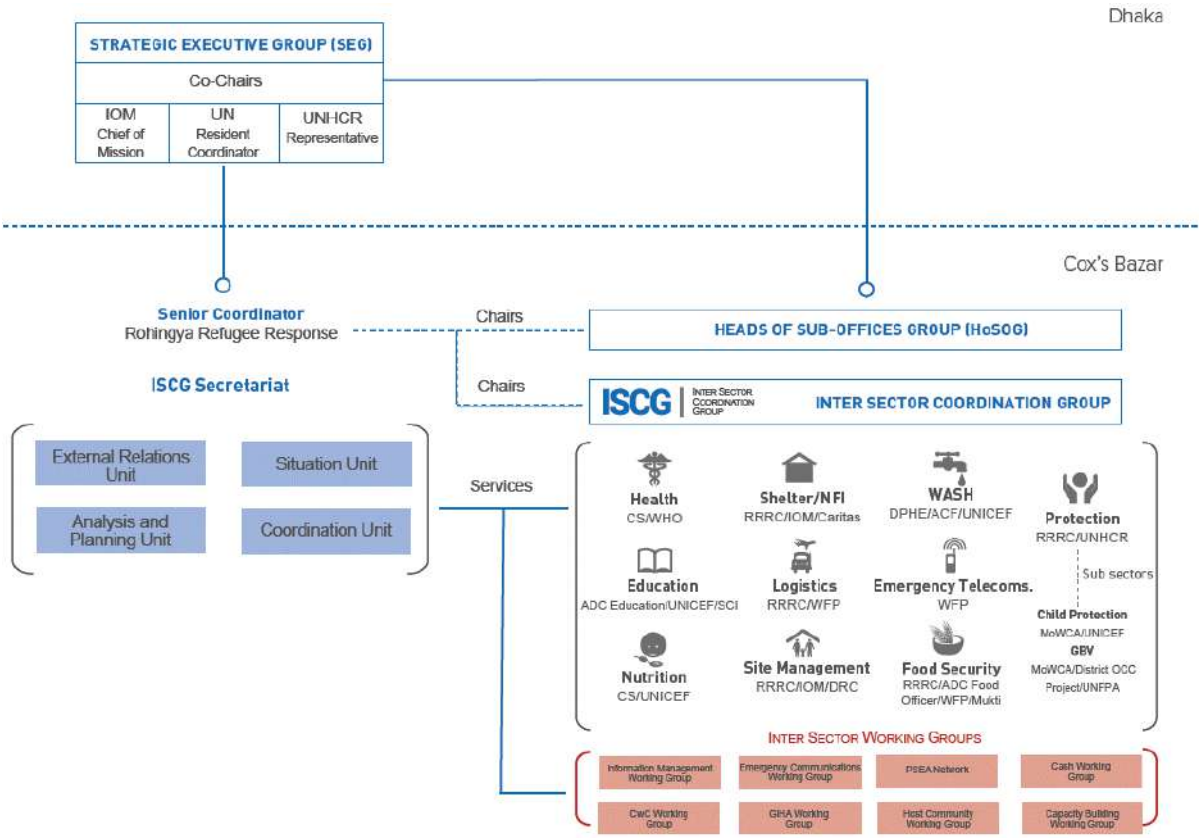


Figure 2: The unit working for Rohingyas (Source: March - December 2018, JRP For Rohingya Humanitarian Crisis 2018.)

In Bangladesh, UNHCR co-chairs Strategic Executive Group (SEG) with UN Resident Co-ordinator and IOM. WFP, UN-HABITAT, UNDP, ISCG collaborates with UNHCR and co-ordinates the delivery of assistance. Ministry of Disaster Management and Coxs' Bazar based Refugee Relief and Repatriation Commissioner (RRRC) is main government counterpart of UNHCR. IOM, UNDP provides tangible support being collaborated with UNHCR. The staff of UNHCR works closely with the Camp In-Charge official and a range of international and national actors in different refugee settlements [22]. The strong network of 23 partners include: ACF, ADRA, BDRCS, BNWLA, BRAC, CARITAS BANGLADESH, CODEC, DRC, FH, GK, HELVETAS Swiss Interco-operation, HI, IUCN, NGOF, OXFAM, PUI, REACH, RI, RTMI, SCI, SI, TAI, TDH.

4.4.How they started living here

Many of the Rohingyas were impelled to essential hiding because of the threat of arrest or death and deportation back to Myanmar by BGB [8]. Many of them started living with their relatives in the informal refugee camps of Kutupalong and Leda. Some of them started abiding in surrounding villages and some hide themselves in forests [3]. As they didn't have access to aid, they fought for survival in a very poor condition. Dependency on the local communities for basic necessities was obvious. As the aid agencies documented, shelter was one of the most pressing needs [8,9].

Amnesty International documented interviews with Rohingya people, who arrived Bangladesh after the persecution of 2012. A woman of age 40, who lost her husband and son in the persecution, said on 22nd November, 2016, "We are sleeping outside in the mud. My son is two years old and is crying all the time, he is very cold in the mornings. Still, compared to Myanmar, Bangladesh seems like heaven to me."

After the persecution happened on 25th August,2017, the operational update of UNHCR, IOM and concerned authorities with other agencies engaged themselves in registration, establishment of camps and settlements, provision of humanitarian assistance, and provision of support to the host communities [19].

UNHCR classified 'Shelter' one of the most pressing needs in that situation and documented the amounts as follows:

Table 2: Number of beneficiaries and reliefs

Shelter and NFIs	• 313,000 people receive core relief items • Temporary sheds comprising bamboo framing and plastic sheeting arranged for new arrivals inside camps

UNHCR profiled their responsibility as follows:

- Providing life-saving assistance (blankets, shelter materials, hurricanes, sleeping mats.
- Upgrading WASH facilities
- Provision of life saving health services and medicines.

Jamalida, A woman living in makeshift settlement, described that IOM and UN migration Agency hired Rohingya refugees to build the shelters for vulnerable people. Their houses were made of bamboo and thin, ripped polythene. After being surveyed by IOM, her family was given a token that they can exchange for materials to reinforce their new home and protect them from the elements. IOM will also ensure that they have help installing the materials [17].

UN agencies and NGO partners published the 2018 JRP (Joint Response Plan) for the Rohingya Humanitarian crisis on 16th March,2018. One of the 4 important pillar of protection framework is "Preparing for durable solutions in the short- and mid-term by promoting refugee self-reliance, and by working with development actors alongside central and local government authorities" [13]. JRP planned providing shelter materials, tools and technical assistance to upgrade shelters and improving the plots around the shelters as one of the priority activities. JRP will support host communities directly through structure interventions across at district, community and household level. Moreover, host communities will be supported indirectly through the design of programs for refugees. JRP declared 4 stages for sector strategy under 'SHELTER AND NFI'. Those are described concisely below:

Phase One (through February 2018):

- distributing primarily acute emergency shelter kits of one tarpaulin and rope per household
- and sticks built rudimentary makeshift shelters by refugee's own efforts.

Phase Two (November 2017 through April 2018):

- Site improvements and shelter upgrades with strong community participation.
- Complementary to the distribution of kits, the sector will provide technical guidance.
- Community led initiatives will be supported to carry out neighbourhood site improvement works contribute to disaster risk reduction.

Phase Three (post-monsoon season - September through December 2018):

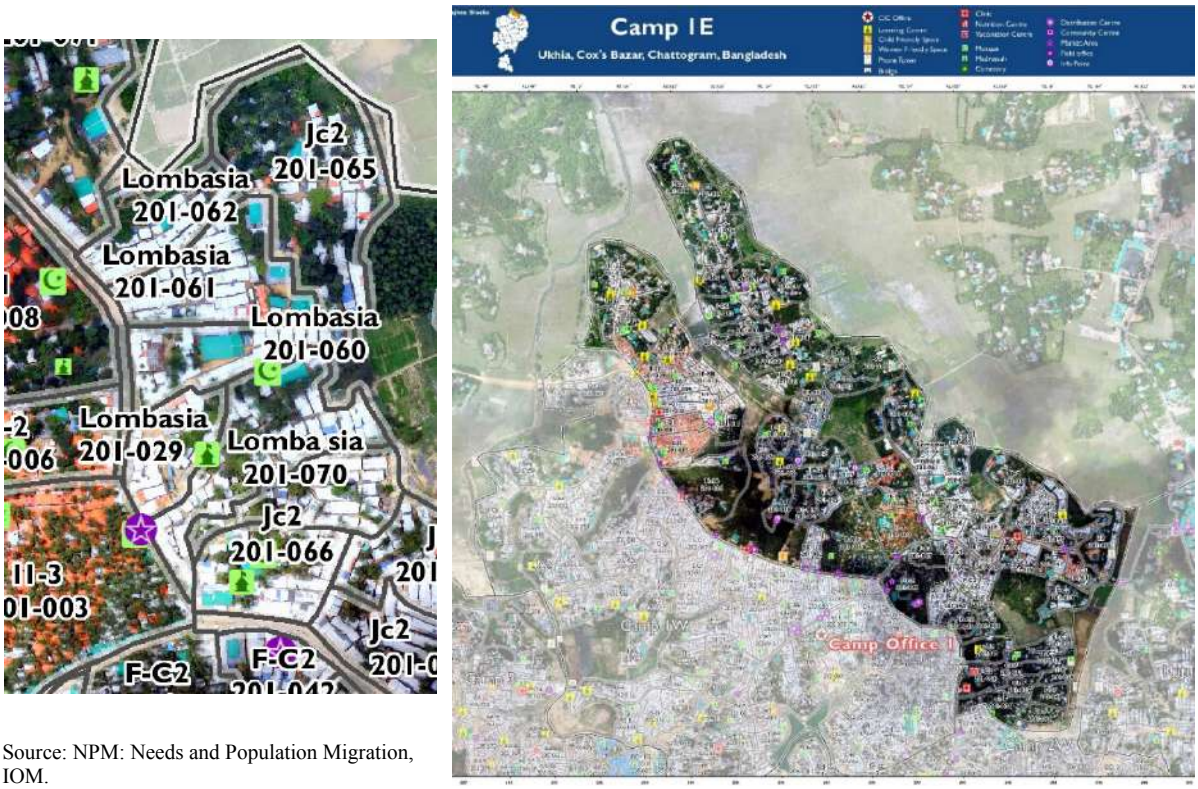
- The response will incrementally move towards the provision of more appropriate and viable shelter solutions.
- localised site improvements or recovery efforts will continue throughout the monsoon season.

Other Initiatives: emergency preparedness, Disaster Risk Reduction (DRR), and Housing, and Land and Property (HLP) rights assistance will continue to evolve based on needs and findings from stakeholder engagement.

5. Site selection

The selected site is Kutupalong camp 1E in the largest camp in Bangladesh for Rohingyas. The camp expansion has a population density of 533 refugee per hector and the total population is 713000 Rohingya people. The Kutupalong - Balukhali camp expansion is situated at the latitude of Latitude: 21°12′36.70″N and Longitude: 92°9′52.41″E. The average elevation in buffer zone is 23 m (source: Mohammad Mehedy Hassan, Audrey Culver Smith. Katherine Walker, Munshi Khaledur Rahman, Rohingya Refugee Crisis and Forest Cover Change in Teknaf, Bangladesh. Received: 6 March 2018 / Accepted: 25 April 2018 / Published: 30 April 2018.)

The simple random sampling has been held in Lambashia area in camp 1E. The study mainly focused on the transformation in homestead level.



Source: NPM: Needs and Population Migration, IOM.

Figure 3: Lambasia, Camp 1E, Kutupalong Rohingya camp, Ukhiya, Chittagong.

6. Case study selection

Three cases by simple random sampling has been selected to know the phases of transformation. All of them came to Bangladesh in the monsoon season and after the genocide of 25th August, 2018.

Case 1: Mahfuja, age 17, mother of 3 children, lives in a room. As asked she said UNHCR gave the materials and labors that were hired from within the Rohingyas. She had cloths, a hurricane, a sleeping mat in her room. There was no partition in her room. An oven (chula) was made just beside the semi-outdoor entry of the room. An earthen oven is made inside the room to cook at the rainy season.

Case 2: Amena, age 21, lives in a shelter that consists of three rooms and cooking area with an adjacent dining area. A space for storage of fuels was made. A wash facility was made using partition of terrapollin. She has made a barrier with cement between the wall and the floor to prevent rats from coming into the room.

Case 3: Abdul has family members and a shelter in the camp. Though very dark his shelter is keeping his mother and wife safe. In the two roomed shelter a family of 9 persons survive.

7. Outcome

7.1.Case 1

From an in-depth interview with Mahfuja, it has been sorted out that, Mahfuja didn't have anything when she entered Bangladesh. After coming in the refugee camp, she got bamboo and terapollin to build shelter. The shelter she built didn't have any side plane. She used to have an earthen oven (chula) at a corner of her shelter and some utensils on the piece of land. UNHCR has provided newer materials and relief items this year. Mahfuja developed her shelter making walls made of bamboo splits and terrapolin creating a partition inside the shelter she divided the outer space for cooking from the living space. The living space is used multipurpose . She does not have any wash corner in her shelter.

7.2.Case 2:

Amena revealed about the transformation that, she started living in the place when it was a forest. People cut the trees and she got the land. Firstly, she had two

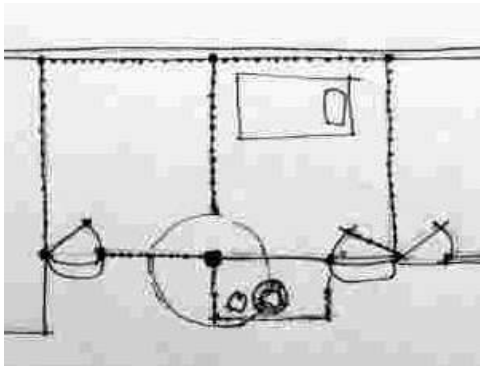


Figure 7: 1st Phase of Case 2

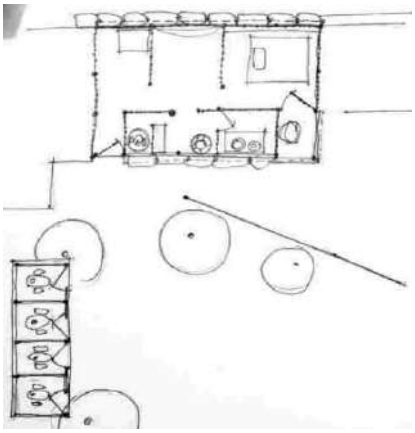


Figure 8: 2nd Phase of Case 2

Figure 9: Existing Condition of Amena's shelter

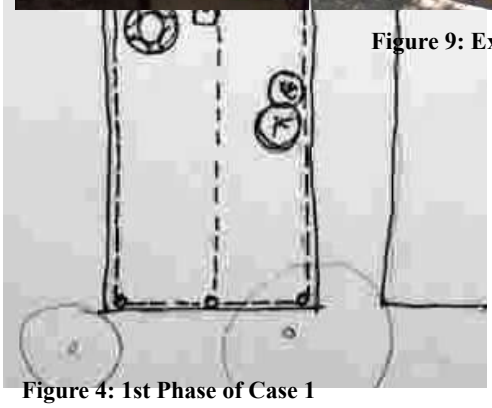


Figure 4: 1st Phase of Case 1

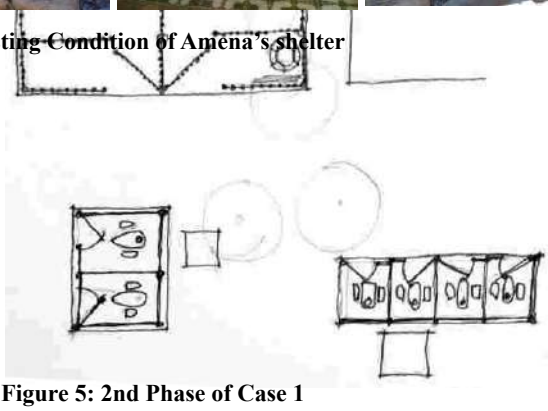


Figure 5: 2nd Phase of Case 1

Figure 6: Existing condition of Mahfuja's shelter

Figure 12: Existing Condition of Abdul's shelter

rooms for her brother in law and father in laws. But now she has organised the rooms three in number. The shelter was strengthened after the monsoon and by putting patch of earth beside the walls, the plinth was levelled up. Amena built barriers between the sleeping area and outside so that rats and insects can not come into her shelter. She created different cooking and dining area, which is spacious. Though the wash area is small, but that is tidy and clean to use.

7.3.Case 3

Abdul informed he has 9 members in his family. He doesn't do anything. His shelter was in the forest at the first stage. Many families came and started living, when the forest disappeared They have got wash facilities and water for survival. Step by step, when relief comes, they upgrade their shelter.

8. Limitations

The study could represent more information about the shelters. The transformations have a close relation to economy and social interfaces, which are absent in the study. Only the architectural interventions and interpretations are explored in the study.

9. Conclusion

Bangladesh is a disaster-prone country and it has also proved the efficiency in reducing disaster risk very proficiently. The shelters of the Rohingya people are still in a process and they are happy about it. Still experiments are going on by the authorities related to shelter and they will soon make it sustainable until the repatration of the Rohingyas.

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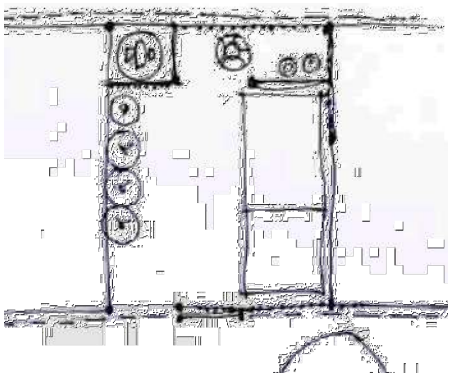

Figure 10: 1st Phase of Case 3

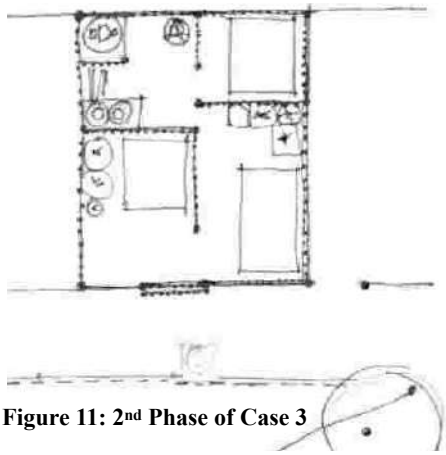

Figure 11: 2nd Phase of Case 3

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Building capacity and developing community women leadership for disaster resilience in Fiji

Helen Giggins [a,*], Iftekhar Ahmed [a], Thayaparan Gajendran [a]

[a] University of Newcastle, Australia

Abstract

Worldwide disasters have a cumulative global impact, while the nature, characteristics and typology of disasters vary widely across regions and localities. Communities in Fiji, particularly in remote and rural locations, are highly vulnerable to hazards. Women in such contexts are usually embedded in their communities and have strong potential as community leaders to contribute to disaster resilience. This paper presents the outcomes of an action research project conducted in Fiji in 2017. The aim of the project was focused on building capacity of Fijian women in disaster risk assessment, preparedness, response and recovery through a 'Training of Trainers' (ToT) Program. The team worked with key local stakeholders in Fiji to provide ToT and support for empowering women leaders for disaster resilience. Beginning with a project planning workshop in Suva, a ToT on women and disaster resilience was then run in Nadi for stakeholders from key agencies in Fiji. A team of Fijian policewomen trainers who were trained at the ToT were then provided a training package and support to run a training course in Naboutini village. Initial assessment of the training undertaken in this pilot study was very encouraging, including positive feedback from the stakeholders involved and indication of a strong appetite for further training to be undertaken in the community. Future work will look to facilitate mechanisms for long-term assessment, quality assurance and sustenance of the capacity building initiative through local ownership.

Keywords: Resilience; Community Participation; Gender; Disaster Risk Reduction; Fiji.

1. Introduction

Communities in Fiji, particularly in remote and rural locations, are highly vulnerable to hazards. Fiji ranked third in the world, and second in the group of Small Island Developing States (SIDS) in the Climate Risk Index for 2016 (Eckstein, Künzel, & Schäfer, 2018; Pelling & Uitto, 2001). Women in such contexts are usually embedded in their communities (Enarson, 2012) and have strong potential as community leaders to contribute to disaster resilience. Building social resilience, the capacity of social groups and communities to recover from a disaster is a key strategy for disaster risk reduction (DRR). Research suggests that particularly 'at the grassroots, women leaders can ensure that the specific needs of women and vulnerable groups are accounted for' (Tanner, Markek, & Komuhangi, 2018, p. 6). Moreover, it is critical that the 'women affected by disasters have a right to participate in the decisions that affect their lives (Tanner et al., 2018). In 2016 the United Nations indicated that women and girls should be at the core of DRR as part of human rights (United Nations (UN), 2016). However, the engagement of women in rural and remote areas receives less attention. Therefore, the need to deliver training to rural women leaders to achieve disaster resilience partly through building capacity to nurture social resilience; that is, developing women's capacity to lead the resistance, preparedness, response, recovery and creativity part of DRR (Maguire & Hagan, 2007).

In this context the Australian Government's Department of Foreign Affairs and Trade (DFAT)'s United Nations Educational, Scientific and Cultural Organization (UNESCO) Commission funded a capacity building action research project to develop a training of trainers (ToT) program to build capacity of women leaders to prepare for disasters. The objective of the project was four-fold: The first objective was to consult with key local stakeholders in Fiji to ascertain capacity building needs, the corresponding form of training and the directions of the long-term outcomes of the training. Secondly, to develop a suitable and contextual ToT training package based on consultations with key stakeholders. Thirdly, to provide structured ToTs on disaster resilience to local trainers nominated by stakeholder partners in Fiji. Finally, supporting trainers to run a training course for women community leaders in a remote/rural location and evaluate the training in the process.

* Corresponding author. E-mail address: helen.giggins@newcastle.edu.au

There is very limited literature on women leadership in the context of building disaster resilience and associated training. The aim of this paper is to present an account of the action research experience of engaging with the ToT program focused on building capacity of rural Fijian women in disaster risk assessment, preparedness, response and recovery.

2. Overview of literature

Involving women in forums that make decisions on DRR helps to ensure that the needs of most vulnerable groups are brought to attention. The report on 'Women's Leadership in Disaster Preparedness' released in 2018 (Tanner et al., 2018) identifies key aspects of women's leadership in disaster preparedness. Among them are the issues of increasing women's participation and the need for more resources to champion the implementation of strategies to increase women's participation. Women's leadership in DRR can be categorised into two levels: one at organisational/institutional level and the other at grassroot/community level.

The evidence of women taking up a central role in community and grassroots decision-making is positive. However, most of the time participation does not lead to leadership roles. Leadership in the context of DRR is a process that assists a community to reach its desired level of disaster preparedness, response and recovery outcomes through the guidance of a leader, who understands the local values and feelings, and can motivate, represent and delegate others with DRR tasks. The need to seek participation opportunities and devise a strategy to train more women with effective utilisation of limited resources is crucial. That is, the need for capacity building to develop leadership is important. Capacity development is about "combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals" (Oxfam & NIRAPAD, 2011, p. 46).

The Oxfam and NIRAPAD (2011) Handbook identifies four key vulnerabilities disproportionately impacting women and children:

- Location and environment – Living in hazard-prone areas - coastal areas, riverbanks, seismically active zones, etc - causes vulnerability. Recurring hazards diminish their assets and make them increasingly more vulnerable to disasters. Often, poor and marginalised groups live in risk-prone areas.
- Infrastructural – Vulnerable infrastructure such as inappropriate buildings/houses that cannot withstand the impacts of natural hazards and weak civil infrastructure such as embankments and road networks to protect people from floods or storm surges contribute to vulnerability.
- Socio-economic – Low socio-economic conditions leading to resource constraints can prevent people from building disaster-resistant houses and remain vulnerable. Disasters may compound their already uncertain livelihoods, especially subsistence agriculture, fishing, and day labour.
- Knowledge, awareness and skills – Unawareness or lack of access to knowledge about disaster risks and disaster preparedness also contributes to vulnerability.

In most societies the given roles of women as caregivers and organisers of family and community activities can allow involving women as leaders or decision-makers, which can result in effectiveness of DRR (Işık et al., 2015). This requires relevant and targeted training for increasing women's skills and confidence. Knowledge, awareness and skills are central components to develop effective DRR leadership. It is an important part of capacity development. This also provides a platform for sharing knowledge and field experiences. However, the lack of opportunities for women to build leadership skills can be seen as both a cultural as well as a resource problem. Particularly in rural and remote societies where the village head is respected as the leader and is often a male.

2.1.Cultural context for women's leadership training

Communities are exposed to greater risks if traditional practices and social structures are weak or not orientated toward risk reduction and limit women from participation. In most circumstances, the cultural contexts and protocols impact on the procedures for the participation of both women and men in building disaster resilience. Therefore, developing training for women leadership need to be contextualised within the social and cultural norms that act as obstacles to women's leadership within formal spaces. This provides additional challenges in developing training programs and funding them. Thus,

1. The training program needs to be culturally appropriate for women to take on a leadership role.

2. The training needs to initially revolve around women's social roles and include traditional leadership roles to be complementary instead of challenging.
3. Trainers need to be sensitive to local culture and developing local trainers can be more effective.

2.2.Funding and training approach

Funding for DRR training programs for developing countries is limited and often comes from the United Nations or NGOs (non-governmental organisations), or in the form of international aid from donor countries. In this context, the use of funding for one-off training programs has limited outreach. However, training the local community or local emergency officers to train rural women leaders, that is training of trainers (ToT), will be a more effective approach. If the trainers who are being trained are women, the program has dual benefits as it increases institutional capacity and also capacity at the grassroots.

2.3.Training of Trainers (ToT)

ToT is characterised by 'expertise conducting the training of individuals (trainers) with ties to the community for whom the knowledge is intended' (Makanjuola, Doku, Jenkins, & Gureje, 2012). The structure of ToT is set by (a) establishing the particular needs of the people who will be trained; (b) identifying the criteria for satisfactory performance of trainers to be accepted as trainers; (c) producing the resource materials and the training guide for the trainers; (d) identifying the mode of training the trainers, such as short courses, seminars, workshops, in-service training, self-directed study programs, and practical experience; (e) preparing the trainers to run training workshops using the materials and guidelines developed; and (f) evaluation of trainers (Douglas, 1987). Makanjuola et al. (2012) from a medical discipline perspective suggests that the trainers should be taught such that there is limited variability in the way the knowledge is passed by the trainers. ToT programs for women leadership in DRR should be culture/community specific and also based on the nature of the local hazards. In this regard, there will be significant variations in the way the programs are run, and the materials need to be improvised case by case based on the same key guiding principles. This means the capability of the trainers to be agile is very crucial.

The strength of a TOT is its cost-effectiveness as the resources are only required to train people (that is, trainers) within an institution. These institutions usually ensure the wide distribution of knowledge and make the program sustainable. Moreover, the ToT model delivers knowledge to relevant communities by trainers who are trusted and respected within their community and promotes self-reliance and empowerment of the community (Makanjuola et al., 2012).

3. Research method

Action research is a form of practice-led inquiry where action and reflection are core tenets of the design of the process (McNiff, 2013). A single case study was conducted in Fiji. The boundaries of the case study evolved with the engagement of the Action Research process. The project team was affiliated to CIFAL-Newcastle at the University of Newcastle, as part of a global United Nations Institute for Training and Research (UNITAR)-supported network, and had extensive experience in the Asia-Pacific. The acronym CIFAL stands for 'International Training Centre for Authorities and Leaders' from the French 'Centre international de formation des autorités et leaders', these international training centres sit under the banner of the UNITAR global network. The team worked with key local stakeholders in Fiji to provide a ToT program and support for empowering women leaders for disaster resilience.

Table 1: Outline of the activities (four step process)

Research Process	Intended ToT process
Consult with key local stakeholders to ascertain the needs and training design strategy.	(a) Establishing the particular needs of the people who will be trained. (b) Identifying the criteria for satisfactory performance of trainers to be accepted as trainers.
The development of the contextual ToT package	(c) Producing the resource materials and the training guide for the trainers. (d) Identifying the mode of training the trainers, e.g. short courses, seminars, workshops, in-service training, self-directed study programs, and practical experience.
To prepare the trainers.	(e) Prepare trainers to run training workshops using the materials and guidelines developed.
Support the trainers in initial delivery of the package in a rural village.	(f) Evaluation of trainers.

The key engagement process involved high level institutional support though two workshops and the final implementation of monitoring of the ToT activity. Beginning with a project planning workshop in Suva, a ToT on women and disaster resilience was then run in Nadi for stakeholders from key agencies in Fiji. A team of policewomen trainers who were trained at the ToT activity were then provided a training package and support to run a training course in Naboutini village.

4. Results and discussion

The results presented in this paper focus on the action research engagement undertaken in the preparation and delivery of the ToT program in Fiji. It is often a challenge to attract the interest and engagement of local stakeholders and communities in developing countries such as Fiji in voluntary disaster resilience capacity building and awareness raising initiatives, even though they are much needed. In this project, the voluntary involvement of local agencies from both government and NGO sectors in participating in the ToT course, the subsequent training by the Fijian Police Force in a rural location, and the voluntary participation of the rural community in the training, are all indicators of effectiveness in terms of achieving local engagement.

The initial workshops with key local stakeholders, held in Nadi and Suva, allowed identifying a key partner – the Fijian Police Force – for development of trainers and subsequent training provided by the trainers, assisted by the University of Newcastle team, in a rural location. These workshops also provided useful insights into the unique needs of rural women. The first workshop in Suva was exploratory to assess local interest and to identify organisations/institutions interested in receiving the ToT. In the second workshop in Suva, which was the ToT, participants from a number of governmental and non-governmental organisations were provided training, and eventually a team of policewomen indicated the most interest and skills to deliver training at the village level.

Based on the information gathered in the initial consultations, and the previous experience of the project team in delivering disaster resilience material, a training package was developed by the research team in Newcastle, Australia. This training package was contextualised to the local context, and local conditions were considered in relation to the method of delivery for the training. Activities in the training package included, conducting a group transect walk around the village to identify possible risks and hazards in the local environment, undertaking a hazard ranking, identification of leadership attributes, and development of an action plan. The intention was to both deliver knowledge and skills on disaster resilience, but also to have participants potentially see themselves as future resilience leaders in their own community.

In late September 2017, with the assistance of the Fijian Police Force training volunteers, a suitable rural village, Naboutini approximately 10km outside of Nadi, was identified and participants were recruited for a three-day training workshop conducted by the ToT policewomen. A majority of women and three to four men made up the approximately twenty local village participants. Three researchers from the project team at the University of Newcastle were in attendance, in an advisory and evaluation capacity. The training was primarily conducted by the local female trainers in the local language.

The following are observations from the evaluation of the two and a half day training workshop conducted in Naboutini village. The participants were enthusiastic and understood the need for disaster preparedness, as evidenced by the comments they made on the first morning of training in response to the question 'What do you expect to get out of this workshop?'. Some sample responses included, "*How to be prepare* [sic] *for disaster for my family*"; "*I expect to learn more about hazards and disasters to help me be prepared at all times*"; "*How to prepare before and after disasters*". Despite the relatively low level of education of many of the participants, they were very engaged and provided quite insightful responses to the activities undertaken. The role-play session gave the participants a chance to show their personalities and step out of their regular roles.

Evaluation of the training highlighted the following areas for improvement. There was a need to be more generous in the time allocated to the activities - some elements were too rushed, and other activities needed to be combined in order to get the main objectives of the training delivered. From a practical standpoint, using a portable data projector to present slides was probably not the most effective technique, hard-copy paper workbooks would perhaps have been more useful. Printed, translated handouts would have been preferable.

A final comment on the importance of cultural awareness in the undertaking of this type of research project: On advice from the Fijian Police Force liaisons, it was evident that it was of critical importance to seek permission to conduct the training from both the rural village chief, and elders in the village where the training was to be conducted, as was done. Without this local insight it would not have been possible to know the correct cultural protocols, and it would have been very difficult to have undertaken the rural training and engagement.

Figure 1: Training in the community centre at Naboutini Village (left) and transect walk around the village in progress (right).

5. Conclusion

This was a pilot project with a limited budget, yet it was possible to achieve its objectives largely due to the voluntary involvement of local stakeholders, with networks established in the process to potentially expand upon the outcomes of the project. The need for more training programs on women and disaster resilience in Fiji was underscored by the training participants, and the University of Newcastle team is interested in addressing this need in the future.

Acknowledgements

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Factors contributing to flood resilience among rural community: case study of East Coast Malaysia

Noraini Omar Chong [a, b]*, Khairul Hisyam Kamarudin [a], Siti Nurhuda Abd Wahid [a]

[a] Universiti Teknologi Malaysia (UTM), Malaysia
[b] Town Planning Officer, Federal Department of Town and Country Planning Peninsular Malaysia, Malaysia

Abstract

In Malaysia, almost 31% village nationwide are identified as disaster risk village, which flood remains as the highest contributor to damage and economic losses. Annual flood occurrences during monsoon season mainly between November to February in the East-Coast region of Peninsular Malaysia have affected livelihood or rural communities including damaging properties and disrupting of local economies (loss of income and jobs) mainly to small-scale farmers and rubber tappers. Affected communities have no other ways but to build resilience towards flood and continue to achieve Sustainable Development Goal (SDGs) by 2030. Objectives: To assess internal and external factors that contributed to rural community resilience towards disaster particularly flood. Method: Measures implemented by the local community, governmental agencies, and non-governmental agencies analyzed within the context of the disaster management cycle (DMC). Three case study areas have selected for household surveys including (1) Lubok Setol village in Kelantan state; (2) Teladas village in Terengganu state and; (3) Gajah Mati village in Pahang state. Two round of data gathering carried out namely (1) Key informant interview with the government agencies, non-governmental organizations and local leaders; (2) Questionnaire distribution to 90 respondents using stratified random sampling. Findings (1) Community resilience to flooding in all three villages strongly contributed from respondent's adoption of local knowledge combined with intervention and support from related government agencies as well as from non-governmental organizations and; (2) Respondents are able to 'bounce back' after the disaster, indicating an affirmative act of resilient to disaster. Conclusion is drawn from the data analysis to prove that both the internal and external factors significantly contributed towards rural community resilient to disaster particularly flood.

Keywords: resilience community; resilience factors; rural community; Malaysia; flood; disaster

1. Introduction

The frequent occurrence of disasters in Malaysia had posed an alarming and concern to the government considering the rising number of casualties and amount of economic loss as recorded by Emergency Event Database (EM-DAT). For instance, a total of 867 casualties, and 3,033,011 people are directly affected by major disasters and with an estimation of USDs.4 billion worth of damages between 1996 – 2016. Given these circumstances, agenda towards the management and disaster risk reduction and building a resilient community to disaster become crucial. Despite a growing interest in adopting the DRR and mitigation efforts for enabling rural communities in dealing with various types of natural disaster, different observation, however, can be seen for translating global effort into local initiatives which were quite an evidence after reviewed of relevant literature. Many existing literature focusing on explaining the possible impacts of floods to the livelihood of the community, i.e., economic losses and social disturbance, however, lacking on the discussions related to community efforts and strategies to minimize the effects from flood. Therefore, a specific study is needed to identify and discuss influential factors for rural community resilience. With lack of inputs and information on local community resilient and able to rise above adversity (in the case of natural disaster), rural community that affected by disaster might find difficulty for establishing a more effective post-disaster and recovery measures in the future.

In this light, three rural communities in the East Coast of Malaysia identified and selected including (1) Lubok Setol village in Kelantan state; (2) Teladas village in Terengganu state and; (3) Gajah Mati village in Pahang state. Information gathering process is utilizing multiple methods including interview, questionnaire and partial-participatory observation intended to identify measures implemented in disaster management within communities. Findings from the survey presented in forms of measures implemented by related parties including the local community, government agencies and non-governmental organization (NGO) and these measures classified according to the DMC. Later on, the impacts of the flood on the community are determined followed

* Corresponding author. E-mail address: noraini49@live.utm.my

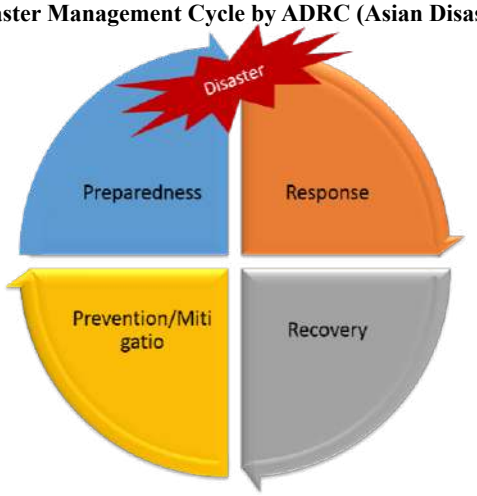
by identification of the state of community recovery from disaster. Finally, the measures implemented in DMC were interpreted based on the disaster resilience model and life cycle.

2. Literature review

2.1.Disaster management cycle

In 2005, the Asian Disaster Reduction Centre (ADRC) (2005) had formulated the DMC consists of four main stages of disaster management namely prevention/mitigation, preparedness, response, and rehabilitation and reconstruction (Figure 1). The government of Malaysia is implementing the DMC recommended by ADRC, and it is in line with the existing legislation on DRM and to promote a more efficient practice involving multidisciplinary practitioner backgrounds (JKM, 2016; National Security Council, 1997).

Figure 1: Four stages in Disaster Management Cycle by ADRC (Asian Disaster Reduction Center, 2005).



2.2.Disaster resilience model and life cycle

As defined by Hayashi (2017), the damage is equal to the sum of hazard, exposure, and vulnerability (refer to the mathematical model in Figure 2). The damage that resulted from disaster shall ***be*** reduced by implementing suitable prevention/mitigation and preparedness measures (in pre-disaster stage). However, for the post-disaster stage (including during the disaster stage), recovery from damages should become the main priority for the disaster victims as well as the agencies i.e. adopting the appropriate activities for recovery and time factor becoming crucial elements for determining the speed of the recovery process (Hayashi, 2013). In this light, installing good preparedness measures such as emergency drills and preparation of emergency kits would help in search and rescue effort. As for the long run, particularly on the rebuilt of people's livelihood, it would be crucial to developing strategies that will allow the majority of disaster victims to be able to resume work and generate income, which could minimize socio-economic losses and/or damages by the disaster.

Figure 2 (left) shows resilience towards disaster in lifeline model (Hayashi, 2017; Wilson, 2011; Akter and Mallick, 2013; Bruneau and Reinhorn, 2006). The blue shaped triangle represents the ideal situation for disaster resilient progress where the vertical axis shows the implementation of prevention/mitigation measure to alter hazard and reduce vulnerability. Meanwhile, the horizontal axis indicates the appropriate activities that carried out to speed up the recovery process after the disaster and initiate community bounce back process, or in an ideal situation, community's ability to bounce back better (Omar Chong *et al.*, 2018). As a result of reducing hazard and vulnerability, together with improving the community capacity building as assert Kelman (2012) would increase the community's ability for resilience and ability to reduce disaster risk. Upon attaining this ability, the community is expected to utilize resources in a more efficient way and with minimal internal and/or external aid and assistance for the recovery process. The disaster recovery process could also be achieved in a much shorter time, signaling the resilience concept has rooted within the community.

Therefore, understanding the 'calculation' for resilience and all relevant factors including activities suitable for damage control and risk reduction into considerations will promote a stronger linkage between the concept and Sustainable Development Goals (SDGs) discourse. The implementation of resilience concept shall expedite or could become a catalyst for strengthening the Sustainable Development Goals (SDGs) agenda in the event of natural disaster management and risk reduction (Weichselgartner and Pigeon, 2015).

$$R = f(\underbrace{H, E, V}_{\text{Prevention}}, \underbrace{A, T}_{\text{Recovery}})$$

R - Resilience;
D - Damage = f (H, E, V)
H - Hazard
E - Exposure
V - Vulnerability
A - Human Activities
T - Time

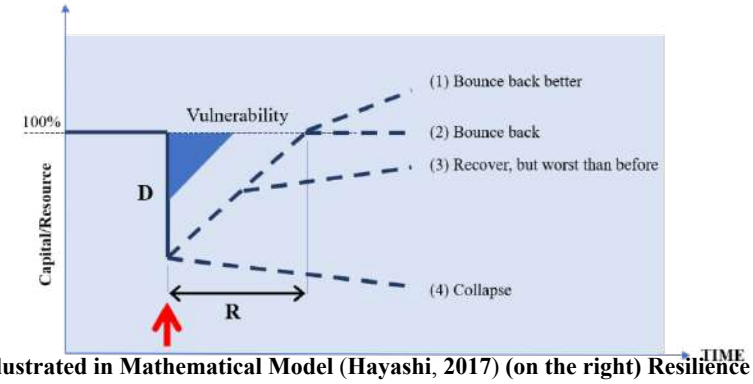


Figure 2: Resilience towards disaster as illustrated in Mathematical Model (Hayashi, 2017) (on the right) Resilience towards disaster illustrated in Lifeline (adaptation from Hayashi, 2017; Wilson, 2011; Akter and Mallick, 2013; Bruneau and Reinhorn, 2006) (on the left).

2.3.Resilience concept as SDGs catalyst

SDGs is a global commitment to ensure 'what we possess today can sustained for the next generations.' This paradigm, later on, was expanded into the context of disaster risk reduction (DRR), i.e. by linking the resilience concept with SDGs in the form of lifeline model (refer to Figure 3).

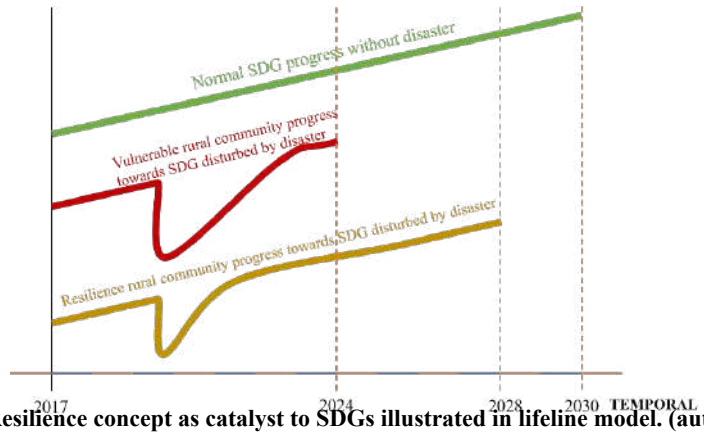


Figure 3: Resilience concept as catalyst to SDGs illustrated in lifeline model. (authors, 2017)

As indicates in Figure 3, the lifeline model described the link between resilience concept and SGDs using three different scenarios (and by assuming three scenarios possess similar capital and functions). The green line represents the community progress towards SDGs without disturbances (disasters), i.e. without taking the element of disasters into equations. The red line on the other hands represents the progress towards SDGs with the inclusion of elements of disturbances (disasters) but without taking into account the concept of community resilience. The yellow line is showing the progress of SDGs with an element of disasters and by taking into account the resilience concept which instilled in the community. The second assumption is that for each colored line (green, red and yellow) is a string (cotton thread) with similar length. These green, red and yellow strings will be placed accordingly in the horizontal axis to represent the SDGs 2030 target achievement. The red and yellow strings then were pulled down in the vertical axis to represent distortion, i.e. the disasters which impacted the community functions. Using simple comparative on the length of each string, it becomes obvious that the green string will stretch all the way to the year 2030 (i.e. achievement of SDGs) in normal progress without taking into account any disaster elements. On the other hands, for the red string which distorted by disaster (was pulled down dramatically) will leave behind at 2024 (slow recovery process of capital and functions), and the community involved will require a longer time to achieve SDGs target. Therefore, to obtain faster recovery process, the community represented in the red line will need further assistance and longer time (probably 6 years more) to recover to its normal capital and functions, hence to achieve SDGs. The community which represented in the yellow string however incorporated resilience concept and DRR and they shall continue to progress towards SDGs even with occurrence of distortions/ disturbances. By mitigating all possible damages and speed up the recovery process, the community in yellow line will require lesser constant assistance and recovery towards SDGs 2030. In conclusion, the green line represents an ideal situation however it is almost impossible to

be obtained in a complex real world as observed today (considering climate change, etc.). On the other hands, the red line represents undesirable living condition and threat to livelihoods, and the yellow line is the intended scenario which needs to nurtured so that the community could react accordingly in improving livelihoods with the occurrence of disasters.

3. Research methodology

3.1.Selection of case study area

This study utilizes the case study approach by focusing on the East Coast regions of Malaysia. Selection of case study areas based on the following five (5) criteria namely:

- The case must be traditional village(s) with disaster risk as identified by DPFDN 2030 report (Criteria 1)
- Village(s) that located in the East-Coast region which frequently experienced disaster occurrences based on the record provided by the Malaysia Social and Welfare Department (JKM) (Criteria 2)
- Village(s) with own disaster response team established under Village Development and Security Committee (JKKK) (Criteria 3)
- Village(s) which has Standard Operating Procedure (SOP) endorsed by Disaster Management agencies (Criteria 4)
- Village(s) that participated in Community Based Disaster Risk Management (CBDRM) Program conducted by MERCY Malaysia (Criteria 5). Program by Malaysian Medical Relief Society, also better known as MERCY Malaysia. Established in 1999, this non-governmental organization aimed to represent Malaysian at the international humanitarian arena (MERCY, 2018)

Based on the five (5) criteria listed, three (3) potential villages were identified as suitable case study areas as they have fulfilled most of the selection criteria. These villages are (1) Lubok Setol village in the State of Kelantan; (2) Teladas village in the State of Terengganu; and (3) Gajah Mati village in the State of Pahang (refer to Figure 4 for locations of case study areas).

State	Village	Comments of Assessment Criteria				
		C1	C2	C3	C4	C5
Kelantan	Lubok Setol	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Pasir Mas	Have established disaster response team sub-committee	Coordination meeting lead by evacuation center manager (JKM officer)	NA
Terengganu	Teladas	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Kemaman	Have established disaster response team sub-committee	With SOP acknowledge by NADMA	NA
Pahang	Gajah Mati	Listed as traditional village with disaster risk	Experienced most frequent flood occurrence in Temerloh	Have established disaster response team sub-committe	Coordination meeting lead by evacuation center manager (JKM officer)	Participated in CBDRM by MERCY

dy areas based on selection criteria (https://i2.wp.com/investvine.com/wp-content/uploads/ecer_all4.gif, authors, 2017)

3.2.Data collection

This study utilizes a mixed method for data collection including household survey using questionnaire (quantitative approach), followed by several qualitative approaches including partial-participatory observation, photograph and content analysis (reviews of relevant documents and reports). First visit to study areas was in Sept 2017 to engage with the local government agencies and local community leader and gather relevant information, reports, and documents to prevention/mitigation and preparedness. The second visit was in January 2018 (i.e., immediately after a major flood in the East Coast in December 2017) until mid-February 2018 to conduct (Table 1) where a total of 90 respondents participated in the survey conducted. It is worth mentioned that the feedback gained from fieldwork, i.e. household survey and field observation might only relevant during the study was conducted and might not be consistent over time. This study also focusing on identification of

resilience factors among rural community towards flood hence might not include other analysis for instance, there is no further analysis and/or assessment made of community's existing and on-going post-flood recovery plan which might require separate observation for a detail study.

$$n = \frac{n}{1 + N.(e)^2} \quad (1)$$

n - sample size;
N - population size;
e - level of error;

Table 1: Distribution of sample size for the household survey.

Village	Number of families	% of each village	Sample size (n=90)
Lubok Setol	131	40	37
Teladas	121	37	32
Gajah Mati	70	23	21

Source: Research fieldwork in 2018

4. Findings and result

4.1.Impacts of the flood on communities' livelihood

Based on data analysis, respondents from all three villages indicated their livelihood were directly affected by the flood including Teladas village (96.9%), followed by Lubok Setol (83.3%) and Gajah Mati (76.2%). In general, 86.7% percent of respondents have agreed that their livelihood was affected after the flood, causes property damages and economic losses (i.e., loss of income particularly among farmers/smallholders). Field observation on the physical quality of the village indicated components of property which damaged by the flood are including wooden houses structure and soil erosion. Meanwhile, economic losses as mentioned by respondents include loss of income because many of them cannot continue farming and rubber tapping and more money needed for reconstruction of damaged house structure and slope repair project (Figure 5).

Figure 5: Evidence of physical damages caused by flood including (from left) damage to wooden house structure, main road covered with mud, slope collapse, debris in the river. Source: Research fieldwork in 2017 & 2018.

4.2.Implementation of measures according to disaster management cycle

There is evidence of measures for reducing disaster risks implemented in all three case study areas. For better understanding, these measures classified into four (4) stages of DMC with references to the three main stakeholders or actors in DMC namely (1) government; (2) non-governmental organization; and (3) local community. The classification also intends to differentiate any efforts taken and adopted by communities (defined as internal factors) and by other parties (defined as external factors). However, the listed measures are based on the respondent's perception and field observation, compare to a more details measures based on documents review and agencies engagement which has been presented in the previous research paper (refer to Omar Chong and Kamarudin, 2018).

A. Adoption of DMC measures during prevention and mitigation stage

At this stage, the most significant measure is the construction of a reservoir to reduce flood severity which could enhance community recovery process. Among all three (3) case study areas, only Lubok Setol village equipped with a water reservoir constructed by the Drainage and Irrigation Department (DID) (Figure 6). Meanwhile, for Gajah Mati village, there is a plan by DID to construct a reservoir in Raub (a neighboring district) which in turn shall ease flood issue in the study area in future. In Teladas on the other hands, there is no plan for constructing a reservoir or any other mitigation measures in the near future.

Figure 6: Construction of the reservoir by DID. Source: Research fieldwork in 2018.

B. Adoption of DMC measures during the preparedness stage

During the preparedness stage, all three major stakeholders/actors have made necessary preparation to facing the flood (as the monsoon season approaching). Based on the analysis, all measures stipulated by the ADRC (2006) installed by stakeholders (Table 2). Among these measures, government agencies (e.g., Malaysian Meteorological Department (METMalaysia)) have installed meteorological observation and early warning system in all three (3) villages (provide life feeds using CCTV and alarm system in strategic locations). CCTV units installed for monitoring water level of adjacent rivers in the villages. When the images captured showing water level in the rivers approaching the level of danger, then it will trigger the alarm, and warning siren will be deployed automatically to warn communities and for evacuation.

Another preparedness project undertaken by the government is conducting emergency drills which aim to educate and train local communities in study areas about safety measures, evacuation procedures, and “do’s and dont’s” during the event of a flood. Based on an interview with the head of the village, only Gajah Mati village currently received CBDRM training provided by MERCY Malaysia. The result from the survey also indicated the component of “food and material stockpiling” need further coordination since all are taking similar or redundant actions.

Local communities in all case study areas have demonstrated some evidence of utilizing local knowledge in strengthening their preparedness level in facing the flood. To reduce economic losses, local communities usually suspended all farming or o-farm activities during monsoon season. In addition, all three communities have taken proactive measures including constructing overhead storage units/cabinet setting in their houses. Community in Lubok Setol has put more efforts by improving the house design (elevated pillars, higher parking garages), using materials that can withstand water penetration and building animal shelters.

Table 2: Preparedness measures implemented in case study areas

	Village		
	Lubok Setol	**Teladas**	**Gajah Mati**
1. Government agencies	• Food and material stockpiling by Malaysia Social and Welfare Department (JKM).		
	• The installation of early warning system - CCTV and alarm system.		
	• Emergency drills before monsoon season by Fire and Rescue Department (JPBM).	NA	• Emergency drills before monsoon season by Malaysia Civil Defence Force (APMM).
	NA	• Aid and equipment store in the operation room at the evacuation center.	• Aid and equipment store in operation room at the evacuation center.
	NA	• The construction of alternative bridge in 2008.	NA
	NA	• Clean water supply during flood using rainwater harvesting by the Ministry of Rural and Regional Development (KKLW)	NA
2. Non-Governmental Organization (NGO)	• Equipment assistance - boat donated to the community.	• Equipment assistance - boat, washing machine, and dryer for the community to be utilized during the flood	• CBDRM by MERCY Malaysia
3. Local community	• Food and material stockpiling.		
	• Higher storage cabinet setting.		
	• Stop agricultural activity in monsoon season to avoid loss e.g. cultivation of new rubber tree or rubber tapping.		
	• House design - stilted house not only to catch winds of higher velocity but also to avoid moving out during the flood, secure the house and household equipment.	NA	NA
	• The material of the house also changes to concrete.	NA	NA
	• Rising elevation for the animal shelter.	NA	NA
	• Building ramp and rise house elevation.	NA	NA
	NA	• Own boat for mobility	• Own boat for mobility
	NA	• Built hut for storage	NA

Source: research fieldwork in 2017 & 2018.

C. Adoption of DMC measures during response stage

Based on the survey, the JKM has gazetted an evacuation center for each village. Response measures were taken by relevant government agencies often focus on the rescue and first aid for disaster victims. The rescue effort was led by Police and Fire Department (JPBM), while first aid and emergency treatment led by the District Heath Department (KKM). After all flood victims safely arrived at the designated evacuation center, the JKM officers will keep records of the victims and provide food and necessities. The process assisted by APMM, JKKK and local community (Table 3).

In general, all local communities studied were equipped with knowledge in disaster preparedness before the emergency drills and CBDRM program by MERCY Malaysia. Majority of respondents also indicated they are willing to move to temporary shelters after receiving information and instruction for evacuation, and the rescue

activity normally happens in some occasions involving survival who initially refused to evacuate and later on trapped in their house when the flood worsen.

Table 3: Response measures implemented in case study areas

	Village		
	Lubok Setol	**Teladas**	**Gajah Mati**
1. Government agencies	• Rescue efforts by various agencies in search and rescue cluster under Directive No.20 such as Police, JPBM, APMM, KKM with the support from Malaysian Red Crescent Society (BSM). • Evacuation of victims to the evacuation center. • Monitoring of secondary flood by METMalaysia.		
2. Non-Governmental Organization (NGO)	• Providing food and basic needs		
3. Local community	• JKKK support the evacuation of victims to the evacuation center by the government agencies. • JKKK assist government agency in victim registration, distribution of basic needs, preparation of food, security and cleanliness in evacuation center.		

D. Adoption of DMC measures during rehabilitation and reconstruction stage

Based on the analysis, the role of relevant government agencies is vital in providing financial aid particularly to disaster victims at the evacuation center. The aid is channeled through the JKM as stated in the Directive No. 20 (i.e. financial aid to be allocated only to all eligible disaster victims using funding from the Kumpulan Wang Amanah Bantuan Bencana Negara (KWAABN)(1997)).

5. Interpretation of community resilience and the way forward

This study summarised a few key discussions on different measures installed by various stakeholders and at different DMC cycles as discussed in the early section of this paper. As shown in Table 4, more intensive efforts implemented during the preparedness and response stages as compared to prevention/mitigation and rehabilitation stages by relevant stakeholders. Findings also demonstrated a prominent role of relevant government agencies in leading and executing disaster management and risk reduction in all study areas as stated in the Directive No.20. The efforts on disaster mitigation particularly the construction of reservoir requires a huge amount of investment hence require capable agency which in this case the government sector to step in and take the lead. However, at the community level, the role of NGOs gaining positive feedbacks from the disaster victims since the organization ability in supplying food, first aid treatment, building materials and conducting training on CBDRM.

Table 4: Summary of measure implemented by the government, NGO and community based on the disaster management cycle.

	Lubok Setol village			Teladas village			Gajah Mati village		
	Government	Non-Governmental Organization	Community	Government	Non-Governmental Organization	Community	Government	Non-Governmental Organization	Community
1. Prevention/Mitigation	✓								
2. Preparedness	✓	✓	✓	✓	✓	✓	✓	✓	✓
3. Response	✓	✓	✓	✓	✓	✓	✓	✓	✓
4. Rehabilitation and reconstruction	✓			✓			✓		

Source: Research fieldwork in 2018.

The study also concluded that local community in all study areas have utilizes their experience in facing annual flooding by strengthening local knowledge in DRR. For instance, a respondent in Lubok Setol village has recorded annual water level from Golok River in every monsoon season by putting a marking on his house pillar. By doing so, a person will be able to share vital information about the worst flood that occurred in 2014 (marking of water level at 10.84 meters) as compared to flood in 1965 (below 10 meters of water level). This information confirmed after a cross reference with data from Malaysia Drainage and Irrigation Department for a flood in Rantau Panjang in 2015 and 2017. After experiencing a big flood in 2014, more local community knowledge was accumulated and could be useful in assisting vulnerable communities in building capacity for disaster resilience particularly flood. This is evident from the survey whereby nearly 94% of respondents from Teladas village, followed by 70% from Lubok Setol and Gajah Mati (61.9%) agreed their community managed to recover from flood within few months (41.1%) higher than those mentioned as they recovered within just a few weeks (29%). Only a small portion did mention "in a few years" (<6%). In putting into perspective, the results from surveys of the three villages with comparison of lifeline model as presented in Figure 2 of this paper, some DMC measures and local knowledge adopted by communities in study areas are able to (1) reduce the level of socioeconomic and physical damages (D); and (2) time for recovery/faster recovery period (R). It is also an important indication that could support the agenda of SDGs through building resilience rural community to disasters.

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Challenges of post-disaster reconstruction projects: an empirical investigation according to project management knowledge areas

Omimah Alsaadi [a,*], Emrah Acar [a]

[a] Istanbul Technical University, Turkey

Abstract

Successful management of post-disaster reconstruction projects (PSRPs) can ensure the efficient use of resources and lead to improved outcomes. The literature on PDRP management is yet in its embryonic stage, and systematic research efforts are necessary to address the topic. Paper compares the challenges faced in conventional projects to those in PDRPs according to project management knowledge areas, through an analytical evaluation of the interdependencies between different areas of expertise. The descriptive-exploratory research was designed, and qualitative data from interviews with 11 managers with PDRP experience from different countries were analysed. Cause-and-effect relationships between the factors leading to 'frequent changes in scope,' 'time overruns,' 'cost overruns,' and 'low quality' were identified. Outputs suggest that managing stakeholders, risks and communications appear critical to coping with an evolving scope, while procurement management has a significant impact on project outcomes due to resource scarcity.

Keywords: Project management; Post-disaster reconstruction; Knowledge areas; Project management triangle.

1. Introduction

Post-disaster reconstruction projects (PDRPs) involve the "the modification, conversion or complete replacement of an existing facility that involves expansions, additions, interior renovation, or upgrading the functional performance of a facility" (Attalla et al. 2004). PDRPs aim to restore essential services and life support infrastructure to normal, while they may also provide valuable opportunities to build back better and achieve sustainability in the long term (Barakat, 2003, p.1). The conventional construction processes, however, may be inadequate especially in the case of large-scale disasters, which generally require a higher degree of coordination effort to achieve project targets (Le Masurier et al., 2006). Research studies that focus on the management of disaster recovery projects are quite limited (Mojtahedi and Oo, 2017, p. 841). "The project management literature has little to say about its application to disaster management, and disaster management literature has little to say about project management" (Walker et al., 2017, p. 855). There is a growing interest in a better understanding of managing PDRP, as part of a global concern for increasing resilience at all levels.

2. The 'iron triangle' and beyond

Project management knowledge areas provide an extensive guide on the management of the different aspects of projects, which are expected to be integrated by a project manager within the realm of each project. Project Management Institute (PMI) defines ten major knowledge areas including the management of scope; time; cost; quality; procurement; human resources; communications; risk; stakeholders; and integration. Each knowledge area described by its component processes, practices, inputs, outputs, tools, and techniques. According to many professionals, the objective of any project is to achieve the desired quality, as described by its stakeholders, considering its primary constraints including budget, cost, and scope - 'The Project Management Triangle' ('The Triple Constraint' or 'The Iron Triangle'). Keeping all other factors constant, project managers can trade between these constraints, while changes in one constraint will necessitate changes in other constraints. Scholars, however, criticize the 'triple constraint' perspective due to its ignorance of the project managers' limited control over the external factors, which may easily change the balance between scope, cost, time and quality, or due to project managers' incapability to balance all the objectives and requirements of stakeholders in a project (Kalkman and de Waard, 2017, p. 890). Due to the unique features of a project, the focal point of 'the triangle' may settle in different ways, and the level of expertise needed regarding different knowledge areas and the

* Corresponding author. E-mail address: omimah.alsaadi@gmail.com

associated tools and the techniques necessary may also change, for which the interdependencies between different areas of expertise can be critical.

3. Managing PDRPs

Peculiarities of the PDRPs originate from a variety of factors such as the relatively large number of stakeholders that are to collaborate in a turbulent environment; the complex interactions of social, technological and economic factors and the need for a cultural perspective to address the peculiarities of the disaster-affected areas (Baroudi and Rapp, 2011, p. 17). PDRPs typically deal with a high level of uncertainty and complexity; many local and international organizations compete for scarce resources, and the donors who finance the projects may ask for quick results due to a desire for normality (Hidayat and Egbu, 2010, p. 1271). According to Lin et al (2017, p. 913), "time pressure is the main factor which makes disasters unique, distorts the conventional project management practice that would work under normal circumstances, and calls for a more "contextualized application of project management methodologies." Kalkman and de Waard (2017, p. 890) argue that the linearity and rationality assumptions of the current PM should be questioned in the chaotic environment of PDRPs, where it is difficult to set clear goals and boundaries, define tangible end products, and establish well-working monitoring and control mechanisms hierarchically. The involvement of stakeholders and providing flexibility, the authors contend, can be more highly valued than control. Kalkman and de Waard (2017) suggest a right balance between trust and control, and a comprehensive combination of contractual requirement and informal relationships for the success of PDRPs, where stakeholder management plays a central role. Considering the critical role of soft resources such as community participation and trust, implementer capacity, transparency and accountability, and institutional support, Vahanvati and Mulligan (2017, p. 805-806) call for a process-oriented, rather than just an outcome-oriented approach for evaluating PDRP success. They highlight research findings which support the adoption of agile approaches, concerning building capacity within communities, which goes beyond the scope of a single project. Kalkman and de Waard (2017, p. 890) and Walker et al (2017, p. 885) also support the agility perspective for PDRPs where "a series of relatively small tasks are defined and implemented incrementally as the situation demands, in a flexible and adaptive manner, rather than as part of a fully pre-planned *process*."

4. Method

To investigate the challenges of PDRPs, a highly structured questionnaire was delivered to projects managers with PDR experience (The questionnaire is available at URL1). Open-ended questions allowed respondents to provide in-depth feedback on their PDRP experiences, including both the challenges faced and how they responded on the field. Due to space limitations, these paper reports findings concerning the former. Authors adopted a purposive sampling strategy to approach managers from different countries and organizations (Table 1). The corresponding author arranged Skype, face-to-face and telephone interviews. Data collection efforts also included site visits to Jordan, in February 2017, and to Lebanon, in March 2017. The former visit aimed to approach the participants of an international conference on Yemen, where many PDR experts and donors gathered. The corresponding author was able to collect data from experts from international NGOs, Islamic Development Bank, World Bank, United Nations, governmental agencies and local organizations. The second visit to Lebanon aimed to interview project managers who took the role in the post-war reconstruction of the country. The author met with university professors who gave consultancy to the Lebanese government together with UN-Habitat Office, and the contractor companies which was responsible for the reconstruction projects.

Table 1: Characteristics of respondents

Code	Types of projects involved	On behalf of	Geographical location	Years of experience with PDR projects	Organization
A	Infrastructure/ Residential	NGOS	Middle East	20	UNOPS
B	Residential	NGOS	East Asia and Pacific	10	International NGO
C	Infrastructure/ Residential	Government Public institutions	Middle East	5	Islamic Development Bank
D	Infrastructure	Government Public institutions	Middle East	34	United Nations Development Program
E	Infrastructure	Contractors Subcontractors	Central Asia	2	University
F	Industrial	Contractors Subcontractors	Middle East	2	Construction Company
G	Residential	NGOS	Middle East	4	United Nations
H	Infrastructure/ Residential	Contractors Subcontractors	Middle East	2	UN-Habitat
I	Infrastructure/ Residential	Government Public institutions	Middle East	12	Small & Micro Enterprise Promotional Services
J	Infrastructure/ Commercial/ Residential	Government Public institutions	Middle East	16	Reconstruction Fund
K	Infrastructure/ Residential	Government Public institutions	Middle East	10	Ministry of Public Works and Highways

A qualitative content analysis was conducted to identify the themes (challenges) which correspond to different project management knowledge areas. While the 'Project Management Triangle' was a central focus, the remaining knowledge areas were analyzed to understand their interrelationships and combined impact on the triangle. Perceived cause-and-effect relationships between the factors leading to 'frequent changes in scope,' 'time overruns,' 'cost overruns,' and 'low quality' were identified. Outputs were visualized by using Vensim, which is simulation software for developing and analyzing models (see http://vensim.com). Once the relationships between themes or variables are identified manually by arrows (see Figure 1), the 'Causes Tree' tool of Vensim automatically produces the 'Causes-Tree(s)' for the interrelated themes (Figure 2 through 5). Figure 1 shows the partial screenshot from Vensim, however the reader can see the full figure at URL2.

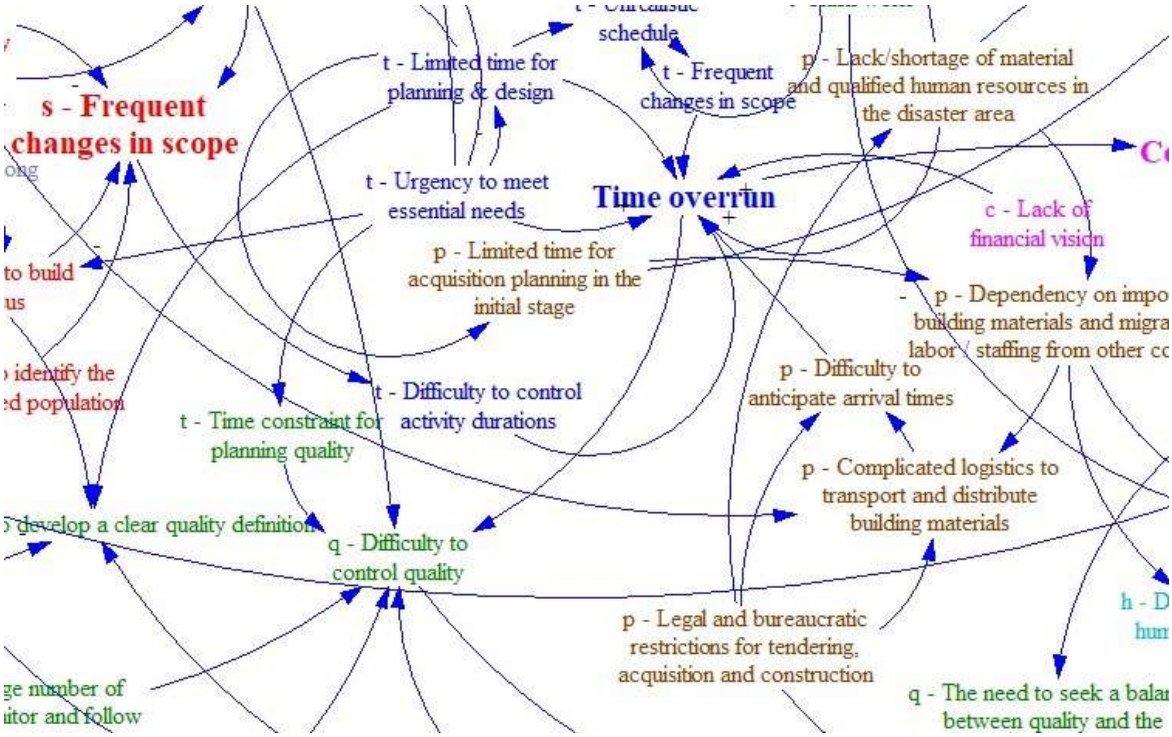

Figure 1: Partial screenshot from Vensim - Identification of interrelationships between themes (The full screenshot is available at: URL2)

5. Findings

5.1. *Scope management*

According to Figure 2, primary causes that lead to frequent scope changes in PDRPs include lack of communication among stakeholders; difficulty to build consensus among due to conflicting aims; difficulty to identify the needs; lack of communication in the early stage projects; and uncertainty about project inputs.

> "Scope was constantly evolving as the project progressed. Initial damage assessment scope was created but constant updating was required as more extensive investigations occurred. It was challenging at the beginning as the scope started small and continued to grow. This was of course concerning the many stakeholders involved in this project… Discerning exactly what scope was disaster-related vs. non-disaster related during reconstruction was difficult to discern but turned out to be very important at project completion" (D)

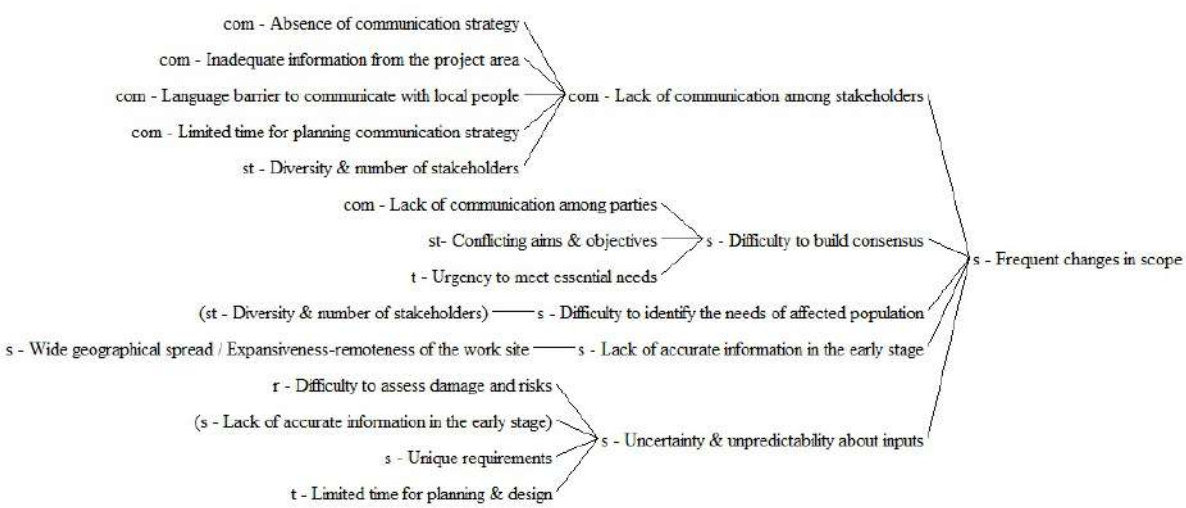

Figure 2: Causes tree for frequent scope changes * com: communication; st: stakeholder; s: scope; t: time

5.2.*Time management*

According to Figure 3, primary causes that lead to time overruns in PDRPs include the following: lack of financial vision; difficulty to anticipate the arrival times of building materials; lack/shortage of human and non-human resources in the disaster area; limited time for planning and design; and the difficulty to control activity durations as a result of frequent changes in scope.

> "Shortage of local resources, and dependency on donors, who, in many cases, do not deliver on their commitments [is a challenge]… The procurement regulations and laws, and government regulations for purchasing, which require large amounts of time during implementation" (K)
>
> "As scope was constantly evolving, schedule and resource requirements were always changing. Being in a PDR restricted area, it was difficult to add additional resources if required…" (L)

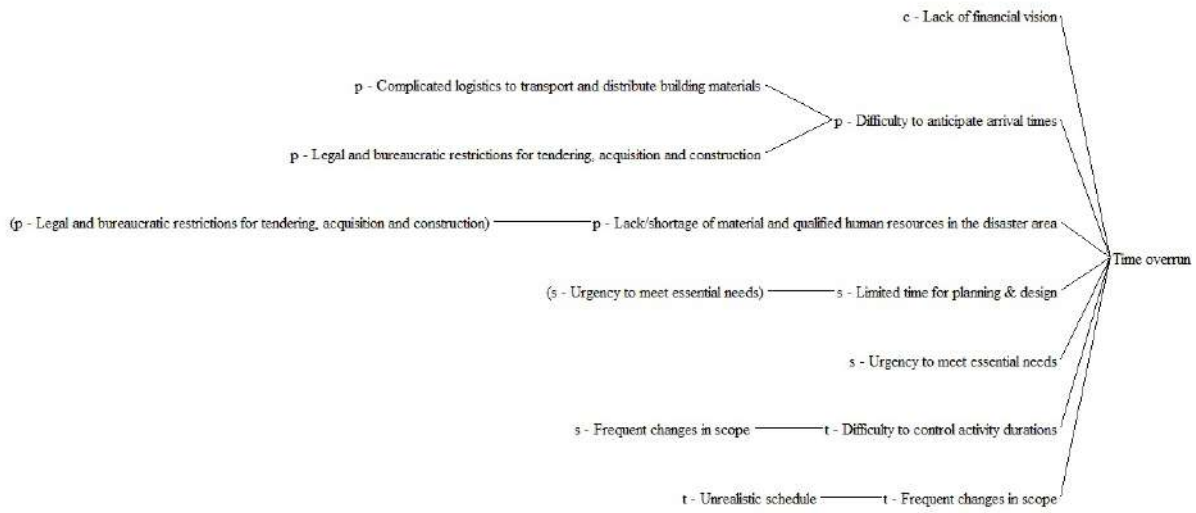

Figure 3: Causes tree for time overruns * c: cost; p: procurement; s: scope; t: time

5.3.*Cost management*

According to Figure 4, primary causes that lead to cost overruns in PDRPs include the following: Difficulty to develop cost plans due to unrealistic estimates; failure to get the best prices for resources; instability of local currency exchange rates; lack of insurance systems in the economically less developed countries; poor funding; high financial uncertainty; in addition to inflation and time overruns.

> "An insufficient time during design stage did not allow us to properly plan the required purchases. Hence we mainly depended on local sellers who most of the time provided higher prices." (F)
>
> "Scope [is] constantly evolving and therefore cost estimates are always changing…Cost control was extremely difficult due to the push to have the facility up and running as quickly as possible led to over resourcing in many areas…Difficult restrictions imposed at the time of PDR made it difficult to anticipate when items were to arrive. This has an effect on schedule and costs. It was also hard to receive responses from sellers due to the remote nature and restrictions in place for access onsite at the time." (L)

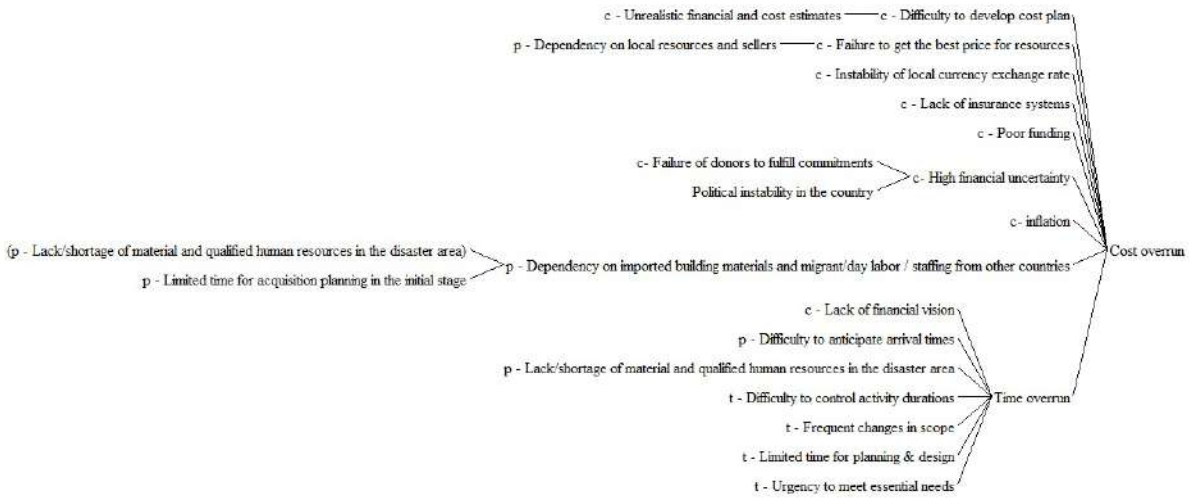

Figure 4: Causes tree for time overruns * c: cost; p: procurement; t: time; s: scope

5.4.*Quality management*

According to Figure 5, primary causes that lead to low quality in PDRPs include the following: poor funding; dependency on imported building materials and migrant/day labour and staffing from other countries; dependency on local sellers; difficulty to control quality, and rush work as a result of unrealistic schedule.

> "Challenges in reconstruction projects relating to total quality management increase the bigger the project gets because there is an inability to carry out total monitoring and evaluation of the quality." (K)
>
> "…The expansiveness of the worksite means that a large number of consultants are needed to monitor and follow up with the work. Implementing through the beneficiaries, who do not have enough experience, has a negative effect on the work that is carried out." (J)

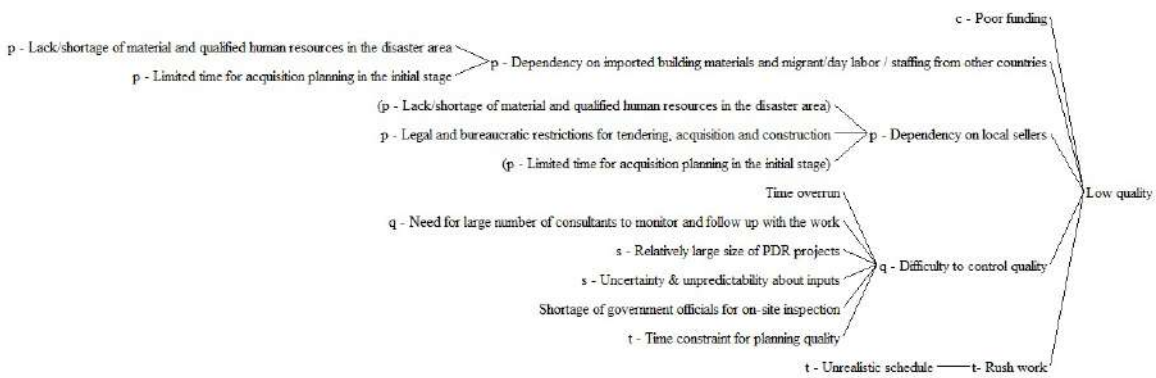

Figure 5: Causes tree for low quality * c: cost; p: procurement; q: quality; t: time; s: scope

6. Discussion

Table 2 shows a summary of causes-trees which have been explained so far in the previous sections. Cross-tabulation of findings according to codes of causes (see the codes/abbreviations under each figure) suggests that managers with an extensive PDR experience highlight especially the critical relationships between i) procurement management with time-cost-and quality, and ii) scope management with risk-stakeholder-communication management (Table 2). Procurement management and risk-stakeholder-communication management areas deserve attention within the context of PDRPs, regarding their impact on the essential elements of the PM 'Iron Triangle,' including scope, time, cost, and quality. These main findings are elucidated below within the light of previous research findings on PDRPs.

Table 2: Interrelationships of PM knowledge areas

Knowledge Areas	Scope	Time	Cost	Quality
Scope		X		
Time	X		X	X
Cost				X
Quality		X		
Procurement		X	X	X
Risk	X			
Stakeholder	X			
Communication	X			
Human resources				
Integration				

It is typical of PDRP environments that many local and international organizations and donors compete for scarce resources (Hidayat, B and Egbu, C, 2010, p. 1271). Resource management in a PDRP depends on multi-stakeholder collaboration, donor management and government intervention, and the improvement of tools and policies to allow market adaptability (Chang et al., 2010, p. 247–259). Procurement strategy should be part of the long-term sustainability efforts and contribute to local communities and economies in the disaster-affected areas (PMI, 2005:28, McGee, 2008, p. 551). Design solutions should support appropriate types of construction and building materials (Barakat 2003), and consider recycling and re-use options where available. The shortage or decimation of resources in the local construction market may require their import, slow down the construction process (Green et al., 2007, p. 311-335), significantly increase costs (Steinberg, 2007, p. 150–166) and put local, traditional building techniques at risk (Barakat, 2003, p. 29). Assessment of local capacity can be a critical element of the procurement strategy (Barakat: 2003, p. 34). Long bureaucratic procedures for getting legal approvals, restrictions for construction materials, and the shortage of government officials necessary for monitoring and controlling construction work can affect the estimates for activity durations (Kennedy et al, 2008; Alexander, 2004). Qualitative evidence presented in this study also shows that complicated logistics to transport and distribute resources is the result of a set of factors including the legal and bureaucratic restrictions for acquisition, wide geographical spread or remoteness of the work site, and the dependency on imported building materials and staffing from other countries due to resource shortages and the limited time available for planning in the initial stage. Accordingly, procurement management has a critical impact on the project management triangle; more specifically on time, cost, and quality management in a PDRP environment.

Integrated management of *stakeholder* relationships, *risks* and *communications* is imperative to managing an evolving scope in PDRPs. Recognition of the expectations of different stakeholders is a valuable asset for managers to develop context-specific project strategies, especially when the "*the ends and means* [scope] *of projects are constantly redefined based on the interaction of participating organizations*" (Artto et al., 2008). Researchers have shown that ensuring the active participation of stakeholders is a means to develop a consensual project scope definition (Jafari, 2008) Apart from the operational plans, the sustainability plan should be a critical element for developing scope definition in a post-disaster setting and outlining how the disaster victims will continue to sustain themselves when the implementing agencies depart (PMI, 2005). More recently, Mojtahedi and Oo (2017, p. 841) reported that stakeholders with power, legitimacy and urgency attributes perform better in the disaster recovery processes, where the socio-economic and transport infrastructure conditions have mediating effects. Equally important is the establishment of a strong and reliable line of communication and information system in post-disaster situations to make people aware of existing opportunities for participation (Sadiqi et al, 2017:900). Lack of community capacity, gender issues, lack of professional competence in NGOs, government policies and practices, and lack of adequate security can be barriers to community participation in PDRP settings (Ibid.).

From a broader perspective, findings support Vahanvati and Mulligan (2017, p. 802) who argue that the significant impact of external stakeholders on PDRP outcomes requires a boundary-spanning approach regarding understanding the sustainability-related effects of a PDRP, beyond its technical scope. As researchers have shown, low-cost and community-based procurement strategies may not be put into place when a disaster reduces the capacity of a community. External resource dependency may negatively affect the technical scenarios if choices are to be made between traditional building technologies and industrialized solutions, where the time pressure to meet urgent needs may dictate the latter. Calls for a more context-specific and agile approaches to PDRP management (e.g., Walker et al, 2017, p. 855; Lin et al, 2017, p. 913; Kalkman and de Waard, 2017, p. 890), when project managers have limited control over the external factors, appears highly relevant in terms of considering the unique features of each project and handling contradictory situations. Due to the close relationship between the agility concept and the evolving scope of a PDRP, managing risks, communications and stakeholders appears critical to obtain successful outcomes.

7. Conclusions

The conventional PM processes may be inadequate to address the peculiarities of PDRPs. The 'Project Management Triangle' was re-visited with a PDRP lens and the interdependencies between various PM knowledge areas analysed within the particular context of PDRPs. Since the components, practices, inputs, outputs, tools, and techniques vary for different PM knowledge areas, such interdependencies can be critical to set priorities in different settings. Understanding the peculiarities of PDRPs about PM methodology is of particular value for the managers of future projects and other decision-makers, especially in the economically less developed world, which has limited resources and capacity to handle complexities. Findings also provide insights into how the special circumstances such as the post-disaster environments affect the conventional project management processes.

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URL 1 – Questionnaire of the study - https://drive.google.com/open?id=13rwCqaZlkV4U4-ObA0qN20x8LT986RV0

URL 2 – Figure 1 - Full screenshot from Vensim screen - https://drive.google.com/open?id=1cSOJ1gYwquGec5MU7B4Zs4g8NrwgFJHF

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Assembling an alternative: pushing the development of a new housing programme in Porto

Aitor Varea Oro [a,*], Nuno Travasso [a]

[a] CEAU-FAUP, Portugal

Abstract

Through an analysis of the process that enabled the implementation of a programme developed as a reaction to the housing problem in Porto, this paper seeks to understand how academic actors can participate more directly in society. This process draws on the theoretical work of several authors who have studied how to create a political and operational space for innovative actions to take place, and it is presented here as an example of how those theories can be put into practice. The text is divided into three parts: 1) description of the set in which this action takes place; 2) review of this process in more detail from the smaller actor's point-of-view; 3) some conclusions that point out the path for the future development of this (or other similar) process(es).

Keywords: Institutional innovation, actor-network, public value, affordable housing.

1. Introduction

The lack of affordable housing is a growing problem in many European countries, which has become a major topic in academic forums. Although there is some consensus on the roots of the problem – liberalisation of the housing market and new economic dynamics– it is hard to find a common position to respond to this crisis. One possible approach is social re-assembly, which aims to gather and reorganize all available actors and resources in order to counterbalance hegemonic dynamics. Cases that manage to move from theory to practice provide valuable information in order to analyse the pros and cons of these approaches.

This paper aims to contribute to this discussion by presenting one of those cases where both authors are directly involved. This particular action seeks a broader impact by moving from collective practice to public policy. The paper does not focus on the outcome - the results are not clear yet - but on the process – context, practices and networks – aiming to discuss how to promote institutional innovation and what the role of small actors and academic institutions in that process can be. The process will be presented focusing on three main questions:

- How to recombine different actors with opposing interests in order to create a new transformative collective actor?
- Is it possible to build a satisfactory public response to the housing problems and, if so, which kind of relation is needed concerning public administration?
- How to choose the right equilibrium between a) following each actor's established protocols that grant coherence of speech but lack operational ability, and b) accepting compromise with other actors, gaining transformative capacity, but risking coherence, critical distance and acceptance of peers?

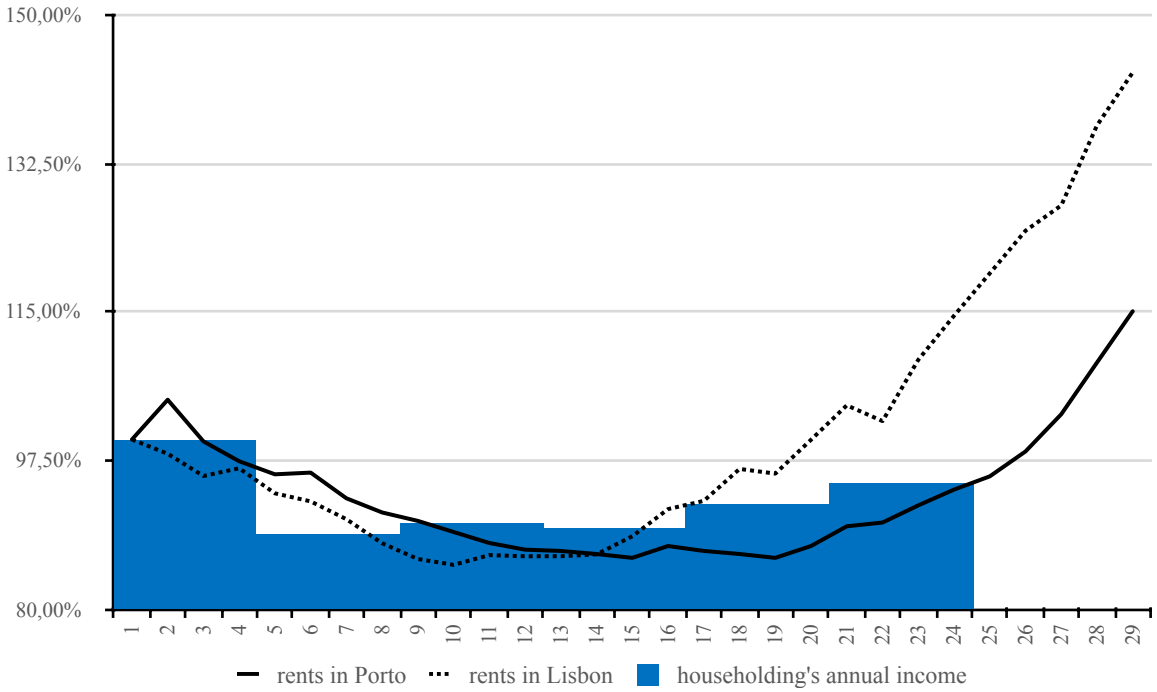
2. Reacting to the housing crisis

2.1. Housing problem as a matter of public policies

In Portugal, the aftermath of the recent economic crisis aggravated existing housing problems. In urban centres, housing rents increased 49% (Lisbon) and 33% (Porto) in a 30 month period. This situation can be understood by acknowledging the key role of public policies. During the crisis, the government tried to reanimate the stagnant economy by boosting emergent dynamics (changes in financial markets and tourist trends), through the liberalization of the housing market and investment incentives, thus creating a major housing problem. Recently, reacting to the rise in broad public awareness, the leftist coalition who took office in 2015 presented a New Generation Housing Policies (NGHP) aiming to promote affordable housing based on urban renewal and to regulate the sector.

* Corresponding author. E-mail address: avoro@arq.up.pt

Graph 1: Housing rents and evolution of household income. Source: Nuno Travasso



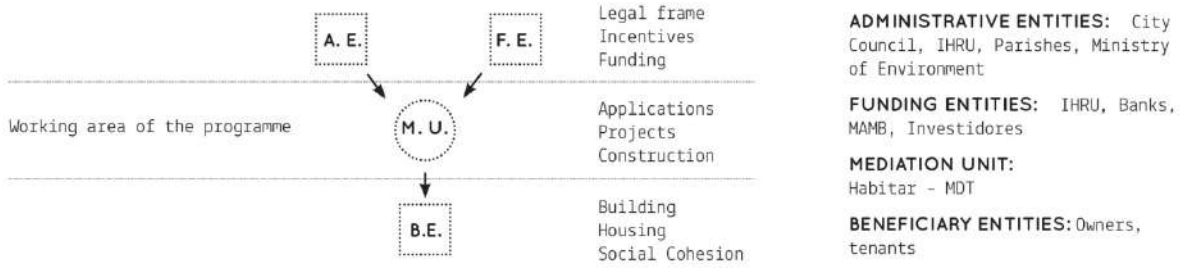
2.2.*Two actors*

Within this context, MDT (an academic research group) and Habitar (a third sector association) joined efforts to promote an answer to the housing crisis. They have sought to actively participate in the society they are part of, and to test and produce knowledge. This collaboration relies on a common basis: the answer to the crisis should not be dependent on a structural change or on the addition of exogenous elements, but should come from the activation and recombination of already available actors and resources (Boeri, 2012; Portas et al, 2015), which implies a change in the planning culture of public institutions (Ferrão, 2011)

2.3.The programme

The two actors have reached an agreement with the municipality of Porto to create a programme that aims to democratize urban renewal through a new mediation structure that will connect all the actors involved (owners, residents, technicians, public entities) promoting simple, fast and transparent processes, granting existing public funding and enabling the accumulation of experience in order to optimize future operations (see Varea Oro, A., Vieira, P., 2018). In this way, owners who do not have the means (financial, technical) to enter the existing real estate market, gain a new choice, besides selling their property or leaving it to fall apart. Moreover, by solving owner's problems, the programme expects to answer the needs both of the people looking for affordable housing and the city itself, by promoting exemplar urban regeneration interventions.

Graph 2: Programme structure. Source: A. Varea and P. Vieira (2018)



3. The strength of weak actors

In order to create the political and operational space to promote the intended action (Cels *et al,* 2011), creating the social awareness that the problem has a public, accessible and reasonable solution is as important as gaining authorization from institutions themselves. We will now introduce the theoretical basis and the methodological framework needed to understand the development of this action and the approach of the paper.

As Latour explains, (2005), in order to make a thing public (in all the senses of the word), one has to compose a *matter of concern*, gather an *assembly* around it, and establish a *common language* to discuss that. According to Bourdieu (2000), in the housing field, the State establishes the rules of the game, which every actor tries to change, in order to turn the features that distinguish him/her from the others into valuable capital.

This State – which, as Leilani Farha recalls (2017), is made up of all its administration levels and which has the responsibility to assure the implementation of human rights – is not well equipped for innovating actions (Cels *et al.*, 2011). However, it is permeable to exogenous forces, mainly to pressures from major actors but also to weak actors dwelling on the system's periphery.

In fact, these actors are the ones who are more capable of risking and innovating (Granovetter, 1973). The challenge, as underlined by Laclau (2005), is in the movement from *the politics* (the problem construct) towards *the policies* (the solution in a stable institutional frame), aiming to move practices from the periphery to the centre of the system, seeking to grant them stability by changing institutions themselves.

In order to show how these theories can take place, we will focus on the smallest actor in this process and analyse the dialogical relationship between: 1) the general context, 2) the practices developed by Habitar, and 3) the constant re-assembling of actors. These specific situations, choices and dilemmas will depict the contingent and (apparently) chaotic nature of these kinds of situations and allow us to systematize some of their structural variables.

Graph 3: Evolution of the conflict. Source: A. Varea and N. Travasso

3.1.The context: between centre and periphery

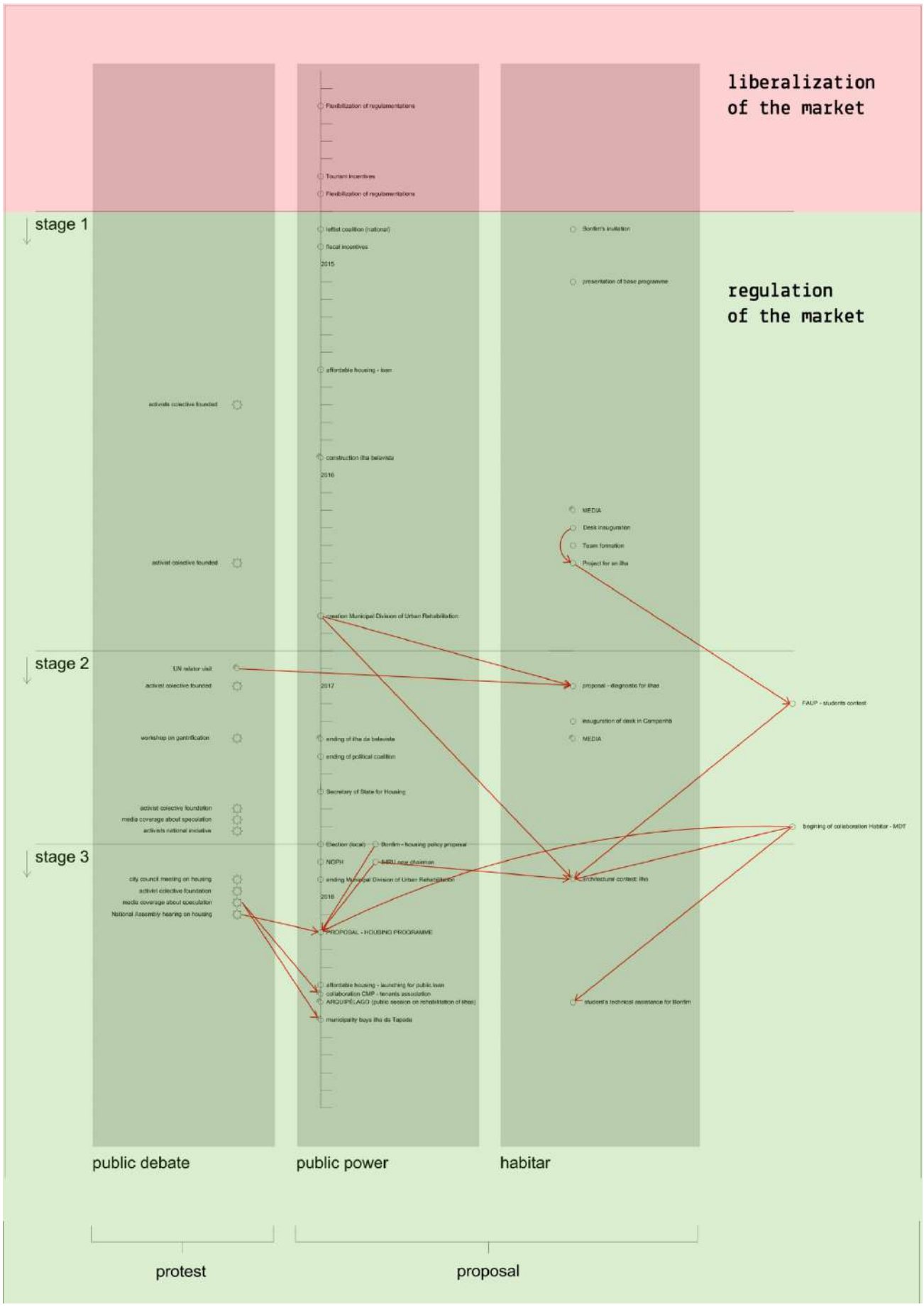
Figure 1: Institutional debate (on the top – Domus Social) and public protests (on the bottom - AIN – Victor Sousa)

The presented timeline depicts the sequence of events that has determined the development of the process until this moment. However, what matters the most is the way those events reshaped the relations between different actors, some of which were previously unconnected.

It seems evident that the conflict is a social construct, where the impact housing cost had on the middle classes was essential to determine the mobilization of certain actors and discourses that determined the public agenda. The actors who took part in this construct can be divided into two groups:

Actors at the centre of institutions.

According to our theoretical framework, public power arises as the central element. It is neither homogeneous nor stable and, as powerful as it may be, it must always try to neutralise criticism and to naturalise its mandate. Public power is formed by institutions, which may accommodate different or even opposed interest themselves (Bourdieu, 2000).



Amongst these institutions, we may find those which can function as an interface - they can assimilate part of

the protests and proposals in their periphery. Sometimes they do it to neutralise conflict, other times to solve it. Be that as may, these processes have the ability to move power from one place to the other.

Actors in the periphery of institutions.

This group ranges from third sector actors to individual property owners or tenants, including the academy and activists. They have more freedom of action than the public body (whose action is framed by strict rules) and can risk more. However, while institutions tend to remain in the field for longer, these actors are highly volatile

The analysis of the timeline shows how conflict growth, from 2017 on, enabled a greater number of events and debates both in academic and activist fields. This was a result of social pressure and the expectations created by the NGHP and encouraged greater permeability between practices, arguments and actors.

A complex assemblage

The relationship between social pressure and institutional interests and competences allowed Habitar to link agents from those two worlds. Institutions with significant technical knowledge, political power or symbolic capital became essential to support alternative proposals led by peripheral actors. As examples, we can point out:

- The Social Welfare Office of Bonfim Parish, which strongly supports the provision of affordable housing and provides both access to the political sphere and proximity to the field work being developed, essential to understanding the social problem.
- Porto's Municipal Department for Urbanism (MDU), interested in combining technical work with a closer relation with the territory. This actor was essential in understanding and overcoming the technical dimension of the problem.

Even though this whole context might seem favourable for the implementation of the programme, assembling all these different demands and actors is not an easy task. For instance, the NGHP is not without resistance, from not only property owners and developers, but also from inside the public body itself. Furthermore, combining different levels of public administration requires the ability to speak and understand different languages and interests, as well as accept their assessment and bureaucratic rules.

3.2.Shaping discourse

Once the rules of the game which shape the conflict have been underlined, we can show how can a weak counter-hegemonic actor can accept those rules and successfully bring together a group of disconnected actors, resources and interests, to have potential operative ability in the housing domain, using public power as a binding factor.

It is therefore important to point out some of the principles that shape the *discourse strategy* used to overcome those obstacles. By *discourse strategy* we mean the set of apparatuses (practices, arguments, symbolic interactions) used to build both a shared agenda and the means for interaction and implementation. Those principles are:

- Neither identities nor interests pre-exist the process; on the contrary, they are shaped with the development of the conflict.
- The conflict construct draws on the existing discontent of different actors, but it does so by giving a new and broader meaning to the reasons that justify such discontent.
- Exploring polysemy is decisive. Each actor and each practice have several possible interpretations, which amplifies the chances of combination and agreement between different actors.
- To combine and stabilize action groups, it is necessary:
  - to mobilize actors who are on the periphery of the matter under concern: they can express the conflict in different terms and increase the permeability between different actors;
  - to use broadly recognized practices and symbols, useful tools to disseminate, legitimate and enrich minority' points of view amongst broader social groups.

This abstract set of principles can be explained with three examples chosen from the three stages of the timeline.

From communitarian development project to a help desk: one step behind?

In order to gain the support of Bonfim Parish (the level of administration closest to the territory and its inhabitants) Habitar abandoned the use of Participatory Research-Action methodologies (its first choice) and decided to interact with the population inside the frame of a technical, juridical and bureaucratic welfare office. This compromise brought a benefit and a challenge:

- The benefit was that this was a standard structure that was able to call up landowners, a group not so easy to captivate with phrases such as "right to the city", and which it would not have been possible to involve with the kind of practice initially desired by Habitar.
- The challenge was how to assemble a collective actor, made of individual parts, which did not interact with each other. This was important since endorsement from civil society (and not only from the owners or even other users of the help desk) was needed.

To do that, Habitar had to be presented as a symbol of shared interests binding separate (and often opposing) actors.

Figure 2: Negative discourse on tenants in the mainstream media (on the left – *O Diabo*) and Habitar's positive discourse on affordable housing loans (on the right - Publico)

Class is not the binding element: social demand is. "Housing at fair cost"

To answer to this challenge, the help desk gained a new function outside the protocol established with the parish: using the media to actively participate in the on-going housing debate, through presenting the problem in innovative terms. It was possible to overcome polarization with a positive discourse about opportunities (the programmes granting owners financial support for urban renewal) instead of a negative one about problems (the scarcity of affordable house, which, in fact, could be solved by using the programmes).

Since day one, Habitar has presented the same discourse: one owner without the resources to renew their property; one tenant who can not find a house at affordable cost; one architect or engineer who longs to work in a different way – these are not three problems, these are three expressions of the same problem, this problem being the difficulty to access the financial and bureaucratic sphere.

The individual stories presented in the help desk have enabled Habitar to construe a new actor: the owner who does not want to sell or abandon their property, and who wishes to renew their property through public funding and place it on the affordable rent market. Those landlords may not be supporters of symbolic social housing policies and programmes the academy normally advocates (namely SAAL), but they became the perfect protagonists of a new pragmatic narrative Habitar successfully presented in academic, administrative and activist forums.

Spaces where things can be explained and carried out in other ways

Seeking institutional innovation implies risking acting outside each actor's established protocols. Each actor needs to compromise in order to open space for the recombination of actors and the emergence of new practices. However, the larger the actor, the less they are able to compromise, which means smaller actors must adapt the most. When this adaptation is no longer possible, other creative solutions must be adopted.

Aiming to overpass the tensions the help desk was creating within public sector protocols, Habitar created a new operational space that provided a response to an owner's demand (an architectural project needed to apply

for funds), accomplishing the expectations of all involved actors and, simultaneously, avoiding their specific protocols. This space was materialised as an architecture competition – an established formal practice which:

- Enabled Habitar to produce and share knowledge, as it was necessary to explain and reframe all the regulations related to the licensing and access to financial support. This information was developed in partnership with the MDU and responded to the expectations that its technical officers had concerning Habitar's mission.
- Pushed for an open and transparent process, neutralising any unfair competition accusations. Simultaneously, it provided architects with a new way intervening, with evaluation criteria more attentive to how each project would serve existing social needs, aiming to disseminate and normalize good practices.
- Created a platform for a broad public debate on housing combining several actors (city council, parishes, central government, MDT, media, local citizens) that proved that acting differently was possible and that institutional support for the refurbishment of private properties could create public value (exemplary interventions).

Figure 3: Successful project in the competition (on the top - Merooficina) and parallel sessions – making public the problem (on the bottom – MIRA forum).

3.3.Networks of actors

Habitar's case shows how discourse can ascend via capillary action. Although the programme started at the parish level in April of 2016, in February of 2018 it had become part of the discussion at national level, as a

result of a hearing in the National Assembly, when the mayor of Porto endorsed Habitar's narrative, referring to it as a good practice.

At that point, Habitar's strategy was seen as legitimate regardless of observers' ideological positions. To call owners, tenants, technicians and different levels of the administration onto the same platform sounded like a reasonable idea. The formative dimension of the strategy, as shown in the competition (in alliance with MDT) suggested that the University should be the agent to boost the expansion of the strategy as an official programme.

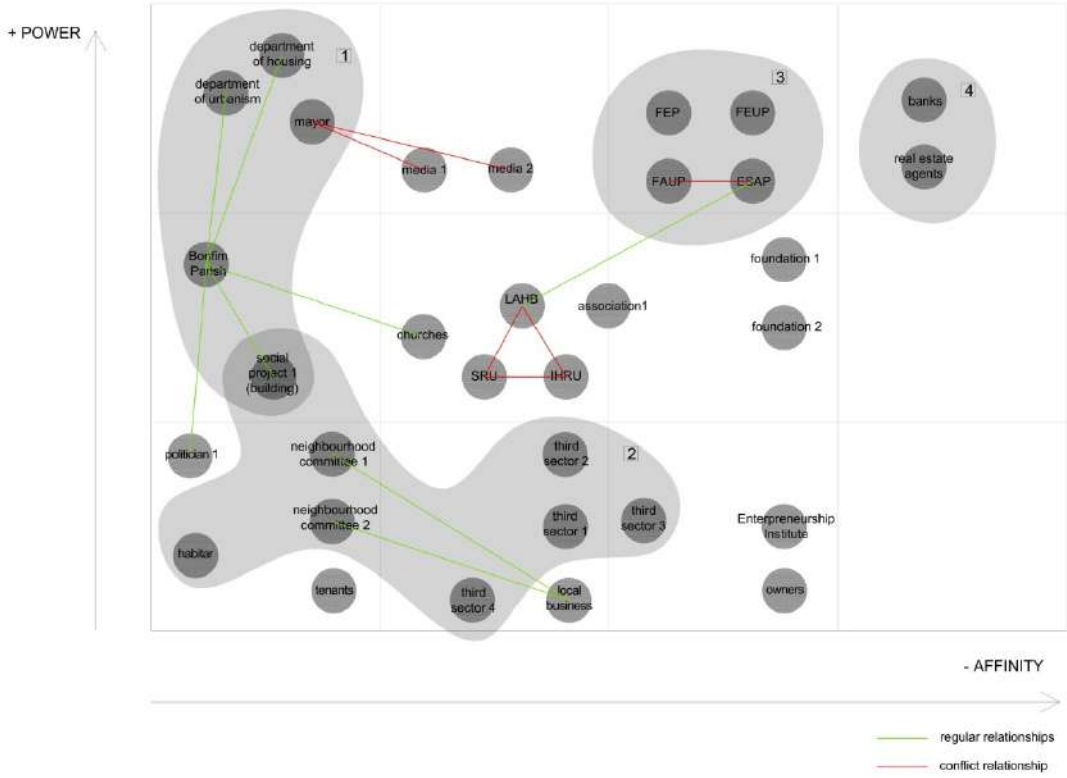
The Habitar actions presented were only made possible by a broader recombination of actors, resources and interests, which is, at the same time, cause and consequence of the successive stages of the process. To better explain this point, we will analyse a set of maps of actors developed from 2015 to 2018. This analysis will be carried out considering two variables:

- the different sets of related actors;
- the level of internal organisation needed to respond to different contexts.

Stage 1: Trying to assemble a collective actor

In the first map, we can see how both the academy and public administration – two types of institutions that pursue public interest – see the other one as an actor with different interests. The Academy argues it has transformative knowledge, the administration reclaims executive knowledge for itself. These two points of view are presented as contradictory.

Habitar is seen as an "activist", interacting with a set of third sector actors pursuing social justice, who were related to Bonfim Parish. However, once again, two kinds of actors that share the same purpose were not able to build a common action, as their practices were too distant. While Habitar aimed to act in the domain of trans-sectorial public policies, the others were acting in the realm of social entrepreneurship with sectorial goals.

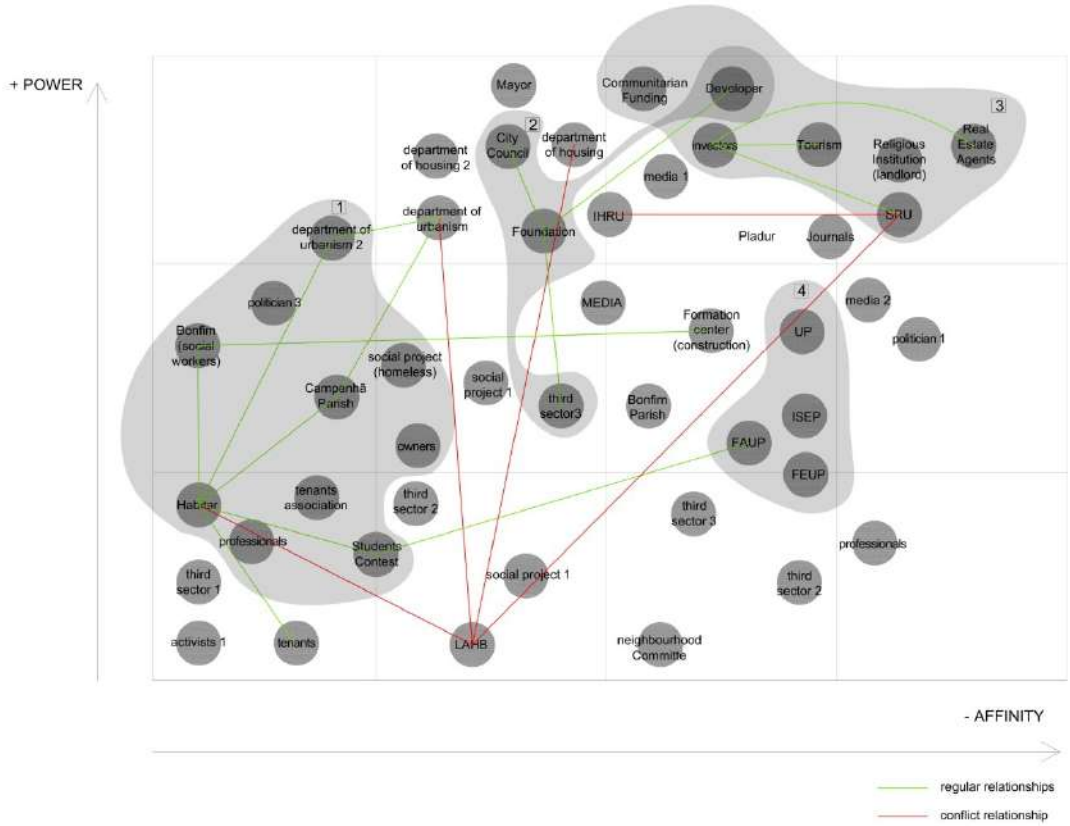


Graph 4: Actor map (2015). Group 1: Administration. Group 2: Third sector. Group 3: Academy. Group 4: Market. Source: A. Varea

Stage 2. Exploring and multiplying alliances

Here, we can confirm that public administration contains many contradictory interests, creating gaps that may be filled in. Parishes led by different political parties or Municipal divisions led by specific individuals are opportunities to discuss problems from different points of view and to amplify the number of accepted practices that, once tested, can gain acceptance.

At this point, Habitar was already seen as a "best practice", and it formalised itself as a third sector association. This was mandatory for it to be able to create protocols with other actors (increasingly institutional), and to act independently, outside not only market rules but also grants, foundation prizes or patronage criteria. The broad scope of action of Habitar makes it a transversal and interesting actor, able to bind actor's practices.

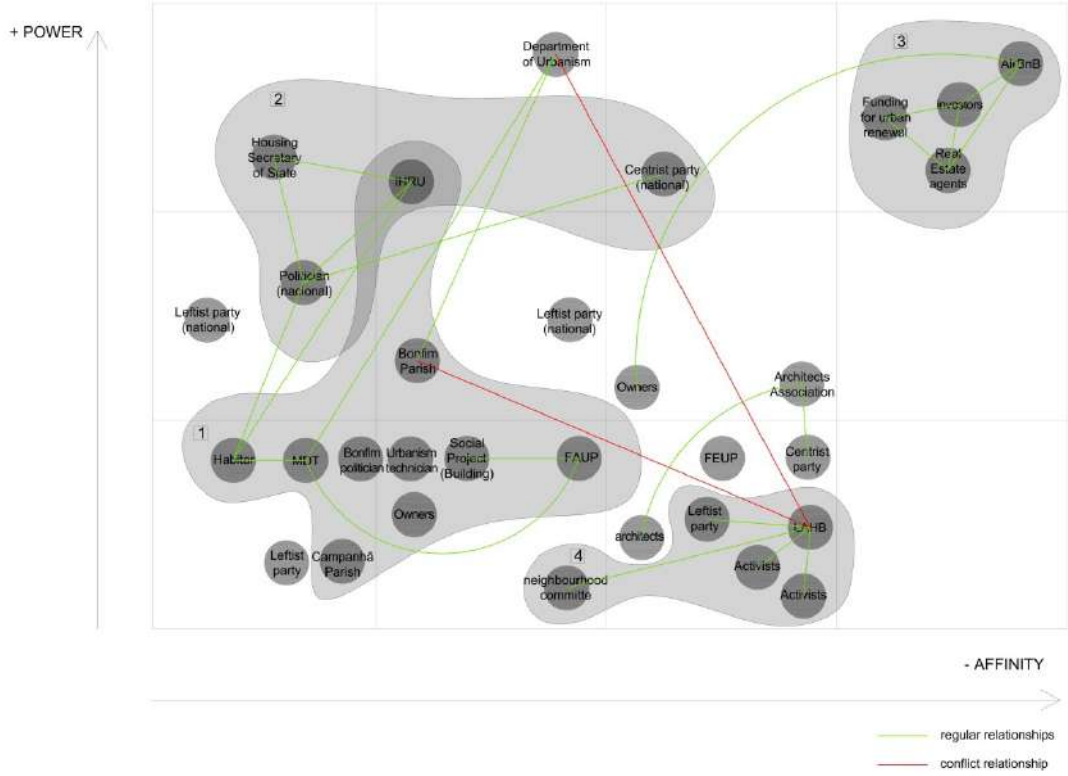


Graph 5: Actor map actor (2017). Group 1: Assembly of Administration and Civil Society; Group 2: Assembly of Administration, philanthropic agents and third sector; Group 3: Market; Group 4: Academy. Source: A. Varea (Students contest = student contest formation centre = training centre (??))

Stage 3. Consolidation of part of the practices

In this stage, the action group combining Habitar, the academy (MDT) and local administration (city council and parishes) has been assembled. These actors are bound by practice – the expectation of the new programme they are designing. However, they are simultaneously becoming disconnected from a set of actors with influence on inhabitants, social movements and architects.

Habitar is now institutionalised, not only due to the kind of actors it relates to, but also as a result of the type of work it is developing. Fieldwork is now reduced and follows the protocols of a socio-spatial inquiry commissioned by the city council. The remaining work is technical and bureaucratic, destined to ease landowners' and designers' actions, aiming to materialise the renewal projects supported by the help desk.



Graph 6: Actor map (2018). Group 1: Academy, Administration and civil society. Group 2: Top levels of administration; Group 3: Market; Group 4: Activists and third sector Source: A. Varea (nacional = national, Urbanism technician = Urbanism technical officer conflict relationship = conflict relationships)

4. Making housing public

In this paper we described how a small actor, in connection with allies linked to academia and a public body, can contribute to differently frame the terms of public discussion resulting in the consolidation and improvement of a set of weak practices. The output of this struggle is a programme, fostered by the academy, that aims to:

- Build a number of affordable housing units, improving deprived areas;
- Produce and share knowledge amongst architects, engineers and other agents;
- Create guarantees in institutions in order to simplify and expedite bureaucratic procedures.

Figure 4: "Ilhas", the housing typology that the programme will be focused on (source: A. Varea)

It is clear that the new programme will consolidate the collective platform described and make the product of action accessible to all in equitable and transparent terms. Furthermore, it will grant more resources and stability, as well as a clear set of rights and obligations, which enables commitment. However, moving from collective to public practices is a choice that brings some challenges.

- Although Habitar defended this approach for all typologies and users, the programme will focus only on deprived areas, since it was only possible to gather enough consensus around this point.
- The level of institutionalisation will be directly proportional to the amount of available resources, and inversely proportional to the level of freedom of action (which is what enabled Habitar to create the described space).
- The programme will simplify the implementation of urban regulations, not the regulations themselves. This might cause problems since there are situations that meet real life demands but not urban regulations.
- The programme will call upon mainly local actors. The involvement of the central government is also expected, which should imply changes in its internal practices; however, this is not guaranteed by the programme.
- This new programme will challenge the way some actors are already working and the role that other institutions have, which may create conflicts with agents that have important corporative weight.
- The goal is to boost social development, and many problems such as employment, mobility, health or education may be related to the programme. However, they will not be solved by the actors called upon in this union.
- The Academy will have the responsibility to suitably frame the programme, so that public discussion around it is useful to build the common good, not breeding individual or corporativist interests.
- It is not expected that the new programme will have enough margins to improvise inside the established rules or correct its negative externalities. Being conscious of this is essential to call upon peripherical actors.

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A methodological framework to assess disaster risks at cultural heritage sites: the case of the Roman Ruins of Tróia

Mohammad Ravankhah [a,*], Maria João Revez [b], Rosmarie de Wit [c], Inês Vaz Pinto [d], Nasos Argyriou [e], Angelos Hliaoutakis [e], Patrícia Brum [d], Maja Žuvela-Aloise [c], Apostolos Sarris [e], Joern Birkmann [a], Ana Patrícia Magalhães [d], Nesara Pradeep [a], Paola Coghi [b], Vanni Resta [f], Silvia Boi [g]

[a] *Institute of Spatial and Regional Planning (IREUS), University of Stuttgart, Germany*
[b] *Nova Conservação, Lda., Portugal*
[c] *Zentralanstalt für Meteorologie und Geodynamik, Austria*
[d] *Troia Resort, Portugal*
[e] *GeoSat ReSeArch Lab, F.O.R.T.H., Greece*
[f] *KPeople Ltd, UK*
[g] *Engineering Ingegneria Informatica S.p.A., Italy*

Abstract

This paper aims to present an integrated methodology of risk assessment for cultural heritage properties facing the adverse effects of natural hazards and climate change-related events. The paper develops a Cultural Heritage Risk Index comprising three components: 'hazard' (leading to sudden- and slow-onset disasters), 'exposure' (the elements of heritage sites and their associated values), and 'vulnerability' (susceptibility and coping and adaptive capacities), to measure the level of risks. The proposed risk assessment methodology is applied to the case of the Roman Ruins of Tróia, in Portugal. Undertaking the assessment procedure in Tróia enables the clear identification and ranking of the natural hazards and climate change threats affecting the site, and subsequently, analysing their associated risks. Accordingly, relative risk maps are generated to allow sharing a common understanding of the risks among the stakeholders. The output of the site risk assessment offers a more reliable guidance on the ascription of risk treatment priorities, thus further supporting decision making on risk mitigation and preparedness strategies.

Keywords: Cultural heritage; Disaster risk assessment; Natural hazards and climate change; Tróia; Vulnerability analysis

1. Introduction

The EU-STORM (Safeguarding Cultural Heritage through Technical and Organisational Resources Management) project aims to provide processes and methodologies on the sustainable and effective safeguarding and management of European Cultural Heritage. Within the context of the STORM project, while considering the existing approaches and methods (e.g. Stovel 1998; FEMA 2005; UNESCO WHC 2010), this paper provides cultural heritage with a methodological framework for risk assessment. The proposed methodology was applied to the Roman Ruins of Tróia in Portugal, which are exposed to diverse natural hazards that may lead to sudden-onset and slow-onset disasters. High-tide/storm combinations will yield higher than usual tides, largely increasing the odds of stone loss and eventual wall collapsing at the shoreline structures. The intensity of heavy rainfall at the site is projected to increase due to climate change. This may increasingly cause the sliding of the large sand dune pressuring against the tallest remaining shoreline wall; dune instability caused by ongoing coastal erosion favours this process. Potential hazards affecting the site and their corresponding risks to the heritage assets are identified and assessed through the proposed risk assessment procedure.

2. The STORM methodology of risk assessment for cultural heritage sites

"Risk assessment is the overall process of risk identification, risk analysis and risk evaluation" (ISO 31000:2009). In respect to applying risk assessment to heritage conservation, Taylor

* Corresponding author. E-mail address: mohammad.ravankhah@ireus.uni-stuttgart.de

(2005, p. 128) emphasises that "risk assessment is an extremely useful concept for preventive conservation and planning because it does not rely on the existence of damage to establish priorities for its prevention". This study applies the risk index method for analysing risks to heritage sites. "Risk Index is a semi-quantitative measure of risk which is an estimate derived using a scoring approach using ordinal scales" (IEC/ISO 31010, 2009). Risk indices provide a systematic assessment method for analysing the elements of risk, widely applicable to natural and human-induced hazards and climate change-related extreme weather events. The STORM Cultural Heritage Risk Index comprises the following components to measure the level of risks (Figure 1):

- Hazard: hazards leading to sudden-onset and slow-onset disasters;
- Exposure: mainly focusing on the value of heritage assets within the site; and
- Vulnerability: the susceptibility of elements of the site according to their structural and material characteristics, as well as, the adaptive and coping capacity of the management system.

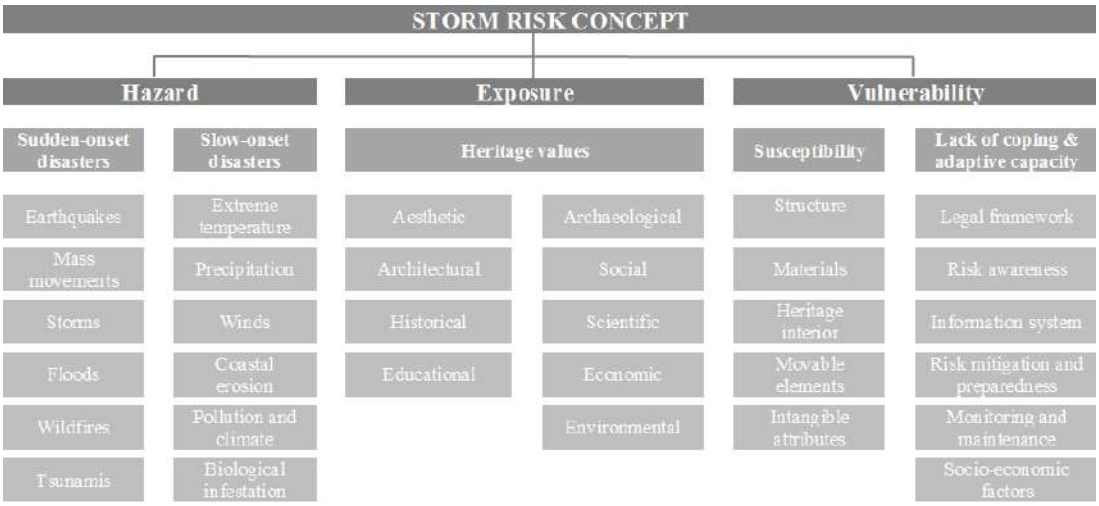


Figure 1: STORM risk concept: risk components and related indicators

The components of risk and their corresponding indicators will be described in detail in Section 4-Applying the STORM risk assessment to the case of the Roman Ruins of Tróia.

3. The case of the Roman Ruins of Tróia

The Roman Ruins of Tróia are located on the estuarine shore of a peninsula between the Sado River estuary and the Atlantic Ocean, with archaeological structures stretching along 2km. The site is heavily affected by the marine and estuarine environments. River discharge fluctuates strongly, therefore the ocean influences the estuary strongly, with most of the basin behaving as a coastal lagoon with reduced freshwater influence. Locally generated waves, semi-diurnal tides with large amplitudes and strong tidal currents along the site are responsible for coastal erosion (Andrade et al. 2006; Silveira et al. 2014). Tróia has very dry summers and more humid winters with on average 24 heavy precipitation days per year.

In Roman times, the settlement specialised in the production of salted fish and fish sauces and was the largest of its kind in the Roman Empire. It was active from the 1st c. AD to the 5th c. but its occupation continued at least until the 6th century (Pinto, Magalhães and Brum 2014). The remains of 27 fish-salting workshops are visible, some quite well preserved (RRT-1a) and others on the shoreline and affected by tide currents (RRT-1b) (Figure 2). There are also a bath complex (RRT-2), a residential area (RRT-3), a Mausoleum cemetery (RRT-4), a Mensa tomb cemetery (RRT-5), a Mausoleum (RRT-6), an Early Christian basilica with surrounding buildings (RRT-7) and a concentration of structures on the shoreline known as Roman harbour (RRT-8) located on-site. The site was designated a National Monument in 1910, with *non aedificandi* area and buffer zone, and was inscribed in the Portuguese World Heritage Tentative List in 2016.

Figure 2: Roman Ruins of Tróia: main archaeological area (on the left, © Tróia Resort) and remains of a fish salting vat on the shoreline (on the right, © Maria João Revez)

Applying the STORM risk assessment to the case of the Roman Ruins of Tróia

3.1.Hazard assessment

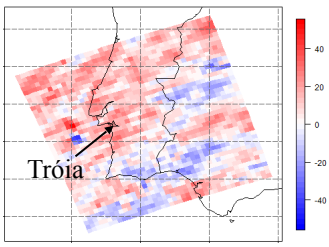
To adequately address the short and long-term effects of natural hazards and threats on heritage sites, they are categorised according to their associated sudden-onset (e.g. earthquakes, storms, and flooding) and slow-onset (e.g. wetting-drying cycles, wind-driven rain, and heat waves) disasters. Hazards and threats affecting the pilot site were identified via an interview questionnaire and a hazard profile to explore the historic frequency and severity of the hazards. Afterwards, the identified hazards are incorporated into a detailed climate analysis and hazard modelling as follows:

Climate analysis and projections

In order to quantify the STORM climate change hazards, standardized climate change indices based on definitions by the Expert Team on Climate Change Detection and Indices (e.g. Karl et al., 1999) were assigned to these hazards, and determined based on observations and (future) climate projections. For example, the climate indices 'maximum one-day precipitation amount' and 'number of heavy precipitation days' are used to study (changes in) the intense rainfall hazard, among others. By comparing the historical and future values, it is then possible to determine the climate change signal of the hazards under consideration.

To determine the current climatic state, observations as well as climate model runs forced with historical greenhouse gas conditions averaged over the climate normal period 1971-2000 are used as a baseline. An ensemble of climate projections based on the RCP8.5 forcing scenario, representative of a future with no specific climate change mitigation targets (Riahi et al., 2011), averaged for the 2036-2065 period are used to determine the future state of the climate. To obtain results optimized for the pilot site area, statistically downscaled global climate model simulations (provided by the Coupled Model Intercomparison Project; Taylor et al., 2012) well as regional climate model results (obtained from the EURO-CORDEX initiative; Jacob et al., 2013) are used.

A detailed climate analysis considering the past and future state illustrated using climatologies, time series, frequency distributions and maps is performed. An example is shown in Figure 3 (left panel), indicating the change in maximum 1-day precipitation amount (maximum value for the period 2036-2065 minus that for period 1971-2000). In order to summarize the results in an efficient manner for further use in the risk assessment, the climate signals for the STORM hazards are compiled in a table, and colour-coded using a semi-quantitative approach to enable a quick overview of the results (Figure 3, right panel).



Index		Baseline	Change (SD)	Change (RCM)
Intense rainfall				
	Observations	24.0 days/yr		

Figure 3: The change in maximum 1-day precipitation amount (in mm) for the period 2036-2065 relative to 1971-2000 (on the left), and the table used to summarize the results (on the right). SD = results obtained from the statistical downscaling, RCM = results obtained from the regional climate model ensemble.

Hazard modelling and mapping

Hazard modelling and mapping were based on the availability of spatial data related to the hazards of interest. In this context, it was essential to specify the factors associated with the respectively identified hazard via appropriate spatial analysis tools. The combination of hazard-related factors was implemented through GIS spatial analysis. For instance, factors associated with earthquake events such as the earthquake epicentres, proximity to active faults and geological formations were combined to produce an earthquake hazard map. Another hazard consideration for Tróia pilot site was the tsunami hazard. Its corresponding hazard map was developed considering as an input dataset a 30m resolution digital-elevation-model (DEM), while the modelling process was conducted via spatial analysis algorithms for a corresponding sea-wave height of 3-4m infiltrating into the mainland for a specific distance from the coastline (70-80m) (Figure 4).

The occurrence of landslides can be a result of human interventions to the landscape and/or be due to the geomorphological and climatological factors (Agapiou et al., 2015). In order to calculate the landslide hazard map, various factors were considered such as hydrolithology, geomorphometry (e.g. slope gradient) and climatic attributes (e.g. rainfall). The sea-level rise hazard map was developed by using the same DEM with the modelling process considering a 50cm sea-level rise. Salinization can produce a significant damage to cultural heritage monuments located close to the coastline due to salt-decay (Robinson et al., 2010). Thus, a salinisation hazard map was also produced acknowledging the distance to the coastline with respect to the elevation and aspect as related to the dominant recorded wind direction. The coastal area of Tróia located at the lower elevations and facing the north-west (as exposed to the dominant north-westerly wind direction), is particularly exposed to salt-decay (Figure 4).

A multi-indicator analysis was applied to analyse the potential hazards affecting the site. The analysis was carried out based on four ranking criteria of likelihood, severity, relevance of hazards for site managers, and expected intensity of impact. The significance of hazards may fall into one of the levels of Very low (1), Low (2), Medium (3), High (4), and Very high (5). Table 1 shows the result of the hazard assessment to determine which hazards or threats need to be integrated into the further risk assessment procedure.

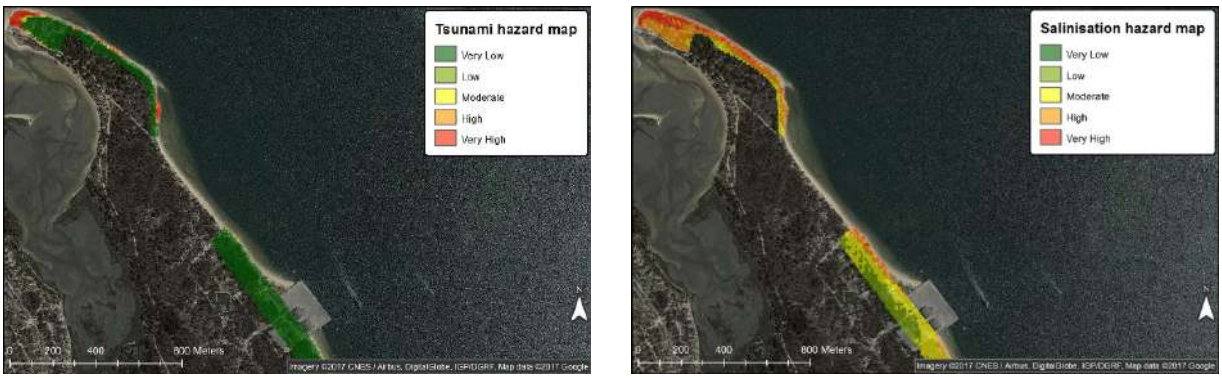


Figure 4: Tsunami hazard map for Tróia representing the susceptibility of the area to Tsunami (on the left) and Salinisation hazard map for Tróia indicating salt-decay susceptibility of the area (on the right).

Table 1: The output of hazard assessment to identify the hazards of interest

Level of significance	Hazards/threats	Further step
Very high and high	earthquakes, coast erosion, tides, tsunami, wind-generated waves, rain, biological colonization, landslides, rainstorms/ thunderstorms, strong winds, humidity changes	Hazards/threats are considerably subject to the further risk assessment.
Medium	strong winds, intense rainfall, sea-level rise, saline spray and salinisation, solar radiation, coastal floods	Hazards/threats are subject to the further risk assessment.
Low and very low	wind, wind-driven particles, wind-driven rain, heat-waves	Hazards/threats do not need further risk assessment, and should be managed by the existing heritage management system.

3.2.Exposure assessment

The term 'exposure' is widely agreed to correspond to elements-at-risk, i.e. elements such as people, resources, systems and/or other valued assets whose location subjects them to potential adverse impacts from hazards (UNISDR, 2009). Within STORM, heritage assets, their tangible and intangible attributes, are the elements-at-risk; accordingly, their exposure assessment is structured as follows:

- description of heritage elements, including immovable and movable assets, within the site and its setting;
- characterisation of the values of all heritage elements, based on a value category system adapted from Worthing and Bond (2008) and the Burra Charter (Australia ICOMOS, 2013);
- assignment of value levels (Very low (1) to Very high (5)), ranking the relative importance of the site elements, based on Kerr (cited in Worthing and Bond, 2008).

For Tróia, the results of this assessment are summarised in Table 2. Applying the mean aggregation, the overall value level, which represents the exposure score, may fall into one of the equal-sized classes of 1-1.8, 1.8-2.6, 2.6-3.4, 3.4- 4.2, and 4.2-5 that are qualitatively interpreted from Very low (1) to Very high (5) exposure.

Table 2: Summary assessment of the value of the elements-at-risk in Tróia

Area	Chief significant elements	Exceptional/considerable values	Overall value
RRT-1	Unique set of fish-salting workshops	historic, archaeological, scientific educational, aesthetic, architectural, social, environmental	5 (Very high)
RRT-2	Bath complex with complete plan	aesthetic, archaeological, scientific, educational, environmental	4 (High)
RRT-3	Good example of late Roman palatine house	aesthetic, architectural, historic, archaeological, educational, scientific, environmental	4 (High)
RRT-4	Partially unexcavated late Roman cemetery	archaeological, educational, scientific, environmental	3 (Medium)
RRT-5	Unique Portuguese example of semi-circular mensa tombs	architectural, historic, archaeological, scientific, environmental	4 (High)
RRT-6	Typical Roman funerary monument	scientific, architectural, educational, environmental	4 (High)
RRT-7	Early Christian Basilica with well-preserved frescoes	aesthetic, architectural, historic, archaeological, educational, scientific, environmental	4 (High)
RRT-8	Concentration of Roman structures on the shoreline	archaeological, environmental	3 (Medium)

3.3.Susceptibility analysis

The STORM project adapts the concept of vulnerability from the WorldRiskIndex (Birkmann and Welle 2015), comprising the major components of susceptibility, coping capacity, and adaptive capacity. The vulnerability of the areas of the site was assessed through a structured questionnaire. The respondent group involves site managers, expert partners familiar with the sites, and local and national organisations responsible

for the protection of the sites. In the context of cultural heritage, susceptibility or sensitivity represent the extent to which a heritage asset might be adversely impacted by a hazard or threat. The criteria determined to analyse the susceptibility encompass structural parameters (e.g. quality of construction and structural damage), material parameters (e.g. cracks and discolouration of stones), immovable heritage interiors (e.g. decorative elements), movable elements (e.g. collections and archives), and intangible elements (e.g. social practices and festive events).

The susceptibility of the site areas was assessed by ranking the above criteria. For instance, for analysis of the current damage three levels of Low (rare or no signs exist), Medium (some signs present), and High (many signs present across large areas) were assigned to the elements. The susceptibility levels obtained from the vulnerability questionnaires have values ranging from 1 to 3. The overall susceptibility scores were reclassified to fall into one of five equal-sized classes that are qualitatively interpreted as Very low (1), Low (2), Medium (3), High (4), and Very high (5).

3.4.Coping and adaptive capacity analysis

The level of capacity to mitigate, respond to and recover from disasters contributes to the level of risk. In the STORM project, coping and adaptive capacity describe the institutional capacity of existing heritage conservation and risk management systems to manage the risks of natural hazards and threats to cultural heritage through structural and non-structural measures. The indicators to measure the level of coping and adaptive capacity of the site comprise legal framework (e.g. legislation related to cultural heritage conservation or civil protection), risk awareness among the site staff regarding impacts of disasters on cultural heritage, information and communication system (e.g. heritage information), risk mitigation activities, risk preparedness activities (e.g disaster drills and field exercises), monitoring and maintenance plans (e.g. monitoring of environmental parameters), and socio-economic factors regarding risk management (e.g. financial resource for risk management).

The coping and adaptive capacity obtained from the vulnerability questionnaires have values ranging from 1 to 3. Similar to the susceptibility, to keep the consistency of the number of classes in the risk index, the overall capacity scores were reclassified into five equal-sized classes that are qualitatively interpreted as Very low (1), Low (2), Medium (3), High (4), and Very high (5).

3.5.Risk analysis and evaluation

Following the analysis of the risk components, they will be incorporated into the risk index to rate the level of the risks. The scores of the components will be multiplied to rank different risks. For each hazard, a risk statement needs to be defined that represents the potential impacts of the hazard on the site. While considering the overall risk statement, the risk score for each area will be separately calculated. **Erro! A origem da referência não foi encontrada.** shows the risk index of earthquake hazard for the eight cases of Tróia and the earthquake risk map which has been generated by aggregating the risk elements.

Risk Index							
Areas	Risk No.	Overall Risk statement	Hazard	Exposure	Vulnerability		Risk score
					Susceptibility	Lack of Coping & Adaptive Capacity	
Sudden-onset disasters							
Hazard 1: Earthquakes							
RRT-1a	R1.1a	*Potential structural cracks or total collapse of building components and archaeological elements at the Tróia site caused by an earthquake*	Medium (3)	Very High (5)	Medium (3)	High (4)	High (4)
RRT-1b	R1.1b		Medium (3)	Very High (5)	Very High (5)	High (4)	High (4)
RRT-2	R1.2		Medium (3)	High (4)	Low (2)	High (4)	Medium (3)
RRT-3	R1.3		Medium (3)	High (4)	Medium (3)	High (4)	High (4)
RRT-4	R1.4		Medium (3)	Medium (3)	Very Low (1)	High (4)	Low (2)
RRT-5	R1.5		Medium (3)	High (4)	Medium (3)	High (4)	High (4)
RRT-6	R1.6		Medium (3)	High (4)	Low (2)	High (4)	Medium (3)
RRT-7	R1.7		Medium (3)	High (4)	High (4)	High (4)	High (4)
RRT-8	R1.8		Medium (3)	Medium (3)	High (4)	Very High (5)	High (4)

Figure 5: Developing an earthquake risk index for Tróia

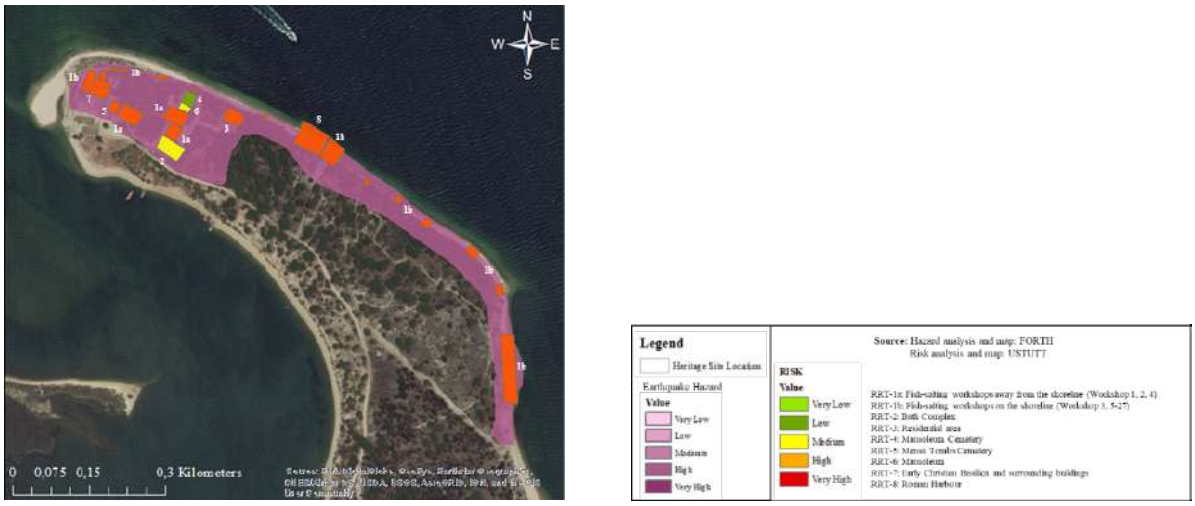


Figure 6: Developing an earthquake risk map for Tróia

The ALARP principle (as low as reasonably practicable) was applied to evaluate the risks and to determine which risks need further risk treatment strategies. According to AEMC (2010), the identified risks may fall into one of the three zones in Table 3:

Table 3: Earthquake risk evaluation for the Roman Ruins of Tróia

Risk level	Areas needing risk treatment	Further step
SUDDEN-ONSET DISASTERS		
Hazard 1: Earthquakes		
Very high (Intolerable region)	RRT-1a, RRT-1b, RRT-3, RRT-5, RRT-7, RRT-8	Risks must be treated to derive them at least to the tolerable region
High (Intolerable region)		
Medium (Tolerable region)	RRT-2, RRT-6	Risks should be treated to drive them to the acceptable region
Low (Acceptable region)		Risks do not need additional risk treatment options, and should be managed by existing management system
Very low (Acceptable region)		

4. Conclusion

This paper proposed an indicator-based risk assessment methodology by adapting the risk management methods and principles to the area of heritage conservation. In comparison to risk management on the urban and regional level, in terms of some hazards, there might not be any alteration of hazard probability or severity in the different parts of the site. However, the level of exposure and more importantly vulnerability significantly influence the output of the risk assessment.

The risk assessment will further assist the decision-making process with necessary information to understand which risks need treatment strategies and on which level. Moreover, the above procedure of risk assessment for the Roman Ruins of Tróia gives a clear perception of the risk elements to develop a site-specific risk reduction plan through avoiding or reducing the identified hazards, reducing the structural susceptibility, promoting the coping and adaptive capacity, and increasing the effectiveness of emergency response using the GIS hazard and risk maps.

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Post-disaster recovery of cultural heritage at global level: evolution, challenges, and lessons learned from World Bank projects

Barbara Minguez Garcia [a,*]

[a] World Bank, USA

Abstract

Since its establishment in 1944 to help rebuild war-torn Europe—supporting countries in their reconstruction and development—the World Bank has gained experience in good practices that address cultural heritage in the face of disasters and conflicts. At the same time, the World Bank has become, over the past decade, a global leader in disaster risk management, providing client countries with technical and financial support for risk assessments, risk reduction, preparedness, financial protection, and resilient recovery. Several projects and programs illustrate its evolution in supporting post-disaster recovery of physical cultural heritage. Since the restoration of the iconic Mostar Bridge in Bosnia and Herzegovina, in partnership with UNESCO and other international organizations, to the comprehensive technical assistance project on Resilient Cultural Heritage currently being developed in the framework of the Japan-World Bank Program for Mainstreaming DRM in Developing Countries, the World Bank has developed substantial knowledge and expertise in resilient recovery engagements helping countries assess the impact of disasters and supporting recovery planning including in fragile and conflict situations, and it is progressively including cultural heritage as a crucial sector. This paper analyses the evolution, challenges, lessons learned, and new opportunities to mainstream post-disaster resilient recovery of heritage at global level.

Keywords: Cultural Heritage; Disaster Risk Management; Resilient Recovery; Sustainable Development.

1.Introduction: evolution of the World Bank approach to cultural heritage

The World Bank was conceived in 1944 at the Bretton Woods Conference in New Hampshire, U.S., as the International Bank for Reconstruction and Development, with the initial aim of helping rebuild European countries devastated by World War II. In the following decades, the focus widened to include funding large infrastructural projects in member countries from Africa, Asia, and Latin America. In the 1980s, the World Bank continued to enlarge its focus and addressed issues in social development, environmental protection, and, more broadly, human development. Issues of social life, including education, communications, cultural heritage, and good governance came to the fore. Today the World Bank works toward two ambitious goals: end extreme poverty, by reducing the percentage of people living on less than US$1.25 a day to 3 percent by 2030; and boost shared prosperity, by improving the living standards of the bottom 40 percent of the population in every country.

From early on, cultural heritage has been an object of the World Bank's assistance to its clients in the developing world. The underlying principle has been to promote conservation and reuse of heritage assets to strengthen local economies. Initial efforts focused on a safeguard-oriented, do-no-harm approach were progressively enriched to develop a specific-intervention approach during the 1990s, investing in individual cultural heritage assets to develop sustainable tourism.

1.1 Safeguarding cultural heritage

In terms of safeguards the World Bank has been among the first international financial institutions to adopt formal policies on cultural heritage issues, since 1986. The safeguard approach was recently reviewed, and the Environmental and Social Framework was approved in August 2016 (World Bank, 2016). Under the framework's Standard 8 on Cultural Heritage, all projects are required to use chance finds procedures and other approaches to protect cultural heritage and consult with affected communities. For the first time at the World Bank, the definition and treatment of cultural heritage has been broadened to include both tangible and intangible heritage. The primary responsibility for safeguards implementation belongs to the client country, with the World Bank playing an implementation support role. The standards also call for a proactive approach, which is particularly important to targeted heritage efforts that face disaster risks.

* Corresponding author. E-mail address: bminguezgarcia@worldbank.org

1.2 Integrating culture into sustainable development

Since 2000, the World Bank has been developing an approach focused on integrating culture and heritage into inclusion, sustainability, and resilience strategies. This approach goes beyond tourism, considering tangible and intangible cultural assets comprehensively, with a specific focus on historic city regeneration and the goal of unlocking its potential for job creation in a holistic, sustainable manner. This approach also includes an increasing awareness of the need to be prepared for disasters, especially in the context of climate change and massive urban development. In fact, since the beginning of the 21st century, concepts such as disaster risk management, post-disaster reconstruction, ex ante preparedness measures, and increasing resilience in countries have become progressively more relevant in the World Bank portfolio.

In the framework of the World Bank's twin goals to end extreme poverty and boost shared prosperity, protection and conservation of cultural heritage can be seen as an asset-based approach to local economic development and social cohesion. It has the potential to improve connectivity and support job creation and economic growth at the local community level. With this purpose, the World Bank has cooperated closely with governments and financed several initiatives, some of which are presented in this paper.

1.3 Connecting cultural heritage with disaster risk management

In the area of disaster risk management, the World Bank has significant resources and a professional network. For instance, the Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change; works with over 400 local, national, regional, and international partners; and provides grant financing, technical assistance, training, and knowledge-sharing activities. World Bank tools and analytical work provide numerous examples, while a robust portfolio has helped shape an undoubtedly relevant role for the institution in the global arena. This includes a progressive inclusion of cultural heritage components into post-disaster reconstruction and recovery operations, as well as projects and initiatives to reduce disaster risk.

2.Post-disaster recovery of cultural heritage: experience and challenges

The World Bank has implemented a successful model focusing on the effective conservation and management of heritage sites and historic downtowns, and the improvement of living conditions in nearby communities, as an effective mix to improve the enabling environment for local businesses to grow.

2.1.Some examples of post-disaster operations focused on cultural heritage:

Post-earthquake reconstruction in Lijiang, China. In 1996, a M7.0 earthquake caused significant damage to the city's historic buildings, bridges, paving, infrastructure, and vernacular housing. The World Bank worked with the Lijiang County Construction Bureau, emphasizing more earthquake-resilient materials and techniques in rebuilding and repair. In addition, the Earthquake Reconstruction Program identified a need to take into account the population's rising expectations, improve housing and upgrading infrastructure while preserving the World Heritage quality of the city's historic buildings, including the restoration of the Mu Fu complex, built in 1382 (Read & Ebbe, 2001).

Post-conflict reconstruction in Bosnia and Herzegovina. The restoration of the iconic Mostar Bridge, a tangible symbol of tolerance before the war destroyed it in 1993, was the result of an important partnership among international organizations, bilateral donors, and local community, with the prominent role of UNESCO. In 1999, the World Bank approved a project that included not only the restoration of the old bridge with the Tara and Halebija towers but also the restoration of selected monuments in the historic district of the city, together with the conservation of the old town historic character through a series of neighborhood initiatives (Hannah, 2001, p. 387).

Historic cities rehabilitation in Lebanon. The World Bank with funds from bilateral donors, financed a large cultural heritage and urban development project between 2003-2016, focusing on five historic cities: Tyre, Byblos, Baalbek, Saida, and Tripoli. The project was designed and implemented in collaboration with UNESCO and financed large works in the historic cities. The project helped improve conservation and management of cultural assets and establish cultural heritage as a driving force for social inclusion and economic development. This is a good example of how a post-conflict reconstruction can evolve to support sustainable growth (World Bank, 2016).

Multi-hazard vulnerability assessment in the Philippines. In 2013 the Philippines experienced two major events: the M7.2 Bohol earthquake, and the category 5 typhoon Haiyan, which affected 3.2 and 12.2 million people respectively. Both disasters destroyed or severely damaged many centuries-old heritage structures, including historic buildings, churches and valuable monuments. The Department of Tourism requested a technical assistance, funded by GFDRR, to improve the resilience of 16 selected cultural heritage structures to multiple natural hazards such as earthquakes, typhoons and floods. The multi-hazard vulnerability assessment, developed in three pilot locations across the country (Intramuros in Manila, Cebu and Bohol Provinces), led to specific recommendations on risk reduction interventions for each structure, with conceptual designs and cost estimates for structural strengthening and restoration.

Post-earthquake assessment in the archaeological site of Bagan, Myanmar. The historic structures of Bagan suffered considerable damages after a M6.8 earthquake in 2016. The World Bank together with UNESCO and other partners, supported a rapid assessment of the impacted structures, as well as a more detailed assessment for select monuments. These assessments evidenced the poor-quality conservation and reconstruction of some monuments affected by a previous earthquake in 1975. Some structures which were added during previous reconstructions, created in fact additional vulnerability, which caused major damages during the 2016 earthquake.

Damage and needs assessment in Iraq. Recently, the Government of Iraq requested World Bank support to estimate the effects and impacts of the current crisis on key infrastructure, livelihoods, social, and productive sectors, to identify recovery and reconstruction needs. This assessment aimed to help inform recovery efforts toward creating enabling conditions for the return of the displaced population to their place of origin and restoring livelihoods and service delivery (World Bank, 2018a). In this regard, it was crucial to include cultural heritage as one of the social sectors: the deliberate destruction of cultural heritage is considered a war crime, as it is used as a war strategy to erase cultural identity. Indeed, the crisis in Iraq has created an emergency situation at global level, due to the universal value of ancient Iraqi heritage, known as the Cradle of Civilization.

However, an important challenge still remains the systemization of processes to collect information and document post-disaster actions. The World Bank is currently exploring opportunities and mechanisms to support the development of systematized inventories of cultural heritage in post-disaster situations, including data on heritage status, as well as information about post-disaster interventions.

2.2.Challenges and opportunities to mainstream cultural heritage in post-disaster scenarios

The World Bank has developed substantial knowledge and expertise in resilient recovery engagements helping countries assess the impact of disasters and supporting recovery planning including in fragile and conflict situations, and it is progressively including cultural heritage as a crucial sector. However, there is still opportunity to further mainstream cultural heritage in the disaster risk management agenda of developing countries.

Since 2017, a technical assistance project on Resilient Cultural Heritage and Sustainable Tourism is being developed in the framework of the Japan-World Bank Program for Mainstreaming Disaster Risk Management in Developing Countries. Inspired by the Great East Japan Earthquake and Tsunami in 2011, the Japanese Ministry of Finance and the World Bank established the Program in 2014, to support technical assistance, pilot projects, thematic initiatives, knowledge mobilization, and capacity building, following the Sendai Framework. The Program is administrated by GFDRR through its office in Tokyo, which taking advantage of the Japanese expertise in risk management of cultural heritage, is developing the mentioned technical assistance project on resilient cultural heritage.

The main challenge faced is that in most countries, the disciplines of disaster risk management and cultural heritage are not connected. Therefore, it becomes fundamental to connect professionals from different fields and agencies to collaborate in the protection of cultural sites.

In order to do so, a learning event was developed in Tokyo and Kyoto in April 2017. It brought together nine teams from World Bank client countries (Albania, Bhutan, China, Myanmar, Nepal, the Philippines, Saudi Arabia, Tanzania, and Uzbekistan) to share their own experiences and learn from the Japanese expertise in post-disaster resilient recovery and management of cultural heritage. This initiative focused on finding solutions to key concerns identified by the participant countries, aiming to inform countries' investments by bringing together experts and practitioners from both disaster risk management and cultural heritage agencies.

Although the countries and their World Bank projects were very different, the event participants identified common challenges and approaches required. Excluding the lack of funding to invest in heritage, which is probably one of the first concerns for each team, the main challenges included:

- Limited technical expertise, especially regarding restoration of heritage and maintenance.
- Lack of researches and data collection about natural hazards in cultural heritage sites.
- Lack of regulatory framework and governance, including guidelines on protecting heritage from disaster risks.
- Difficulty in engaging communities, creating awareness, and ensuring collaboration between stakeholders from different sectors.

This experience raised awareness among the participants, and some of them requested additional support to develop further training and workshops in their respective countries.

International cooperation and support has therefore become fundamental. The renewed and strengthened partnership between the World Bank and UNESCO (World Bank, 2017) includes the development of a joint position paper on the integration of culture into the recovery and reconstruction processes. This not only shows the increasing awareness and commitment to support resilient recovery of cultural heritage at global level, but it will also provide new opportunities for institutional collaborations to support developing countries at national and local levels, in post-crisis recovery processes mainstreaming culture as an engine for inclusion, livability and resilience.

3.Lessons learned from the disaster risk management of cultural heritage practice

The management and safeguarding of cultural heritage requires coordinated efforts from multiple levels of government and private stakeholders, particularly as prioritized sites and assets are at risk from natural hazards, including the growing threats posed by climate change. Key practices and concepts from disaster risk management have proven useful in addressing these challenges.

The aforementioned program on resilient cultural heritage proves a model for helping countries to integrate disaster risk management and cultural heritage. It gives countries a structure to diagnose their unique and shared challenges, engage experience and expertise from Japan and beyond, and connect to development financing support and international frameworks.

The main challenge and at the same time lesson learned from Japan, applicable to both countries and international organizations, is the need to connect both disciplines. Disaster risk management measures need to be integrated into sites management plans, and cultural heritage components included into disaster risk management projects. In particular, there is a need to act and invest at the:

- Institutional level: strengthening the institutional organization at national and local levels, and promoting interaction between departments, as well as collaboration with universities, private owners, among others. International organizations such as the World Bank can help in this regard by providing references and supporting initiatives to increase the capacity of governments and develop measures to connect disaster risk management with their respective cultural heritage assets and sustainable tourism development.
- Technical level: many countries identify lack of technical skills as one of their main challenges. The international network of institutions and specialists can help providing/connecting countries with specific expertise and solutions fitting their needs. Capacity building programs could be the solution in many cases. For instance, there can be a focus on increasing the number of heritage conservation professionals or training emergency response teams on how to act in and around cultural sites.
- Social level: examples of active engagement of local communities such as several from Japan, show how local communities planned and executed disaster risk management plans to protect heritage and build resilience, as well as how they shared traditional knowledge that in many cases provides economical and appropriate solutions in the face of hazards. Drills, training and workshops have proven strong initiatives to engage local groups, and Japan has developed innovative practices such as the Disaster Imagination Game, which is easily replicable in other contexts.

The key idea from this experience is to combine technical knowledge (locally and internationally), targeted development financial support, and improved policy and investment frameworks, to better integrate disaster risk management and cultural heritage.

For instance, Bhutan was one of the countries requesting additional support after the learning event in Japan, to develop draft guidelines to integrate disaster risk management for the protection of cultural heritage across the country. The Department of Culture organized a workshop, with the support of the World Bank, inviting participants from different Bhutanese agencies, including the Department of Disaster Management, as well as police and army divisions related to disaster risk, among others. They worked together with international experts to set the key principles and practices to develop the future guidelines, and strengthen the cooperation between agencies at the same time.

4.Conclusion and next steps: culture as the cornerstone of post-disaster recovery

Recovery, after disaster or conflict, needs to be resilient, based on culture, and involve the community in the process. Culture is the foundation on which cities are built (Wahba, 2018), and today more than ever, both natural hazards—incremented due to climate change—and man-made threatens—including conflicts and rapid urbanization—pose important challenges to cities and cultural heritage, especially in developing countries. The World Bank's examples demonstrate the experience gained by the institution and the capacity to effectively link disaster risk management to cultural heritage with results. However, there is still potential to expand further, especially based on an additional area that represents a definite comparative advantage of the World Bank: project financing.

As the joint UNESCO-World Bank position paper mentioned before states, there is a need for a new framework with culture as a driver and enabler of post-conflict/disaster city reconstruction and recovery. Based on existing approaches, especially the build back better approach (Hallegatte et al., 2018), the new framework could guide policy-makers, planners, and practitioners engaged in addressing the planning, financing and implementation phases of post-crisis reconstruction, ensuring the inclusion of culture.

At the same time, it would be crucial to ensure the gathering of information and documentation of the processes (damaged cultural heritage assets, reconstruction works, and other post-disaster actions), both for the country and for the international community. Likewise, this should lead to emphasize the creation of national inventories for cultural heritage, fundamental to keep knowledge of the disasters impacts.

International institutions, national and local authorities, and practitioners from both cultural heritage and disaster risk management disciplines, have the opportunity to work together with local communities to mainstream culture and cultural heritage into post-disaster resilient recovery.

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Human-made risks and preventive strategies for architectural heritage under threat from urbanization

Xuan Jin [a, b,*]

[a] Ion Mincu University of Architecture and Urbanism (UAUIM), Romania
[b] Shandong University of Arts, China

Abstract

Architectural heritage sites are irreplaceable. However, natural and anthropogenic hazards threaten their safety. Especially due to urbanization, the level of human impact on these structures is increasing. Historic architecture faces various man-made risks, which increases their vulnerability. Obviously, any post-disaster recovery is not as effective as active prevention measures. Therefore, implementing proactive measures to prevent damage through accident or disaster is fundamentally important. This paper focuses on man-made risks caused by inadequate urban planning and the misuse of architectural heritage sites. The purpose is to identify the human factors that contributed to these risks of damage and discuss preventive strategies to protect these irreplaceable cultural treasures.

Keywords: Architectural Heritage; Man-made Risks; Urbanization; Preventive Strategy.

1. Introduction

Historic architectures have not only witnessed human technological, cultural and aesthetic evolution, but also remain valuable resources for strengthening a communities identity and promoting the social and economic development. Therefore, it is the responsibility of our present generation to protect these valuable heritage sites for future generations. However, various hazards and disaster risks threaten the safety of these buildings. Natural disasters like earthquakes, floods, storms endanger the structures, and the long-term physical and chemical erosion undermine the building materials. Inconceivably, there are greater risks associated with human factors than natural disasters. The excessive activities of human beings aggravate the destructive power of natural hazards. Human factors like construction of roads and railways, deforestation, mining and other economic activities can cause landslides, debris flow, mountain collapse and other disasters. The large reservoirs can often induce earthquakes, which more than 100 cases globally having been reported (Gupta, 2002). In 2008, the 7.9 magnitude Sichuan earthquake killed an estimated 80,000 people was triggered by a four-year-old reservoir – Zipingpu Dam (Sharon, 2009).

Ongoing urbanization led to greater vulnerability of historic buildings due to the impropriate planning, deliberate demolition, incongruous new construction and excessive traffic, etc., and misuse, impropriate reconstruction and management have undermined the authenticity of heritage sites as well.

Obviously, any post-disaster recovery is not as good as removing risks earlier. due to increasing human impact on the architectual heritge, the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks (UN, 2015). In the process of risk reduction, monitoring heritage sites, identifying and evaluating possible risks, taking reduction measures in advance are fundamentally important. Using literature research, case studies and systematic reasoning, this paper focuses on the man-made disaster risks occuring from intrusive urbanization and improper heritage usage, analysing the human factors which caused these risks, discussing the potential consequences to the architectural heritage sites, and exploring effective preventive conservation strategies to reduce risks and prevent further damage.

2. Architectural heritage protection

Architectures in different eras and areas have obvious distinguishing characteristics of aesthetics, technology, culture, which represent the time and local identity. Therefore, historic architecture is recognized as an important heritage due to its unique attributes, values and significance.

* Corresponding author. E-mail address: qhmyjx@163.com

2.1. What is architectural heritage

Architectural heritage as a legacy from our ancestors, is no doubt one of the important issue mentioned in international heritage policy. *The Athens Charter* of 1931 for the first time regulated the general principle, administrative and legislative measure of historic monuments. *The Venice Charter* of 1964 extended the content of architectural heritage from individual monuments to historic settings, which respect their integrity attribute. *Council of Europe Charter of the Architectural Heritage* of 1975 emphasized the value of the lesser buildings group, believed architectural heritage includes 'all areas of towns or villages of historic or cultural interest'. *Nairobi Recommendation* of 1976 developed architectural heritage to be the spatially and culturally connected built and natural framework which 'should be considered in their totality as a coherent whole'. *The Washington Charter* of 1987 indicated the content of architectural heritage: urban patterns; relationships between buildings and open spaces; formal appearance, interior and exterior of buildings; relationship between the town or urban area and its surrounding setting.

Therefore, Architectural heritage is not only the outstanding buildings, but also the whole area which includes less important building groups and sites. From a building to its related environment, from a singly structure to groups, from historic sites to whole city, the process of definition development reflects the changing concept of architectural heritage conservation which involves the attributes of authenticity, integrity and continuity.

2.2. Why to protect the architectural heritage

With the development of the public awareness, the values of architectural heritage expanded. In 1877, William Morris in the *'Manifesto' SPAB* (Vaccaro, et al., 1996) pointed out that architectural heritage is 'anything which can be looked on as artistic, picturesque, historical, antique'. *The Venice Charter* of 1964 proposed to preserve those more modest structures and believed that these buildings may have no particular artistic value, but have nevertheless acquired cultural significance. In *Convention Concerning of the Word Cultural and Natural Heritage* of 1972, architectural heritage has 'Outstanding Universal Value from the point of view of history, art or science'. *The Washington Charter* of 1987 declared that conservation plans should address the values of archaeology, history, architecture, techniques, sociology, and economics. *The Valletta Principles* of 2011 proposed the social values which connected with the social fabric, spirit of place, tangible and intangible elements that give an area specific identity, meaning, emotion.

Utilizing these valuable resources in our present society will significantly benefit us in various aspects, such as strengthening local identity, revitalizing local economices, creating job opportunities, and stimulating a sence of pride of residents, etc. Meanwhile, it should be noted that architectural heritage holds values not only for individual nations, but for all mankind; not only for our present generation, but future generations as well. However, as a non-renewable resource, architectural heritage sites are facing various risks, especially from the man-made risks caused by urbanization.

3. Human-made disaster risks of architectural heritage in urbanizaiton context

The Hyogo Framework for Action (2005) defined hazard as 'A potentially damaging physical event, phenomenon or human activity.' And disaster risk is a consequence of hazard, which lead to property damage, buildings vulnerability, cultural and economic disruption, environmental degradation and even the loss of life or injury. Obviously, due to the geological, hydrometeorological and biological events, natural hazards such as earthquakes, hurricanes, flash floods, landslides and wild fires can adversely impact the safety of heritage sites. However, excessive and inappropriate human activities due to urbanization degrade these historic structures in the long-term.

Our world is undergoing urbanization at an unprecedented rate. In 1950, 30% of the world's population was urban, and by 2050, 68% of the world's population is projected to be urban. Today, the most urbanized regions include Northern America (82% population living in urba in 2018), Latin America and the Caribbean (81%), Europe (74%) and Oceania (68%). The level of urbanization in Asia is now approximating 50% (UN, 2018), and in China, the rate of urbanization reached 58.5% by end of 2017. Due to urbanization, problems such as densification, heavy traffic, environmental degradation, the destruction of cultural relics, overburdened infrastructure increase. These various man-made hazards and risks put tremendous pressure on urban heritage sites, impacting the architectural heritage sites and their surroundings.

3.1.Inadequate urban planning

Urban overpopulation requires the continuous expansion of cities. Meanwhile, the demand for modern living has prompted increased construction in cities. However, this process have resulted in a large number of valuable historic architectures being damaged to various degrees, even deliberately demolished, becoming the victims of urbanization. In 1950s Beijing, due to the new urban planning, torn down the original city wall, numerous gate towers and corner towers which were built in 1553 (Chen, 2003). Due to the improper urban planning decisions, architectural heritage sites have become an isolated island in modern architecture, destroying the cultural integrity and continuity. In 2013 in Jina, the original surrounding of a handred-year old historic building was demolished (Figure 1). In the same year, an architectural heritage was torn down overnight to make room for residential construction in Guangzhou (Figure 2).

Figure 1: The isolation of architectural heritage in jinan (Source: http://news.sina.com.cn/c/ 2013-11-28/052028831198.shtml).

Figure 2: An architectural heritage was demolished overnight (Source: Cao et al., 2014).

3.2.Heavy urban traffic

The flow of public transport has an impact on architectural heritage sites. Air pollution and noise pollution caused by crowded urban traffic affect the building quality and degrade the environment. Physical vibrations produced by traffic deteriorates the quality of historic buildings (Ma, et al., 2016), whereas exhaust gases and dust are chemically corrosive to the heritage building materials. Furthermore, traffic accidents can have a direct impact the buildings.

3.3.Urban ecological risks

The discharge of massive pollutants in the city every day leads to environmental changes such as air pollution, water pollution and soil pollution, etc. Dust in the air, chemicals in rain and snow, corrode the materials on the surface of the buildings. Meanwhile, unintentional poison leakage, radioactive material diffusion due to industrial accidents caused degradation of the ecological environment. For example, the fine

particulate matter PM 2.5 in the air produced by coal combustion and mining of construction materials lead to well-known Beijing air pollution events. The concentration of the dangerous particles in the PM2.5 size category reached 993g/m3– nearly 100times the WHO safe level of 10g/m3 (Cao et al., 2014), resulting in urban climate disasters such as acid rain, corroding the surface material of the historic architectures.

3.4.Technological disaster risks

The development of science and technology, while benefiting human society, has also led to disaster risks due to carelessness in operation and management, posing threats to architectural heritage. Technological disasters such as electric fires, gas explosions and urban waterlogging due to the ground materials and imperfect drainage systems, have impacted the heritage sites (Figure 3).

Figure 3: The waterlogging in the Wu Temple of Gongcheng, Guangxi (Source: Qixing Yan).

3.5.Criminal activities

The urbanization and the gap between rich and poor area has led to an increasing of criminal phenomenon that threatens social stability. A number of criminal cases in 2011 had increased to 5.8 times of its 1978 level (NBS, 2000–2012). The criminal activities in city area such as arson, terrorist attacks, burglaries of cultural relics resulted in the serious damage of architectural heritage sites. In particular, the illegal purchase and sale of cultural relics have led to vandalism of the building heritage artifacts, destroying the quality of these sites.

3.6.Disaster risks in heritage usage

The best method of architectural heritage protection is to use it. However, there are various risks due to usage. Improper function, excessive renewal, neglected maintenance and management led to damaging buildings to varying degrees. The architectural heritage as tourism sites also face deterioration due to the negative tourist behavior, changing the condition and integrity of historic sites by mechanical interactions such as trampling and handling (Roura, 2011).

With the improvement of living quality, upgrading facilities is inevitable. But combining these modern conveniences with architectural heritage is a challenge. Inappropriate facilities updating not only affects the culture and the aesthetic value of architectural heritage but also causes risks due to fire, flooding or explosion, threatening the safety of buildings. For example, the location of utility poles, wires, cables, air conditioners and other facilities is a common phenomenon that affects the quality of architectural heritage.

4. Preventive conservation strategy in an urbanization context

The concept of preventive conservation was first put forward in 1930, discussing scientific methods for artistic works preservation in Rome. Cesare Brandi (2005) in his book *Theory of Restoration* defined preventive conservation activities as the unified action of all efforts aimed at eliminating hazards and ensuring the implementation of protective measures. The content of preventive conservation in this period is mainly based on the monitoring and control of the environmental temperature, humidity, light, pest and climate of the museum

collections. Since 1980s, the role of preventive conservation has been recognized in architectural heritage field. In 1987, *The Washington Charter* mentioned preventive measures for natural disasters and environmental pollution, advocating pre-disaster prevention rather than post disaster restoration. In 2007 and 2008, the Forums on preventive conservation of architectural heritage were held in Belgium. In 2009, the policy of preventive protection, monitoring and daily maintenance of the architectural heritage were set up in UNESCO.

In the same year, the International Conference held in Switzerland explored monitoring technology and risk evaluation. With further development, the preventive measures were not only limited to environmental monitoring and control, but also take into account the factors such as organization, planning, public, security defence and risk assessment management. In 2011, the international conference on preventive conservation of architectural heritage held in China, discussed monitoring, maintenance, public participation, management models, hazard risk evaluation, disaster prevention measures. Sendai Framework for Disaster Risk Reduction in 2015 – 2030 (UN, 2015) proposed to reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures.

Although, human factors are the main causes of the urbanization risks that destroy the architectural heritage, they can also be the main force of heritage protection. Therefore, how to stimulate positive aspects of human factors and establish appropriate preventive conservation strategy is the key to conserve heritage from urban man-made disaster risks.

4.1.Urban planning policy considering architectural heritage preservation

Disaster risks caused by political decisions have had great impact on the survival of architectural heritage sites. The Chinese Cultural Revolution is a typical man-made cultural disaster, while the *'four olds'* movement has destroyed a large number of cultural heritage sites (Chen, 2003). In 1950s, the improper urban planing of Beijing led to the destruction of old city area. Therefore, government decision-making is the key to preserve architectural heritage, and it is the most basic preventive strategy to formulate the urban planing legislative framework considering heritage sites protection. Meanwhile, economical policy is essential to arouse the enthusiasm of the stakeholders protecting the heritage.

Although the conflict between urbanization and architectural heritage protection is inevitable, an appropriate urban planning policy, placeing emphasis on architectural heritage, can alleviate the destruction of architectural heritage and create an opportunity for the revitalization of these buildings in modern society. Supervised by the government, urban planning will protect architectural heritage sites, and embed them into modern urban life.

Numberous heritage sites have been protected, reused and integrated into new urban plan under the stimulation of political and economical policies in China. For instance, the local government protects the ancient town of Nanxun, and held design competitions on revitalized local architectural heritage sites (Figures 4 and 5).

Figures 4 and 5: Old Town Revitalization in Nanxun (Source: Xuan Jin, 2018).

4.2.Urban man-made disaster risk monitoring and evaluation

Ecological and cultural risks threaten the quality of heritage sites in both tangible and intagible ways. A real-time monitoring system for man-made urban ecological and cultural risks is essential. For example, GIS is the powerful monitoring tool for visually identifying and locating on-going risks. Meanwhile, creating a heritage security system for monitoring social and cultural behaviour, preventing improper cultural decisions is also essential to reduce cultural risks of heritage sites.

- Urban ecological monitoring

Urban man-made ecological disaster monitoring is vital to forsee the urban ecological risks such as air quality, soil pollution, waterlogging, which impact the quality of architectural heritage sites. Evaluating the trend of risks based on monitor data is a precondition for proposing legislation and measures for prevention and protection. For example, the traffic noise and amplitude around the heritage sites, the water sources, air and pollutants are monitored.

- Urban cultural monitoring

The intangible characteristics of architectural heritage should be protected and the harmony between cultural activities in modern society and ancient architectural heritage should be emphasized. All activities that damage architectural heritage and spiritual culture should be prohibited, and a spirit of heritage should be promoted. Therefore, it is very important to monitor the cultural activities around architectural heritage sites, with ongoing evaluation of the risks and hazards to the physical and spiritual aspects of architectural heritage sites.

4.3.Urban man-made disaster risks management

The goal of disaster risk management is to strengthen the resilience of architectural-heritage sites when threatened by all kinds of disaster risks. Therefore, it is essential to set-up management organizations at all levels to deal with the collected monitoring data, identify potential hazards and assess risks, so as to formulate preventive measures in time. Disaster risk managment not only focuses on man-made risk monitoring and evaluation, but also takes into account factors such as organization, planning, and public participation. And it is vital for disaster management departments to organize disaster emergency response and post disaster reconstruction when urban disasters occur. In order to minimize losses caused by disasters, the creation of disaster early-warning systems is crucial.

4.4.Architectural heritage digitalization

Preserving the original data and documentation of the architectural heritage sites in information sharing databases is vital by providing the foundation for post-disaster restoration. Furthermore, the disaster risk simulation, digital restoration, construction simulation and management functions in digital technology software such as HBIM system provides information for disaster prevention and restoration of the heritage sites. HBIM is an effective tool for the digital management of the whole life cycle of architectural heritage, which can preserve data, record conservation processes, and share information to provide the basis for the restoration of buildings damaged by man-made disasters in the city. Virtual reality and augment reality technology also play an important role in the preservation of heritage data and the display of heritage image, as well as spiritual culture.

During preventive processes, digital technology can be deployed in monitoring, disaster management and database maintainence. It provides not only the means for real-time monitoring, improving the accuracy and efficiency in risks analysis, but also plays the primary role in recording and archiving of heritage information, digital restoration, simulation construction and management. Combined with internet technology, architectural heritage sites become a shared global cultural resource by establishing database, digital museum, etc.

4.5.Heritage usage control

The monitoring of the architectural heritage usage includes the control of the usage purpose and the monitoring of the usage process. Risks data such as fire, water, explosion, dampness, facilities replacement, additional construction and renovation are regularly assessed and submitted for examination and approval in time. For example, In 2014, a fire broke out in Dukezong ancient town of Yunnan. The 1,300-year-old ancient town became ruins and 242 houses were burned down (Figures 6 and 7). A famous historic educationalist Chen Mian's former residence has been over-rebuilt and transformed into a complex, which is a lack of supervision and guidance to the stakeholder of heritage. Meanwhile, in addition to the building itself, in the usage process, the condition of the building's intangible cultural spirit in the usage process should also be monitored. An 108 years old building was developed as a barbecue restaurant for commercial purposes, resulting in the damage to the building and the blasphemy of culture (Figure 8).

In addition to the monitoring of heritage usage process by the relevant government departments, it is an effective way to eliminate the risks of misuse by owner and users by creating stakeholder’s partnership, conducting daily maintenance, communicate and heritage usage education, etc.

Figures 6 and 7: Dukezong Ancient Town (Source: http://www.iqwhw.com/news_info.asp?id=4752&smallid=73&bigid=7)

Figure 8: Dukezong Ancient Town (Source: http://sd.dzwww.com/sdnews/201607/t20160727_14687133.htm)

4.6.Public participation of heritage protection

At present in China, the determination, protection and conservation of heritage is largely decided and managed by the government with experts and scholars. People's awareness and participation therefore is relatively weak. However, the public awareness is an important factor in man-made risk prevention. Daily usage of architectural heritage can be closely related to increases in public awareness. Therefore, positive public awareness of heritge protection encourage owners, users and communities to appreciating the significance of heritage sites, and safeguarding their safety consciously. At the same time, strengthening urban disaster education and emergency activities is vital. Heritage management departments should organize training for disaster risk reduction and conduct emergency prevention exercises regularly, to improving the ability of public emergency response to protect heritage when disaster occurs.

Many cultural relics enthusiasts, cultural researchers, artists, heritage protection volunteers, retired elderly, teachers and students in schools have contributed to the publicity, census, data collection, supervision and protection of architectural heritage in varying degrees. For example, Lu An, an American Chinese social activist and media worker who once lived in Nanxin Street of Jinan, has been devoting himself to the investigation of the ancient streets and historic figures' former houses in Jinan. Valuable historical data are provided.

Through cooperation with educational and research institutions, architectural heritages can be used as a historical education bases for students, a research centers, and other means for communication with the public. Combined with the architectural heritage sites, school curriculum can especially achieve the excellent teaching and practice results (Figures 9 and 10).

damage of cultural relics and buildings have resulted in destroyed and lost cultural heritage. At the same time, public participation is not a superficial and passive behavior, but a way to broaden the scope and depth of taking part in the heritage management, and integrate this historic resource into public life while eliminating destructive behavior of it.

5. Conclusions

Disaster risks caused by urbanization are the primary reasons for architectural heritage destruction in contemporary society. Historical buildings are frequently subjected to these long-term and large-scale urban risks. Excessive human activities, inadequate urban planning, and technology, etc. have caused significant problems to their continued existence. Fortunately, these man-made risks can be alleviated and eliminated. The emergence and development of the preventive conservation concept has played a significant role in prevention of architectural heritage sites from being irreparably damaged.

However, it is noteworthy that preventive conservation often emphasizes the physical and chemical aspects of the building itself through monitoring, assessment, and corresponding maintenance measures. City planning defects caused by the disaster risk, and heritage usage risk can not be fully prevented, especially for the intangible cultural side. Human factors are the major threats to architectural heritage sites, but proper human activities of preservation and usage can have a significant impact on the survivability of heritage site. Public participation shows its importance, requiring formulation of methods for future development in this area. People and social organizations will consciously and voluntarily protect the architectural heritage through the supervision of urban planning programs, participation in disaster management, supervision of the heritage usage and the acts which may endanger cultural heritage, playing a greater role in mitigating the risks for man-made disasters in urbanization.

Any positive punlic activities involving architectural heritage protection should be encouraged. Only by integrating architectural heritage into our modern life, stimulating public interest, educating the public awareness of man-made risks to heritage, and establishing positive relationships beween architectural heritage and public can we protect these sites from urban man-made disaster risks efficiently.

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Poverty-reduction strategies in slums and ghettos: Bucharest as study case

Ionuț-Laurențiu Dinu [a,*], Claudiu-Andrei Mușat [a]

[a] Ion Mincu University of Architecture and Urban Planning, Romania

Abstract

The main theme of the research is the design of a new type of public policy on poverty reduction in ghettos, that are urban spaces that prevail at the outskirts of the former working-class cities in Romania. This public policy will be part of the planning process of a new national strategy on poverty reduction, having the main objective to make it operational. The implications, from the perspective of a normative frame work, will have an architectural and urban character, its main objective being to change the urban form. This approach, viewed from a social perspective, can be fundamental in the poverty reduction process. The focus on ghetto poverty is related to the fact that in recent studies, conducted by Romanian sociologists, the ghetto stands out from the other two types of poverty labeled areas in Romania (dumps and historical center areas), having the highest indices of extreme poverty, misconducts and crime. The most dangerous ghetto in Romania is located in Bucharest, in Ferentari neighborhood, which also represents the case study of the research.

Keywords: urban poverty; ghetto dispersal; public policy; architectural approach; education.

1. Introduction

This study will have mostly an informative character on the general thematic and on the area where the future public policy will focus. Whereas the doctoral research is not completed yet, neither the final conclusions, those with prognostic character, cannot be stated in an exhaustive way. Studying the poverty inside the ghettos, we have found that it affects all age groups and that there is an inter-generational poverty cycle to be interrupted, and in this respect, education is the key word, in all its forms, applied at all age levels.

In order to provide a coherent answer to the issues outlined above, we used as methodology three main research objectives, that were found following a set of criteria, for which we identified different research tools: Ins1 - bibliographic research, through which we found out what is the stage of current research. Thus, it will solve us Ob1 - linking the proposed strategies of NGOs to the existing national strategy; Ins2 - analysis of comparative data, by identifying statistical data and comparing them in order to identify similarities and differences. With the aim of solving Ob2 - implementation of architectural and urbanistic principles in Ob1, developing a hybrid strategy that will contain both spatial and non-spatial interventions; Ins3 - social survey using the method of polls and semi-structured interviews, the questions being grouped in sections specific to the typology of the interviewed groups. Through which I will achieve both Ob1 and Ob3 - generating macro-scale principles so that the new hybrid strategy can be extrapolated and used successfully in several similar areas in the country.

2. Poverty in Romania

2.1.Poverty – general data

It is considered to be in the destitute zone people, families or groups whose resources (material, cultural or social) are so limited that they exclude themselves from those minimum standards of living that are recognized as acceptable in the societies in which they live (European Economic Community, December 10th, 1984).

Poverty is a social phenomenon encountered in almost every world, in underdeveloped countries, developing countries, even in developed countries. The causes of the worldwide poverty have political and historical nature, and interventions either cannot be made, or are very difficult to accomplish. However, it has been found in programs that are more advanced in terms of material, temporal and human resources, that interventions on the poverty maintaining factors can be successfully achieved. These factors are five in number (ignorance, illness, apathy, dishonesty and dependence) and make up The Big Five (Phil Bartle, 2013).

* Corresponding author. E-mail address: ionutdinu.la@gmail.com

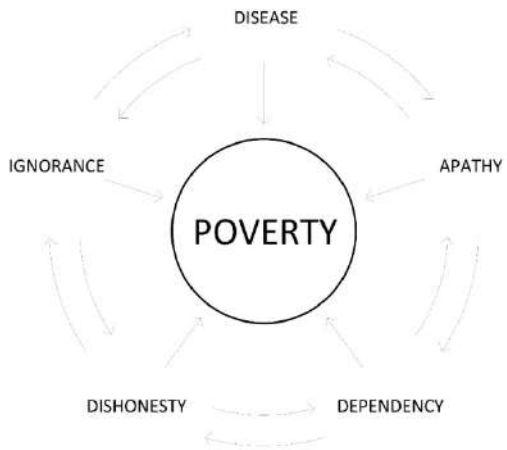


Figure 1: Factors of poverty (Phil Bartle, 2013).

Factors of the Great Five refer to general poverty, but it can be divided into two broad categories, depending on its sternness: standard poverty, described as the lack or inadequacy of the income, and extreme poverty, described as the standard poverty that expands and, in time, it monopolizes all the spheres of life (Stănculescu, 2004, p. 37). The present paper aims at highlighting the urban areas that gather extreme poverty, and outlining ways to intervene on these maintenance factors, concentrated in the form of a new public policy.

In order to better understand the phenomenon of extreme poverty, it is necessary to look at it from the system theory perspective. But before, the other two concepts need to be defined, which, along with extreme poverty, are subsystems of a wider system which has a destructive character related to any urban organism.

- Marginalization is, in conventional language, a complex process of denying or pushing a specific group of people to the bottom or outer edge of society. These groups are actually pushed to the edge of society, from an economic, political, cultural and social point of view, following the parameters of exclusion and inclusion (Mionel, 2014, Architecture Magazine, 4-5).
- Social exclusion is often defined as a dynamic process of a multi-dimensional and progressive breach of social link at an individual or a collective level (...) (Silver, 2007).

Each of the three phenomena is cause or effect for the other. Thus, between the three social entities found in a process of interconnection, a system is formed, having the following characteristics: open, complex, dynamic, disjunctive, continuously discretized and probabilistic.

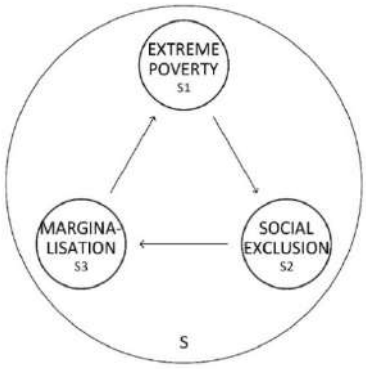


Figure 2: The main poverty-keeping system.

In order to combat this system and the subsystems that generates it, we need to think about strategies and systems, both efficient in terms of economy and timing. It should be noted, however, that extreme poverty, called in the specialty literature "the new poverty", requires a complex approach from the perspective of human rights and social inclusion.

2.2.Historical evolution of povery in Romania of 20th century

Romania is a state located in the southeastern part of Central Europe, on the lower course of the Danube, north of the Balkan Peninsula and having its way to the north-western shore of the Black Sea. In the history, different parts of the territory were under foreign administration, the most powerful occupations being the Ottoman and the Russian occupations. It was founded as a state in 1859, by the union of two states, Moldova and Wallachia, but also under the autonomy of the Ottoman Imperium. It was formed as an independent country only in 1918, by annexing to the new state the extremities of the west and the east. Modern Romania was marked by the occupation, after the Second World War, of the Soviet army, being transformed into a socialist state for almost 50 years, until, in 1989, it came out of the auspices of the communist regime through a civil revolution.

Since 2007, it is an EU Member State with a population of more than 18 million inhabitants, but regarding the living standard, it is one of the lower side of the EU.

The earliest forms of poverty in Romania were mentioned in specialized studies around the '80s, when the economic crisis, which occurred on the background of an economic and political bankruptcy, led by the Communists at that time, reached a critical point for the Romanian society of those times (it was not about the lack of income but the lack of services and goods). We can talk about a worsening of this degree of poverty, first emerging at the background of unemployment, and even about a poverty-stricken form, as it is currently understood.

Figure 3: Romanian people waiting in line to buy meat (https://identitatea.ro/tara-umilintei-templele-foamei/).

Figure 4: Romanian people waiting to get the bus to work (https://www.4tuning.ro/poze/poze-stiri-76/bucuresti-comunism-24507-poza-493221.html#lg=1&slide=3).

After the 1989 Revolution, the consequences of the economic policies of the old regime led to a first unexpected explosion of poverty, which increased the percentage of the poor population from 7% in 1989 to a value between 22% and 39% in 1994 (according to a study by the Institute for Research on Quality of Life). However, this time we cannot talk about an extreme form of poverty, but rather a degree of standard poverty that can be divided into two levels, the Subsistence Level, which is a more severe form of poverty, on basic consumer needs and the Decent Level, which is similar to the form of poverty in the 1980s.

The second explosion of poverty, though, occurred after 1997, due to huge inflation, the main outcome of the phenomenon of mass privatization and the diminution or completely elimination of the industrial sector. At that

time, the percentage of people in poverty exceeded the 40% limit, and besides this increase, the poverty rate has also worsened, with extreme poverty levels being recorded for the first time.

Figure 5: The former Electroaparataj factory, the main factory of Romania, where electronics and home appliances were researched, designed and manufactured, now transformed into a big shopping mall.

On the background of these economic fluctuations, the phenomenon of socio-economic segregation emerged, which divided society into social groups with similar economic characteristics, who occupied similar spaces, either selective environments or degraded backgrounds, each with a cultural footprint due to their way of life. Thereby, urban areas clearly delimited spatially, distinguished from the rest of the city and enrolled in the process of urban segregation were generated. In urban areas, due to urban segregation, there has been a concentration of extreme poverty in three types of areas:

- Landfills, specific to large cities, represented by improvised shelters near or inside the dump, inhabited by groups of people who survive by collecting iron, bottles, papers, etc. which they capitalize;
- "Old-center" areas, represented by nationalized homes, in an advanced degradation state, being attributed by authorities to poor families;
- Ghetto-like areas that prevail in the outskirts of the former working cities, consisting predominantly of blocks of flats, inhabited by groups of people whose ownership is uncertain.

Nowadays, the ghetto areas are the most important points of extreme poverty concentration in Romania. In these areas, two types of segregation converge, socio-economic and ethnic segregation, the groups of inhabitants being predominantly made up of Romani people suffering from a major shortage of living conditions, often being victims of marginalization and social exclusion. The causes for which the Romanian ghettos concentrate a majority population of Romani people are of a historical nature, their nomad character which is not defined by safety standards, and also the criminal one that some of them probably acquired at the end of the 19th century, in the immediate period of their emancipation, possibly as a direct consequence of the abuse they have been subjected to for over 400 years, making them victims of a severe form of discrimination. This discrimination has in time led to a combination of factors, among which we can list the low level of education, the high level of illness, the marginal position on the labor market, the lack of material goods, etc., which gives the Romani population a strong vulnerability from the economic, social, physical and psycho-emotional perspective.

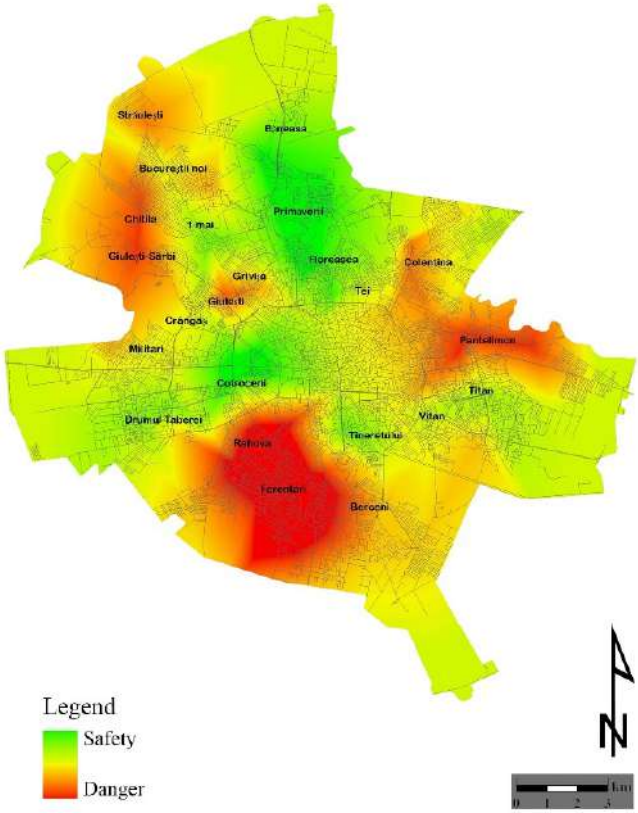
2.3.Ferentari district

In Bucharest, the poorest administrative areal is represented by the 5th sector, which gathers, in the Ferentari neighborhood, a big amount of disadvantaged social categories. They have severe housing problems because of the lack of hot water, sanitation, electricity and district heating.

Ferentari is a peripheral area of the present Bucharest. Before its inclusion in the city, this area was similar to the other rural areas on the outskirts of the city, where, instead, the orchards and vineyards prevailed. In the '60s and' 70s, as a result of industrialization, the two-room studio blocks or two-room apartments were built, forming the future most feared ghettoes of Ferentari. Their degradation began to take place before 1990, progressively, at present being in a very strong state of deterioration, being abandoned by the old tenants and often illegally owned by a Romani population, originating from the Ferentari or other areas of Bucharest.

According to urban legends, it is said that after the end of the war, the gangsters of Bucharest were hidden in the Ferentari area, where they remained definitively, thus representing the first contact of the district with a criminal population. Currently, the neighborhood is in the top of the city's citizens frightening places, following a map of fear, made in 2012 by geographer Cristian Ciobanu. This is caused by the concentration in its blocks of flats, ghettos, of a subsistence society that is the victim of urban, socio-economic and ethnic segregation, marginalization, social exclusion and extreme poverty.

Figure 6: The mental map of fear in Bucharest (Ciobanu, 2012, p. 160).



The district of Ferentari is distinguished from the other districts of Bucharest because of its negative indexes, which are well below the EU average:

- 90% is the percentage of the Romani population living in the neighborhood, of which 80% are people living in social assistance;
- 5/1 is the average ratio of people living together in one apartment (most of the times, for studios);
- 25% is the percentage of infant mortality (8.8% in Romania and 4.1% in the EU);
- 40% is the percentage of school drop-out (10% of the national level).

Figure 7: Ferentari actual situation, Aleea Livezilor street.

Figure 8: Ferentari actual situation, Zăbrăuți street.

Figure 9: Ferentari actual situation, inside a studio apartment from Aleea Livezilor ghetto.

3. De-ghettoization strategies

By doing a field analysis, we have identified at least one reason why it is difficult to intervene in the Ferentari ghettos, and it is that there is a drug-related subsistence mechanism at a local level. Interventions upon drug dealers involved in the trafficking network can be very difficult and it can only be achieved with help from several social entities, but interventions that have a lower level of difficulty are those upon children and women, these two categories having a considerable chance of recovery.

In order to discuss de-ghettoization, one must first understand the process of ghettoization that is made up of six stages that also sustain its development: a. Labor market discrimination; b. Economic devaluation of the area; c. Discrimination on the real estate market; d. Discrimination regarding access to services; e. Degradation of the architectural space; f. Isolation and self-isolation.

The system composed of these stages of the ghetto process is called the cycle of disadvantages and leads to marginalization, social exclusion and extreme poverty. Ghettos are among the areas in which the phenomenon of extreme poverty is present and growing. So the ghetto can be seen as a consequence of extreme poverty and other factors that often accompany this phenomenon.

The goal of a policy aimed at facilitating integration is to improve social and national inclusion, increase social cohesion and solidarity, and reduce segregation, as well as discriminatory social patterns of segregation.

As the funds are not unlimited, the problems need to be prioritized, thus focusing on the most disadvantaged groups, the elimination of extreme forms of poverty and the stimulation of initiatives that achieve the most efficient results with fewer financial resources. At the same time, special attention should also be given to measures aimed at eliminating root issues, which may interrupt the transmission of these issues and which may have long-term effect.

Statistics provided by the National Institute of Statistics in 2017 show that economic benefits could be situated between € 3.4-9.9 million per year if by investing in social literacy, non-formal and vocational education programs, it would reduce from the allocated social assistance services.

3.1.Methods of the intervention strategy

To be able to have a reference system, we identified a macro-scale set of methods of the future intervention strategy, that we have divided according to their applicability, as it follows:

a) Non-spatial

- promoting professional reconversion policies in a changing labor market;
- creating awareness programs among the poor on the risks of drug use and the lack of sexual education;
- developing and implementing a monitoring system for children at the highest risk of school dropout -> redesigning the education system to increase the quality of education for poor and vulnerable groups;
- financial education of disadvantaged people and facilitating their access to credit programs on access to social housing.

b) Spatial

- development and financing of social housing programs dedicated to vulnerable groups in a phased manner (major risk -> minor risk);
- increasing the number of primary care services at the neighborhood level by developing medical centers, common to other functions;
- the development of multifunctional community centers of a social character that will be targeted to certain age groups and will aim at literacy, professional retraining, non-formal education -> alternative to the actual lifestyle.

3.2.Examples of existing strategies

We have identified, in Bucharest, two social programs, different one from the other in terms of strategic approach, however their objectives being very similar. They both are developed by a different NGO according to its character.

a. The Non-Governmental Policy Center for Roma and Minorities

The Policy Center for Roma and Minorities is a nonprofit organization set up in 2008 in Bucharest, having its main goal to try solving the problem of social inclusion of ethnic minorities, especially Roma in the Ferentari neighborhood.

Within the organization, one program stands out regarding the intervention within the vicious circle of marginalization, poverty and helplessness, the Alternative Education Club, that is a non-formal education program present in three neighborhood schools with the following objectives:

- Creating a safe, creative and challenging space for children within the school;

- Providing counseling and mentoring for children involved in the program;
- Develop innovative approaches focused on improving school performance and at developing cognitive, artistic and creative skills;
- Creating united sports teams to improve discipline, team spirit, self-esteem and respect for the opponent;
- Promote the idea of an active citizen and respect among Roma and non-Roma children involved in the program.

This program offers children a multitude of means through which they can express themselves, such as theater, music, sports and street dance, which they have followed successfully. By stimulating the children's artistic side, along with the help they offer to improve their knowledge at school, the program seeks to increase motivation, reducing the dropout rate and aiming to give children a chance to create a different future for themselves.

b. The Gladiator Association "Szobi Cseh"

"The biggest handicap of a society is indifference!" - Szobi Cseh

The Gladiator Association is a non-governmental organization founded in 2005 in Bucharest, at the initiative of the famous actor and stuntman Szabolcs (Szobi) Cseh, from an older wish to help children from disadvantaged families or from placement centers to integrate into society. Szobi's approach to the problem of children is an obvious one, giving them the alternative of sport in a controlled and coordinated environment, thus helping them to channel their energy in a productive way.

The specialized staff, made up of a minimum number of people, coordinated by Master Szobi Cseh, initially carried out volunteer activities. Nowadays, a large part of the club's coaches are even former athletes who have managed to rise from the poor environment they have come from and to pass on the values they have gained in professional training.

The intervention methodology through sporting activities is concealed by a playful general attitude, through which the room becomes a playground, and the training becomes the act of play and entertainment itself.

Therefore, using sport (especially dynamic sports, unconventional sports) as an attractor, Szobi Cseh succeeded not only in preventing juvenile criminality and the subsequent development of disadvantaged children in the future "pariah" of society, but also to obtain a major evolution of them, from a psychic, behavioral and physical point of view, forming future professionals in the field of circus, film, stunt, climbing, etc.

The two programs presented, which have proven their effectiveness, along with others newly established, within a national strategy that is catalyzing an urban gentrification phenomenon, can generate a new public policy on de-ghettoization and poverty reduction in Ferentari, as well as in other similar areas from Romania.

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Can creative placemaking be a tool for building community resilience?

Meghan Venable-Thomas [a,*]

[a] Harvard University, USA

Abstract

Across the United States, heat waves, droughts, and floods are becoming more frequent and severe, increasing risks to individuals and infrastructure. Simultaneously, amplified and rapid urbanization continues to increase pressure on the environment and the local governments managing the confluence of these trends. The threat of these stressors on vulnerable populations, who have consistently experienced trauma, disinvestment, and discrimination, can present significant health implications. Economically constrained, communities of color, immigrant, elderly, and homeless populations are at greater risks and often have limited resources to respond to the changing conditions. In the face of "market" and natural forces, it is up to organizational allies to support community residents in advocating for community-informed investment. This starts with creating environments for collaboration, lifting residents' voices, and building social cohesion and capital. Communities most resilient to disaster are not only structurally sound but also socially empowered and connected. The Climate and Cultural Resilience (C&CR) Program funded five community-based organizations across the country to use creative placemaking toward community resilience outcomes, testing the theory that building cultural resilience—the capacity to maintain and develop cultural identity and critical cultural knowledge and practices—advances communities' overall resilience.

Keywords: culture, climate, resilience, community participation, cultural knowledge, social cohesion.

1. Introduction

As a public health leader, I believe health is a foundational social benefit and seek to integrate this principle across disciplines and practices that support people's ability to live prosperous lives. Essential to making this reality is contributing to the field of community resilience. The Climate and Cultural Resilience (C&CR) program with Enterprise Community Partners attempts to advance resilience development through a diverse approach, using art and culture to create innovative community development practices that actively promote health and well being among the most underserved and enhance climate practices to build healthier and more resilient communities. Additionally, this program seeks to bring together sustainability and art practitioners to engage in new kinds of partnerships that foster the growth of more equitable and resilient communities.

In recent years, the "range of social and physical stressors that people and communities experience has multiplied" (Rand, 2018). Additionally, acute events, combined with these stressors, affect many communities consistently over time. The scholarship and practice of ways to promote resilience for individuals and communities continues to grow. As the scope grows, so does the number of differing perspectives about the most important factors contributing to individual and community resilience (Rand, 2018). However, if we can better understand what resilience means for the communities we serve and what solutions they are already employing to be resilient, we may be able to create and support more effective solutions. This project is an opportunity to explore one approach to fostering community resilience for expansion of such strategies in the future benefiting communities and stakeholder groups. The C&CR Program uses creative placemaking, the integration of arts and culture into community development, as a strategy for supporting community resilience. Enterprise believes that investing in cultural resilience simultaneously with climate resilience will improve overall community resilience (Figure 1). Uplifting cultural resilience offers a more nuanced definition of community resilience that places "capacity to maintain and develop cultural identity and critical cultural knowledge and practices" (Claus-Ehlers, 2010) as an equal contributor with climate to a community's overall resilience.

* Corresponding author. E-mail address: meghanvt@gmail.com

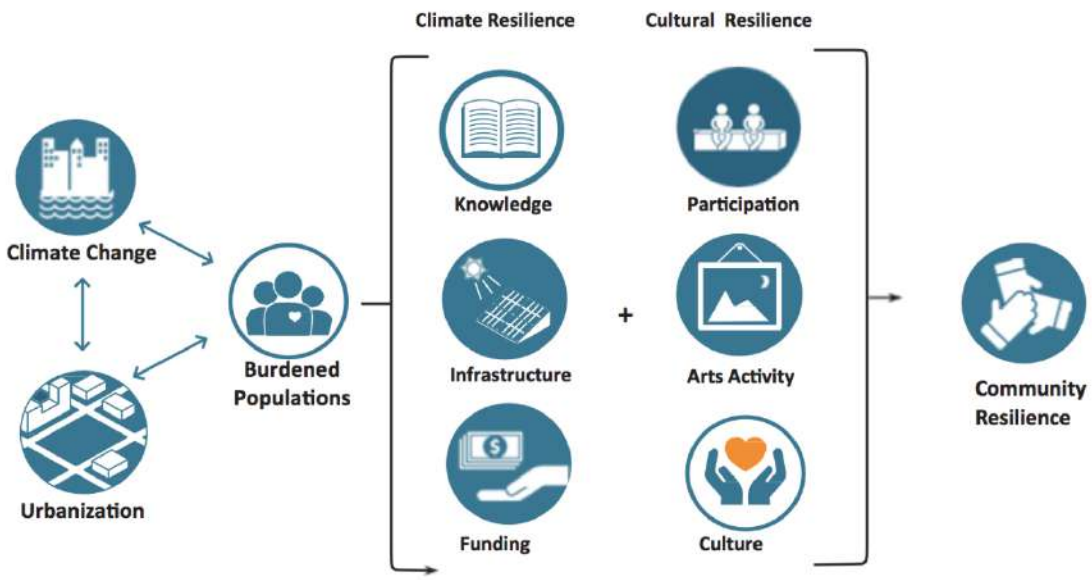

Figure 1: C&CR Community Resilience Conceptual Framework

1.1. Community Resilience

Despite nuances in the definition of community resilience, the underlying premise involves the idea of a group being able to recover from a significant event or prolonged stressor (Yosso, 2015). Grounding community resilience from a population health perspective recognizes that resilience is a process for supporting a broad range of positive physical and mental health outcomes related to socio-environmental exposures and that individual risk of illness or disease cannot be considered in isolation from the disease risk of the population to which it belongs (Berkman, et al 2015). Health inequities are prominent in urban centers across the U.S. and often, because of historical inequality, are related to race and income. Although race is a social construct, disinvestments, discrimination, and social devaluing committed based on race over time have created population-level health disparities in communities of color. This highlights the importance of understanding the social determinants of health in order to begin to overcome present community-based health inequities and disparities and support community resilience efforts.

1.2. Cultural Resilience

Cultural resilience is foundational to community resilience in supporting the people-based component of resilience. Shared cultural identities help people connect and empathize with others experiences. Understanding cultural resilience as a tool for connecting groups to one another and the environment they exist within recognizes its ability as a community resilience component that uniquely supports addressing climate resilience challenges. The cultural resilience concept has been examined in several studies of groups responding to oppression, violence, and adverse socioeconomic conditions in countries around the world. Researchers site the term cultural resilience as a mechanism leveraged by First Nations communities to promote protective mechanisms and behaviors in community youth by maintaining and reviving their cultural heritage (Lalonde, 2005). As we begin to think about why culture matters to resilience and community development efforts, it is important to know that discrimination, another social determinant of health, and the oppression of culture through structural and interpersonal prejudice drives many of the health inequities we see today. Thus, incorporating ways to support and uplift cultural identity and social connectedness of underrepresented groups is an often forgotten but very important component for connection building and, in turn, community resilience.

The most well established literature on social connection is in the realm of health and well-being (Putnam, 2000). Social capital has been linked to improved mental health (Berkman, Kawachi, 2001), decreased mortality (Kawachi et al., 1997), increased adolescent well being (Howard, 2003), to name a few. One of the most well known social capital studies presented by Daniel Aldrich in *Building Resilience* found that the presence of strong social capital, both among people and among individuals and organizations, is a prerequisite for and a predictor of recovery. Additionally, he claimed that social capital might be even more important to resilience than both the

degree of infrastructure damage and the amount of aid received by an area (Aldrich, 2012). Building social cohesion and capital supports health resilience and thus is a critical element of not only building preparedness and facilitating recovery but also maintaining community resilience.

2. Indication of objectives

The C&CR Program funded five community-based organizations across the U.S. to conduct activities that uplift cultural resilience while advancing climate resilience in their communities. Each participant conducted the following projects:

- American Indian Community Housing Organizations Duluth, MN: Revitalized a rooftop garden as a Native American community collaborative space with public art, green infrastructure and traditional foods. Challenges addressed: lack of inclusiveness and knowledge of American Indian culture in the local community, lack of awareness and knowledge of climate concerns, high levels of food insecurity, and persistent power outages and damage due to severe winter weather.
- Chicago Connections Chicago, IL: Created a social and environmental justice initiative with local partners and developed four site-specific art and green infrastructure installations within a half-mile of four transit stops in areas of high economic hardship. Challenges addressed: urban flooding increasing hardship on already burdened communities, people experiencing threat of displacement, lack of affordable housing, and neighborhood division by racial segregation.
- This Belongs to Us Atlanta, GA: Built community understanding of design and development initiatives while embedding community-engaged arts strategies into rainwater retention efforts. Challenges addressed: significant disinvestment and poor housing stock, threat of displacement to long time residents, and heavy flooding and sewage backup during normal and frequent rain events.
- Chinatown Community Development Center San Francisco, CA: Enhanced Built local and government partnerships in redesigning Portsmouth Square Park for the people of Chinatown and implemented an ecofair featuring multigenerational sustainability education and community art installations. Challenges addressed: severely disadvantaged immigrant neighborhood, extremely constricted affordable housing as the only option for local residents, and physical mental health issues from overcrowded living conditions, increased heat island effect due to urban conditions.
- Coalfield Development Corporation Wayne, WV: Provided out-of-work coal miners with retraining in jobs that grow the cultural economy and restore the environment, including reforestation, solar installation, furniture making, and sustainable agriculture on former mountaintop removal sites. Challenges addressed: rich coal history with industry in declined, lack of economic diversification and underemployment, and scarred landscape due to deforestation and mining.

The following study interrogated creative palcemaking's role in the above five projects to increase social cohesion and ultimately strengthen the cultural resilience of local community. This study investigated the ways in which these exemplars leveraged specific activities for promoting cultural resilience, the creative placemaking approaches they used to advance those activities, and analyzed the program parameters alignment with expressed community needs.

3. Methods

Through an interpretative epistemological approach, I developed a qualitative case study, in which I simultaneously worked with theory and empirical material. I collected my findings by performing document analysis, focus groups, participant observation, and conducting semi-structured interviews with people participating in the C&CR Program. Since the aim of this study was to gain a deeper understanding of climate and cultural resilience and creative placemaking in the C&CR Program, qualitative research was the most suitable method. Following Stake (1995) and Yin (2003), I based my approach to the case study on a constructivist paradigm. This paradigm "recognizes the importance of the subjective human creation of meaning, but doesn't reject outright some notion of objectivity. Constructivism is built upon the premise of a social construction of reality" (Searle, 1995). One of the advantages of this approach is the close collaboration between the researcher and the participant, while enabling participants to tell their stories (Crabtree, Miller, 1992).

The criteria used for evaluating cultural resilience activities were based on prior programming that identified particular cultural practices that support outcomes of social connection within community. Each of the grantees were evaluated on their ability to select and conduct one or more of the following activities while identifying

what creative placemaking approaches they used to advance those activities: 1) partner with artists/ designers and community to create a product reflecting community identity, 2) conduct community engaged activities that focus on cultural expression of people involved, 3) partner with local culture bearers, 3) use culturally competent practices to deliver services and gain stakeholder input, and 4) plan on how to support climate resilience efforts through building cultural resilience.

4. Results

From building the case study through focus groups, interviews, observations, existing data and research, and participant observations, the study uncovered the following**:**

4.1.Understanding Climate and Cultural Resilience

There are alignments and misalignments in understanding climate and cultural resilience by community members and clear prioritization of other more critical issues, many of which communities attempted to incorporate in the grant with perhaps less success. It is evident that while there are similarities across communities, the types of resilience challenges most important to communities are diverse and context-specific. Table 1 shows clearly that creative placemaking processes across the board were able to facilitate Enterprise's community-engaged activities that focused on cultural expression and local partnerships with culture bearers. The next most common activities were creating partnerships with artists to create a product reflecting the community's identity and creating a plan for addressing climate resilience needs coupled with cultural resilience efforts for added impact.

Table 1: C&CR Climate and Cultural Activities

Enterprise C&CR Activities Criteria					
	AICHO	WonderRoot & Southface	Chi-Go	Chinatown	Coalfield
2D) Partner w/ artists/designers and community to create product reflecting community identity	▌		▌	▌	▌
2E) Conduct community engaged activities that focus on cultural expression of people involved	▌	▌	▌	▌	▌
2F) Partner w/ local culture bearers	▌	▌	▌	▌	▌
2G) Use culturally competent practices to deliver services and gain stakeholder input	▌			▌	

From the focus groups data, art, and creative and cultural practices support three main outcomes across grantee groups. Those outcomes are lifting resident voice and identity, empowering residents to feel pride and support in place, and fostering social connection and communication. All three of these outcomes are cultural-resilience-focused. However, fostering social connections and communication, as mentioned in the literature, is a shared outcome that supports both climate and cultural resilience. There is a gap in knowledge for community development organizations in fully understanding this connection and being able to use it to plan and support for more impactful climate programming. Discussions of increased safety, political involvement and beautification were other underlying themes but were not highlighted across communities.

4.2.Understanding Creative Placemaking

Creative placemaking is a concept not well understood on the ground. However, communities recognize the importance of creative activities in supporting community resilience. Additionally, the application of creative placemaking projects varied across communities with the achievement of many of the same outcomes,

highlighting the importance of a few primary required creative placemaking activities. Much like understanding climate and cultural resilience, the creative placemaking interventions were most successful when focused on processes that best addressed place-based, community-expressed needs. Although all the creative placemaking practices were not exactly the same, there were several components that were shared across grantee groups. All of the grantee organizations used some sort of community participatory activity to engage and incorporate community voices into the project. Every project engaged other sectors and supported interdisciplinary partnerships to implement their projects. All of the projects highlighted some social issue in their community, such as violence or discrimination. Lastly, every intervention was place-based and publicly visible. These different criteria demonstrate that creative placemaking interventions can vary across different communities but there are some baseline criteria for creative placemaking interventions that can support certain community resilience outcomes (Table 2).

Table 2: Creative Placemaking Approaches

Creative Placemaking Approach Criteria					
	AICHO	**WonderRoot & Southface**	**Chi-Go**	**Chinatown**	**Coalfield**
Community Committee for decision making	▌	▌	▌		
Artist led installation	▌				
Community led installation			▌		▌
Community participatory design activity/ design charettes	▌	▌	▌	▌	▌
Cross sector partnerships/ local institutions/ community groups	▌	▌	▌	▌	▌
Incorporates social issues	▌	▌	▌	▌	▌
Place-based interventions	▌	▌	▌	▌	▌
Publicly visible interventions	▌	▌	▌	▌	▌
Equal community partnership		▌	▌	▌	
Local artist/designer		▌	▌		▌

Creative placemaking supported producing climate and cultural resilience activities as well as producing community social outcomes. However, it did not effectively address many of the other more pressing issues in communities, such as trauma and displacement, and in some places was thought to spur it.

5. Discussion

This program revealed that cultural resilience is not only integral to the ways in which communities understand and experience community resilience but an approach that supports a better connection of residents on a personal level to the issues they face. Because discriminated against communities in the United States often experience disinvestment and inequity because of the cultural groups that they identify with, many of their

resilience challenges are inadvertently connected to their cultural identities. However, climate and culture alone do not fully conceptualize the community resilience model. There are even more components than anticipated from this program that are important to a community's ability to be resilient, such as economic and social issues on top of the experiences of preexisting trauma. This program demonstrated that resilience is not only about rebounding from environmental risks but also about persevering through traumatic experiences and other perpetually stressful events.

As an intermediary organization whose role is to collaborate with government and nongovernment organizations while focusing on development, it is important for Enterprise to understand how utilizing a resilience paradigm might augment traditional efforts to prepare communities to withstand anticipated disasters and emergent and consistent threats (Yosso, 2005). This lies in understanding the significance of human health, wellness, and culture to overall community resilience. Incorporating creativity and cultural identity into community participatory planning processes shifts the research lens away from a deficit view of underrepresented communities, and instead focuses on and learns from the array of cultural knowledge possessed by socially marginalized groups that often go unacknowledged. In addressing resilience issues in underrepresented communities, culture and creativity coupled with community participatory processes must be integrated in public health, environmental, urban planning, and development research and programs, to build institutional knowledge and practice.

Based on my findings my recommendations are that organizations must be adaptive to redefining community resilience and changing the language around creative placemaking while creating shared metrics for evaluating impact. As seen in Figure 2, community resilience needs to incorporate more components than climate and cultural resilience such as economic resilience, social resilience, and trauma that are closely tied with social determinants of health. This distinction provides a more accurate conceptual framework for understanding resilience that further supports the connection between creative placemaking, culture and community resilience. Additionally, it further connects this resilience work to other disciplines like public health doing the same work. This broadens the field of literature, practice, and expertise that can be accessed to advance resilience work. The language around creative placemaking needs to better incorporate place-based context. Organizations need shared metrics that cross disciplines to begin evaluating the impact of and interaction between creative placemaking and community resilience efforts. More research is necessary to understand the long-term impact of creative placemaking to building cultural resilience and the extent these communities can leverage that in the face of resilience challenges.

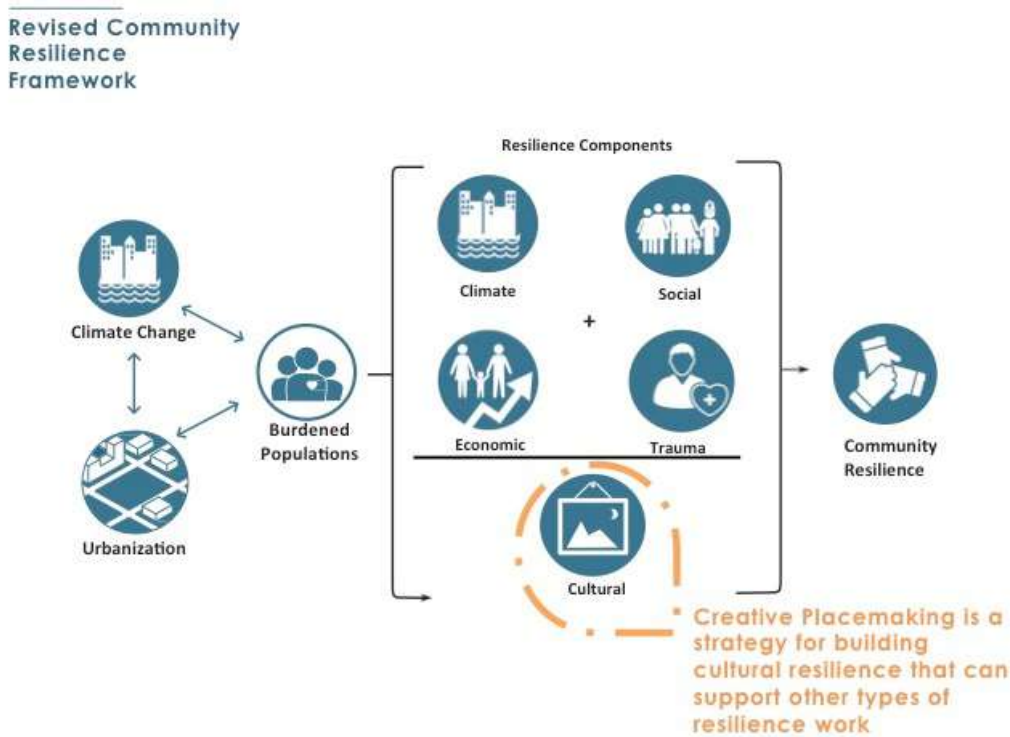

Figure 2: Revised Community Resilience Conceptual Framework

6. Conclusions

From this research, it is clear that cultural resilience is a component of community resilience that if not included leaves significant value on the table for community development organizations and their funders. By exploring five different exemplars for using creative placemaking as a tool for building cultural resilience and analyzing their alignment with expressed community needs I was able to uncover how the communities of the C&CR Program were conceptualizing the concepts of creative placemaking and community resilience and if, in fact, these conceptualizations aligned across stakeholders. In order to evaluate the impact of these concepts it was important to first understand the ways in which these concepts were realized in practice. Through focus groups, interviews, observations, existing data and research, and participant observations, I created a case study of these five exemplar organizations participating in the C&CR Program. There must be an understanding that creative placemaking cannot solve all acute or chronic stressors, particularly because the issues exacerbated by the impacts of climate change are those created by community disinvestment over time. Creative placemaking can be a mechanism for bringing diverse voices to the table. Recognizing the importance of cultural resilience, as a viable approach for community development and community building is extremely important because research, health, and community development decisions are still being made without the inclusion or voice of those most impacted by the decisions. We are seeing that this is a mechanism for inclusiveness. When we think of resilience as a privilege unequally supported across different communities, it changes the responsibility of stakeholders in investing in equitable interventions.

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Capacity of the temples and shrines for using as evacuation places and shelters on the tsunami hazard: the case study for the coastal area of Muroto, Kochi Prefecture in Japan

Dowon Kim [a,*], Hiroki Tanaka [b], Takeyuki Okubo [c], Michiko Hayashi [d]

[a] Kinugasa Research Organization, Ritsumeikan University, Japan
[b] Shimizu Corporation, Japan
[c] College of Science and Engineering, Ritsumeikan University, Japan
[d] Faculty of Environmental and Urban Engineering, Kansai University, Japan

Abstract

This research focuses the capacity of the temples and shrines for using as evacuation places and shelters. Firstly, we suggested the investigation form by collecting the research data of the cases of the temples and shrines which had utilized as an evacuation places after the Great East Japan Earthquake and Tsunami. And we conducted the case study on the one of the hugest possible damaged area by the next tsunami (Nankai Trough Earthquake) in Muroto, Kochi prefecture in middle-west Japan. We evaluated 25 temples and shrines by the investigation form which we suggested with the previous research data. All 25 temples and shrines have the outdoor spaces for possible using as the temporary evacuation and emergency staying. There are 12 temples and shrines which were allowed their indoor spaces to be utilized as the evacuation shelter. By the interview research, we investigated the stocks of foods, water, beddings and facilities on the 10 temples and shrines, and the community activities which would help to make cooperation between these built heritage and the local community.

Keywords: tsunami; local culture heritage site; resilient built heritage; Nankai Trough Earthquake; evacuation planning

1. Introduction

1.1.Research Background

The tsunami occurring after the Great East Japan Earthquake on March 11, 2011 severely damaged the designated public evacuation shelters such as schools and community centres, resulting in an insufficient number of evacuation shelters. Previous studies have showed that undamaged temples and shrines that were not designated as evacuation shelters were used as evacuation shelters to support life. (Michiko et al., 2012 and Takeyuki et al., 2011) These studies surveyed the temples and shrines in the regions where there was an outbreak of fires due to tsunamis. They confirmed whether the temples and shrines were used as evacuation shelters and how their firefighting equipment such as water tanks helped in the firefighting activities of the city. (Hiroki et al., 2015) This study found that temples and shrines can be used as temporary evacuation shelters and shelters and disaster prevention bases for activities such as firefighting.

This is because temples and shrines that have experienced many great earthquakes and severe tsunami damages in the past are located at places that will potentially suffer less damage. The possibility that mountain roads are suitable as emergency evacuation routes and that temples and shrines have habitable spaces such as main hall, kitchen, and tatami rooms, some of them have been officially designated as evacuation shelters and shelters during disasters. (Satoshi et al., 2012)

The Nankai region has experienced a significant earthquake at intervals of approximately 100 years and suffered damages from tsunamis.

It is expected that the Nankai Trough Earthquake will occur in the future. Therefore, the Cabinet Office has cited Muroto city, Kochi Prefecture among the five districts considered as Special Enhancement Areas for the Tsunami of the Nankai Trough Earthquake. The maximum height predicted for tsunamis is 24 m if a shock of seismic intensity 7 occurs; this is the highest class for the prefecture. Muroto city has currently designated 14 facilities as public evacuation shelters, but these facilities are not sufficient to accommodate all the evacuees. (Muroto City Tsunami Disaster Prevention Map, 2015)

* Corresponding author. E-mail address: kim21@fc.ritsumei.ac.jp

Table 1 shows the designated evacuation shelters of Muroto city and number of evacuees who can be accommodated in the shelters, number of evacuees estimated by Muroto city, number of evacuees who cannot be accommodated, and the accommodation possible rate. From this, the problem of inadequate accommodation for evacuees in the disaster shelters designated by Muroto City is expected to continue.

Table 1: Number of evacuees who can be accommodated in the designated evacuation shelters and number of evacuees in each area, number of evacuees who cannot be accommodated and accommodation possible rate for Muroto city.

Area	Capacity of evacuation shelters	Number of evacuees	Accommodation possible rate (%)
Sakihama	170	1348	12.6
Muroto	1439	3250	44.2
Murto Misaki	1497	3392	44.1
Kiragawa	728	1800	40.4
Hane	1043	1578	66

1.2.Objectives of the Study

We targeted Muroto city in Kochi prefecture in this study based on the above facts. The lack of evacuation shelters and shortage of stocks are challenges assuming enormous damage due to the Nankai Trough Earthquake. Our objective was to find out the number of people who can be accommodated, stocks, evacuation routes, and evacuation center management assuming that temples and shrines are utilized during disasters caused by tsunamis. We also evaluated how temples and shrines can be used as disaster prevention shelters during tsunami disasters.

2. Temples and shrines targeted for the survey and research methods

2.1. Information on the temples and shrines targeted for the survey

The temples and shrines selected for this survey were;

(1) Located outside the tsunami inundation area, 15 m above the sea level, and within a distance of 300 m from the coast and,

(2) Selected as the evacuation shelter for the district in the resident's workshop conducted by Muroto city in 2011.

A total of 25 temples and shrines satisfied either (1) or (2). Table 2 shows the temples and shrines that were targeted for the survey, whether they are selected as evacuation shelters in that district, height above the sea level, and distance from the coast. The reason for selecting temples and shrines of (1) was because the standard height above sea level for evacuation has been set to 15 m in Muroto city. The time for a tsunami to reach the Muroto city coastline is 0 to 5 minutes. If the time available for evacuation is set to 5 minutes and walking speed is considered as 1.0 m/s, the distance up to which people can be evacuated is 300 m. The temples and shrines of (1) were selected based on the above reasons.

There was a shortage of shelters to accommodate evacuees in the Hane area, but since there were no temples and shrines in the region fitting the conditions set in (1) and (2), we decided to exclude this area from the present study.

Table 2: Temples and shrines that were targeted for the survey, whether they are selected as evacuation shelters in that district, height above the sea level, and distance from the coast.

Area	Name of temple/ shrine	Selected as evacuation shelters	Height above the sea level (m)	Distance from the coast (m)
Sakihama	Hozen-ji	O	27	129
	Sakihama Hachimangu	O (a hill behind)	12	271
	Hamamiya-shirine	O (a hill behind)	12	331
	Dainichi-dera	O (a graveyard of the temple)	16	447
	Myogen-gu	O	65	1050
	Isobe-shrine	O	16	140
	Tenjin-gu	O	16	210
Muroto	Chudo-ji	O	20	294
	Iwato-shrine	X	21	242
	Ichiki-shirine	O	22	335
	Sugio-shrine	O	19	590
	Tsusho-ji	O	35	375
	Houdo-ji	X	18	997
Murto Misaki	Yasaka-shrine	O	26	310
	Hachiouji-gu	O (a hill behind)	15	310
	Yasaka-shrine	O	17	102
	Sugio-shrine	O (a hill behind)	40	258
	Koufuku-ji	O	20	229
	Meijoraiei-ji	O	19	138
	Zendo-ji	O	18	198
	Ouji-gu	X	23	160
	Suzuki-shirine	O	18	186
Kiragawa	Kansyo-ji	O	20	266
	Ondahachiman-gu	X	26	321
	Taniguchi-shrine	O	20	330
Hane	n/a	-	-	-

2.2.Research methodology

To conduct a field survey of all the temples and shrines of Muroto city, interview-based surveys of the chief priests present in 10 of the 25 temples and shrines were formulated. In the survey, we checked the both internal and external areas, evacuation routes and guidance lights, and availability of fire protection equipment in the temples and shrines. In the interview-based survey, we surveyed the food stocks, year of construction, emergency drills, and relationship with the residents of the surrounding locality and nearby temples and shrines.

3. Estimation of the number of evacuees based on the actual survey.

3.1. Information on the external area size

We measured the size of the external area of all the temples and shrines with the actual survey. The external areas within the premises that can be used as evacuation shelters were identified. The number of people who can be temporarily evacuated to temples and shrines was calculated by considering the space required as 1 m^2/ person. Table 3 shows the external area of temples and shrines and the estimated number of people who can be evacuated.

Table 3: Size of the external areas of temples and shrines, and estimated number of people who can be evacuated

Area	Name of temple/ shrine	Size of the external areas (m²)	Number of possible evacuees who can live in
Sakihama	Hozen-ji	406	406
	Sakihama Hachimangu	2790	2790
	Hamamiya-shirine	252	252
	Dainichi-dera	568	568
	Myogen-gu	135	135
	Isobe-shrine	110	110
	Tenjin-gu	168	168
Muroto	Chudo-ji	340	340
	Iwato-shrine	697	697
	Ichiki-shirine	24	24
	Sugio-shrine	133	133
	Tsusho-ji	51	51
	Houdo-ji	125	125
Murto Misaki	Yasaka-shrine	82	82
	Hachiouji-gu	332	332
	Yasaka-shrine	59	59
	Sugio-shrine	282	282
	Koufuku-ji	123	123
	Meijoraiei-ji	300	300
	Zendo-ji	168	168
	Ouji-gu	539	539
	Suzuki-shirine	40	40
Kiragawa	Kansyo-ji	406	406
	Ondahachiman-gu	954	954
	Taniguchi-shrine	96	96

3.2.Information of the internal area size

For the temples and shrines that were targeted in the present study for survey, we confirmed the locations within the temples and shrines for evacuees to live during their evacuation, such as the main hall and kitchen that were determined by the chief priests, and interior spaces that we could survey for 12 temples and shrines during the survey.

The area required per person to live during evacuation at temples and shrines was set to 1.62 m2/person. (Taku et al., 2009) Table 4 shows the size of internal area of temples and shrines and the estimated number of evacuees who can live in the area.

Table 4: Size of the internal area of temples and shrines and estimated number of evacuees who can live in the area

Area	Name of temple/ shrine	Size of the internal areas (m²)	Number of possible evacuees
Sakihama	Hozen-ji	41.65	25
	Dainichi-dera	89	55
Muroto	Chudo-ji	63.75	39
	Tsusho-ji	58	36
	Houdo-ji	83	51
Murto Misaki	Koufuku-ji	94.11	58
	Meijoraiei-ji	169.07	104
	Zendo-ji	298.1	184
	Sugio-shrine	63.28	39
	Ouji-gu	99.8	62
Kiragawa	Kansyo-ji	159.1	98
	Ondahachiman-gu	59.3	37

4. Situation of stocks, facilities, relationship with surrounding residents and nearby temples and shrines based on the interview-based survey

We conducted an interview-based survey with the chief priests of 10 temples and shrines targeted for the survey and confirmed information on stocks, equipment, and relationship with the residents of the surrounding locality and nearby temples and shrines.

4.1.Information on stocks

We checked the availability of food, water, futon, and other stocks. Tables 5 and 6 show the stocks in temples and shrines where we conducted the interviews.

Table 5: Results of the interview-based survey (1)

Area		**Sakihama**	**Muroto**		**Murto Misaki**	**Kiragawa**
Name of temple/ shrine		**Hozen-ji**	**Chudo-ji**	**Tsusho-ji**	**Koufuku-ji**	**Ondahachiman-gu**
Selected as evacuation shelters		O	O	O	O	O
Date of investigation		5th Aug. 2016	3rd Aug. 2016	18th Nov. 2016	3rd Aug. 2016	17th Nov. 2016
Results of stocks	**Food**	only for family`s daily	n/a	Instant noodle 2 boxes	n/a	only for family`s daily
	Water	a cistern	a well	only for family`s daily	n/a	only for family`s daily
	Futon	10 sets	3 sets for visitors	only for family`s daily	4 sets	5 sets

Table 6: Results of the interview-based survey (2)

Area		Sakihama	Muroto	Murto Misaki		Kiragawa
Name of temple/ shrine		Dainichi-dera	Houdo-ji	Meijoraiei-ji	Zendo-ji	Kansyo-ji
Selected as evacuation shelters		O (a graveyard)	O	O	O	O
Date of investigation		16th Nov.2016	14th Nov. 2016	4th Aug. 2016	4th Aug. 2016	3rd Aug. 2016
Results of stocks	Food	only for family`s daily to preserve dried food offerings for emergency using	n/a	n/a	only for family`s daily	n/a
	Water	only for family`s daily	only for family`s daily	only for family`s daily	n/a	only for family`s daily
	Futon	10 futon sets 25 floor cushions	5 futon sets 50 floor cushions	3 futon sets	3 futon sets 100 floor cushions	3~4 futon sets

Even though some of the temples and shrines had been selected as evacuation shelters for the region at the residents' workshop in 2011, we did not find any temples and shrines with food stocks since none of the temples and shrines were considered to be used as evacuation shelters to support evacuation for long durations.

4.2.Facilities of temples and shrines

We confirmed the year of construction, availability of heating appliances, restrooms, and bathrooms in the temples and shrines. Tables 7 and 8 show the stocks in temples and shrines where we conducted the interviews.

Table 7: Results of the interview-based survey (3)

Area		Sakihama	Muroto		Murto Misaki	Kiragawa
Name of temple/ shrine		Hozen-ji	Chudo-ji	Tsusho-ji	Koufuku-ji	Ondahachiman-gu
Selected as evacuation shelters		O	O	O	O	O
Date of investigation		5th Aug. 2016	3rd Aug. 2016	18th Nov. 2016	3rd Aug. 2016	17th Nov. 2016
Results of building condition and facilities	Construction and restoration year	Only for family`s daily	n/a	Instant noodle 2 boxes	n/a	Only for family`s daily
	Air conditioner	a cistern	a well	Only for family`s daily	n/a	Only for family`s daily
	Bath	10 sets	3 sets for visitors	Only for family`s daily	4 sets	5 sets

Table 8: Results of the interview-based survey (4)

Area		Sakihama	Muroto	Murto Misaki		Kiragawa
Name of temple/ shrine		Dainichi-dera	Houdo-ji	Meijoraiei-ji	Zendo-ji	Kansyo-ji
Selected as evacuation shelters		O (a graveyard)	O	O	O	O
Date of investigation		16th Nov.2016	14th Nov. 2016	4th Aug. 2016	4th Aug. 2016	3rd Aug. 2016
Results of building condition and facilities	Construction and restoration/ retrofitting year	Main hall: 1942 Re-roof: 2000 Reception room: 2003 Residential area: 2003	Approx. 1980 No retrofitting (RC frame)	Main hall: 1984 Residential area: 1985	Main hall: Edo era (17C) Restoration of main hall: 1971 mortuary room: 1995	Taisho era (19C)
	Air conditioner	1 at main hall 1 at reception room 1 at residential area	No air conditioner 5 kerosene oil stoves	1 at residential area	1 at main hall 1 at mortuary room 5 kerosene oil stoves 6 air fans	9 air fans 5 kerosene oil stoves 1 air conditioner at residential area
	Wash room	1 at main hall 2 at residential area	2 toilets for men 1 toilet for women 2 at residential area	1 at main hall 1 at residential area	1 toilet for men 1 toilet for women	1 at main hall 1 at residential area
	Bath	1 at residential area	1 at residential area	1 at residential area	1 at residential area	1 at residential area

4.3.Relationship with the residents of the surrounding locality

Temples and shrines that were used as evacuation shelters during the Great East Japan Earthquake had a strong association with the residents of the surrounding locality involving the temple priest and patrons supporting the temples and shrines. This bond made identification of the evacuees easy, and the residents felt safe[1)] as they shared a bond with the chief priests of the temples and shrines. It is known that during disasters, the association between the temples and shrines and residents of the surrounding locality is a factor that helps in collecting information and giving mental relief to the residents. Therefore, we conducted an interview-based survey for the temples and shrines of Muroto city targeted in the present study to find out the relationship between the temples and shrines and the residents of the surrounding locality.

At all the 10 temples and shrines where we conducted the interview-based surveys, the chief priests and patrons supporting the temples and shrines became acquainted during Buddhist memorial services and local festivals. We found that seven temples and shrines out of the total 10 regularly conducted emergency drills after they were selected as evacuation shelters of the district at the workshop held in 2011.

4.4.Relationship with other nearby temples and shrines

During the Great East Japan Earthquake, temples and shrines belonging to the same religious sect in the Kanto and Kansai regions delivered the necessary supplies to the temples and shrines that were used as evacuation shelters and had formed voluntary organizations. In addition, they exchanged relief supplies such as food with the temples and shrines that were used as evacuation shelters in the surrounding areas. We found that during disasters, the community associated with a particular temple or shrine supplied relief materials and engaged in voluntary activities. Therefore, we conducted an interview-based survey for the temples and shrines of Muroto city targeted in the present study to find out the relationship between the temples and shrines with other nearby temples and shrines.

We conducted an interview-based survey and found that 7 out of the 10 temples conducted Buddhist memorial services and festivals with other nearby temples and shrines belonging to the same religious sect. For example, Tsusho-ji, Myoujoraiei-ji, and Dainichi-dera celebrated festivals together.

The region between Yasuda and None areas in the southern part of Kochi prefecture houses temples of Jodo Shinshu belonging to the Aki sect. Once or twice a year, the chief priest brings all the people together so that they can get to know each other.

5. Conclusions

Table 9: Designated evacuation shelters of Muroto city, number of evacuees who can be accommodated only in the internal spaces of the temples and shrines surveyed and number of evacuees in each area, number of evacuees who cannot be accommodated and accommodation possible rate.

Area	Name of temple/ shrine	Number of possible evacuees	Number of maximum evacuees against tsunami	Number of evacuees who cannot be accommodated	The possible accommodation rate (%)
Sakihama	Sakihama DRM Center	30	1348	1095	18.8
	Sakihama Nursary	143			
	Hozen-ji	25			
	Dainichi-dera	55			
		Total: 253			
Muroto	Muroto high school	564	3398	1833	46.1
	Otani community hall	197			
	National Muroto youth hall	678			
	Chudo-ji	39			
	Tsusho-ji	36			
	Houdo-ji	51			
		Total: 1565			
Murto Misaki	Muroto central park	200	3392	1448	57.3
	Prefectural Muroto gym	1297			
	Sugio-shrine	39			
	Koufuku-ji	58			
	Meijoraiei-ji	104			
	Zendo-ji	184			
	Ouji-gu	62			
		Total: 1944			
Kiragawa	Kiragawa primary school	270	1800	937	47.9
	Kiragawa community hall	428			
	Kiragwa DRM center	30			
	Kansyo-ji	98			
	Taniguchi-shrine	37			
		Total: 863			

Table 9 shows the designated evacuation shelters, number of evacuees who can be accommodated only in the internal spaces of the temples and shrines surveyed, number of evacuees in each area, number of evacuees who cannot be accommodated, and accommodation possible rate. From Table 9, the accommodation rate increases when temples and shrines are used as evacuation shelters: for Sakihama area from 12.6% to 18.8%, Muroto area from 44.2% to 46.1%, Muroto-misaki area from 44.1% to 57.3%, and Kiragawa area from 40.4% to 47.9%. We found that there was a shortage of evacuation shelters required to accommodate all evacuees during an evacuation in all the areas when an earthquake occurs.

There were no temples and shrines of Muroto city with stocks, and facilities such as emergency supply storehouses where stocks can be stored must be arranged to utilize the temples and shrines as evacuation shelters during disasters. However, temples and shrines have offerings, and there are some reports where offerings of temples and shrines have been used during the Great East Japan Earthquake. In the Dainichi-dera of Sakihama area, we were informed during the interview-based survey that the offering was changed from perishables to dry bread for effective storage after they saw images of the temples that were used as a shelter during the Great East Japan Earthquake. Temples and shrines have offerings, and this may be useful in times of disaster.

There were five places where emergency drills are held for understating the evacuation routes to the temples and shrines, and it is likely that the residents will be aware of the evacuation routes to temples and shrines during disasters.

We found that all temples and shrines provided the required space for evacuation centre management. Due to the presence of the Aki sect, it is considered that exchanging goods and grasping the damage situation become easy.

Acknowledgements

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Protection of cultural heritage in case of forced mass migrations and its contribution to community rehabilitation during return process

Saadet Gündoğdu [a,*], Zeynep Gül Ünal [a]

[a] Yıldız Technical University, Turkey

Abstract

This study aims to examine the issue of protecting tangible and intangible cultural heritage whose existence is threatened by man-induced disasters such as war and armed conflicts, as well as the resulting forced migrations; and to discuss the role that cultural heritage as a driving power might play in returning home. Studies conducted on forced migration in terms of different parameters since the last quarter of 20th century by international organizations specialized in the subject show that the relationship between the migration and the cultural heritage as a constituent of migrant communities' collective memory is becoming an issue of bigger concern as the number of migrant increases. In this context, it seems that emergency actions are required as a step forward from treaties concluded and recommendations issued on protection of cultural heritage. The fact that displaced communities by migration constitute the key point of issue; significance of sustainable returns in case of displacements by mass migrations; role of cultural heritage as a driving force in social and physical rehabilitation should be carefully considered when taking actions. That the sustainable development in the long run is made possible by the resources of country exposed to disaster; local structure production knowledge; specific user participation evidences the necessity of specific users' returning home.

Keywords: Cultural heritage; war-conflict; the return home and protection planning; collective memory; sustaining culture.

1. Introduction

International organizations working on the elimination of the effects of war and armed conflict evaluate the intensity of the conflict on the basis of its physical impact and its impact on people. The forced mass migrations resulting from the occurring destruction, accelerates the loss of both the tangible and intangible cultural heritage and engenders new risks on more than one issue.

Global Trends 2016 report published by United Nations High Commissioner for Refugees (UNHCR) indicates that the number of forced displacement due to **security concerns** reached 65.6 million people by the end of 2016.

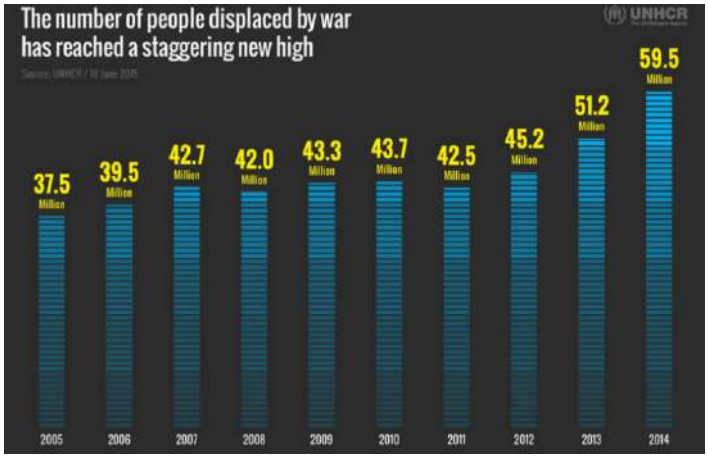

Figure 1: The number of persons displaced due to wars after 2005 according to the 2015 UNHCR report

* Corresponding author. E-mail address: saadetgundogdu@gmail.com

Taking case of Bosnia-Herzegovina, Kosovo, Lebanon, armed conflict-migration-return-cultural heritage protection relations, as well as similar destruction process started in Syria in March 2011 were investigated in respect thereof. In this study, a model recommendation on "the planning of repatriation in forced mass migrations due to human induced disasters, and of the rehabilitation of the historical environment" was also developed as guidance for setting strategies to enable taking of appropriate actions throughout, during, and particularly after the armed conflicts with the aim of reducing risks that the cultural heritage is put under as a result of forced migrations.

2. The Emphasis on the Subjects of Conflict, Migration, Repatriation, Cultural Heritage and Local Participation in International Conventions / Meetings

Many difficulties were experienced in risk quantification, as **disaster risk awareness** was not systematically assessed on a **global** level up until the turn of the 21st century. It was only realised that risks could be mitigated and systematically assessed following the 1989 IDNDR Declaration.

When looked at the treaties ratified by several countries, relationship between mass migration and cultural heritage is not defined; some of them underlined that culture and heritage could be positive drivers for recovery of cities; and grounds should be laid for promoting the main role that the two play in human development.

The Paris Declaration, 2011, highlights tha**t** sustainability is an act that **combines tangible and non-tangible cultural heritage** and one that prompts a development process. Furthermore, it also stresses that "the sense of place and the spirit of place" is a necessary vision and condition to preserve the integrity of heritage in every sense.

Within the 2012 UNESCO **Sustainable Development** theme, Article 17 emphasizes the dynamic interaction between tangible and non-tangible aspects of facets of cultural heritage. It explains that heritage has a much more comprehensive definition, highlights the prosperity and inherent connections of local communities, and also underlines sustainable development (UNESCO, 2012a). By focusing on community involvement and the development of heritage/the improvement of heritage (UNESCO, 2012b, p.2), the three target groups in practice are defined as**: practitioners, institutions and communities**. In the **spirit** of the heritage sites in the 2011 Paris Declaration, and following the **role of the local community** in Kyoto 2012, the implication to be made is this: Great importance must be given to protecting the historical spaces along with the people using those spaces after armed conflict, when it comes to any practical or intellectual applications.

On the subject of the preservation of Sendai's cultural heritage (2015), the necessity of disaster risk reduction planning and the strengthening of the resistance of the heritage are emphasized. Moreover, demographic changes that exacerbate disaster risks and special precautions which focus on combatting to reduce the effects of disaster risks are addressed.

In the SDG and Habitat III, it is stated that social, economic and environmental dimensions are inseparable components of sustainable development and that the human factor, besides being the main factor in the creation of cultures, is essential in the sustainability of culture as well. The SDG requires the recognition of cultural heritage's role in enabling social cohesion and participation; supporting immigrants settling into their space, the integration of new settlements and existing settlements and the usage of cultural heritage for sustainable urban development; and its role in promoting participation and accountability. In the 11.4 objective of the SDG's it is explained that the preservation of heritage enables the creation of a link between urban participation and sustainability.

UNESCO's "Strategy for The Reinforcement of UNESCO's Action for the Protection of Culture and the Promotion of Cultural Pluralism in the Event of Armed Conflict" No 39/C, dated October 2017, approaches the issue of raising global awareness about the fact that cultural protection during armed conflicts would be devised in strengthening fast recovery; and emphasizes the solution under the title "The Key to Lasting Peace". In this vein, the actions conducted with the purpose of preserving cultural heritage under attack, must complement the preventive and intervention measures taken to manage disaster risks pertaining to cultural heritage (UNESCO, 2017).

3. Comparative assessment of case studies in Bosnia and Herzegovina (1992-1995), Kosovo (1998-1999), Lebanon (1975-1990) and Syria (2011-)

While three of the four areas selected for case studies describe war, migration, repatriation, cultural heritage, restructuring and displacement, and the rupture of cultural continuity in the context of war and migration; the last

example attempts to examine the situation of a country where the armed conflict is ongoing. A questionnaire was also made by directing questions related with topics such as cultural heritage at homeland of Syrian citizens, whose majority migrated to Turkey due to armed conflict; as well as pre-conflict historical/ social texture, alterations in physical space were questioned with the aim of revealing perception about cultural heritage protection.

The most prominent common point of the selected regions is that many ethnic groups have been living together for centuries, hence enabling the formation of a highly rich cultural heritage. Nevertheless, alongside this there are differences in terms of restructuring strategies, concepts adopted to achieve this, and the conditions controlling the course of the process.

In order for applications to be carried out in historic regions/areas and to expediate the return of people the clearing of unexploded ordnance is necessary.

In the case studies, no program information was obtained regarding the clearance of debris, such as the designation of rubble dump sites etc. Moreover, other information on the subject such as the removal and storage of usable rubble (damaged/ undamaged, traditional/ local building materials) has not been obtained either.

3.1.Returning home and population distribution

It is much easier to manage the repatriation and rehabilitation process in returning home, since information on the traditional/ local building production and the use of traditional/ local materials, especially in areas which are rife with historical structures, is available in resources.

When scrutinized in this context, the lengthy period of conflict in Lebanon does not allow for a sound assessment of migration and return records. The population of Lebanon was 2.6 million in 1975 when the war began. According to the records of the UNHCR between 2005-2007, 680.000 people have returned. Based on this it is thought that 1.5 million people in Lebanon, accounting for more than half of the population, have migrated and that the returning population is close to half of the migrating population. In 1991, in Bosnia and Herzegovina the population was 4.4 million, a total of 2.5 million people migrated and approximately half of them returned. In Kosovo, the total population in 1997 was 1.97 million, from which about 1 million people migrated, and a total of 467,900 people returned between the years of 1999 and 2016.

Considering the above numbers, it is observed that in cases of war/ armed conflict, the internally displaced coupled with those who migrated abroad constitute more than half of the population of the country in almost every single case. In addition, even though the available data varies across different sources, when the repatriation records are examined, it is seen that more than half of the migrating population returns. This data can provide us with a future projection for the case of Syria. In this situation, solutions for rehabilitation and returning home must be developed, programs must be established, and the protection period must be considered in this context, taking into account the population movements and numerical data.

3.2.Methods adopted in the rehabilitation of the historical environment, residential restructuring programs, and the use of financial resources

In the approach adopted during the rehabilitation stage of post-conflict cities, various methods were used together in the revitalization of the cities. When research is carried out in case studies on the housing production approach, the implementation methods encountered are the contractor (the contractor) model and the self-build model.

The projects were managed and implemented centrally, resources were utilised efficiently, the historical area rehabilitation works were harmonised, and coherence and cohesion were prioritised in reconstruction. Hence, a highly comprehensive operation was achieved in Lebanon. However, in Beirut's Central Area, the restructuring solely catered to the upper crust of the society and the reconstruction here intensified neglecting the surrounding regions of the country and its residents. This is regarded as one of the main obstacles for Lebanon in attaining sustainable peace.

In the case of Bosnia, it is evident that there are difficulties in systematising the post-war rehabilitation implementations. Since the laws and regulations cannot be established or implemented immediately, various difficulties have been experienced in the directing of financial resources. In Bosnia and Herzegovina, the budget that was accrued through aid amounted to a large sum and yet the majority of the projects were undertaken by different companies outside of the local government.

According to the assessment of the institutions working on the subject, it is thought that the costs would have been under 40% had the dwellings been built through **the self-build model** projects (SIDA, 2001). Moreover, the assessment shows that some of the repair works done through the implementation of the self-build model adopted in Bosnia and Herzegovina between 1996 and 1997 with the assistance of the UNHCR, were of low quality and also that 60% of the budget allocated for repairs was spent on preventing the further deterioration of the houses instead of producing housing (Barakat, 2003, p.34).

In Kosovo, national reconstruction activities have been left to international organizations, traditional building materials have been replaced with standard building materials, and they have been more flexible with new building designs in historical areas. Furthermore, Kosovo has undergone self-building model housing reconstruction work processes, which mostly use informal sector mechanisms; and it has made use of the resources/ capacities other institutions and contractors could never have developed, in an efficient and productive manner. Nevertheless, the 2007 report "Migration and Poverty Reduction in Kosovo" states that despite the high numbers of returnees following the armed conflict in Kosovo, job opportunities are scant; and that although the country has an immigration policy a sound repatriation cannot be realised due to the country's external economic dependence.

In Kosovo, post-conflict conservation principles have been neglected due to the expediated work conducted by non-expert institutions, organizations and persons; and restoration work has been carried out in a manner that has erased all traces of destruction. Despite the 18 years that have passed since the conflict in Kosovo, sound protection project programs, workshops and activities have only just been initiated with projects done in the last 5 years. In Lebanon, the Waad Project progressed with its user involvement content but this project only started in 2006, 16 years after the armed conflict.

In Bosnia-Herzegovina, there have been several resident changes in houses due to urban migration from rural areas and people from nearby villages settling into the houses of the Serbs who had left the city. Nevertheless, the lack of the need for housing led to an increase in residing in low quality houses. The UNHCR launched the project "Open Cities" to enable the return of refugees and people who have been displaced due to war to their former homes.

3.3.The evaluation of the survey study conducted with Syrian guests living in Turkey

During this process many salient responsibilities fall on the shoulders of countries hosting immigrants who have been forced to mass migrate due to war or armed conflict. It is expected that the surveys conducted with Syrian students living in Turkey will contribute to the development of a more comprehensive program pertaining to the protection of cultural heritage and the return process during and after wars/armed conflicts which are ensuing in Syria and which can be experienced anywhere in the world.

When the answers provided by the survey participants were assessed; it was seen that the responses given to many different questions included descriptions and names of historical places/areas even though the concept of cultural heritage had not even been mentioned in the survey.

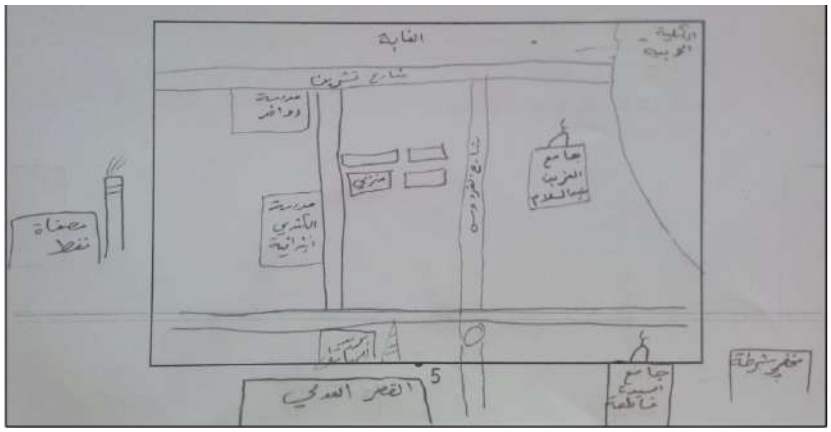

Figure 2: Survey question 20, mental mapping, drawing of student who participated in the survey

4. The planning of repatriation in forced mass migration due to wars and armed conflicts, and of the rehabilitation of the historical environment

A comprehensive and sustainable **disaster management** program comprised of the above-mentioned processes, concepts, solutions, based on return migration and the preservation of cultural heritage should be developed; specific models should be generated; **the role, significance and necessity of repatriation in reconstruction** should be discussed and research must be carried out in this area.

4.1.The disaster management approach to be implemented before and during wars armed conflicts

Endeavouring to reduce the vulnerability before disasters contributes both to mitigating disaster risks and to **sustainable development**.

In the event that cultural heritage is damaged or destroyed, storage options for the storing of cultural rubble should be considered; spaces for temporary shelter in safe areas within the country should be identified (location, structures, etc.) and organised; a team to work on immigration and settlement should be formed; international legal consultations should be arranged with countries from which temporary shelter systems that can be assembled rapidly can be acquired (with countries that are close/ at a reasonable distance with no transportation difficulties). In emergencies there are people (emergency actors) working as officers and using construction vehicles in areas that are forbidden/unsafe to enter after disasters. These people should receive training in the areas of the preservation/protection of cultural heritage/architectural works.

The values/artefacts and buildings in key areas (library works, museum artefacts, portable cultural assets) should be collected at a centre and temporarily transferred to another country if necessary; some objects should be placed underground; the border countries of the countries experiencing conflict/ war should be subject to the existing legislation on the transport of the artefacts, precautionary measures should be strengthened; an online information network of cultural heritage and cultural sites should be established. Registered cultural heritage lists and inventory information should be preserved. Information regarding the demographic structure, property owners, architects/ conservation experts, master builders, employees should be preserved; people working on the subject and experts in this area living abroad, who are well-acquainted with the characteristics and heritage of the region should be contacted. The aforementioned steps should be taken, and their continuation should be maintained until the peace process. Thus, if the process takes longer, the changes will have been documented.

In forced mass migrations during armed conflict: settlement planning should be done bearing return in mind; temporary settlement areas should be determined with other available alternatives. Projects should be developed on cultural heritage loss/the protection of damaged structures during conflict , after the end of the armed conflict the revitalization and regeneration of the area must be thought out and planned; those who will be working in the areas of repairs/comprehensive repairs/strengthening activities and reconstruction should be determined along with their means of employment, great importance must be given to the issue of the illegal trading of looted ancient artefacts and ensuring that they are not smuggled outside the borders of the country.

Turkey is one of the countries hosting the largest number of Syrian refugee guests during the armed conflict in Syria, and during this period, several practices and studies have been carried out in Turkey on the protection and preservation of the cultural heritage of Syria.

4.2. Post war/armed conflict disaster management approach

In the context of the protection of cultural heritage and repatriation, the conceptual infrastructure must first be defined for post-conflict disaster management practices.

Once all the studies have been brought together; the vision, participation (community participation/ participation in management), security (the creation of a safe and stable environment), reconciliation and justice, equality (social and economic development and prosperity), restructuring and development, restriction capacity/ capacity building and sustainability/ sustainable development should all be planned as a whole in the applications to be carried out after the disaster.

Once equality is established this brings about a healthy participation process. Changes are seen in the demographic structure due to armed conflict. Post-war women, disabled adults, unaccompanied children, farmers, industrial workers, returning immigrants and former fighters constitute a vast majority of the country. When peace is achieved, these groups need to be integrated into the practices.

As seen in the case studies investigated, it should be decided what kind of road/ vision should be followed at the beginning of conservation/ restoration works of the historical environment, new construction and other implementations. First, a legal/ managerial framework should be established. The cohesion of the material to be used, the application models and the actors involved in the application should be considered. A working plan for the long, medium and short term should be drawn up. Mostly short-term work is encountered in case studies. Importance should be placed on the improvement of not only the central areas but also of their surrounding areas. Work should be carried out within the framework of specific program decisions.

The development of local skills and materials, as a step-by-step approach, allows time for further public participation and, more importantly, it makes it easier **to reduce the dependence on external sources and to attain sustainability**.

After the armed conflict; the traditional production capacity, access to local materials, and the ability to supply enough local materials gains significance.

The resumption of the physical production of monumental structures, civil architectural elements and local productions in workshops in order to rebuild social ties makes it easier for communities to return to their daily lives in the aftermath of armed conflict. Therefore, cultural continuity and the coexistence of the space and the users is maintained constantly.

It would be pointless to rebuild an entire city that has been destroyed in the war, and to restore the entire fabric of a city in ruin after the war. The reconstruction process **requires a different approach in each case**, depending on the particular circumstances in each area.

4.3.A proposed model

The fact that the local user is involved in the practice of restoring the cultural heritage in the process of restructuring, and that cultural heritage constitutes a driving force actively ensuring sustainability in the return process, provides a systematic framework within the context of the "Planning of return/ return home and historical area rehabilitation in the context of forced mass migrations due to human induced disasters" model.

Furthermore, the country that has newly emerged from war/ armed conflict should facilitate the sustainability of the return process in every context, and the countries hosting the migrants should help with **staggered repatriation** during the return process once peace has been achieved.

Table 1: Action Plan for the post armed conflict protection of cultural heritage and repatriation planning

A	Regulating legal procedures and Planning user participation
B	Using and sharing funds, the regulation of the distribution of income sources
C	Planning the clearance of unexploded ordnance and debris
D	Conducting a post- disaster/ incident analysis of situation and need
E	Storage of usable rubble (damaged/ undamaged, traditional/ local building materials)
F	Analysis of damage
G	Evaluation analysis of damage
H	Beginning of returning home activities
I	Classifying cultural heritage values regarding protection criteria
İ	Making reconstruction application decisions
J	Preparing protection project
K	Taking decisions pertaining to traditional material procurement and usage
L	Procurement and usage of technological materials
M	Taking decisions on new design/ new placement decisions

It should be noted that all the areas damaged after the disaster cannot be repaired/ renewed at the same time. Cultural heritage values should be revaluated in the context of **the remaining heritage**; damaged and demolished structures must be rebuilt; conservation areas should be reidentified regardless of whether their borders have changed or not; borders/ areas should be reassessed and recorded.

Although a new city will be built on the remains by preserving old remains and traces of war, with the aid of technological applications, the reconstruction and the demolition of some structures constitutes a necessity. Vision-wise the new structures should be grounded in the existing accumulation of the country, demolitions should be considered objectively and by taking into account the space, people, existing tradition of the structures, cultural applications and ways of life; a reconstruction/ repair vision should be formed within the context of these elements.

When looking at the issue within the context of post- war/ armed conflict **protection theory**, the concept is either shifting or evolving. Building upon old accumulation is also a form of **restoration work**, since originality should not be compromised.

5. Conclusions

Disasters affect the social environment as well as the physical environment and cause changes. A kind of **social interruption** also occurs. The bond that cultural heritage creates between a society and its past, collective memory and identity becomes even more prominent after the disaster. The collective memory of societies also migrates when migration occurs, and even dissolves, and disappears with time. Children leaving their homeland before their collective memories are even formed, will result in **the rupture/ interruption of traditions that have been passed down for generation**s.

It is seen from the human induced disasters in the past years that the interventions made against historical monuments during war/armed conflict resemble each other. As it is evident from the cases of Bosnia, Beirut, Kosovo, Yemen, Iraq and Syria; the deliberate attacks on, firstly, libraries, museums and places where historical information/documents are stored followed by the attacks on world heritage siteswhich are universal values that represent the continuity of cultures, that have been around for centuries and which are the symbols of civilizations–are escalating each day. Since cultural heritage is regarded as a value for all humanity, the values that are being destroyed are the values belonging to all of humanity as well. Therefore, in cases of war/armed conflict/security problems, it is necessary to develop contracts/ regulations/ laws at an "international platform" while searching for solutions.

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Architecture and war: a look at the city of Aleppo

Margarida Louro [a,*], Inês Ribeiro [a]

[a] Faculty of Architecture, University of Lisbon, Lisbon, Portugal

Abstract

This theme Architecture and War has as main scope the reflection about the role of architecture and its relation with the contexts of war, destruction and crisis. In fact, one of the great scourges of the twenty-first century is the explosion of conflicts and threats that arise from all parts, abruptly and unexpectedly. Daily the media report situations of war, attacks, and deaths, where armed confrontations have increasingly become a reality, making this a pertinent topic of urgent reflection. Faced with these contexts of instability we must find solutions to problems that are being created, believing that more and more the word unpredictability is part of the daily lives of many people who deal with it day by day. In the background, being the architecture in its structural base a system of ordering, rule, harmony, in the confrontation with the collapse, establish new logics of survival and spatiality towards this unpredictability.

Keywords: War, Destruction, Aleppo, Human Living, Home

1. Introduction – Memory and Architecture

Figure 1: War moments – photo montage, Inês Ribeiro, 2017.

Understanding the assumptions underlying the restructuring of the role of the architecture faced the war are the main objectives of this research and intervention, based on the following points: to analyse the theme of destroyed cities and the role that architecture plays in its relation with memory of spaces and places destroyed; realize the true importance of emergency architecture in a scenario of destruction and collapse; propose a transitional shelter solution to respond to real needs by focusing on a specific example, as context of analysis, in the face of an immediate response situation in several times: short and medium term.

The methodology was based on perceiving the behaviour of the people in a scenario of war, where their city, their houses and all its roots happened to be part of a scenario of destruction. And in this sense understanding what the role of memory in architecture becomes a primary relevance.

* Corresponding author. E-mail address: mlouro@fa.ulisboa.pt

Memory assumes itself as a psychic faculty that allows us to store information. It is with this characteristic of the human being that knowledge is consolidated allowing us to learn. Our identity is made up of everything we have experienced since our brain has developed this ability to withhold information. One of the main building blocks of architecture is memory.

According to John Ruskin (1988) memory in architecture is given to us as a souvenir, the idea of constructing a space that provides the comfort and safety of a home that can be maintained over time passing from generation to generation a family heirloom. This notion of the durability of the architecture is what allows to create this memory in the architecture making the architecture itself into an inheritance. With the thought of John Ruskin we have been able to base what memory brings back to our notion of the value of architecture, a house is in our daily lives the accumulation of countless actions and moments that we are collecting throughout life and that will help us to define every space we inhabit. If it is possible for a space to be experienced consecutively by different people who make it the same experience, even in different generations, it will give it an enormous emotional load, also gaining a very significant patrimonial value.

"Since ancient times it has been recognized that different places have different character. Such a difference of character is often so strong that it is sufficient to determine the basic properties of the exterior images of the majority of the persons present, making them feel what they experience and which belong to the same Place. (...) the existential space cannot be understood only because of the needs of man, but rather only as a result of their interaction and reciprocal influence with an environment that surrounds them, which they must understand and accept." (Norberg-Schulz , 1975: 33)

Beyond the basic needs of shelter, what holds us to a specific place and not to any one is the experience we had with the place. This experience is made in the way we move in space and the way we orient ourselves. It is important for the man to know where he is and identify a location. The structure in architecture gives us real and physical elements that allow us, through experience, to identify ourselves or not with the places. All the information that we retain throughout life, the result of our actions and our experiences result from simple things like testing our surroundings based on the 5 senses. It is palate, touch, hearing, sight and smell that are the basis of our experience, and this is what will make us identify with the places we frequent and want to inhabit. Christian Norberg-Schulz introduces us the concept of "genius loci" that goes through the personification of this experience that is made of a place. Through this concept we can perceive the exact sensation that a space creates and thus gives it a sense that is always the result of the experience of each one. If we have the notion that each being makes different experiences of the same space always with the influence of what is its "I" (defined by the memory that is the result of a storage of experiences throughout life), then we realize that the same space will have different meanings. The genius loci allows each place to become irreplaceable because once there is a meaning and an identity then reproduction is no longer possible. This poetic side of architecture allows us as architects to provide those who use space, not only comfort and function but essentially experience and memories, giving a unique meaning to each architectural element.

It is increasingly difficult not to worry about the destruction that is being done to the heritage of countless countries that have been involved in armed conflicts in recent years. Robert Bevan (2005) helps us think about how there is always a relationship between the destruction of buildings and the deaths, and how in these scenarios of war and conflict the destruction of architecture is not only a collateral damage, way to promote war. Destroying all the buildings of a city creates not only a new psychological reality but also the destruction of a nation and a rewriting of history. Robert Bevan describes three modes of architectural destruction with different historical examples. The first is reflected in the destruction of ethnic communities and genocide as the destruction of the former Yugoslavia where a new ethnic reality was created with the loss of multi-ethnic communities and Islamic heritage, or the Nazis who destroyed the Jewish architecture as a principle for the holocaust . Secondly the terrorist attacks, which in recent years we have verified its growth mainly in Europe. The terrorist attacks have as their main goal to lower the confidence of opponents, one of the greatest examples of this is September 11 in 2001, a planned terrorist attack against some notable American buildings generating a climate of terror and tension for the purpose of political change. This totally unnecessary form of destruction is revealed in the book as "vengeful vandalism." (Bevan, 2005: 82) The last mode of destruction referenced by Robert Bevan is related to the reorganization of territories, for example Israel, where the architecture was destroyed to reflect a continuous Jewish presence - entire Arab villages were demolished, "the desire of the conqueror to leave nothing recognizable for the exile to return "(Bevan, 2005: 104). In other words, it is a question of reorganizing territories that have been conquered or to reaffirm, for example, a change of government, for revolutionary regimes like the Soviet Union, the destruction of buildings associated with previous governments was an immediate evidence of change.

It is thus perceptible the importance of architecture as a collector of memories and consequently the loss it causes when destroyed and affected by unexpected war situations. The main objective of this study on the importance of memory in architecture is to realize what causes people to often not want to leave their homes and live in areas where danger is imminent and conditions are decaying. The relationship that people create with the spaces they inhabit gives them the necessary sense of security to prefer to continue their daily life in their homes, even knowing the danger they are in, than to seek peace in unfamiliar areas. In this situation the uncertainty of a new home causes more fear and insecurity than remaining in a place of good memories.

It is important then to create solutions for these people who remain in war zones, or any other emergency situation where it is necessary to provide security and basic conditions of survival for those who are in it.

2. The City of Aleppo

So from the study of the city of Aleppo and its massive destruction since the start of the war in 2012, assumed today as the symbol of the massacred city where in addition to everything there are still hundreds of inhabitants who cohabit in this context of destruction, the main purpose of this analysis is to understand the forms of survival and the responses of architecture to new logics and ways of life as a strategy for urban reflection and reconstruction. Thus, this proposal has as its main focus emergency responses, and how architecture and the architect can be fundamental movers in the process of transition between the immediate, a situation of destruction and uncertainty, until a definitive moment, corresponding to the regeneration and recovery of the destroyed city.

Since 2012 we have been following one of the largest armed conflicts in recent years, Syria's civil war. There has been a time since the uprising by various populations in the Middle East against their leaders and governments. The lack of jobs, the economic crisis, and the lack of democracy removed the minimum conditions for them to live. Against these facts and seeking to fight for change, various revolutions and protests of civilians against the regimes of their countries were carried out. Egypt, Tunisia, Libya, Syria, Yemen and Bahrain, were some of the countries involved in this manifesto where called Arab Spring.

In March 2011, in Syria, after some protests against the Bashar al-Assad regime, an armed revolt took place, where civilians took up arms to defend themselves and fight for democracy, and on the other hand the regime fought against rebels who against the government. Soon this revolt intensified, the riots began to take over the cities, first Damascus and finally Aleppo in 2012. However the self-proclaimed Islamic state took advantage of these conflicts, to act and create their space, having to fight the rebels and the regime to conquer territory, ending in 2014 to proclaim his caliphate.

In short, what was a demonstration by civilians seeking freedom of expression and dignity became a battlefield in which civilians (rebels) fight against the Syrian regime (Bashar al-Assad), and both fight to protect invasion of the Islamic state. Great powers such as the United States and Russia were involved in this conflict, only defending their interests, Russia in favor of the Syrian government based on political interests as naval bases linking important points of maritime trade routes, and the US with the eternal struggle against the Islamic state in favor of the rebels.

In the midst of so many geopolitical conflicts of interest there are people. This five-year war has already killed more than 400,000 people and about 4.8 million people have fled seeking asylum in neighboring countries and others in Europe. On the other side of the war there are those who just want to continue their lives in safety, where comfort, food, water and dreams are not limited, a world in which smiling is a right, and access to essential goods is a Warranty. Unfortunately the reality that comes to us shows that more than 2 million people have been displaced and live in precarious conditions.

Today we know that the war in Syria has not ended and the end seems to be far away. We have the role of trying to help those who have seen their lives destroyed. Realize what moves them, their convictions, their fears, their needs, and try as architects to find solutions, to emergency situations like this, in which entire cities are erased destroying memories, lives and dreams.

Since 2012 Aleppo was divided into two parts, the neighbourhoods controlled by the regime the west zone and on the other side the domain area of the rebels, the eastern zone where they lived more than 300 thousand civilians. With the evolution of the war the regime began to create a siege to the city with the objective to dominate definitively all that zone blocking first the road that connects the controlled areas to the north of the country finishing by completely encircling the city.

In this scenario, support and assistance organizations for civilians were eventually prevented from reaching people in besieged areas that were totally inaccessible. This is the strategy chosen by the regime to be able to fight the rebels and the Islamic state, eventually leaving the local people with a huge shortage of resources. Making active the action of architecture as an answer to these problems of rupture and mismatch, promoting new forms of adaptability.

3. Architecture and war

The main result of this approach is effectively, given the contexts of unpredictability and uncertainty, to see how one can through architecture find solutions that adapt to different events, needs and atmospheres. This being the major challenge of this study, to find, through the tragic example of Aleppo solutions that mould and adapt to any emergency of war, promoting new states of urbanity and safeguarding conditions of basic human habitation in extreme situations.

The architecture acts in these scenarios with a social role only, the objective is to create safety zones and to provide the essential means of survival, to provide shelters, hospitals, and sanitation. Unfortunately in the years in which we live these phenomena are increasingly present, thus arising the emergency architecture.

Emergency Architecture is one of the architectural strands where more and more young architects seek to intervene, and the architect has a fundamental social role in these crisis scenarios. This form of architecture, owing to its emergency nature, requires a variety of solutions resulting from various experiments that are molded according to where they are inserted.

According to Ian Davis in his book Shelter After Disaster there are three phases of action in an immediate post-disaster (the first phase and the immediate relief), temporary (a second rehabilitation phase), and permanent (last phase of reconstruction). (Davis, 1980: 13)

In the immediate phase there is a need to seek shelter almost instinctively from the need to survive. When there is a catastrophe and there are people displaced it is necessary to find places where they can shelter all those who can not find accommodation in the home of family and friends, or do not have the financial means to stay in public dormitories. Usually, at an early stage, civil protection takes care of this route to safe areas.

Architecture, in an immediate phase, is in its primal state and purest where the functional priority is to provide protection to a vulnerable person, and its technique is based on basic and primary elements looking for local materials or easily accessible, it can be a construction or start from just one process. The important thing is not the durability but the fulfilment of your primary safety objective.

The temporary phase is characterized by the transition phase, where there is a period of change and adaptation. It is a phase that transits between the emergence of the immediate and the rehabilitation of the definitive (permanent phase). Here the architecture gains another characteristic because it is already important to guarantee a character of temporality and minimal housing to the evicted one.

The notion of shelter thus goes from meeting only the need for protection and security, to meet the basic needs of the condition of living. Thus allowing a new relationship with the place that is inhabited, thus returning to the displaced his dignity and rights.

4. Conclusions

Today Syria is a totally devastated territory, resulting from a huge conflict of political interests that overlapped human life and human rights. This is a universal reality, the news about the humanitarian crisis and the slaughter that is being carried out in these territories alert us to our social responsibility. Today in Ghouta we find the same scenario that we saw a few months ago in Aleppo, the consecutive bombings by the regime followed by a siege made to the city limiting the access to the besieged area where thousands of civilians live and looking for some dignity and security. In this situation there were already more than 900 the dead in the city of Ghouta.

It is the duty of each of us to put our efforts in areas of destruction like these, fortunately we live in a century where technology breaks down barriers and distances and we can access from anywhere in the world what is happening in these areas of armed conflict because there are many people who share and describe what goes on in those places, they seek help and try to circulate as much information as possible to help all the organizations involved in irrigation and relief in these conflict zones, to create support methods by trying reach the largest number of people.

The main problem in this case in Syria is the humanitarian crisis and the situation of the people debating daily with slaughter that is there to be made. People who are still in Syria are currently homeless, lacking food, hygiene and very difficult access to health. Even with the help of the red crescent, the NGOs and the white helmets, it is impossible to keep up with the speed of destruction and reach all those who need help. The daily life of these people is to look for goods that will support them, daily and try to be safe.

In the background we have a country destroyed, entire cities devastated and fallen to the ground. The long-term consequence for mankind will be the enormous loss represented by this mass destruction, thousands of years of history, memory and heritage lost and difficult to recover.

The main objective of this study is to find solutions that respond immediately to basic survival needs in an emergency scenario.

Once you realize that access to the land is often limited or null, you need to find solutions that allow this remote aid. In this sense the strategy is to find in the place the necessary materials and with the help of information of construction techniques provide methods that allow to solve some of the needs encountered.

Although this area is still little explored in architecture, there are already many techniques of construction using what the site gives us. For example, debris resulting from the destruction of buildings, fabrics, tires, metal fence nets, reinforced concrete wires, bricks, metal pipes, metallic fences and the earth, which has always been one of the main raw materials used in construction. This solution deals with the impediment of being able to get prefabricated materials for the construction of shelters and, despite the efforts of the architecture to create ecological structures based on reusable materials originating ephemeral structures that are very used in the social emergency, they result in a set of prefabricated elements that need transportation and instructions from the architects who are in the grounds.

Promote a response strategy that sets up an emergency architecture as a transitional shelter for thousands of people who could not or did not want to leave their homes and their cities.

"Architecture and war are not incompatible.

Architecture is war.

War is architecture.

(…)

I am an architect, a constructor of worlds,

a sensualist who worships the flesh,

the melody, a silhouette against the darkening sky.

I cannot know your name. Nor can you know mine.

Tomorrow, we begin together the construction of a city."

Woods, 1993, Manifesto.

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CIAUD, Faculty of Architecture, University of Lisbon, Lisbon, Portugal.

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Upcoming temporary and memorial city; a proposal for Syria post-war housing

Sílvia Afonso Martins [a,*], Ana Rita Ochoa [b]

[a] DECA-UBI, Portugal
[b] CIES-IUL/UBI, Portugal

Abstract

Since World War II, the war has as battlefields the cities, which, in the most recent cases, are the principal stages of the conflict. With all the violence and bombing involved, the societies are being affected and the humanitarian crises of migration have been increasing. Nowadays, we can assist how war is being one of the biggest atrocities against human life and a crime against the contemporary cities. The violence and massive exodus have a huge psychological impact in all the inhabitants that are forced to leave or fight. However, after or even during the conflicts they want to come back to their country. It is fundamental to think about the future of the cities and in those who want to come back. In this context, this paper focuses on a proposal of a temporary town for Syria after war. This proposal was developed in the scope of the International Ideas Competition "Syria Post-war Housing" and the aim is to create a place for housing people while the cities are being rebuild, to receive the displaced people that want to come back and help to build their country.

Keywords: Post-disaster reconstruction; Housing; Temporary city; Future city; Memorial.

1. Introduction

Cities have become the battlefields of the wars and its inhabitants are part of their fighters. With the invention of long-range air bombs in the 20th century, cities became targets for military attacks, a format that uses the population and its living space as strategic objects within the conflict (Charlesworth, 2006). This transmutation of battle space affects the entire urban contexts and consequently its societies (Maurer, 2017; Charlesworth, 2006). The destruction of urban spaces seems to be growing and the aim at war seems to be centred both on the destruction of buildings and structures and on cultures.

Recently, there are about 50 million people affected by their cities becoming confrontational areas, such as Aleppo in Syria, or Donetsk in Ukraine, among others. This situation forces the deprivation of the future generation's education, the psychological trauma of the society and the migration, forcing a prolonged displacement of their country (Maurer, 2017). Communities affected by the war's deepest desires yearn to re-live their cities in peace but rebuilding them is a process of extreme complexity for that very reason. In this respect, some questions should be raised as "how to rebuild the cities for these societies?" or "how should the architects work to reconstruct around peace and healing the wounds of the communities?". But the main question is "Who can or Who should do such task?"

Urban planners and architects have an important role to play in this matter. According to Barakat (1998, p. 12) the *"reconstruction as healing*" is primordial to create a stable and better future and there are three primary concepts that must be considered by architects and urban planners: hope, healing and reconciliation. Thus, as Woods (1993, p. 19) points out, it can be assumed that the wreckage arising from war may be the beginning of *"new ways of thinking, living, and shaping space, arising from individuality and invention"*, and from this beginning, a new community can be formed, a society that prevents the basis of the organization of violence and war.

In this context, this paper has as main objective to discuss the role of the architects in the reconstructions' processes and to reflect about the different ways of cities' regenerations through a proposal developed in the scope of the International Ideas Competition "Syria: Post-war Housing". The proposal focuses on a temporary town for Syria after war and turned out to be a criticism to the Competition.

In terms of Methodology, a preliminary study on local architecture, both traditional and contemporary, was carried out through authors such as Chibli (2004), and on Arab architecture and new types of housing through video conferences as *Jean Nouvel on Arabic Architecture, Context and Culture* (2014) and *How to reinvent the apartment building of Moshe Safdie* (2014). And, for an improved understanding of the current mass migration

* Corresponding author. E-mail address: m.silviafonso@gmail.com

of Syrian refugees, some research was made through consultation of references such UNHCR (2016) and by documentary films as *Return to Homs* (2013), *Children on the frontline* (2014) e *Salam Neighbor* (2015).

In addition to this research, this project required more in-depth contact with the Syrian question for a more exclusive approach. Various institutions for the reception of refugee families in Portugal were contacted, such as *PAR Famílias*, through *Refugiados* magazine (Marques, 2016), and interviews with Syrian students, some of them refugees, who were in Portugal were conducted.

The applied project methodology did not anticipate any fieldwork since it was unfeasible to visit the country. Moreover, admittedly, it did not focus on any specific city of the country. The project intended the hypothetical representation of a temporary city in any city and to any extent. In a country that still faces a war and a struggle for stability, the projected idea was to create a relationship between architecture and imagination, devising a temporary housing space to welcome the first to come to rebuild their city, where they would settle to its rearmost. After stabilizing the city and with a built urban organization, the projected "temporary city" acquired new functions necessary for the fullness of the reconstructed city.

Conceptual and imaginary thinking was generated, centered in criticizing the competition itself: it is questionable to draw up a definitive project for a country that we do not know and that, currently, still struggle for peace and freedom.

2. City lights – Syria: post-war housing project

A contemporary example of how cities have become the arenas of conflict and violence is Syria. The war set up in its cities produces large-scale suffering and a major challenge in terms of future reconstruction, both physical and social. Meanwhile, the country continues struggling, waiting for peace, for a new way of life, and for its inhabitants who long to return to their roots. According to Maurer (2017), every 3 minutes, more than 3 people are forced to leave the country, and more than 6 million live in shelter communities within Syria. This war has led to a huge migratory crisis, displacement and immense destruction of the country's cities. Today, many of Syria's urban landscapes are heaped with rubble and ruins, shrouded in fear and silence by the lack of its inhabitants.

The developed proposal does not aim at an early and possibly illogical configuration for post-war posterity in Syria, nor a set of dwellings for a certain unknown area and without urban fabric. The idea thus arises from a middle ground between architecture to reinvent the cities after they are destroyed and the emergency architecture of immediate action - a temporary city of shelter to those who return and who long to rebuild their country.

In this context, this proposal aimed to criticize the purpose of the contest, to create a permanent housing model for the future of Syria and for its inhabitants, who want to return and build a new life in Syria. In fact, it condemns this pragmatism through the utopia and proposes an immediate, but temporary, solution for when the war is over along the cities. Subscribing to Victoria Harris (2011), it becomes necessary a new conscious thought of the actuality. Thus, the idea of the temporary city emerges exactly as a solution to the crisis in the country in question: the need of shelter for the return of those who lived there and who yearns to return and rebuild the country.

2.1.Results

According to the criterion of the contest *Syria: Post-war Housing* for the project life span (over 50 years), a combination of concepts of housing, temporary and memory was intended, resulting in an interpretation of the project as a memorial space.

The concept of memory related to the permanence of the ruins set a scene where the remaining walls and the existing debris would be reused and transformed to the new dwellings, which translated a new approach through the existing ruins. The content of the past and its brands will continue to be present in the future. In operational terms, after removing the surrounding debris, the "surviving" pillars will participate in the construction of the concept in two ways:

- In a symbolic sense, the pillars that remain will "swell" and grow with the strength and courage of the inhabitants. The analogy between pillar and family force is created, and each single-family housing element will interpret the strength of each family, that is, a pillar that grows according to the number of familiar elements, creating a set of high dwellings with different heights. The idealization of the pillar was born of the utopia and as such, the dwellings will be the targets of this design (Figure 1).

- Simultaneously, an urban lighting system will be created on the pavement in the area where the dwellings are erected. These are located at ground level and will be integrated into the housing complex, in the exact place where, before the war, there were other pillars of housing or other infrastructures. It is intended to generate an emblematic light, emphasizing the notion of memorial. In short, some of the demolished pillars will be replaced by a light earth in their memory and by vertical dwellings that will rise like new pillars. They will thus be symbolic and metaphorical elements (Figure 2).

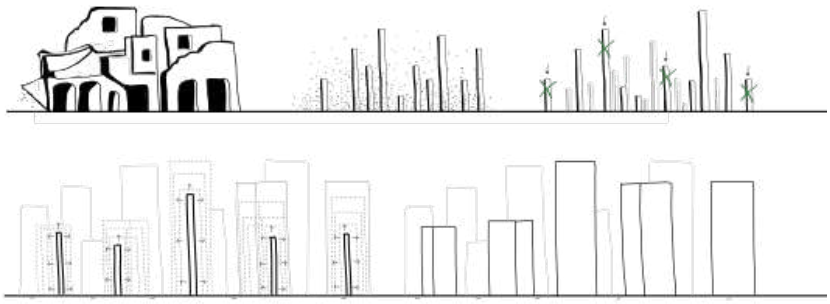
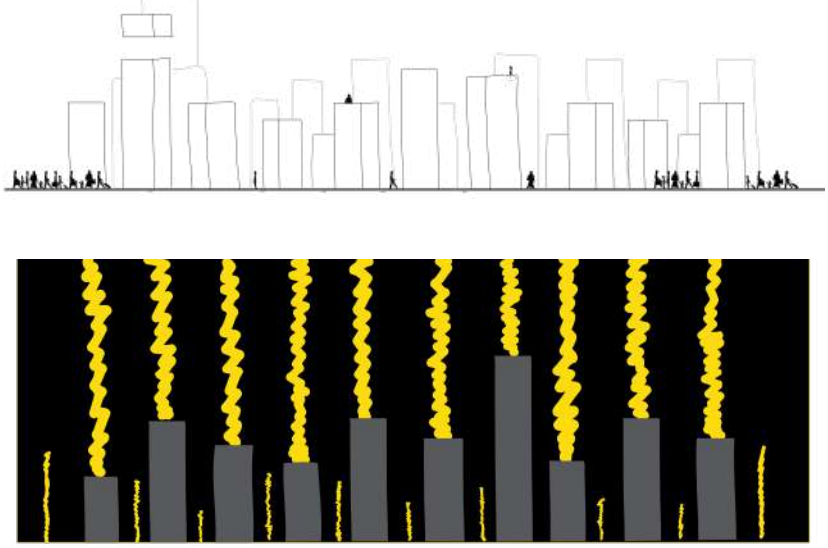


Figure 1: From the ruins to the city. Sequence of conceptual process of the project. Author's drawing.



The concept of memory inherent in design uses light as a shaping element of remembrance, but also of the sky-earth connection line. The light in the place of the pillars will thus establish a symbolic relationship between sky and earth, the light of the memory of that which lived there projected to the sky.

As a fast-acting architecture, was necessary to think of the simplification of the constructive methods together with the recycling of the resulting materials of the ruins and, according to these criteria, to think about the ideal form for its quick, easy and economic execution. For a conceptual and functional question, the building module plan was designed to be square - 5,30m x 5,30m – which allows a more rational organization of spaces, according to the random provision provided and since it deals with mass housing for a large number of people. This dimension also consents the creation of insulated parts with the same measure for the construction of a prefabricated building, which provides the flexibility of manufacture and assembly in several places.

Following the thought of modular construction, the space was divided into two parts - the full and the empty (Figure 3). This division will functionally organize the tasks and desired spaces of the dwelling, crowding out certain functions in one place and freeing the rest of the space for others. This idea also goes to the idea of

provisional city, which allows a better manipulation of the space, freeing it to a greater multiplicity of functions that are not possible to predict from the root. Given the reduced area of the resulting plant (22m2), each floor of the house will be assigned a floor, these designed in tune with the Syrian architectural thinking and what appeared to be the needs of its culture (Figure 3).

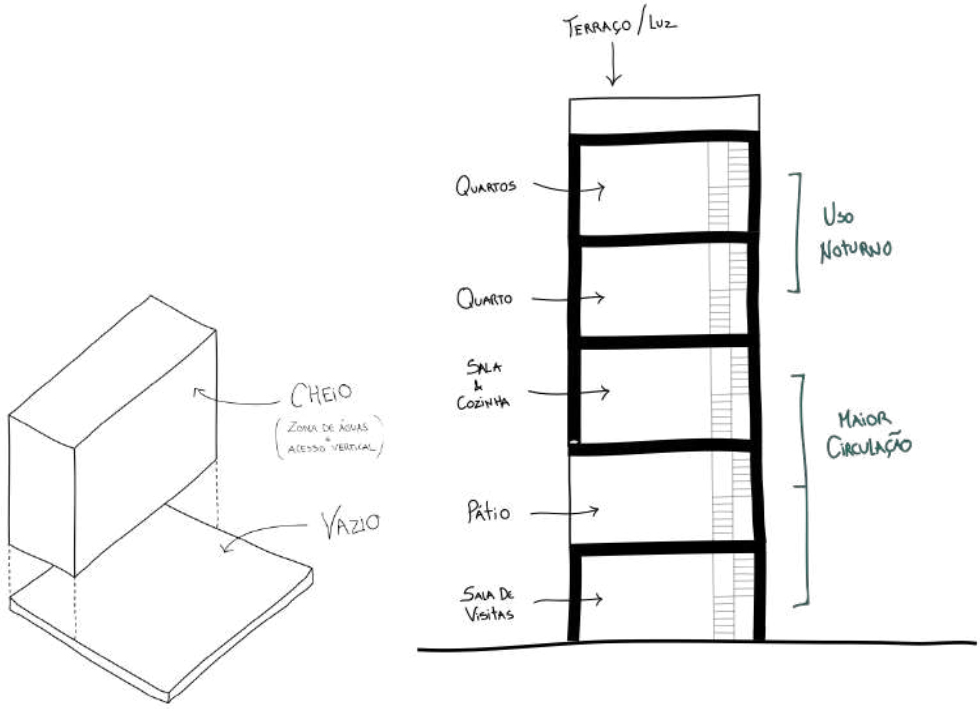
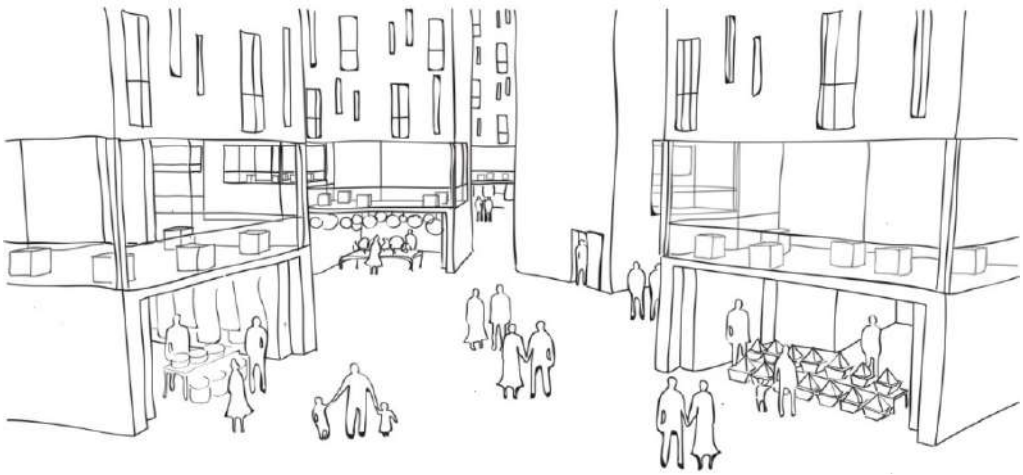


Figure 3: Full and empty scheme (on the left) and organization of household functions (on the right). Author's drawing.

Investing in the idea of temporary city, it will have to be spaces for daily life, namely commercial areas for the management and proper functioning of the resident communities. The solution was based on Islamic markets, known as the souks. Intensifying the idea of own unit and family and once these houses were designed for a rapid and modular construction, then the possibility of flexibility of the spaces of the ground floor appears, allowing its opening to the outside, thus disclosing the family's own commerce and the ideal of the Islamic market: foreign trade and free circulation organized in the form of "streets" (Figure 4). In addition, it allowed the establishment of a public space, familiar with the creation of ties and social interactions, enabling the formation of bonds of a post-war society. From an urban complex closed and illuminated at night, may arise, according to the will and availability of



its inhabitants, the opening of the housing during the day, intended for commercial activity. When adding from this private trade, the proposal evolved into a combination of the living room on the ground floor with the commercial area, organized second a flexible architecture within the useful area of the project.

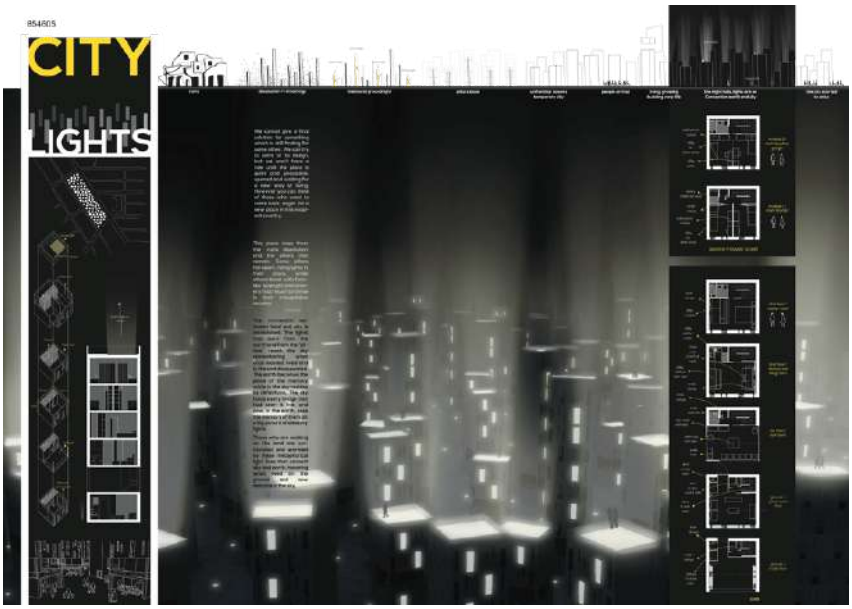
This model of single-family housing aims to occupy as little space as possible, facilitating its multiplication and housing as many families as possible. The urban space composed of this set of buildings has no minimum or maximum extent, nor a designated fixed location. This project allows the flexibility in its urban spatial organization and positioning in the city, through the reproduction of small or large sets, distributed throughout the city.

The proposal designed for the competition “Syria: Post-war Housing” is translated through the metaphor of the pillar. It illustrates the traces of pre-war urban fabric through a memorial and builds a temporary city that

seeks the urgency to shelter those who want to return to the now uninhabitable country to transform it into their new home (Figure 5).

Figure 5: Overview. Author's drawing.

When cities begin to reborn, this ephemeral city of life-cycles will take on new functions, taking on a new role in the city - a new public urban component with new and varied functions necessary to the city, linked to commerce, leisure, culture, among others and always lasting its sense of memorial. Assuming its utopian sense, this urban model that proposes metamorphoses of its own function, will remain as place of memory (Nora, 1993), as a "monument-town". This proposal for the “Syria: Post-War Housing” competition was named City Lights (Figure 6) and carries a timeline of present and future actions and supports past memories - remembers



what existed and starts a new chapter of a new country.

Figure 6: Panel for the contest Syria: Post-war Housing

3. Discussion section

Postwar reconstruction becomes even more relevant today. When we talk about the reconstruction of the cities after World War II, it is about interventions in cities of a traumatized population that suffered from the immeasurable loss and disturbance intrinsic to armed conflicts, and from authoritarianism and its cruelty. Nowadays, we speak mostly of civil wars. The cities that are to be destroyed are the houses of societies fragmented by ethnic, religious, and political issues, living directly with the reality of migration and the deprivation of a peaceful daily life in their country. Thus, the question that arises is: How to build for these people?

Reminding Barakat (1991), three fundamental values must be followed: hope, peace and reconciliation. Based on these notions, it is important to think of a social reconstruction through architecture and beyond urban rebuilding. It is necessary to address such factors as physical destruction and economic and social recovery for peace building, and thus act in a direction of relief from trauma and the building of social bonds and peaceful bonds. This responsibility is not merely political, it is also the responsibility of the architects.

Despite the difficulty of the action, it is hoped that one of the measures to be considered may be contact with war victims and city dwellers, and their participation in measures to design and present aid and reconstruction projects. In this way, there can be respect and cooperation between the architect / town planner and the inhabitant. This idea was partly realized in the postwar period of England, in several exhibitions based in different cities with their future strategies (Larkham, 2015), as for example in London in July 1943. But even so, the inhabitants weren't heard. The strategy was to present to the public what was planned for their future, and in this way at least the communication between the architect / urban planner and his main client were consecrated.

Despite the extreme complexity of building up for such weakened countries and societies, it is hoped that future reconstruction efforts with countries now at war, such as Syria, will not be implemented lightly and not deliberately by people external forces that do not commit themselves to solving the associated social problems and which aim for other purposes, for example economic ones, as was the case in Beirut in Lebanon.

The case of the "Syria: Post-War Housing" competition, despite being an idea contest, it illustrates very well this issue: the proposal to intervene in a reality that is, at the outset, unknown to us and that, even with a deeper investigation into the contexts to intervene, it is still difficult to act without support and contact with local technicians and inhabitants, without a visit to the devastated space, and without extensive inquiry about the problems intrinsic to the unleashing of the present conflict.

For this reason, the answer to the contest has a different purpose: the goal was to create both a memorial and a temporary city, while the country is built and not for an already built country. Instead of creating an urban housing component that is part of an unimagined future city, the idea starts with the concept of a transitional housing space that aims the returning and housing before the reconstruction of cities. It is considered that it is not legit to think that the future reconstruction of the cities of Syria can be conceived through ideas from external entities, which at the outset are unaware of the essence and the intrinsic peculiarities of the country, and which can ignore how to reconstruct a society and its links, in order to establish peace and set the population.

4. Conclusions

In the end, there are no specific reconstruction strategies after the wars, and the difficulty of the theme does not point for a unique answer. One can, however, predict that there are some principles of action and weighting inherent in each specific context that can take shape through architectures that recognize the past of cities and that present a symbiosis between history, tradition, memory and the future, instituting urban improvements and for the reconciliation and healing of the trauma of the affected societies.

In this way, the proposal developed during the "Syria Post-war Housing" competition was at the same way a critic to it, precisely as a warning for fast and ineffective responses to the post-war reconstruction. It takes the shape of a temporary and fast-building city for those who want to return, representing at the end of the reconstruction a monument for other functions, allowing a thoughtful planning of the whole city and its intrinsic problems before and during the war.

While on the one hand the procedures over the last decades have taken divergent and even erroneous directions in the reconstruction of cities after the wars, it is hoped that on the other hand the strategies to be applied on Syria's future, which is still fighting for peace, bear in mind the mistakes of the past, and to look forward to a vision of right and exemplary reconstruction for the benefit of our society.

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Radical pragmatism: the post-disaster reconstruction work of Taiwanese architect Hsieh Ying-Chun and Atelier-3

Chen-Yu Chiu [a,*], Yildiz Kilincer [a]

[a] Bilkent University, Turkey

Abstract

In the past 18 years, architect Hsieh Ying-Chun and his team - Atelier-3 - have conducted more than 3000 houses in the post-disaster areas in East Asia. Facing different critical site contexts and socio-political conditions, Hsieh and his team applied the reinforced lightweight gauge steel frame for conducting housing reconstruction with three fundamental principles: 1) single-line drawings for participatory design, 2) simplified joints for collaborative construction, and 3) open system for adopting and submitting to climatic and geographic condition and local materials. Based on the above principles, this paper thematically describes the architectural practice of Hsieh and his team with selected key projects. These projects closely present how they initiated, articulated, communicated and implemented their principles in different sites. This concludes that 'self-reliance' can be seen as their fundamental philosophy encapsulated in their notions of sustainable construction, green building, cultural preservation and creation of local employment opportunities. Following their philosophical ideologies, Hsieh and his team have treated the survivors as the 'producers' of their own houses, instead of the 'consumers'. Meanwhile, by designing and building the houses together, the survivors had a chance to re-build their communities, regain their socioeconomic status, and re-establish the intimacy between architectural production and everyone's everyday life. As a critique of dominant trends of consumerism, elite professionalism and aestheticism seen in today's architectural practices in general and post-disaster humanitarian projects particularly, Hsieh and his team's work provides an insight into the society of East Asia and illuminates its challenges and prospects.

Keywords: post-disaster reconstruction in East Asia; Hsieh Ying-Chun; reinforced lightweight gauge steel frame; participatory design; collaborative construction open system.

1. Introduction

On September 21 in 1999, the '921 earthquake' hit central Taiwan. More than 2000 people died, and more than 4000 houses were destroyed. The disaster zone included the settlement of the Thao tribe – the smallest aboriginal group in Taiwan. With limited financial aid from the society, Architect Hsieh Ying-Chun and his team conducted their first post-disaster reconstruction work with the survivors of the Thao tribe. This important experience stimulated Hsieh to change his career path significantly: he relocated his practice and home to the rebuilt community of the Thao tribe (Figure 1).

Figure 1: Architect Hsieh and his working place in the rebuilt community of Thao tribe, photo taken in 2016.

Source: Atelier-3.

* Corresponding author. E-mail address: chen-yu.chiu@bilkent.edu.tr

After reconstructing the community of the Thao tribe, Hsieh and his team focused on the post-disaster reconstruction work in East Asia. With more than 3000 houses rebuilt in post-disaster areas, Hsieh received the Curry Stone Prize in 2011 delivered by Harvard GSD, recognizing his contribution in the field of humanitarian approach to architecture. Based on their personal experiences and empirical knowledge, Hsieh and his team have developed a working method to conduct reconstruction projects. This article discusses their working method and intentions behind. The discussion underscores the varied difficulties and limitation they faced in different disaster zones in East Asia, and provides an insight into the challenge and prospect of its building culture.

2. Light gage steel as the key structural material

In every post-disaster reconstruction project, the cost and stability of construction and efficiency of building process are the top priorities of Hsieh and his team's consideration. While building construction was strongly related to its structural system and its applied materials, Hsieh and his team abandon the idea of applying reinforced concrete structure for their reconstruction work to achieve efficiency and contain costs, despite concrete being the most popular material used in the housing industry of East Asia. Hsieh and his team applied light gage steels, produced by bent sheet metal with the process of hot-dip galvanizing, as the key structural elements (Figure 2). These standardized and mass-produced steel elements make the house structure lighter, stronger and cheaper than applying reinforced concrete construction. More importantly, with factory production and onsite assembly, steel elements also help the architects to shorten the period of constructing structure. No doubt, steel is recyclable and much more sustainable than concrete to our environment.

Figure 2 : Light gage steel applied in Hsieh and his team's post-disaster reconstruction work. Source: Atelier-3.

3. Vernacular-architecture-inspired steel frame

In their reconstruction work, Hsieh and his team did not apply the panel wall system, commonly seen in the steel frame structure in Europe and the United States. Their design of steel structure was inspired by the timber frame of vernacular architecture in Southeast Asia. In their inspired frame, the posts played a key role in shaping the roof form and formulating a series of representative lateral frames to constitute the whole housing structure. By further applying cement to reinforce the steel elements and adopting lateral bracing and shear walls to reinforce the inspired structural frame, its stability is significantly improved to withstand potentially destructive

forces from earthquake and typhoon (Figure 3). Comparing with the panel wall system, the usage of steels was significantly reduced by 40 percent, and the weight of the structure is much lighter. This means its cost is lower and the building process more efficient. Meanwhile, this vernacular architecture inspired steel frame was much easier to be conducted by local survivors in East Asia in which its composition was very close to the structure of their owned vernacular houses.

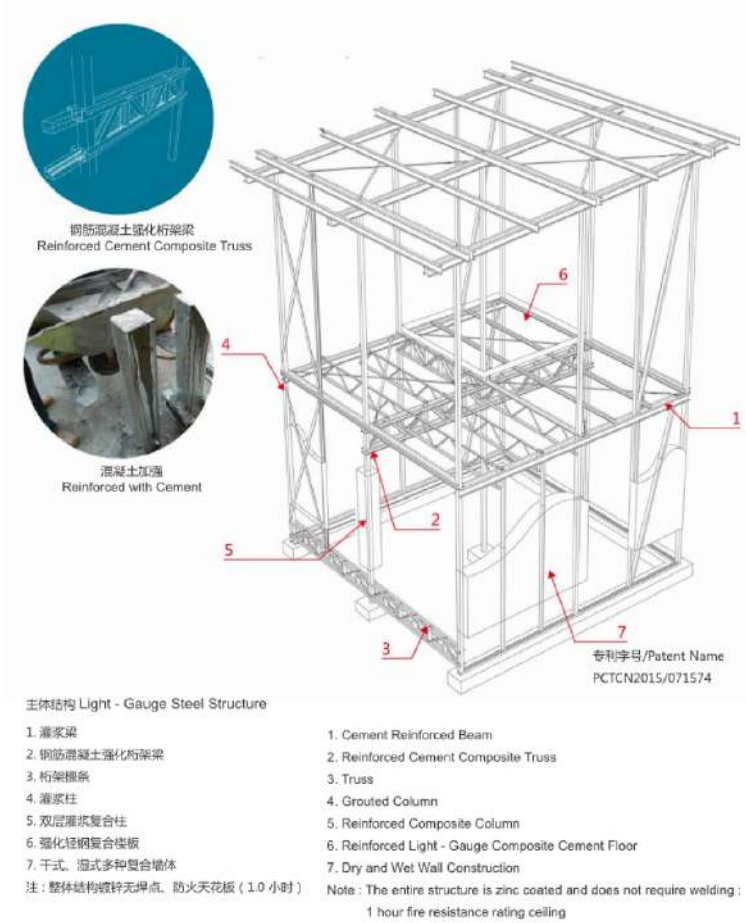


Figure 3 : Vernacular-architecture-inspired and cement reinforced steel frame in the diagram made by Hsieh's team. Source: Atelier-3.

4. Collaborative construction

One of the guiding principles of Hsieh and his team for post-disaster reconstruction was that they did not build houses for the survivors, instead, the survivors should be taught to build houses for themselves. This was the result of careful considerations from Hsieh and his team. They believe, in every post-disaster zone, human resources are extremely valuable. Survivors should participate in the construction work to rebuild their houses to reduce the costs, time and resources of building process. In most cases, the survivors in the rural areas in East Asia knew exactly how to build houses, and to Hsieh and his team, this local knowledge and resource ought to be adopted in the reconstruction work. From a psychological perspective, daily work for rebuilding survivors' own houses could be a good therapy for their mental wellbeing, because survivors could be deeply traumatized after the disasters. To Hsieh and his team, survivors should never be treated as persons passively awaiting assistance; in contrast, the survivors should participate as 'contributors' and deliver efforts to rebuild their own shelters and community (Figure 4). From the education perspective, by participating in the reconstruction, the survivors can learn a skill to work and build. From the social-economic perspective, the building construction could deliver a job to the survivors for them to regenerate their incomes and to regain social status. Moreover, the building process involved many people. This had encouraged trust and relationship building in the community. Ultimately, the survivors could rebuild their broken community. Meanwhile, creating and building someone's own houses are the basic desire of every human being. Through collaborative construction, the desire could be satisfied. Strategically, collaborative construction could also protect Hsieh and his team from any

potential criticism and conflict from the survivors for the reconstruction work, because the survivors were fully involved throughout the construction process and would not criticise and dislike their own work.

Figure 4 : Photo taken on the collaborative construction at Yangliu Village, Abazhou, Sichuan, China, 2009. Source: Atelier-3.

5. Participatory design and single-line architectural drawing

Participatory design with good communications with survivors is crucial for a successful collaborative construction. For this purpose, single-line architectural drawing was produced by Hsieh and his team to indicate the basic layout of houses and applied steel frame composition (Figure 5). These easily-understood drawings allowed the survivors to learn both about the design and the construction of their future houses quickly. These drawings also facilitated effective communications with the survivors when revising and refining the housing design according to their diverse needs. After receiving the ideas and comments from the survivors/builders, Hsieh and his team could quickly update their design without spending too much time and efforts on producing overly meticulous working drawings.

These single-line architectural drawings closely represented the retrained approach to design and construction of Hsieh and his team. As mentioned earlier, most survivors in rural areas of East Asia knew how to build their houses with shared building tradition. Hsieh and his team only delivered what the survivors really needed, and minimalized architects' intervention in the reconstruction process. In some cases, these single-line architectural drawings faithfully replicated the vernacular houses the survivors previously owned, and the single-lines on the drawings presented the minimum use of steel elements to reinforce the structure of the re-built house. Following this principle, in some special cases, Hsieh and his team did not provide any drawing; they only provided some special steel joints and elements to survivors to reinforce the structure they would re-built.

6. Simplified joints with nuts and bolts

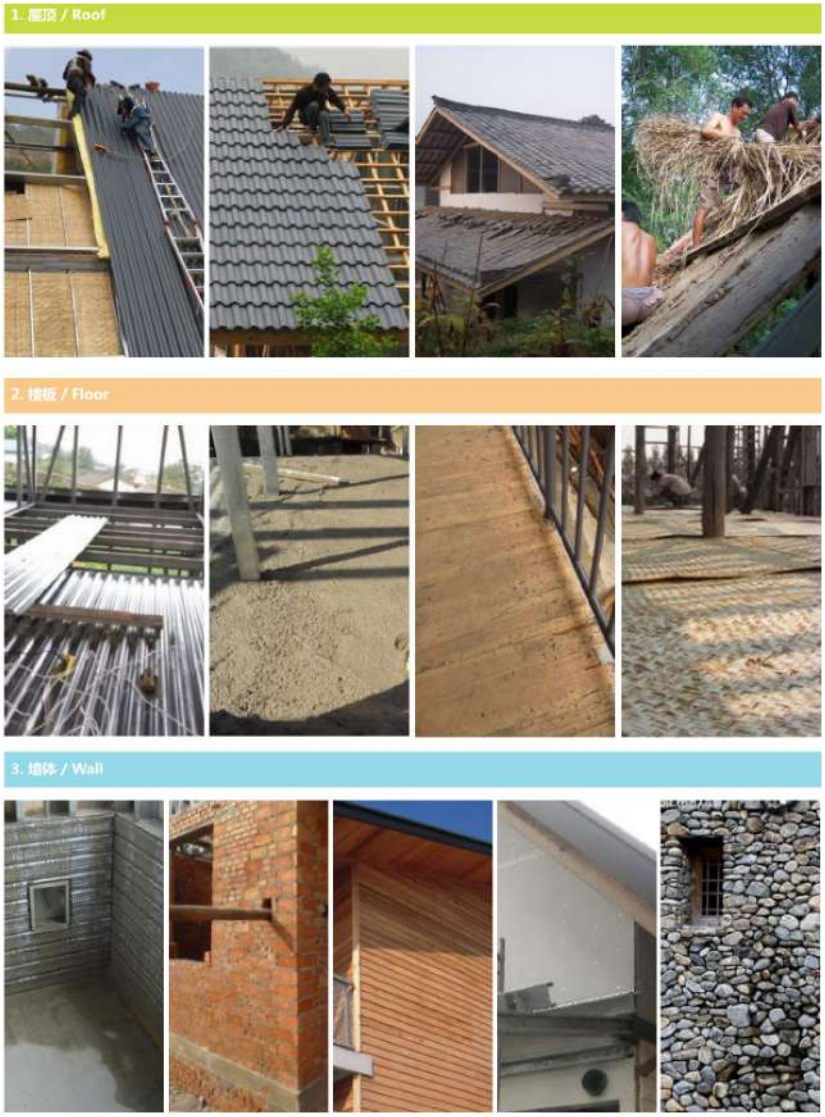
To allow most of survivors to participate in the reconstruction work, Hsieh and his team designed their steel frame with simplified joints with nuts and bolts (Figure 6). This means their steel frame could be easily assembled onsite without electricity and welding process. This is quite important, because some post-disaster areas would not have water, electricity supply and sufficient number of professional workers at the time of reconstruction. The simplified joints and collaborative construction process, usually only require one day for finishing the assembly of the whole steel structure for a two-floor house with 100 square meters floor area. The simplified joints with nuts and bolts could also benefit future restoration and extension of the houses re-built by the survivors themselves. No doubt, this could also help the survivors to re-locate or dismantle the re-built houses, as well as recycle the steel frame.

Figure 5 : Single-line architectural drawings produced by Hsieh and his team for indicating the basic layout of houses and applied steel frame composition for reconstruction work. Source: Atelier-3.

Figure 6 : Steel frame with simplified joints with nuts and bolts for the reconstruction work at Fu-shan Village, Dawu, Taitung, Taiwan, 2010. Source: Atelier-3.

7. Open system applied with innovative construction methods

The steel frame applied by Hsieh and his team was as an open system which could be easily combined with local materials for constructing the membrane, roof and floors of the re-built houses (Figure 7). Hsieh and his team encouraged survivors to adopt the traditional way of housing construction and recycle the building materials in the post-disaster zone. The steel frame provided, aimed to reinforce the stability of the re-built vernacular houses, rather than to replace the building tradition they presented. However, in some cases, the local materials are not sufficient, and the survivors did not know how to re-build their houses. Hsieh and his team could provide their innovative construction methods to build the floor with thin concrete membrane with metal mesh and to construct the wall with rammed earth and straw bales reinforced by metal mesh (Figure 8). These



easily-applied construction methods could not only reduce the costs and time of construction but also rebuild the building tradition by teaching survivors to build their own houses.

Figure 7: Open system of steel frame for being easily combined with local materials for constructing the membrane, roof and floors of re-built houses. Source: Atelier-3.

8. Urine-diverting dry toilet

In some cases, when the reconstruction work was completed, the re-built houses could not be connected with municipal services. This means the houses could be without water and electricity supply for a certain period of time, and standard toilet facility would not properly work in this condition. This was why Hsieh and his team applied urine-diverting dry toilet for the re-built-houses (Figure 9). This toilet could not only save the water and energy but also allow people to recycle excrements as fertilizer to increase agricultural productivity. This would enhance their self-sufficient and sustainable living in the rural areas of East Asia.

Figure 8: Heish and his team provided their innovative construction methods to build the floor with thin concrete membrane with metal mesh and to construct the wall with rammed earth and straw bales reinforced by metal mesh. Source: Atelier-3.

Figure 9: Urine-diverting dry toilet applied at Mianzhu, Guangyuan, Sichuan, 2008. Source: Atelier-3.

9. Conclusion: the challenges and prospects

Clearly, Hsieh and his team reject the elite aesthetics and overwhelming professionalism dominant in today's humanitarian approach to architecture for post-disaster reconstruction work. Meanwhile, their work represents the applied but restrained professionalism to minimise the intervention of professionals in the reconstruction work. This was due to their belief on 'self-reliance' as the key to re-build the survivors' houses and further re-build their community and housing tradition. Meanwhile, Hsieh and his team aim to replace the reinforced concrete structure dominant in the housing industry in East Asia with steel frames. Despite their achievement of more than 3000 houses in post-disaster zones, several challenges remain in their practices.

First, although it is easy to order and mass-produce the steel elements in factory, designing the steel frame to meet the diverse needs of survivors and transporting them to the disaster zones are always challenging. Do we have a better solution to reconcile the relationship between prefabrication and site assembly, as well as between mass production and individual needs?

Second, although steel frame is a much more stable and sustainable structural system than reinforced concrete structure, the production process of steel is not environmental friendly. Do we have more sustainable materials to replace the steel?

Third and finally, infringement on intellectual property has been a threat in the design industry, and in China particularly. Hsieh and his team's idea of applying reinforced steel frame with simplified joints in post-disaster zones has been popularized and plagiarized in East Asia. The market could offer the steel frame at 60 per cent of the price Hsieh and his team proposed, but no one could guarantee the requested strength and stability of applied steel frame system. How do Hsieh and his team deal with this infringement of intellectual property, and price competition with products of dubious quality?

Post-disaster architecture: the role of temporary housing

Daniel Félix [a,*], Daniel Monteiro [a], Artur Feio [a]

[a] Universidade Lusíada Norte - CITAD, Portugal

Abstract

Post-disaster scenarios have frequently many homeless due to the damaged and destroyed houses. During the housing reconstruction process, temporary housing solutions play a crucial role to restore some sense of normalcy in the life of the affected people. However, these solutions have been criticized for being inadequate, unsustainable and for drawing away important resources for the overall reconstruction program. Through literature review and lessons learned from case-studies, the paper firstly defines and discusses the importance of temporary housing, and then presents suggestions, concepts and design recommendations to support the development of temporary housing solutions. The paper aims to improve temporary housing solutions discussing concepts such as design with and for people, local oriented design, and flexibility. While discussing these concepts, the paper also suggests how they can be considered beforehand during pre-disaster planning actions. This way, the paper contributes to build resilient communities improving their preparedness to deal with the homeless problem in case of emergency, and also contributes for sustainable and efficient reconstruction programs.

Keywords: Temporary housing; Design recommendations; Pre-disaster planning.

1. Introduction

During the last decades, several events have resulted in disasters that caused complex situations for affected communities. One of the most visible consequences is the destruction and damaging of housing buildings and, due to that, many people become homeless. After the emergency response in the aftermath, which includes medic assistance and health care, medicines, water, and food distribution, etc., the re-housing process seems to be a key action to assure minimum living conditions and mitigate the impact of the disaster.

Losing a house is more than a physic deprivation because it means to lose dignity, identity and privacy (Barakat, 2003). A house supports psychological, social and even spiritual needs, as well as contributes to the construction of personal identity, sense of belonging and community integration (Bedoya, 2004). The loss of a house is one of the main causes of stress (Caia, Ventimiglia, & Maass, 2010) because it is one essential asset for a living (Barakat, 2003), as it assures conditions for family life, contort, protection, and security. Due to that, it is urgent to quickly re-house those who lost their houses in order to guarantee minimum living conditions.

Reconstruction works tend to take time and that is the reason why temporary accommodation strategies are necessary after disaster (Felix *et. al.,* 2014). According to Quarantelli (1995), these strategies can be Emergency Shelter (used only during the first days right after the disaster and which can be a second house, a friend or family house, public building, *etc.*), Temporary Shelter (such as a tend or collective public shelter used during a short period of time), or Temporary Housing (place to live until the conclusion of the reconstruction or construction of the permanent house), see Figure 1.

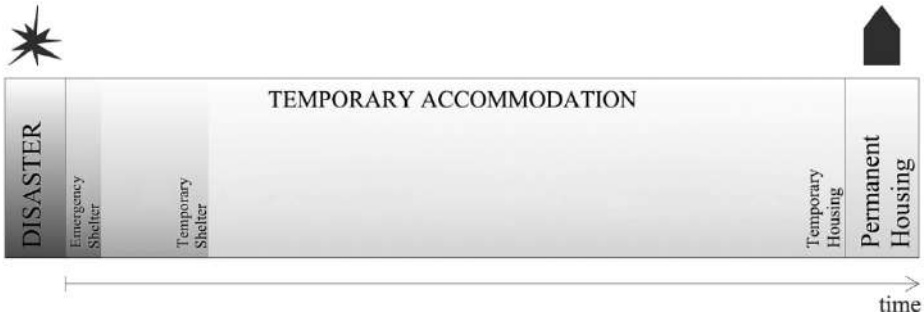


Figure 1: Temporary accommodation process.

* Corresponding author. E-mail address: ffelixdaniel@gmail.com

The present study concentrates on temporary housing, which despite its importance, has been criticized due to repeated problems. In spite of this criticism, the paper emphasizes the important role of temporary housing, identifying the main problems and their origin, and also suggesting strategies to overcome them. Through literature review and lessons learned from case-studies, this study presents suggestions and design recommendations to improve temporary housing solutions. Some of these recommendations can be implemented in pre-disaster planning, hence increasing resilience and preparedness for disasters.

2. Definition and role of temporary housing in post-disaster scenarios

On the one hand temporary housing can be defined as an object (the building or construction people reside in after a disaster), a part of the post-disaster re-housing process, and a place to shelter people during reconstruction until they are resettled in a permanent house to live (Johnson, 2007a). One the other hand, defining temporary housing is complex due to the terms and concepts that are ambiguously used in disaster literature. Particularly in the case of temporary lodging the terms *shelter* and *housing* are used in a variety of unclear and inconsistent ways. According to Quarantelli (1995), while *sheltering* refers to a place to stay during the immediate aftermath of the disaster whilst suspending daily activities, *housing* denotes the return to household duties and daily routine.

In the context of this study temporary housing is the building where the ones who lost their houses can temporary reside, and it can be identified two main solutions (Félix, Branco & Feio, 2013):

- Ready-made units that are totally manufactured in factory and then transported to the temporary location, which may require few simple assembly works in site, see Figure 2-left;
- Kit supplies, which consist on the provision of all the elements that constitute the building to be totally assembled in the site, see Figure 2-right.

Figure 2: Ready-made units (on the left) and kit supply (on the right).

Following the previous concepts of Quarantelli, temporary housing is very important to recover after disasters, allowing people to return to their normal activities such as work, cooking, housekeeping, school, socializing, *etc*. (Arslan & Cosgun, 2008; Johnson, 2007a). In spite of being protected in shelters, people cannot resume daily life, and so it is not feasible to stay too long in them. Likewise, temporary shelters may rapidly decay due to the external factors, and the need to get people out of them in order to be replaced in more durable and resistant solutions also emphasizes the importance to provide temporary housing (Steinberg, 2007). Since reconstruction lasts long, there is a time gap that can be bridged over by temporary housing (Johnson *et al.*, 2010). It is the moment when uncertainty is replaced by security and families regain some tranquility. This way, temporary housing helps people to feel safe and to have a social recognition (Bedoya, 2004). Temporary housing is also crucial to promote the success of the overall reconstruction, since it allows adequate time for proper community planning to reduce risk and increase sustainability for future construction (Johnson, 2008). This way, temporary housing is important to promote the return to normalcy in a chaotic and uncertain situation after a disaster, being a necessary step in reconstruction programs (Johnson, 2007b).

3. The criticism to temporary housing buildings after disasters

In spite of the important role played by temporary housing solutions to re-establish the routine of the affected people, it has been criticized due to several examples of unsuccessful strategies implemented during the last decades.

One of the arguments used to consider temporary housing as unnecessary is because it represents an elevated cost in relation to its short lifespan (Johnson, 2008). A temporary housing unit can cost more than a permanent one (UNDRO, 1982), sometimes reaching a cost three times higher (Hadafi & Fallahi, 2010). Moreover, these units also need infrastructures such as water and energy supply, sewerage system, *etc*. Therefore, one can consider it as a waste of resources due to the consumption of money that could be used in the construction of permanent houses. Additionally, there are problems that seem to persist in most of the programs of temporary lodging implemented during the last years, namely problems of cultural adequacy and of environmental issues.

3.1.Cultural and local adequacy issues

As previously discuss, designing a house is a complex task because it is the reflex a context that results from cultural, social, religious, political, economic, and environmental conditions (UNDRO, 1982). Inside this context people define their identity together with their houses, creating strong symbolic references, and the destruction of houses led to the loss of those crucial references (Bedoya, 2004). Unfortunately, several strategies of temporary housing after disasters have neglected the need to maintain and recover those references. Instead, it is common the creation of bizarre spaces and the supply of inadequate temporary housing units which do not match with the users' lifestyle and needs (Gulahane & Gokhale, 2012; El-Masri & Kellett, 2001). This happens mainly due to the implementation of standard and mass production units, and the idea of a universal solution (Barakat, 2003), which has failed because it cannot cope with the immense singularities of each culture.

3.2.Environmental issues

The temporariness of these units has also revealed many problems because in order to guarantee acceptable levels of comfort, security and durability, the materials and constructions techniques applied make the solutions more durable and resistant than its lifespan requires, and as a consequence arises the problem of what to do with the units when they are no longer in use. Some strategies have been discussed such as dismantle and storage to be used in other emergency scenarios, but it is not profitable due to the added costs. Also, many suggestions to reuse and recycle the units have been suggested (Johnson, 2008; Johnson, 2007a; Arslan, 2007), but it seems that these strategies need more research to be improved.

The places where temporary housing units are settled, called temporary settlements, have been problematic as well. Most of the times the local and natural conditions are ignored and destroyed by irreversible interventions, such as the construction of foundations and roads, and also due to the production of garbage and other type of resources that remains when the residents leave these temporary settlements.

Therefore, temporary housing has not only been responsible for environmental impacts due to high consumption of resources to build units, which is worsen by the lack of solutions to apply when people leave them, but also because of the impacts on the sites of temporary settlements.

4. The role of architecture to improve temporary housing solutions

There is no doubt that emergency scenarios caused by disasters have the conditions to produce inadequate temporary housing solutions. The lack of planning and the need to implement quick decisions and under pressure may in part justify the questions previously discussed. However, there seems to be opportunities to prevent them and architecture may have an interesting role for that. Architects are trained to analyze contexts from their inherent characteristics, namely local ways of living, traditional models of housing, local resources and construction techniques, as well as social and cultural manifestations and the spaces that support them (Félix, Monteiro & Feio, 2014). Likewise, they are able to represent and work with local communities defending their needs, and assuring the balance between building necessities and local ecology (Aquilino, 2011).

The advantages of the mentioned skills have not been widely considered because temporary solutions has been looked as reaction to disasters instead of an opportunity to consider architecture as a discipline to improve disaster prevention in terms of housing issues. While post-disaster scenarios have many constrains that prevent

the plenty introduction of architects skills, their involvement in prevention plans could allow the definition of pre-disaster plans for temporary housing. Considering a disaster prone area, architects working with local communities, and engaged with multidisciplinary teams, would develop plans for temporary settlements and designs for temporary units that would suit user's needs and expectations in an eventual emergency situation.

Using available studies and tools that support the estimation of homeless people in case of disasters (such as Hazus MH - https://www.fema.gov/hazus - and inaSAFE - http://inasafe.org/), architects can identify the best places for temporary settlements and the needed infrastructures. This can be a public space that is used for several activities supporting social activities during ordinary time, which would be quickly converted into a temporary settlement in case of emergency since everything would be prepared for that (Félix, Monteiro & Feio, 2015; Bologna, 2006). Beyond the celerity of the preparation to install temporary housing units, there is also the advantage of local people being familiar with the space, accelerating their adaptation in case they have to temporarily live there. Also, after the use as temporary settlement the place would revert to its previous public use. This also allows the realization of simulations and training sessions for people on the precise place that they may use for real.

Regarding the units, pre-disaster plans can also be the opportunity to previously design them according to existing housing models and the available resources, both in terms of materials and local labor. In this way, local manufactures and companies could be involved, assuring minimum stock to built the units in case of an emergency, and people could be engaged in the referred simulations to learn how to build them. Lastly, this previous design is also the opportunity to consider the second life for units or at least for their materials (Arslan & Cosgun, 2008; Johnson, 2008).

5. Recommendations to improve the design of Temporary Housing units

Learning from previous temporary housing implementations, some guidelines can be suggested to support the design of the units in a pre-disaster phase:

- Design with and for people - the only way to guarantee adequate solutions is to listen to users, understanding their needs, expectations and way of living. Local community must be involved to understand their culture and define the adequate dimensions, level of comfort, needs for privacy, security and protection;
- Local oriented design - local models of housing shall be the starting point to design temporary housing units. It does not mean to copy but rather understand the identity and consider the main features to design temporary units that are familiar and friendly to users, not only in aesthetically terms but also in functional characteristics. Local oriented also means to consider the available resources and construction techniques, as well as to incentive the community participation in construction or assembly works to reduce costs of fabrication and installation. On the other hand, it also helps the affected people to surpass the trauma and to reinforce the community and neighborhood relations. To facilitate that, construction systems must be simple and based on small and light elements. In spite of the importance of using local resources, it does not mean that contemporary solutions should be avoid, since the combination of both can improve the development of the units.
- Design beyond units - as previously discussed, the temporary settlement planning is crucial for the success of the overall strategy. Infrastructures, public spaces, transitional spaces between public and private domains, as well as outdoor spaces surrounding and supporting the units are extremely important. These spaces also create conditions for interaction and socialization among residents, which is advantageous to maintain the sense of community (Caia, Ventimiglia, & Maass, 2010).
- Flexibility - due to the uncertainty regarding the time that people may live in temporary units, the more flexible they are the easier is for users to modify them according their needs during the period of usage. Since it is difficult to develop customized units for each family, flexibility is crucial to improve the connection between residents and the temporary unit, since it facilitates personalization and this way accelerates the adaptation to the temporary lodging.
- Life cycle and environmental awareness - temporary units represent high costs and are used during a short time. Thus, there is a need to think in the entire life cycle of the resources to compensate the investment and also to minimize their environmental impact. Therefore, strategies such as the reuse of the units or reuse and recycle of the materials should be considered in the design of the solutions. Likewise, the use of ecological resources and non-pollutant construction techniques, the introduction of concepts such as design for deconstruction that allows the recovery of most the components, and considering the concept of reversibility

for the global solution (Bologna, 2004), contribute to significantly decrease the environmental impact and to have some return from the initial investments. The integration of systems that use natural resources to make the unit more autonomous, like energy production from sun and rain water saving, is also important.

6. Discussion and Conclusions

The discussed suggestions and recommendations increases resilience of people living in disaster prone areas, improving the adequacy, performance, efficiency, fastness of installation, and also the resources management of temporary housing solutions. If important issues, such as temporary settlements location, community involvement and training, and local resources usage, are planned beforehand, most of the identified problems are mitigated and people get better preparedness, which improves resilience.

Some of these recommendations may also be implemented in existent temporary or informal settlements, since they contribute to increase safety, security, sustainability and global management. Particularly in informal areas, supplying temporary units that provide adequate level of flexibility, to allow a progressive changing and adaptation, could be implemented as a temporary solution that gradually becomes permanent. This transformation could happen in the same place, if the strategy is extended to the settlement or even in a different location provided that recommendations regarding simple, reversible and re-usable construction solutions are granted.

In spite of this study presenting strategies and recommendations that are more profitable if implemented in pre-disaster planning, they can also be potentially implemented in already existent places where people are living in precarious or vulnerable housing conditions, because it provides for gradual improvements on settlements and houses during time.

Therefore, this research contributes to disseminate the important role that architecture can play to increase resilience of communities at risk, particularly regarding temporary housing after disasters, but also to support housing improvements in informal settlements.

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Humanitarian Architecture in practice and education: the role of scientific meetings and design contests

A. Nuno Martins*

*Universidade de Lisboa, Faculty of Architecture, CIAUD, Research Center for Architecture, Urbanism and Design

Abstract

The 8th edition of the International Conference on Building Resilience gathered more than 350 academics and practitioners under the motto: *Risk and Resilience in Practice: vulnerabilities, forced displaced people, local communities and heritages.* Some of the best scholars in the field were present and distributed over 30 thematic tracks and 4 special sessions. The conference organisers further undertook a doctoral school and two design competitions as parallel events. This paper summarises the organisation of these competitions, which addressed architects and NGOs multidisciplinary teams, and the role they played, together with the conference track on Humanitarian Architecture (HA), at the 8th ICBR. Both the competitions and the scientific event focused on HA meant to contribute to the debate on an architectural practice carried out in crisis scenarios near the most vulnerable, notably the poor, the forcibly displaced or the disaster affected. Besides the main data about the design contest it is discussed the concept of humanitarian architecture on the basis of selected readings. The paper concludes with a tentative definition of HA and suggestions regarding criteria for successfully organising both the contests and the scientific event.

Keywords: Humanitarian Architecture, Slum upgrading, Incremental Housing, Residential Building Types, Disaster Risk and Resilience, Vulnerable Communities

1. Introduction

Humanitarian Architecture in practice: Reducing Risk and Building Resilience in incremental housing and postdisaster reconstruction Description

In November 2018, the universities of Lisbon and Coimbra and other partners such as the NGO Building 4Humanity, Design and Reconstruct Communities Association (with headquarters in the city of Coimbra, Portugal) co-organised the 8th edition of the leading International Conference on Building Resilience (B 4H). In representation of the NGO B4H, a few members of the conference organising team have run the first edition of an architectural design contest: the Building 4Humanity Design Competition which appear in line with previous competitions focusing on risk and resilience (DRIA 19, 19b; , iRec 2008, 2019). The competition

received more than 60 submissions from all over the world in three categories: *students*, *professionals-built works* and *professionals-unbuilt works*. The competition attracted various national and international sponsors who granted more than ten thousand euros in prize money. Among the evaluation panels, during the two stages of evaluation, where 90 practitioners and academics from all continents with a strong reputation in the area. All projects were exhibited during the conference (in the premises of the ISCTE, another public university, in Lisbon) and the shortlisted submissions published in the conference and NGO websites. Together with this competition a small part of the organization team organised a second and complementary competition . In this case, it was the launching of a very special award that meant to acknowledge the work of architects and NGOs teams led by architects. This prize was named after the Brazilian civil rights defender and elected council black-women Marielle Franco. Marielle, a sociologist who graduate in one best universities of Brazil but who was born and raised in the favelas of Rio de Janeiro herself (at the huge conglomeration of slums called *complexo da Maré*) became sadly famous when she was brutally killed in the streets of her hometown, possibly by militias at the service of local mafias (two of them are currently arrested and being prosecuted). When the murder took place, in 14 March of 2018, she was trying to implement, with the support of the regional chapter of the Brazilian Council of Architecture and Urbanism in the municipality of Rio the well-know law of Technical Assistance (approved in 24 December 2008, Law 11888), a diploma that in addition to the constitutional right to housing, guarantee the poor support of architects and other built environment professionals, in order to improve or expand their precarious houses and the enjoyment of built public spaces (Kapp 2018).

2. Towards a definition of Humanitarian Architecture (HA).

To explore a definition of HA, we try firstly, to settle ideas about two or three subsidiary concepts that may work as the foundations of the building of HA. Considering their involvement in architectural education and research, we select a few authors and publications as well as moments that are crucial to structure that building.
All the books and articles referenced next analyse the roles of architects in post-disasters or other crisis scenarios. While they portray well-succeed architects, who sometimes share their own achievements, they also highlight the limitations shown by the new generations of architects in engaging in emergency response and making a positive impact (Aquilino 2011, Charlesworth 2014, Smith 2011). In general, the books' authors agree that current curricula of undergraduate courses of architecture schools do not prepare architects for doing the required job in the humanitarian sector (Charlesworth 2016, Acar 2016, Wagemann, 2013). Tauber (2014), in particular, refers to various authors that in the past 15 years have underlined this disconnection between the theory and the practice, i.e. between education and profession. Among them, leading DRR consultant and academic Ian Davis (2016). Although none of them investigate thoroughly why the schools are so reluctant in incorporating a 'humanitarian' focused approach to design, most of them refer to the usual prejudices against the so-called local resources-based architecture (Aquilino). They actually often identify local traditional materials and building techniques as a ground for the people-oriented approach in which architects immersed in post-disaster scenarios seem to build upon. With very few exceptions, they are not talking about architects working

for big corporations or NGOs but those independent architects integrated (or not) in small or local-based NGOs, instead (Charlesworth, Sinclair, Tauber).

Aquilino and Charlesworth refer to a few schools offering newly advanced training or graduate courses in disaster risk-related issues. However, they don't explore in detail those offers. Therefore, they do not go through this relationship between humanitarian architecture and education, either. As mentioned above, they mostly focus on the best HA practices across the world. The projects published by well known NGO Architecture for Humanity, who for ten years championed the mottos *the* (curative) *power of design*, and *design for all*., in a moment of growth of their activity worldwide mainly showcases the NGO design supply (Sinclair 2011). In the case of the book Design for the 90% (Smith, 2011) we can observe various examples of architect successfully working within vulnerable communities. Yet, only a particular chapter gives us a sense of academia and pertinent views on the education of future architects : the fieldwork developed by Christian Werthmann (2011) with his landscape architecture students in Brazil (S.Paulo), which deploys a series of proposals selected through an internal ideas competition. The analysis of the students' team leader emphasizes in which ways the disrupting ideas arose during the visit to the site, and developed throughout a full semester, may contribute singular views to further discussion between the local residents and housing agencies as well as unleash grassroots initiatives.

3. The role played by design competitions and architectural education towards a better HA practice

Two pieces of research, from Narayanan (2013) and Ovink (2016) provide us an analysis of design competitions that can be related with a humanitarian approach to architecture. Yet, despite their focus design competitions involving disaster risk&resilience, these two pieces of scientific literature provide us with little reflection on the essence of an architecture that can be coined as humanitarian (Sanderson 2010). In this sense, they bring us good references to understand the different processes/roadmaps and accomplishments of competitions but do not bridge the gap between design contests goals and the consolidation of an emerging practice.

Additional scientific literature collecting different studies based on case studies confirm the benefits but most of all the drawbacks of post-disaster recovery and rebuilding processes, both bottom-up and top-down processes. In the case of govern-driven operations, the actual experiences provide evidence of resounding mismatches of people's needs resulting in the abandoning of entire new urban settings (Lizarralde, 2010) . In fact, more than one author reports several cases of massive people withdrawing from relocations sites due to lack of engagement in the design and building process, which led to underestimating vital factors such as livelihoods and lifestyles. In other cases, the rejection is associated with a considerable dissatisfaction with seemingly inadequate dwellings (whether assigned by the local administration and major NGO), both in functional, and cultural terms (Boano, 2011, 2012) . In most cases, the repetition of housing building types aside from local architecture culture mostly detached transitional residential units poorly designed and constructed, do not comply either with locally

required thermal comfort, water protection standards and current risk exposure represent a kind of a second disaster (Martins and Guedes, 2015). In conclusion, as for today, there are very few examples of truly people-oriented recovery or rebuild processes after disaster or displacement. Further, the under-preparation of architects is just one of the several factors of these repeated failures. The enormous amount of flops in disaster risk operations can be fairly linked to the incapacity of architecture schools or professional boards to educate and train adequately architects able to work and thrive in the disaster scene.

In this very unbalanced framework, the design competitions focusing on risk and resilience can be seen as an opportunity for both students and professionals to test themselves regarding the required skills to get into the humanitarian aid sector and succeed. If the design brief is in tune with the requirements of a comprehensive humanitarian architecture approach, both students and architects engaging in these competitions will have a chance to develop their best capacities and fuel their imagination. A design brief that demands a good balance between technical, environmental, social, economic and community participation aspects, while providing the freedom to wander, morphologically and aesthetically, may unleash powerful ideas that end up in creative projects, not to say innovative projects.

But a design competition is not only about the participants' willingness to shine and the ability to respond to the demands of the brief. Is also about the assessment carried out by the evaluation committee, which in turn reflects its members' background, expertise and competence. Is this a good moment to stress the importance of combining people with different backgrounds and experience both in the competitor teams' and the Juris. A good project is, of course, a sustainable project which requires the involvement of a wide range of knowledge in such different areas as disaster-risk reduction, community resilience, heritage, biology, landscape, sociology, psychology, engineering, climate change, and of course urbanism and architecture. But how could a good project be recognised without an evaluation committee at the same level of preparation and diversity in terms of disciplinary background?

Thereby, the design competitions, when featuring good teams and jurors can become an unique opportunity to highlight the best of the best architects to offer to disaster science and practice. An encounter between a given well-formulated problem suggesting well-posed questions and demands, a problem-solving multidisciplinary team able to know the place, interpret the brief and respond to it in a creative way, and finally, a group of experimented scholars and practitioners ready to carefully identify quality, innovation and relevance.

4. Final considerations; a tentative definition of a social and humanitarian focused practice

In the past decade case studies and the on going practice in slum upgrading and postdisaster environments, has been providing valuable clues to devise a set of principles for a 'humanitarian' and resilient architectural practice: (1) Prioritising local cultures, knowledge and resources; (2) paying attention to minorities, (3)

investigating urban & architectural design and building strategies and also participation models that strengthen the social and cultural component of sustainability and community resilience, (4) incorporating into 'humanitarian´ architecture intercultural and interdisciplinary dialogue, (5) integrating into architectural practice digital and analogical tools for social innovation, (6) bringing in findings of ground-breaking research and mainstream disruptive practices that attempt, not necessarily prioritized in this order, assertive concepts such as (i) system building type (Muratori, 1960; Durand 1981) (ii) incremental housing (Martins, 2019) (iii) community resilience (iv) disaster risk (v) gender issues (vi) cultural landscape (vii) collaborative mapping (vii), climate change adaptation.

5. Future developments and the role role played by conferences in the discussion

Yet, regarding the consolidation of the emergent body of knowledge of HA a few questions remains unanswered:
- Within the context of urban disaster, informal settlements upgrading and risk and resilience issues, how best to fill the gap between 'humanitarians', 'designers' and 'locals' to improve the assistance to vulnerable communities?
- How mapping and design tools, such as 'incremental housing, 'design-charrettes' and collaborative mapping, can be improved by social innovation and disaster science trends, such as community-building, experiential learning, adaptive resilience, gender issues and DRR (disaster risk reduction) practices?

The aim of the conference track on humanitarian architecture was discuss and better understand, the role played by architects and humanitarians as well as the co-operative relationship between designers, urban planners, NGOs and stakeholders in reducing risk and building resilience in post-disaster recovery and rebuilding processes that emphasizes livelihoods, social sustainability and climatic issues. In line with the 4th priority of the Sendai Framework (UN 2015, UNISDR 2015) and relying on case studies, the conference track allowed to identify patterns, achievements, and failures in this approach. From comparative analysis, the research presented to this session may highlighted how to incorporate social innovation tools, risk and resilience tools into humanitarian planning and design within community resilience processes. Themes suggested to be further discussed covered, among others: the role played by Academia, NGO and stakeholders in bringing in risk and resilience into post-disaster reconstruction architectural projects, design methods for approaching risk in architecture developed in humanitarian aid scenarios, multidimensional architectural projects and urban planning addressing the vulnerability of local communities in disaster-prone areas, post-disaster architecture and the use of the concept of incremental housing, learning from vernacular architecture and traditional practices of DRR in rural areas, risk and resilience in slum upgrading architectural and urban process, contributions of humanitarian architecture to risk governance and public policies, building codes revision to address risk and resilience in disaster-prone areas, post-disaster recovery, rebuilding and resettlement assessment with a focus on housing issues.

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Enablers for improving seismic resilience of vulnerable buildings: a myth or reality?

Temitope Egbelakin [a,*], Jason Ingham [b]

[a] Massey University, New Zealand
[b] University of Auckland, New Zealand

Abstract

The increasing frequency and scale of losses from recent earthquake disasters and previous studies have shown that some stakeholders' practices in the natural hazard mitigation sector could serve as impediment to property owners decisions to retrofit their buildings. This study focuses on examining how other stakeholders practices involved in earthquake resilience can be used to improve the resilience of earthquake vulnerable buildings. A mixed method approach, comprising of Semi-structured interviews and a questionnaire are used in this study. The research findings from this study showed four key enablers essential for achieving seismic resilience in vulnerable regions area. These possible enablers include the annexation of seismic risk appraisal in valuation assessment, publicly available GIS Earthquake Hazard map of earthquake-prone buildings, improved accuracy in earthquake risk assessments and the use of a risk-based insurance premium system. These potential enablers suggests how the other stakeholders and policy regulators can work together to develop earthquake-resilient and sustainable urban communities.

Keywords: Earthquake-prone buildings (EPBs); property market; seismic resilience; risk mitigation decisions, building owners.

1. Introduction

Seismic risk mitigation of earthquake-prone buildings (EPBs) is of core in achieving seismic resilience for urban sustainability due to the severity of earthquake losses. The Ministry of Business, Innovation & Employment (MBIE) defines an earthquake-prone building (EPB) as; a building or part of a building that will likely collapse due to its ultimate capacity being exceeded in a moderate earthquake, and would likely cause injury or death to persons in or near the building, or damage to other nearby properties (Ministry of Business & Innovation and Employment, 2016). Major structural and non-structural losses encountered by property owners during earthquakes are y attributed to the inadequate seismic safety of the buildings (Egbelakin et al., 2015). EPBs owners are often posed with the dilemma of making appropriate seismic investment choices for their buildings, due to the high cost of implementing seismic retrofitting. Other factors such as the trust, risk perception, risk communication, perceived efficacy of mitigation mechanisms and regulatory provision have been identified to contribute to EPB owners unwillingness in implementing adequate seismic mitigation measures (Egbelakin et al., 2011; Egbelakin et al., 2013; Egbelakin et al., 2014). The research reported in this paper sought to investigate how other stakeholders' practices affect building owners to retrofit their EPBs, and how these factors can enhance buildings owners' willingness to retrofit their vulnerable buildings.

2. Strengthening of Earthquake-prone Buildings

Existing research have several identified various factors that contribute to property owners' unwillingness to strengthen their EPBs from the property market perspectives. The assessment of seismic risks in property

* Corresponding author. E-mail address: t.egbelakin@massey.ac.nz

valuation exercises could affect how property owners retrofit decisions. Currently, assessment of seismic risks are often not included in property valuation reports in New Zealand, due to the difficult to the extent of retrofit work required. Consequently, seismic risk is poorly accounted for in property valuation reports and investment decisions. As a result, there is insufficient weighting attached to potential earthquake strengthening costs in many investment and purchase decisions. Likewise, the lack of access to individual buildings' seismic risks information could mislead the market stakeholders in relation to the issues surrounding a building's vulnerability to earthquake risks (Butcher and Cooper, 2004),thus rendering the market for retrofitted and non-retrofitted EPBs inefficient because property valuation and assessment of insurance risk premiums will be erroneous. Inconsistencies in models for assessing seismic risks act as constraints to seismic retrofitting of EPBs (Tufford, 2001). Another factor is the lack of a risk-based insurance premium system. Seismic mitigation actions undertaken in a retrofitted EPB are often not reflected in the cost of insurance premiums and deductibles (Egbelakin et al., 2014). The Earthquake Engineering Research Institute (EERI) (1998) suggest that insurance premiums should reflect risk, and take into account mitigation actions undertaken on the building, provided that the insurance losses on the structure are reduced by implementing such actions. This is yet to be the case in many seismically active countries, including New Zealand. High insurance deductibles and premiums associated with the earthquake insurance policy increase the building's operational expenses, thus acting as a constraint to adopting mitigation measures (Egbelakin et al., 2011). The inability to correctly estimate potential consequences and losses from a potential earthquake disaster could be attributed to the inconsistencies in the estimates of probabilities and consequences of events of different magnitudes (Rynn, 2002).

Availability of information regarding an individual building's seismic properties is an important factor affecting seismic retrofit of EPBs. Information regarding individual seismic risk properties includes the seismic characteristics of buildings within a particular hazard-prone area, type of building structure, materials, age and potential performance in an earthquake event. According to Egbelakin et al. (2013a), the lack of a unified information system regarding an individual building's seismic properties impedes other stakeholders such as property valuers, issuers and financial institutions from making significant contributions to earthquake risk mitigation. The use of a standardised building grading scheme and a third party service for seismic retrofit assessment has been recognised as a driving force for improving how buildings seismic risks and available mitigation options are communicated to property owners, earthquake risk management stakeholders and the public (New Zealand Society for Earthquake Engineering, 2006). A standardised building grading scheme provides an indication of earthquake risk for a given building, while a seismic rehabilitation assessor will aid information disclosure to property market stakeholders. The implementation of the grading scheme may have a dramatic effect on market transactions for EPBs, with the possibility of significant reduction in the rents and property values of such EPBs. Overall, it is clear that various researchers have recognised the potential of practices from other stakeholders could affect how building owners makes decisions to retrofit their EPBs or not. This study, therefore, focuses on examining the extent that other stakeholders' practices affect building owners earthquake resilience decision, and how these factors could be reshape to improve the resilience of EPBs.

3. Research method

The study reported in this paper form part of a large research project. A mixed-method approach comprising both interview and questionnaire are used in this study. Semi-structured interview was employed in the first phase of the research, using an interview protocol. The interview participants were selected for this study based on their experience and knowledge regarding the influence of the property market in attaining seismic resilience. Accordingly, the selected participants comprised of A1: structural engineering and architectural consultants, A2: local council officers, A3: insurance company managers, A4: Property valuers and A5: EPB owners. Building owners included people who had or had not retrofitted their EPBs, and may have or have not been involved in the recent Christchurch earthquakes, while other participants had been involved in retrofitted EPBs projects in the last two years. Forty-eight recorded interviews were conducted, ranging from one to two hours. A total of twenty-six factors were extracted from the interview findings, and were categorised into six groups, using the thematic analysis method (Yin, 2017), and subsequently used in the development of the questionnaire in the second research phase. Two hundred surveys were used for analysis in this study, generating a response rate of thirty-nine percent. The respondents were asked to rank the importance of these factors from 1 to 5 (where 1 signifies the least important and 5 denotes extremely important). Care was taken to exclude the interview participants from the questionnaire. A summary of the interview participants and survey respondents' distributions is summarised in Table 1.

Table 1: Profile of Interview and Questionnaire Participants

Category		Interview participants		Survey respondents	
		Frequency	**%**	**Frequency**	**%**
A1	Consultants – engineers & architects	10	21	74	37
A2	City Councils officials	4	8	24	12
A3	Managers of insurance companies	7	14	12	6
A4	Property valuers	9	19	30	15
A5	Building owners	18	38	60	30
Total		*48*	*100*	*200*	*100*
Respondent's location					
Low seismic risk regions		5	10	62	31
Medium seismic risk regions		8	17	18	9
High seismic risk regions		14	29	56	28
Very high seismic risk regions		21	44	64	32
Years of experience in EPB Projects					
<5years		3	6	74	37
6-10years		18	38	46	23
11 - 15 Years		11	23	20	10
16 - 20 Years		6	12	12	6
21 - 25 Years		6	12	22	11
> 25 Years		4	9	26	13

The quantitative data analyses were conducted using the IBM SPSS 23 software. Independent sample t-test (Hair *et al.*, 2016) was carried out to compare the mean of each factor in order to confirm or nullify the interview findings. For each property market enablers, the null hypothesis (H0) implies that a specific factor that will not be effective in improving EPB owners' willingness to strengthen their buildings in order to mitigate the earthquake risks posed to their buildings (i.e., H0: $\mu \leq \mu 0$). Accordingly, the alternative hypothesis (H1) implies that a specific factor will significantly be effective in improving EPB owners' willingness to strengthen their buildings (i.e., H1: $\mu \geq \mu 0$). For this study, $\mu 0$ refers to the critical rating above which a factor is deemed to have significance (p-value) based on the rating scale. Hence, if the p-value is less than 0.05, the null hypothesis is rejected.

Table 2 summarises the results from the t-test. Furthermore, the F-test (ANOVA) was conducted to ascertain the degree of consistency or agreement of the respondents' ratings among all enablers. The result from the F-test (Table 1) is important in understanding the variance in the respondent's choices of property market enablers for promoting seismic resilience. Additionally, in order to determine how significant a particular enabler is in influencing EPB owners' risk mitigation decisions, the Relative Importance Index (RII) was conducted. The RII was estimated using the formula presented in Equation 1 (Tam et al., 2000). However, the interaction between the property market enablers and the general seismic risk mitigation decision-making initiatives, in influencing EPB owners' seismic retrofit decisions, is beyond this paper's scope. Table 2 summarises the RII indices of the property market enablers.

$$\textit{Relative importance index (RII)} = \sum \omega / (A*N)$$

Where:

ω = weighting assigned to each enabler by the respondent, ranging from 1 to 5; '1'is the least important, and '5' is extremely important, A = highest weight (5), and N = total number of samples, and RII was normalised to range between 0 and 1.

4. Results and Discussion

The findings from this study are summarised in Tables 2 and 3. The results identified four key important enablers for improving the rate of seismic retrofitting of EPBs in New Zealand, and discussed in the next subsections.

4.1.Seismic-risk appraisal in property valuation

Seismic risk appraisal is ranked as an exceptionally important enabler for improving seismic retrofit implementation with an RII value of 0.886. This result relates to the importance of making optimised investment decisions in any property market transactions, especially for pre-1976 buildings that are potentially earthquake-prone due to age, deteriorating building materials and lack of adequate seismic strength. The result suggest that seismic risks are not included in valuation reports unless specifically requested by knowledgeable clients. The annexation of seismic risks in property valuation assessment would provide accurate and relevant information for managing property portfolios, assessing risks and making investment decisions. According to one of the interviewees, *"most times when making real-estate investment decisions, we assume that risk from rare disaster events such as earthquake is negligible compared to other the market risks such as net operating income and taxation*". This statement suggests that the property valuation of buildings that are earthquake-prone is generally inadequate, and its current influence on seismic risk reduction and disaster management remains insignificant.

Table 2: T-test results for identified property market enablers from interview and F-test (ANOVA) statistics

Enablers	F-test								T-test		
	Mean values					SD	F-value	p-value	Mean	T-value	p-value
	A1	A2	A3	A4	A5						
Seismic Risk Appraisals	5.053	5.102	5.172	4.958	4.571	1.43	0.911	0.647	4.965	4.68	0.001
GIS Earthquake Hazard Map of EPBs	5.379	5.131	5.001	4.862	3.895	1.31	1.262	0.777	5.102	4.29	0.001
Accuracy in Earthquake Risk Assessment Methods	3.79	4.108	4.184	4.501	5.281	1.31	0.658	0.18	4.393	5.21	0.000
Risk-based insurance premium system	4.186	3.836	4.461	5.341	3.872	1.18	0.409	0.401	4.027	4.33	0.005
Standardised building rating system	3.641	2.361	4.31	4.032	1.647	1.33	3.421	0.021	3.836	3.88	0.063

*SD- Standard Deviation

Table 3: Relative importance indices in the order of importance

Property Market Enablers		Relative Importance index (RII)
Seismic Risk Appraisals	296	0.886
GIS Earthquake Hazard Map of EPBs	288	0.786
Accuracy in Earthquake Risk Assessment Methods	264	0.654
Risk-based insurance premium system	244	0.574
Standardised building rating system	222	0.231

4.2.Availability of a GIS earthquake-hazard map of EPBs

The availability of a GIS Earthquake hazard map of EPBs is ranked the second highest enabler for improving seismic retrofitting of EPBs (RII= 0.786). This result confirmed in previous studies with respect to earthquake risk mitigation (Lepesteur *et al.*, 2008). The evidence from the previous earthquake disasters in New Zealand provides further justification for the claim that there is a lack of earthquake risk information system on overall earthquake vulnerability in New Zealand (Egbelakin *et al.*, 2013b). One of the interviewees mentioned that *"that there is now a greater need for earthquake-related information for all the stakeholders in the property market"*. The availability of theses hazard maps of EPBs would help relevant professional groups and property market stakeholders to access any building's seismic risk data, and could probably influence the price-setting and valuation process of individual property transactions, and thus informed investment decisions could be made. Such stakeholders can become aware of commonly encountered issues earthquake risks, and possibly improve their practices. The findings implies that the provision of a unified safety assessment information system, which offers risk information about the vulnerability of potential EPBs to stakeholders and the public, is central to improving seismic risks mitigation by overcoming some of the challenges associated with the lack of relevant earthquake risk information.

4.3.Accuracy in earthquake risk assessments

Accuracy in earthquake risks assessments (RII = 0.654) is closely related to the methods of identifying strategies for mitigation hence reported as an important property market enabler for achieving seismic resilience. According to Tufford (2001), inaccuracies in earthquake risks assessment methods could act as constraints to earthquake risk mitigation through inaccurate risk estimations and the adoption of inadequate risk seismic performance standards in many retrofitted EPBs. Improved risk assessment would enhance both appropriate risk estimation and adoption of adequate mitigation measures in retrofitted EPBs, would help insurers to accurately set premiums, and tailor their portfolio to reduce the chances of insolvency, and would reduce information irregularities between insurers, reinsurers and financial institutions. Improved risk estimation could also provide more capital and funding opportunities for risk reduction programmes. An interviewee suggested that, *"the issues relating to accuracy in risk assessment methods could be addressed through improved planning, coordination and interpretation of information among the professionals involved in natural hazard disaster and management, guided by law*". It is possible that streamlining parallel provisions and operating procedures among the several stakeholders involved in natural hazard disaster management would reduce the poor coordination of hazard information and variations in the publication of different documents related to earthquake hazard management". Therefore, this could reduce the inconsistencies in earthquake risk information among stakeholders, which is beneficial to both pre and post-earthquake risk mitigation initiatives.

4.4.Risk-based insurance premium system

The provision of a risk-based insurance premium system is ranked as an important enabler (RII= 0.574). Risk zones play an important part in insurance premium estimation. However, there appears to be a lack of importance placed on this matter by insurers and reinsurers (Goda and Yoshikawa, 2012). Insights from the interviews reveal that, at present in New Zealand, a risk-based approach is not considered in estimating insurance premiums. The present approach allows property owners to insure their property by using a sum insured replacement value based on quantity surveyors' evaluation or current property market value across the country. This approach, according to Orsman (2013), has increased the cost of insurance across the country.

Eighty-two percent of the participants explained that generally the insurance premium is not calculated in terms of risk-based analysis, leading to high premiums, even for buildings that have been retrofitted to the high seismic-performance standard, thus being uneconomical for the building operation and maintenance costs. One of the interview participants pointed out, "*Insurance has gone up enormously for all buildings, and it is probably one of the biggest increases in operating expenses for any property owners and tenants, with some buildings becoming uninsurable.*"

This statement and several other similar assertions made by the interviewees indicate an unfavourable direction towards moral hazard in New Zealand's earthquake risk mitigation. Moral hazard occurs where insurance diminishes the insured's motivation to act safely, resulting in under-investment in mitigation plans (Egbelakin *et al.*, 2014). Insurance used only as a risk management approach is not a measure of reducing seismic risks of EPBs. Insights from the interviews suggest that insurance premiums should reflect risk, and take into account mitigation actions undertaken on the building, if the potential insurance losses on the structure are reduced by implementing such actions. Consequently, buildings retrofitted well beyond the minimum requirement should be eligible for premium discounts, which would indicate that a reduction in insurance premiums is a key component of any hazard mitigation programme aimed at improving seismic retrofit decisions and implementation in EPBs. Hence, a risk−based insurance premium approach would also enable insurers to provide discounts to property owners who invest in cost−effective loss reduction measures.

5. Conclusions

The implementation of seismic mitigation measures by EPBs owners is essential for reducing fatalities and damage to property as well as social disruption during an earthquake event. Findings from this study provide empirical evidence on the use of different enablers to drive the demand for seismic retrofitting EPBs. By using the mixed-methods approach, four key enablers for promoting seismic retrofitting of EPBs risks were identified, and offer a scope for further research. These enablers should be seen as an initial effort to understand how the seism retrofit decisions can be used to reduce earthquake risks. There is a need for further systematic empirical analysis of retrofitting actions adopted following the dissemination of this research report in order to determine the adequacy of these factors in actual promotion of earthquake risk mitigation.

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Increasing resilience to increase value: from mere survival towards opportunities for future

Elisabetta Ginelli [a], Gianluca Pozzi [a,*]

[a] Politecnico di Milano, Italy

Abstract

Resilience must be one of the active qualities of every construction. Considering resilience as passive means not seeing it as an opportunity to increase building value. Resilience should be an "intrinsic capacity of the project to generate active value within the building system". Rather than waiting for or adapting to problems, design should foresee possible changes through strategic choices triggering new interactions amongst components, both tangible and intangible. Change can be seen not only as the reaction to a harmful event, but also as a physiological alteration due to transforming needs and time passing. We assume that the significance of resilience does not depend so much on the individual objects, but rather on the relationship between parts created by the project. These links must be directed towards specific binding requirements, which directly derive from the "design program". This contribution provides procedural and technical examples for improving resilience, highlighting parallel strategies to achieve active resilience: participation and working on connections/joints. The method originates from definitions of design's involved invariants and results in technological and functional solutions, showing a construction system we have been studying where these principles are essentially expressed. This contribution shows how increasing resilience is not a cost, but rather an occasion to produce value in terms of money, duration, performances, etc.

Keywords: active resilience, added value, adaptability, active sensible resilience governance, project-oriented resilience.

1. Introduction and framework

According to Bruneau, resilience has four dimensions [Economic, Social, Organizational and Technical], four properties [Resistance, Speed, Redundancy and Resourcefulness] and three effects [higher reliability, faster recovery, fewer consequences] (Bruneau et al., 2003).

In order for systems, products and design processes to be resilient they need to be economically sustainable for companies and clients, thus trying to follow paths that lead the world of production to a greater profit (e.g. through incentives, differentiated taxation, end-of-life responsibility, etc.). Organizational processes become mandatorily more inclusive, participatory and open in order to constantly envisage possible scenarios of active resilience. Moreover, responses to changes or events have to be fast. This can only be achieved through careful planning and scheduling, often unfortunately underestimated and underpaid. Systems must be redundant to create networks, accumulation of resources and diversified, non-univocal paths, certainly triggering greater resilience compared to linear and rigid routes.

Governance and decision-making scenarios are very different. The ability to structure weaves and the possibility of having an active and adaptive management are both necessary tools to build resilience, as they promote and attract flexibility and openness of public institutions at various governance levels, thus being directly responsible for resilience increasing or decreasing in their membership systems. A management that manifests itself through rigid change control mechanisms can only reduce the level of resilience (Folke et al., 2002). In this way, it should be possible to define policies meant to increase resilience without limiting potential options for future developments.

Communication and knowledge sharing are essential elements for all stakeholders to work together with a common goal. This is true also with regards to end users, who often find themselves in the presence of objects they do not know, cannot manage and do not understand.

Within such framework, bottom-up participatory processes are the basis of resilience construction. End users will discover and interpret their active role only if they are involved as protagonists. Keeping this in mind, there are examples in EU policy (Swedish Government 2012) showing action platforms for adaptive management

* Corresponding author. E-mail address: gianluca.pozzi@polimi.it

processes and flexible multilevel governance, which are capable of learning, generating knowledge and tackling change.

Boston's "New Urban Mechanics" project (www.boston.gov/departments/new-urban-mechanics, a civic research and development team that pilots experiments aimed at improving the quality of life for Boston's citizens) or "Ushahidi" project (www.ushahidi.com, which creates bottom-up projects and connections all around the world) are two different, interesting and very effective examples of bottom-up (the former public, the latter private) sharing and information management to increase resilience at a large scale.

Paradoxically, however, it has been observed that autonomous local communities (Villanueva, Gould, & Pichon, 2016) tend to focus on short-term contingent problems, rather than making long-term planning. This is why public governance must set, in addition to a good example, clear rules and incentive systems, able to educate end users and make them aware of their role and potential.

Finally, it is quite clear that the greatest vulnerabilities of our systems depend mainly on inadequate socio-political decision structures (Eakin et al., 2017). We need new approaches and tools to be aware of their role, implementable and self-learning, able to reason independently, informed about rules and capable of resolving conflicts, accessible and interactive (Juan-García et al., 2017). They could involve as many stakeholders as possible and establish new mental models and geographic information systems, in order to highlight how decisively strategic choices impact on the resilience of our life systems, from urban to building organism scale. This will hopefully overcome the misconception that resilience is a cost, turning it into an opportunity able to counter uncertainty and therefore attract investment and resources.

2. Objectives

This research intends to assign an active role to resilience, unlike most research lines entrusting it with a passive role and using it as an indicator to measure the ability of a system or building to resist or react to any external negative event.

What we would like to achieve here is a definition – and therefore a measurement – of resilience as "the intrinsic capacity of the project to generate active value within the building system". A project able to prevent change instead of waiting for or adapt to it, thanks to strategic choices triggering new relationships between components (both tangible and intangible). Change is seen not only in the sense of a harmful event (which is therefore closely linked to risk forecast and management), but especially as a physiological alteration due to transforming needs, the passing of time, building rehabilitation and re-use, management and end of life planning, etc.

2.1.Active resilience

Figure 1 shows one of the possible ideas of active resilience by displaying how automatic sensors can rapidly modify the system to react to changes or unexpected, programmed or predictable events. This classic, often plant-related approach involves sensors measuring the environment; algorithms run data from sensors and give input to actuators to make modifications.

The problem of such model lies in that it does not take users into account, and thus can't be used for inhabited buildings or cities.

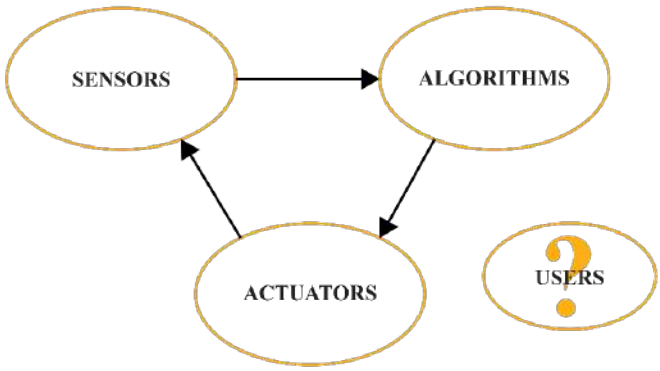

Figure 1: Active resilience.

2.2.Active sensible resilience

If we consider users and their needs according to the environment they live in, the model will change and become more complex. Algorithms will interact with users and environment through a bottom-up bond, where feedback from active users is an essential improving part of the system. In this case, as Ratti (2016) suggested, the users' personal senses as well as their needs, inconveniences and aims play a crucial role (Figure 2).

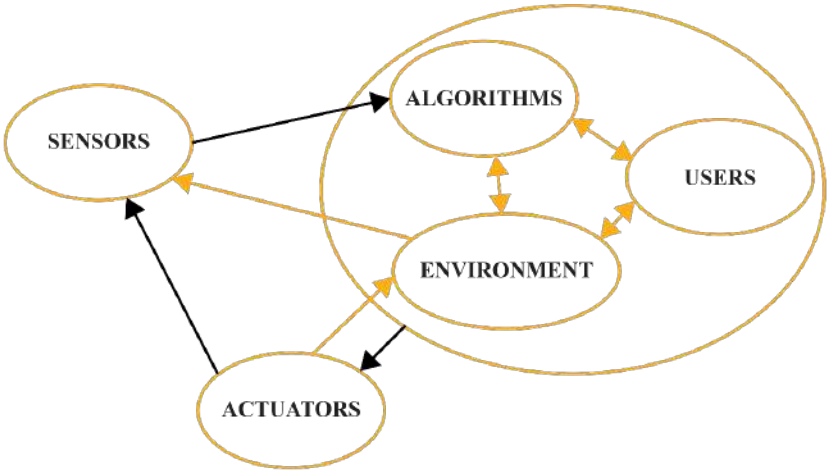

Figure 2: Active sensible resilience.

2.3.Active sensible resilience governance

The aforementioned models are well suitable for plants (the former) or buildings (the latter). But if we imagine a city or a multiuse public background, we need to introduce another degree of complexity involving stakeholders and their role.

Figure 3 shows the complex relations that should be achieved in an "up-driven", bottom-up government process. In this case, stakeholders (public governance) have to play an active role in relation to algorithms, although their choices are suggested and integrated by users' feedback and their prompts are balanced by others, direct and indirect instances.

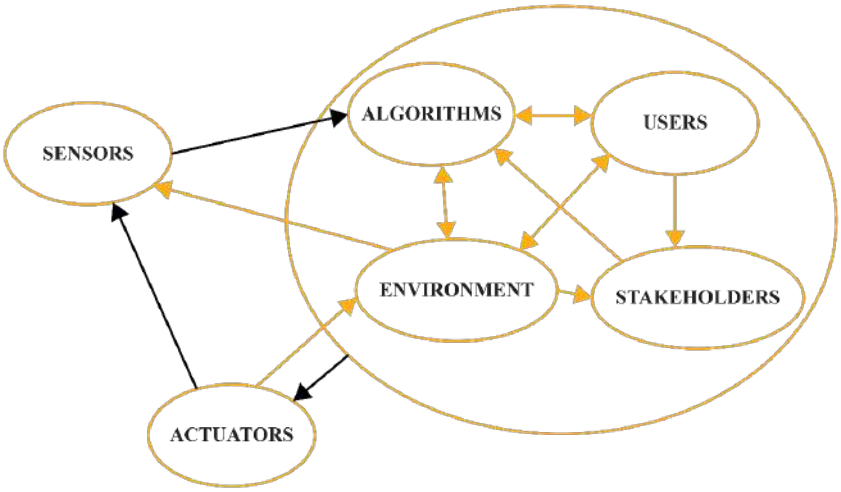

Figure 3: Active sensible resilience governance.

3. Methods

This section means to illustrate a methodological example at building scale of the idea of active sensible resilience governance and its contribution to enhance value.

The pursued approach refers to meta-planning and aims at providing guidelines.

It consists in three steps: first highlighting and defining the project's invariants; then presenting an example of value due to resilience; and finally proposing some meta-design technological solutions for "active resilient" buildings.

Time variable management: quick building schedules, rapid response to external system stimuli, swift dismantling and re-use or recycling times. *Transferability*: the solutions (techno-typological, morphological, structural, plant-related) need to be transferable into other geographical and demanding contexts. Design and production *innovation*: transfer and/or adaptation from and into sectors related to the current generation of products, techniques and knowledge, building sector and other sectors. Qualitative *multifunctionality* of the architectural system, understood as the possibility to use in multifunctional terms both the whole system and the individual components, where the single components institute multifunctional relations for maximizing the use of system potentiality. *Constructive re-active system*: from a structural point of view (active anti-earthquake systems), from an energy point of view (integrated building/plant management) and from a technical point of view, relative to the entire lifecycle of buildings and their components.

The invariants, in turn, were translated into technological and functional resource requirements and objects, due to their strong circularity in the use and re-use of involved resources and because they give substance to the concept of design "active resilience", understood as the capacity of regeneration of its intrinsic value.

An example of such concept, also borrowed from Rusci (2017), starts from the assumption that the value V_0 of a building, calculated at time t_0, should be "regenerated" at time $t_{(0+x)}$, when use conditions no longer meet the users' needs. The value which could be obtained from this regeneration (RV) ("R" stands for regeneration and resilience) has a cost that depends directly on the qualities of the building (V_0) at time t_0 and is a function of the intrinsic capacity to facilitate and actively accept technological, spatial and functional upgrading, as well as the new demanding framework ($Es_{(0+x)}$) to be reached at time $t_{(0+x)}$:

$$RV = f(Es_{(0+x)}) / f(V_0)$$

The greater the intrinsic capacity of a building to accept changes and modifications to achieve a new given performance picture, the lower the cost of this upgrading, and thus the greater its Active Resilience. This concept can also be explained by the following graph:

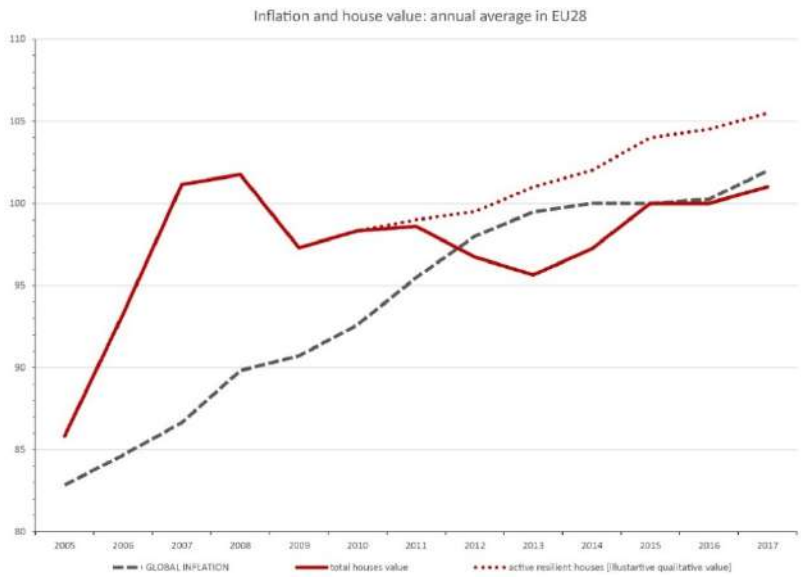

Figure 4: Global inflation in EU28 and value (price) of house, average variation (100 in 2015). "Active resilient house value" is an illustrative and qualitative value, expository of our idea of Active Resilient. Elaboration from EUROSTAT data.

The graph shows the intrinsic link between inflation and house prices: the value of houses usually had the same pattern as the general average price, at least until 2009. This year the financial and economic crisis uncoupled houses value (red line) from all other goods (grey dashed line), causing a huge decrease in building prices. This generic value can be associated to our idea of value (V_0): before the crisis, the house construction apparatus has been quite indifferent to and independent from buildings' real value, which related to location,

marketing and trends. Since 2008 global crisis, indeed, only high performances and well-built houses with advanced construction systems have been able to sustain their value [5]. The dotted red line shows the supposed qualitative trend of enhanced and active-resilient houses: these buildings have high RV and can still be competitive during a crisis, as they can be upgraded and because of their resilience towards changes (also financial and economic changes).

Active Resilience generates invariants and requirements for the project. These requirements are a priori strategies, valid for each project, independently of individual materials and specific products. They can be resilient and thus can actively respond to physiological changes or unforeseen events.

Some technological and functional project requirements have been highlighted, that is: reactivity, replicability, predictivity, redundancy, flexibility, soft approach, sharing ability. However, this is just a small list meant for this contribution and further specifications can be found in Ginelli (2018).

4. Results: the project

The project in which we have experimented our idea of active resilience is the development of a construction system made by high cube shipping containers (Figure 5).

Some tenets of the design have been highlighted below and divided into the different phases of the construction's lifecycle.

Construction of the building and its components: dry technology with "tightening" technique; use of maritime containers as a structural system of the building organism and casing structure; use of a screw foundation system that guarantees the reversibility of the ground condition by dismantling; use of elements already pre-assembled in workshop; use of pre-fabricated elements; minimum work on site; re-use of part of the container's removed sheet metal to reinsert it in the building for other purposes.

Management of the building and its components: independence from electric and gas networks (OFFGRID); reduction of thermal losses to minimum; simplified system management; self-learning of electromechanical equipment; system performance and technological adaptability; substitutability of structural joints.

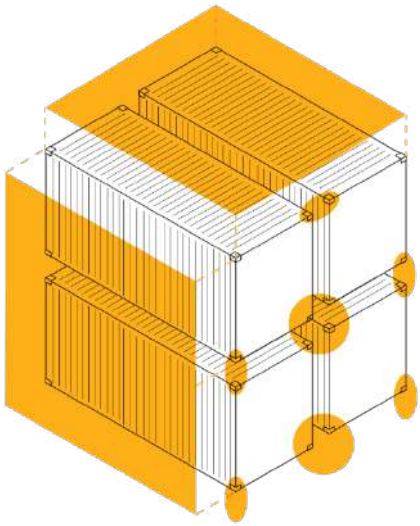

Figure 5: Schematic idea of the project.

"End of Life" of the main function, which stands for system convertibility: substitutability of structural joints; re-use of the container module; multifunctionality of the components; expandability; possible new system reconfiguration; module transformability; module durability; energy recovered at the end of the function.

End of building life: reversibility of the foundation system; disassembly of the components; re-use of the container; re-use of the casing components; recycling of container components.

"End of life" of components and their transformation: disassembly of the components; re-use of the envelope's components; re-use of parts of the container's sheet metal.

This few notes serve only as an introduction to the project. In this context, the project's design process and general idea – better shown in Figure 6 – are far more interesting.

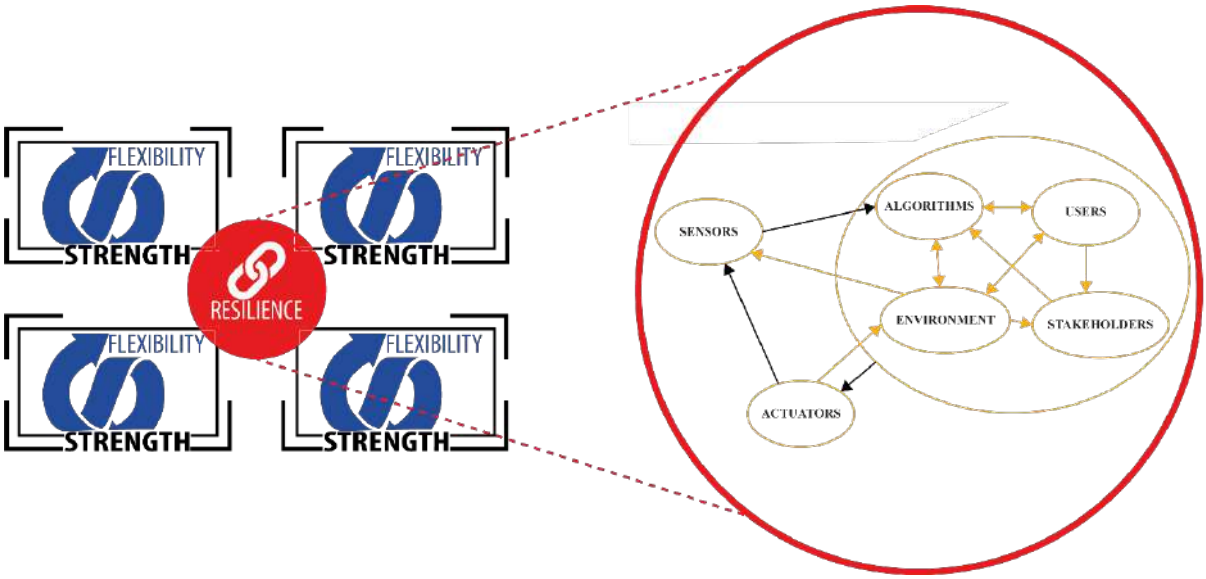

Figure 6: Intrinsic resilience; relation between strength, flexibility and resilience in shipping container buildings.

This figure appropriately shows the relations forming in a shipping container building (SCB) between Strength, Flexibility and Resilience and the abovementioned concept of active sensible resilience governance.

The enormous intrinsic physical strength of a container curtain steel structure makes it a perfect structural frame for construction. Its robustness is suitable for 8-9-floor buildings, without any reinforcement.

The workshop equipment and preparation confer flexibility to the system. Containers are set up in order to provide them with internal and external flexibility, thanks to modular techno-typological solutions, enhanced external adaptable envelopes and active plants (even for off-grid buildings in different climate contexts).

What is important to stress here is the resilience target. All resilience (active, passive and sensible) is concentrated in joints, which are physical connexions supporting and dissipating seismic action, easily replaceable if damaged. Such joints have specific active sensors showing their deformation status and are specific for every building condition, although being simple, small, trackable and replaceable.

Joints can also be immaterial elements. In this case, the design focuses on the relation created between two or more elements to address transformation and external injures.

Our innovative idea of active resilience lies in the joints, rather than in products taken from common industrial production.

5. Discussion

The cultural approach, the invariants, the requirements, the guaranteed performances and the application case described above are the result of a system-based process, according to multifunctional, immaterial (soft) and material (hard) connections. The design, constructive and management proposal is technologically advanced and means to renew the prevailing characteristics of the offer in the current housing market.

Especially in countries like Italy, whose building sector offers handmade and old-fashioned construction techniques, the proposed construction system shows that simple actions can face and solve resilience complex issues.

The core of the project is the design approach and governance: resilience is allocated more in design than in projects or components.

The sustainability of such system certainly depends on the environmental benefit of the used materials, products and methods. However, it is determined mainly by the ability to bind information through a multi-criteria structure, in order to produce benefits not individually, but as a system.

6. Conclusions and final remarks

The aforementioned case shows how design can shape and direct projects, starting from users and their needs, from scopes and scenarios.

Similarly, we could think of city governance. Resilience in cities is made by people and things. Design drives them top-down, but governance must start from bottom-up process. All cities' resilience must have a pro-ject (something that is thrown over and that has a direction) whose design must hardly etch on results, at a multi-dimensional and multi-scalar level.

We think that the only possible way to increase resilience is to increase global system efficiency. This cannot be done component by component. Even single components (as the project we displayed) must be thought as systems themselves. For achieving this itis important for engaging companies and constructors to design and test new building construction methods. Public governance and politics should play an active role, funding experiments able to deliver quality and value to buildings and cities over time.

Two research lines can be outlined.

One is on the building. In a few months we are starting to prototype the construction system described above. We will test and find out new ideas and solutions concerning joints, in order to measure, increase and highlight active resilience.

The second is related to process governance. We are working with public offices to develop and test a participative process for designing and realizing a new public building that could enhance social and public resilience.

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Stereotomy-related studies considering the effect of limited angle of friction on minimum thickness values for semi-circular masonry arches

Gáspár Orsolya [a,*], István Sajtos [a], András Árpad Sipos [a]

[a] Department of Mechanics, Materials and Structures, Budapest University of Technology and Economics, Hungary

Abstract

The classical approach to the Couplet-Heyman problem in the literature assumes certain stereotomy conditions (mostly radial) and derives the corresponding unique thrust line and minimum thickness value based on limit state analysis. This problem set-up is readily turned to an optimization problem: By considering stereotomies a-priori unknown, a range of minimum thickness values are obtained for fixed loading and global geometry conditions. It is shown, that feasible assumptions on the stereotomy suffice for a well-posed optimization problem. An analytic lower bound minimum thickness value is derived for the semi-circular arch subject to self-weight. The resulting stereotomy is found to have an unrealistic topology from an engineering point of view with sections almost parallel to the resultant around the middle hinge, conflicting with the Heymanian assumption about no-sliding. Therefore, the angle of friction - hence the admissible range of stereotomies is further constrained in the updated model. It is concluded, that relaxing the no-sliding assumption significantly reduces the admissible range of minimum thickness values by resulting higher lower bound values. The presented methodology offers a simple tool for incorporating a limiting angle of friction into the framework of limit state analysis.

Keywords: masonry arch; thrust line; limit state analysis; angle of friction; stereotomy

1. Introduction

The collapse of masonry arches is typically due to becoming a mechanism without material failure, even for extreme loading. Thrust line analysis has been a valuable tool in the preliminary structural analysis of masonry arches for centuries. Masonry has very limited tensile capacity, hence it is often modelled (in present study also) as no-tension material. Minimum thickness analysis is based on the consideration, that equilibrium of a structure made of no-tension material is only achievable if the thrust line (the way compressive forces follow through the structure) does not exit its boundaries. It determines the smallest possible cross section, that can still fully incorporate the corresponding thrust line for a given loading and compares it to the actual thickness of the arch. The resulting ratio is called the 'geometrical factor of safety' (Heyman, 1968). It provides insight into the sensitivity of an existing structure to unexpected extreme loads. The theoretical background of minimum thickness analysis was established by Jacques Heyman (Heyman, 1967), who applied the lower bound theorem of plasticity to the masonry arch: Observing the arch on the verge of collapse, the original, hyperstatic problem reduces to pure statics. Authors refer to Cochetti et al (2011) for a detailed description of the method and for a historical overview of the development of thrust line analysis to Ageno et al (2004).

Thrust line is subject to the overall geometry of the structure, its loading and its stereotomy (brick or stone laying pattern). The classical approach (e.g. Heyman, 1967, Cochetti et al,2011) of minimum thickness analysis is to assume certain stereotomy (mostly radial) and determine the unique thrust line and/or minimum thickness value for a fixed loading. Moseley however already suggested (Moseley, 1843) that this set up can be varied: the present study considers the relation of thickness and thrust line fixed (that the latter does not exit the boundaries) and seeks a suitable stereotomy for which the thickness becomes minimal (at which the structure turns into a mechanism). With adequate constraint equations this set up establishes a bounded range of minimum thickness values for fixed geometry and loading conditions. In other words, a well-posed optimization problem is investigated.

The rest of the paper is organized as follows: the objectives of this study is summarized in Section 2, while Section 3 describes the structural model, constitutive hypotheses and defines the term stereotomy more elaborately for the purpose of this study. Makris and Alexakis (2013) showed, that different stereotomies result in different thrust lines and minimum thickness values for the same geometry and loading conditions and the

* Corresponding author. E-mail address: gaspar@szt.bme.hu

upper bound of the range of minimum thickness values was obtained (Alexakis & Makris, 2015). The 'geometric' approach of their referred work is followed but extended in the scope of stereotomies and a bounded range of minimum thicknesses is defined in Section 4. The proposed methodology is demonstrated on the semi-circular arch subject to self-load, although it is readily applicable to other geometries aswell. It is demonstrated, that without further, stereotomy related constraints the lower bound is vanishing.

In order to create a well-posed optimization problem, stereotomy related constraints are considered in Section 5: based on plausible (from an engineering point of view) constraints, the lower bound minimum thickness value is analytically derived as t/R=0.0819 (the minimum thickness value is normed by the radius of the arch, hence the thickness to radius ratio, t/R is used in the sequel). The resulting minimum thickness is numerically validated by the definition of a stereotomy resulting in a thrust line wholly incorporated within the boundaries of the arch. The necessary stereotomy however produces sections almost parallel to the resultant around the middle hinge: This conflicts with the original Heymanian assumptions of the model (in particular no-sliding). Therefore, a limiting angle of friction (δ) is introduced to further constraint the range of valid sections in a similar, geometric manner. Considering traditional engineering materials with a dry friction coefficient (μ) lower than 1 ($\delta<\pi/4$), it is shown, that the range of admissible stereotomies is significantly reduced, resulting in a reasonably higher lower bound of the minimum thickness values: t/R=0.1044 for $\delta=\pi/4$. The relation of limiting angle of friction and the range of minimum thickness values is presented on a diagram for $0<\delta<\pi/2$ (from zero to infinite friction) which illustrates the role of friction in the stability and possible failure modes of semi-circular arches.

2. Objectives

- define the range of minimum thicknesses of a semi-circular masonry arch subject to (non-vanishing) self-load through equilibrium analysis
- based on the geometrical formulation introduce an analytical approach and feasible constraints on the stereotomy to turn the original set-up with vanishing lower-bound thickness into a well-posed optimization problem
- define the lower bound minimum thickness value based on feasible constraints on the stereotomy
- redefine this lower bound by considering a limiting angle of friction
- evaluate the results and its possible implications for engineering practice

3. Modelling

Stereotomy generally refers to the brick or stone laying pattern of masonry structures. The general assumption of thrust line analysis regarding stereotomy is that it guides the failure of the structure, as it is more likely for cracks to develop between the elements than crossing the elements. In case of homogeneous materials (e.g. /unreinforced/ concrete), the (assumed) direction of the cracks defines the stereotomy. Stereotomy throughout this paper is treated as a continuous function that assigns the direction of the sections to the points of the reference line of the arch – this condition makes the model readily applicable to homogenous materials as well.

3.1. Structural model

The semi-circular arch is represented by its axis, parameterized with the internal angle denoted by α. The axis is chosen to be the centre line as shown in Figure 1 and the *loading (self-weight) is distributed evenly* along this reference line, regardless of stereotomy. These two conditions present major simplification compared to other structural models of the literature (Milankovitch, 1907; Cochetti et al, 2011; Makris & Alexakis, 2013), but it allows the vector field of the resultant internal forces ($\mathbf{E}(\alpha)$) to be independent of the stereotomy which seems essential for a tractable study of the problem.

The stereotomy function ($\varphi(\alpha)$) is characterized by the internal angle of the intersection point of section ($s(\alpha)$) and intrados. Note, that the *line of action* for the internal force $\mathbf{E}(\alpha)$ can be determined from the equilibrium equations regardless of $\varphi(\alpha)$ /see below/. Unlike the thrust line ($L(\alpha)$), which is the set of points of intersection between lines $\mathbf{E}(\alpha)$ and $s(\alpha)$ (see Figure 1), hence by definition depends on stereotomy. The effect of stereotomy as a function as opposed to a scalar parameter (e.g. rupture angle) in the definition of the thrust line and corresponding minimum thickness value is further discussed in Gáspár et al (2018). Regardless of

stereotomy, the symmetrical five-hinge mechanism (Figure 1) is considered as failure mode at the limit state. The hinges are assigned to the extrados at the springing and top, the middle hinge formulates at the intrados. φ_1 denotes the internal angle of the middle hinge at the intrados and α_0 denotes the internal angle of the reference point corresponding to the middle hinge –the relation of φ_1 and α_0 defines the direction of section $s(\alpha_0)$ at the middle hinge necessary for equilibrium. Due to the symmetry of the problem, only half of the arch is considered.

3.2.Constitutive hypotheses

The present study considers the assumptions as proposed by Heyman (1967) for the framework of minimum thickness analysis based on plastic theorems:

- the material has no tensile strength,
- the material has infinite compressive strength,
- no sliding occurs between the elements*.

*In Section 5.3 the no-sliding assumption is relaxed: finite friction is considered by introducing limited angle of friction. No-sliding is considered only within this limited range.

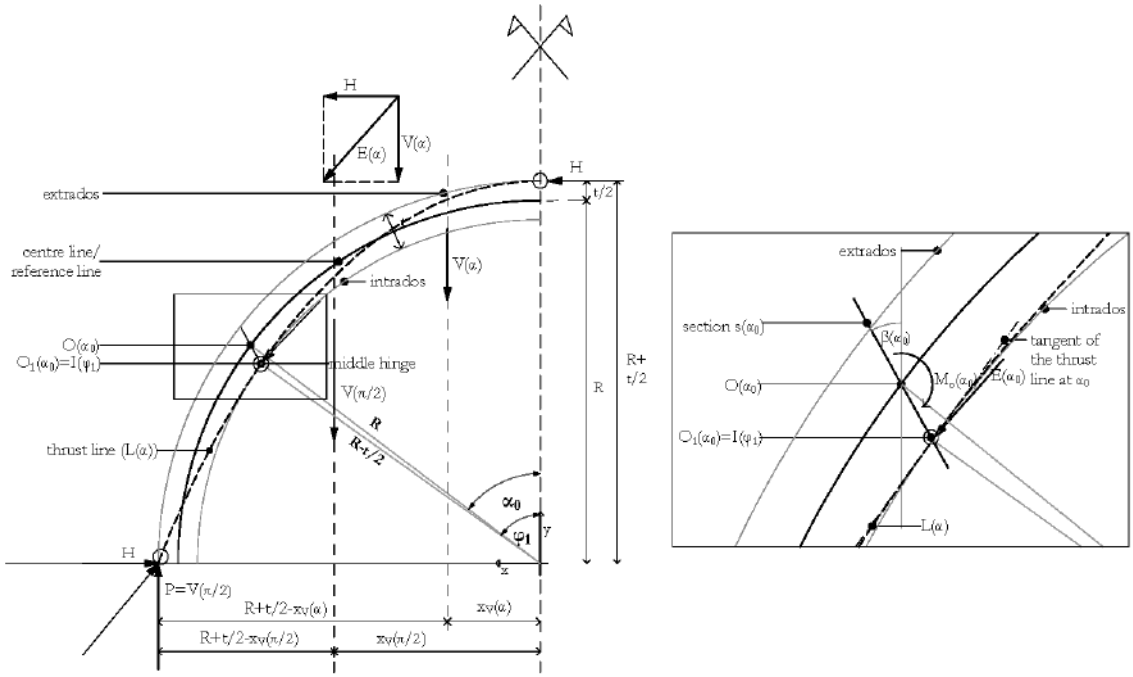


Figure 1: Equilibrium of the semi-circular arch

4. Available range of minimum thickness values subject to stereotomy

A minimum thickness value exists, as long as an admissible and valid stereotomy function can be constructed: The term admissible stereotomy refers to any stereotomy function which results in a thrust line not exiting the boundaries of the arch towards the intrados. The term valid stereotomy refers to a stereotomy function whose corresponding thrust line touches the intrados once. Note, that valid stereotomies are the necessary, but not the sufficient conditions for the existence of an admissible thrust line – for counterexamples see Gáspár et al (2018).

Equilibrium is only possible if the thrust line crosses all hinges - and it does not exit the boundaries of the arch. Let t and R denote the thickness and the radius of the reference line of the arch, respectively.-

The equilibrium of the structure is characterized by the following implicit function of three variables:

(1)

$$F_s\left(\alpha,\varphi,\frac{t}{R}\right)=\frac{\pi}{2}\left(1+\frac{1}{2}\frac{t}{R}\right)^2-\left(1+\frac{1}{2}\frac{t}{R}\right)-\left(\left(1+\frac{1}{2}\frac{t}{R}\right)\frac{\pi}{2}-1\right)\left(1-\frac{1}{2}\frac{t}{R}\right)\cos(\varphi)-\left(1+\frac{1}{2}\frac{t}{R}\right)\left(1-\frac{1}{2}\frac{t}{R}\right)\sin(\varphi)\alpha+\left(1+\frac{1}{2}\frac{t}{R}\right)-\left(1+\frac{1}{2}\frac{t}{R}\right)\cos(\alpha)=0.$$

The graph of F_s is shown on Figure 2.

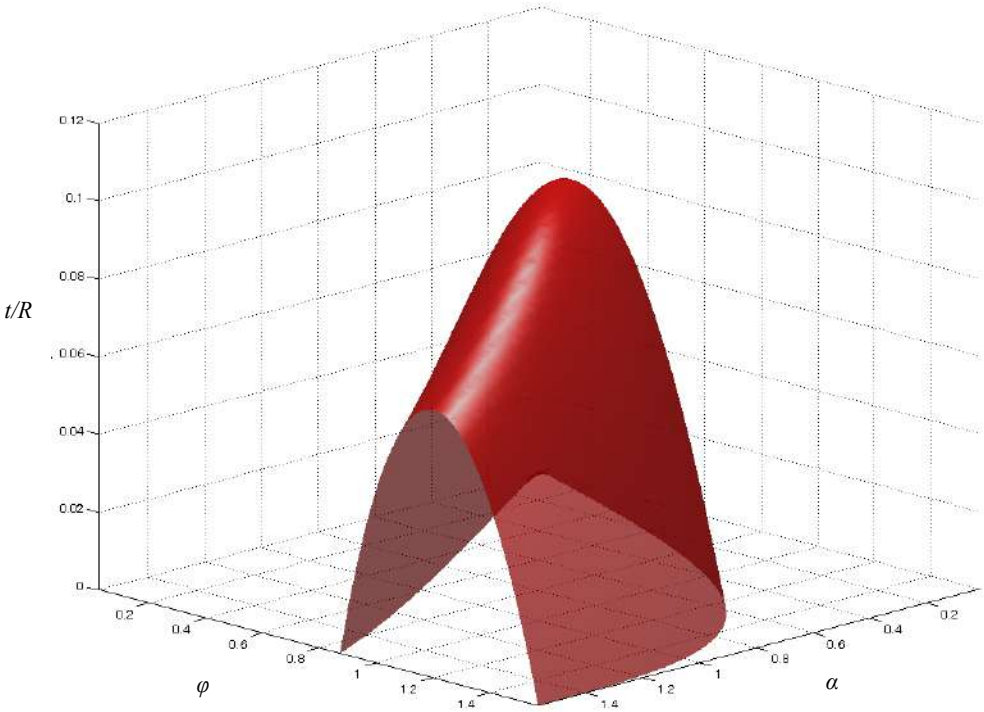


Figure 2: Graph of implicit function F_s (α, φ, t/R)

It is clear from the diagram, that F_s possesses a global maximum with respect to t/R: Should t/R be higher than this value (0.1089, analytically deductible from F_s, see Gáspár et al /2018/ for further details), no equilibrium solution is found, i.e. the middle hinge does not formulate – the arch is too thick (it is stable, but not at its limit state).

For any t/R value lower than this maximum however, multiple solutions in terms of stereotomy are possible for a single minimum thickness value. The left panel of Figure 3 depicts a section of the diagram of F_s parallel to the α-φ plane, the range of admissible stereotomies is left white: The area bounded by F_s is excluded. The physical explanation is shown in the right panel of Figure 3: The range bounded by F_s contains solutions for a fixed t/R value in terms of α and φ that make the thrust line points lay outside the boundaries of the arch towards the intrados. Based on these considerations, the diagram of F_s on Figure 2 clearly demonstrates, that considering solely equilibrium analysis, the range of minimum thickness values is not bounded from below. Theoretically multiple admissible and valid stereotomies can be constructed for an arch of vanishing thickness and finite self-load and it can be shown, that the resulting thrust line is admissible too (Gáspár et al, 2018). This is a non-sense in engineering terms, though. Therefore, below plausible constraints are introduced to establish a well-posed optimization problem.

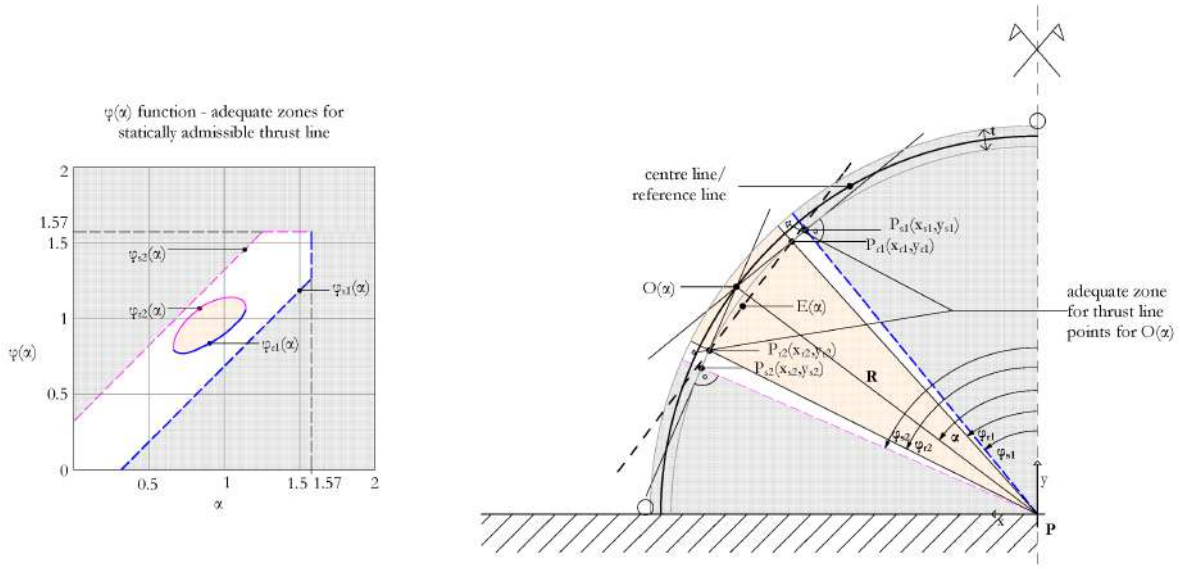


Figure 3: Diagram of admissible stereotomies for a given t/R ratio (left) considering stereotomy related constraints, explanation on arch (right)

5. Analytical derivation of lower bound minimum thickness values considering stereotomy related constraints

If *t/R* is smaller than the upper bound (*t/R*=0.1089): The inner non-admissible range appears, bounded by the implicit function F_s, for a fixed *t/R* value labelled $\varphi_r(\alpha)$. The middle hinge is formulated if the stereotomy function touches $\varphi_r(\alpha)$. Further constraints of stereotomy result another non-admissible range(s). For both cases discussed below, the constraints result two outer set of points bounded by the functions, labelled $\varphi_{s1}(\alpha)$and $\varphi_{s2}(\alpha)$. An admissible stereotomy function requires at least one of the following inequalities to hold:

$$\varphi_{s1} < \varphi < \varphi_{r1},$$

$$\varphi_{r2} < \varphi < \varphi_{s2}\,.$$

meaning, that the non-admissible ranges do not completely overlap. The lower bounds of the minimum thickness value are defined by the cases (A and B), when either of the above inequalities becomes an equality. Graphically it means that the inner set of non-admissible points touches one of the outer sets (eg. Figure 4 left). These situations can be expressed as

(2), (3)

$\varphi_{s1}(\alpha) = \varphi_{r1}(\alpha)$and $\dot{\varphi_{s1}}(\alpha) = \dot{\varphi_{r1}}(\alpha)$ for case A

(4), (5)

$\varphi_{s2}(\alpha) = \varphi_{r2}(\alpha)$and $\dot{\varphi_{s2}}(\alpha) = \dot{\varphi_{r2}}(\alpha)$ for case B

5.1.Assumptions on admissible stereotomies and the resulting lower bound

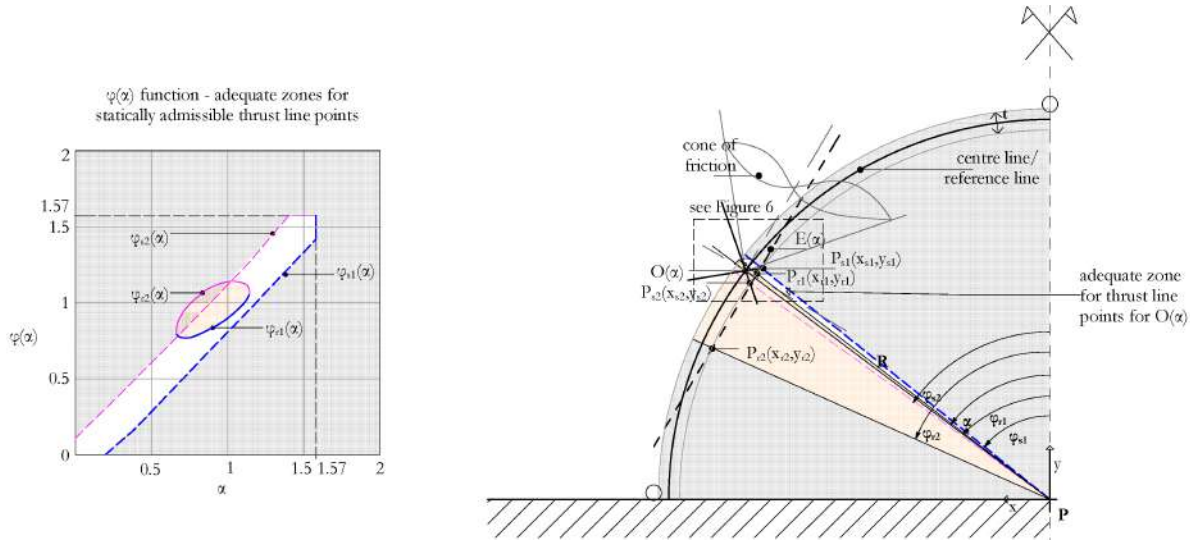
From an engineering point of view the following constraints regarding stereotomy are plausible:

(a) sections should not intersect within the boundaries of the structure,

(b) sections should cross both the extrados and the intrados,

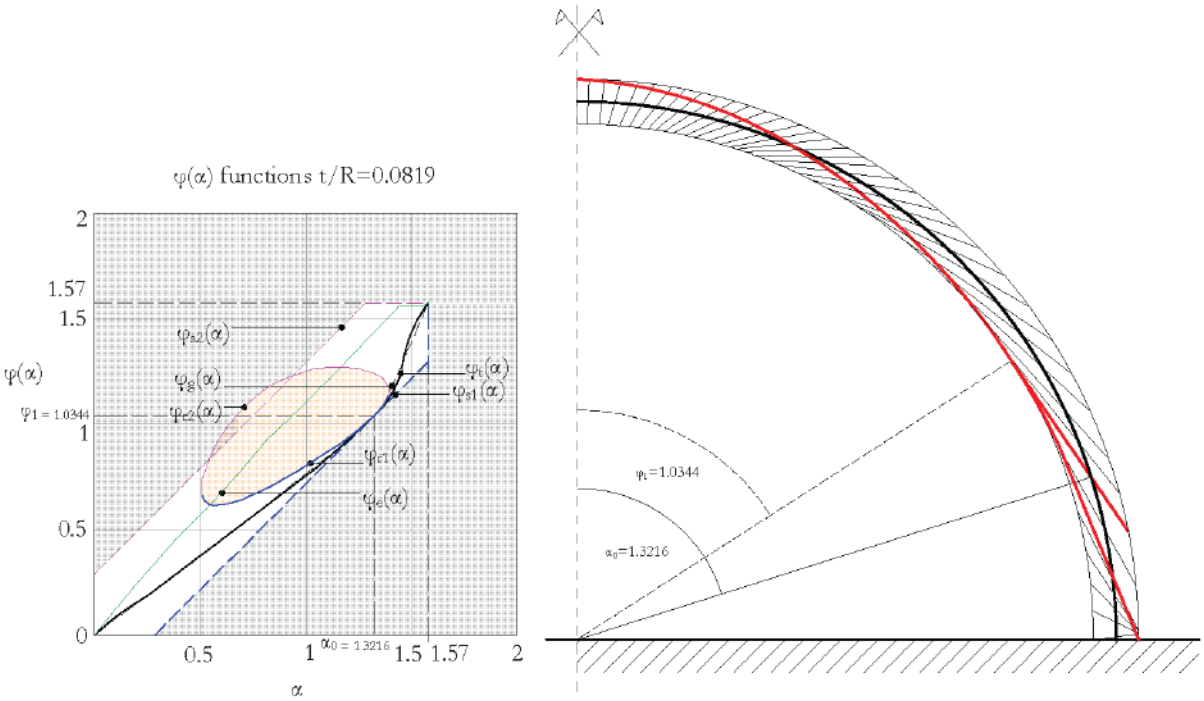
(c) the section at the crown is vertical, and at the springing horizontal.

Here assumption (b) is applied as a constraint in the analytical solution (assumptions (a) and (c) are considered in the numerical validation of the solution, when a stereotomy is constructed resulting in an admissible thrust line /for a discussion of the constraints and description of the numerical process see GSS 2018/). This constraint enforces all sections at most to touch both extrados and intrados.



The resulted limiting values of the range of admissible thrust line points for a given $O(\alpha)$ reference point is defined by the points $P_{1s}(\alpha)$ and $P_{2s}(\alpha)$ (Figure 3 right). They are related to $\varphi_{s1}(\alpha)$ and $\varphi_{s2}(\alpha)$ internal angles for each t/R and α values. At these points sections $s_1(\alpha)$and $s_2(\alpha)$ are tangent to the intrados.

If $\varphi_{s1} > \varphi$ or$\varphi_{s2} < \varphi$, then the section does not reach the intrados, hence it produces non-admissible stereotomies. Simple trigonometric considerations lead to (see Figure 3 right)



(6a)

$$\varphi_{s1} = \alpha - \operatorname{acos}\left(\frac{R - \frac{t}{2}}{R}\right),$$

(6b)

$$\varphi_{s2} = \alpha + \operatorname{acos}\left(\frac{R - \frac{t}{2}}{R}\right).$$

By substituting Eqs. (6a -b) into Eqs. (2-5) the global minimum value in terms of t/R can be obtained (Figure 4, left). Solving Eqs. (2-3) yields t/R=0.0819 (α_0 = 1.3216, φ_1 = 1.0344), while Eqs. (4-5) t/R=0. 0.0924 (α_0=0.7365, φ_1=1.0416), hence the former being the global minimum.

Figure 5: Diagram of admissible stereotomies for a given t/R ratio (left) considering a limiting angle of friction, explanation on arch (rigt)

Numerical validation of the existence of an admissible thrust line at the lower bound was performed by a custom-made script written in MATLAB. The resulting thrust line and corresponding stereotomy (φ_t) is shown on Figure 4, right. The $s(\alpha_0)$ is highlighted on the figure: Note that it is (by definition) tangent to the intrados, which conflicts with the original no-sliding assumptions of the model since it is almost parallel to the resultant.

Figure 4: Lower bound minimum thickness value considering only stereotomy related constraints, diagram of admissible range of stereotomies (left), numerically obtained valid stereotomy (right)

5.2.Implementation of the effect of constrained angle of friction and the resulting lower bound

A limiting angle of friction is considered in the following as a further constraint on the admissible range of stereotomies in order to avoid unrealistic arrangement of sections like in the previous Section. This constraint can be formulated in a similar geometrical manner (Figure 5). Following the notation of Figure 5 and 6:

The slope of the boundary of the friction cone at α (note, that $\tan(\omega)$ is the inverse of the slope of the resultant) based on trigonometric considerations:

(7a)

$$m_1(\alpha) = \cot(\omega - \delta) = \frac{1 + tan(\delta) * \frac{H}{V(\alpha)}}{\frac{H}{V(\alpha)} - \tan(\delta)}$$

(7b)

$$m_2(\alpha) = \cot(\omega + \delta) = \frac{1 - tan(\delta) * \frac{H}{V(\alpha)}}{\frac{H}{V(\alpha)} + \tan(\delta)}$$

Equations of the points P_{s1} and P_{s2} - points of intersection of boundaries of friction cone and intrados are quadratic equations in terms of $\cos(\varphi_s)$:

(8a)

$$m_1(\alpha)\left\{\left(1 - \frac{t}{2R}\right)\cos(\varphi_{s1}) - \cos(\alpha)\right\} - \left(1 - \frac{t}{2R}\right)\sin(\varphi_{1s}) + \sin(\alpha) = 0$$

(8b)

$$m_2(\alpha)\left\{\left(1 - \frac{t}{2R}\right)\cos(\varphi_{s2}) - \cos(\alpha)\right\} - \left(1 - \frac{t}{2R}\right)\sin(\varphi_{2s}) + \sin(\alpha) = 0$$

If $\varphi_{s1} > \varphi$ or $\varphi_{s2} < \varphi$, the section falls outside the friction cone, and produces non-admissible stereotomies.

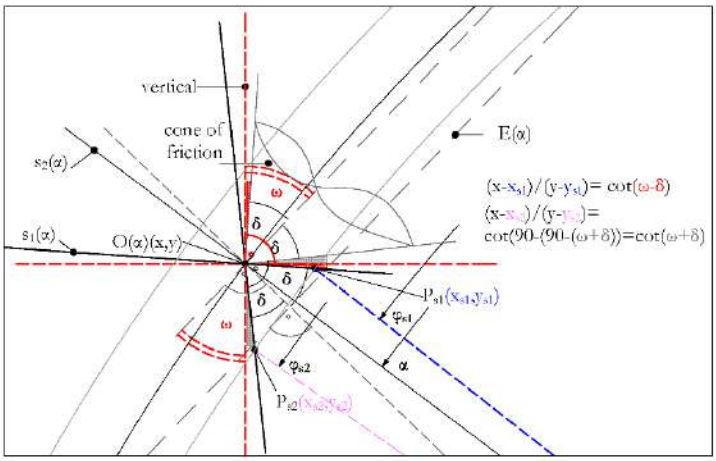


Figure 6: The admissible range of sections for δ

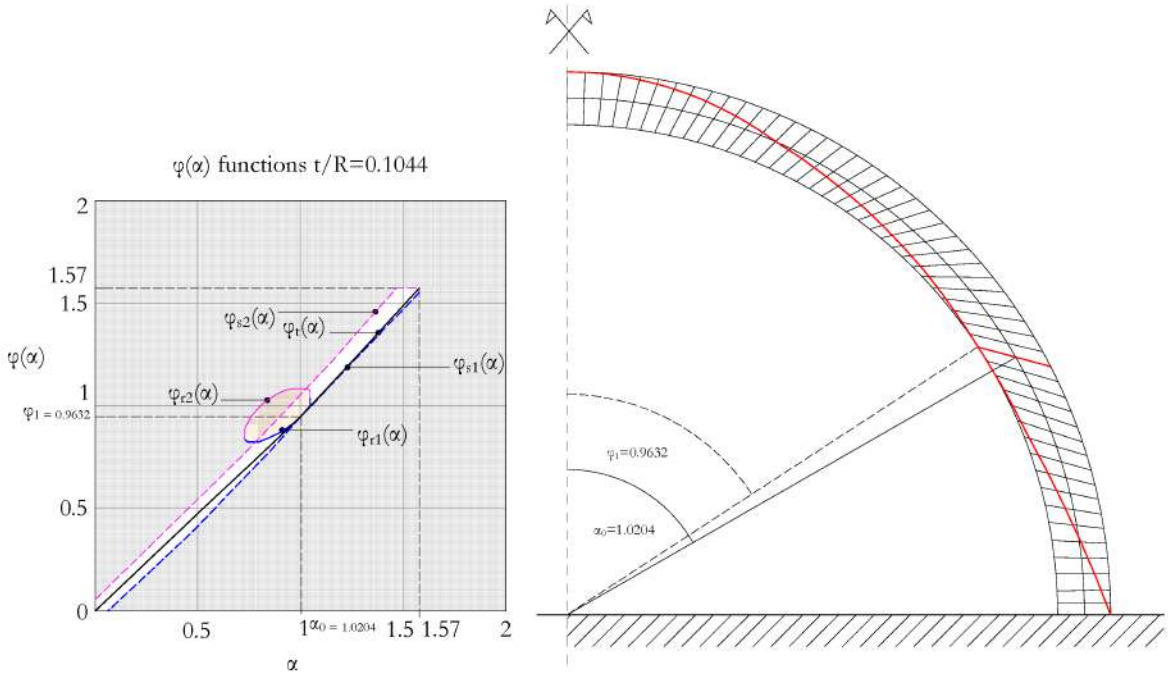


Figure 7: Lower bound minimum thickness value considering $\delta=\pi/4$. Diagram of admissible range of stereotomies (left), numerically obtained valid stereotomy (right)

The effect of various limiting angle of friction can be readily investigated by the proposed method. Note, that for masonry the dry friction coefficient (μ) ranges 0.5 and 0.7 and for traditional structural materials does not exceed 0.8. As a case study, the global minimum value in terms of t/R is obtained for $\delta=\pi/4$ ($\mu=1$) similarly as in Section 5.1, by substituting the valid root of Eq. (8a) into Eqs. (2-3). It yields t/R=0.1044 (α_0 = 1.0204, φ_1 = 0.9632). A stereotomy (φ_t) for an admissible thrust line is constructed numerically and is shown in Figure 7, right.

In order to further illustrate the effect of a limiting angle of friction on the stability and possible failure mode of a semi-circular arch (for further reading on non-Heymanian collapse modes see Bagi, 2014), the resulting range of values of t/R are presented below (Figure 8) with respect to δ, for $0<\delta<\pi/2$ (from zero to infinite friction). The range where a hinge mechanism can formulate (light grey on Figure 8) is constrained from below by t/R=0.0819, deduced in Section 5.1 and from above by t/R=0.1089, the upper bound of minimum thickness values. The bounding functions marked by red and blue are derived from Eqs.(2-3), and

(9), (10)

$\varphi_{s2}(\alpha) = \varphi_{r1}(\alpha)$and $\varphi'_{s2}(\alpha) = \varphi'_{r1}(\alpha)$

respectively (see Figure 9, note, that the blue line is a bound, but not a lower bound to the range, hence the new conditions formed in Eqs. (9-10)). Below the red line, no equilibrium solution is possible, above the blue line only sliding can cause failure but within the light grey range, both sliding, and hinge mechanism can occur-subject to stereotomy. Note, that $\delta=\pi/2$ is assimptotic to the red line: Hence theoretically any t/R value is achievable consdering infinte friction (any other constraint disregarded). The theoretical minimal value of t/R=0.0819 is actually achievable considering (though extreme), but finite friction.

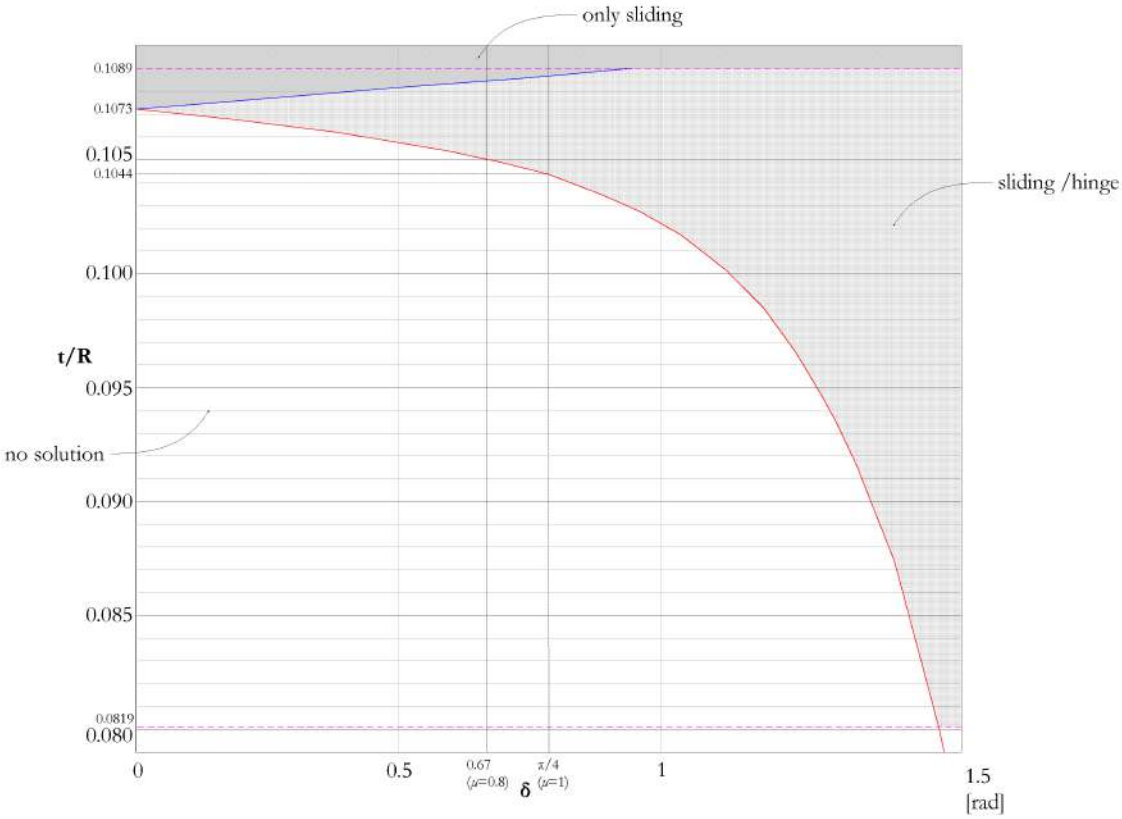


Figure 8: The effect of friction on the possible failure mode and range of minimum thickness values

5.3.Discussion

In order to highlight the effect of stereotomy, the possible practical relevane of Figure 8 and the presented methodology in the evaluation of the stability of arches considering finite friction, the classical case of radial sections is cited. The minimum thickness value for radial sections is t/R=0.1074 (e.g. Milankovitch, 1907). This is only slightly higher, than the one deduced considering zero friction (t/R=0.10733, with a valid stereotomy resulting sections peprendicular to the resultant (see Figure 8). However, Lengyel (2018) argues, that for no-sliding, the limiting angle of friction should be higher than 0.34 radian, which solely based on Figure 8 seems superfluous. The explanation is given on Figure 9, which highlights the effect of stereotomy: It shows the diagram of admissible stereotomies for t/R=0.1074, considering δ=0 (green dashed), δ=0.26 rad (inner magenta and blue pair) and δ=0.52 rad (outer magenta and blue pair). The conclusion based on this diagram is in good agreement with Lengyel: Radial stereotomy (φ_t, marked black) would exit the admissible range for both δ=0 and 0.26 rad – in other words, lower δ would require a different stereotomy function.

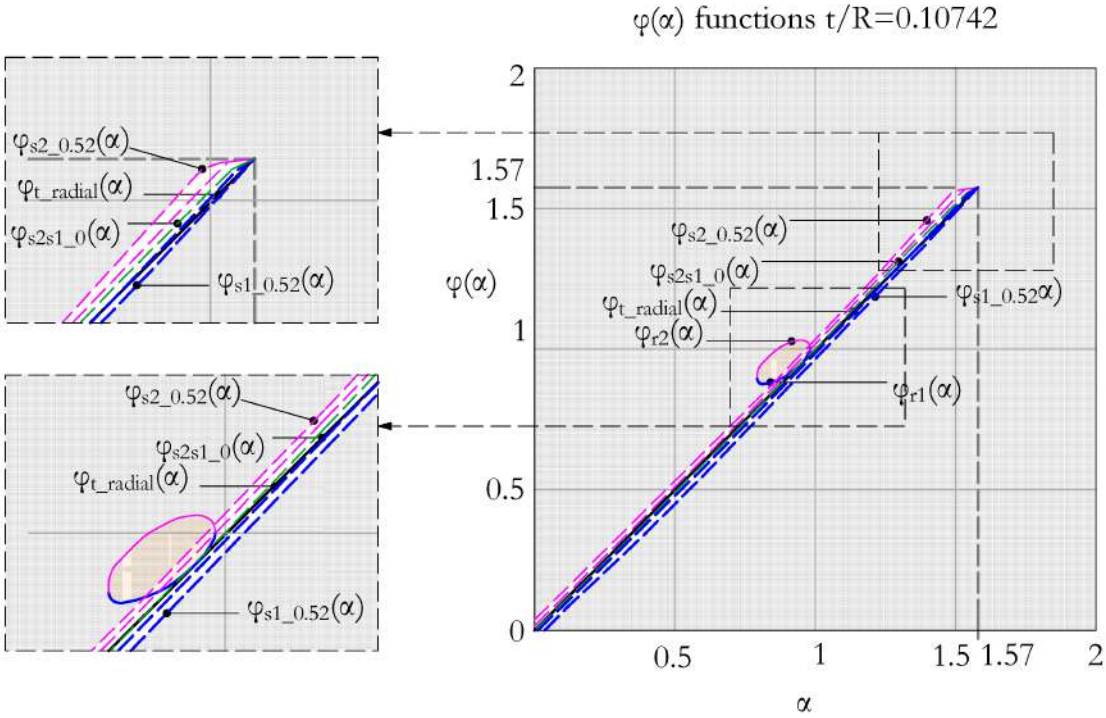


Figure 9: The minimum thickness deduced considering radial stereotomy requires non-zero friction

6. Conclusions

For the evaluation of the sensitivity of the structure against extreme loading in the preliminary stages of analysis, a reasonable assumption on the minimum thickness value is necessary. This paper studied the effect of constraints on stereotomy, in particular a limiting angle of friction on the range of minimum thickness values for a semi-circular arch of constant thickness, loaded by its self-weight. The applied simple structural and material model allowed for a geometric formulation of the problem, resulting in an analytical method applicable to the entire range of equilibrium solutions. In particular,

- it is demonstrated, that the effect of a limiting angle of friction (δ) (as a further constraint on stereotomy) is significant, as it results a higher global minimum thickness value for traditional structural materials
- the general relation of δ and t/R is investigated: The resulting diagram clearly illustrates the role of friction in the stability and possible failure mode of arches

Acknowledgements

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Structural health monitoring and Bayesian decision analysis for resilient masonry towers

Pier Francesco Giordano [a,*], Zehra Irem Turksezer [a]

[a] Politecnico di Milano, Italy

Abstract

In the aftermath of natural hazards there are diverse challenges and limitations to assess the structural capacity and identify the status of historical structures. An effective management of heritage buildings requires an approach which can provide strategies that maximise its resilience. By using knowledge which is acquired from Structural Health Monitoring (SHM) it is possible to make timely interventions to decrease the vulnerability of structure, to minimise the consequences from failures and to decrease the time required to restore the original performance, which is directly related with the structural capacity. This paper deals with historical masonry towers, as a widely diffused historical structural typology on which SHM techniques has been tested. The role of Bayesian decision analysis and Value of Information (VoI) as supporting tool in structural management and therefore in enhancing the resilience of architectural heritage is investigated.

Keywords: Resilience; Structural Health Monitoring; Bayesian Decision Theory; Masonry Tower.

1. Introduction

From past to present, cultural heritage has fulfilled its unique role as an origin of significance and identity of communities and individuals. Heritage is not a remnant from previous ages, but it is a source of cultural identity of communities and individuals, driving force of the economy and promoter of local and regional development and wellbeing (Jigyasu, et al., 2013). Besides this, cultural heritage structures (architectural heritage) are encountering various threats and severe damages due to the natural and man-made hazards. Effective strategies and tools to anticipate, evaluate and reduce disaster risk are essential to protect heritage structures and thus enhance their resilience (United Nations, 2015). In this regard, Structural Health Monitoring (SHM) may provide precious support in disaster risk reduction and management of heritage structures (Ramos, et al., 2010). For instance, SHM is beneficial in the immediate aftermath of a hazardous event to assess the occurrence of structural damage and to provide a prognosis about its evolution. The paper is organized as follows. First, resilient heritage structures are defined. Then, SHM and its applications for masonry towers is described. After that, the framework of Bayesian decision analysis is established and the VoI is defined and applied to the case of masonry towers. Finally, the role of Bayesian decision analysis as supporting tool in structure management in case of natural hazard and therefore in enhancing the resilience of architectural heritage is investigated.

2. Definition of Resilience

Architectural heritage is a link connecting people to their identity and history, being a representation of a territory, supporting local and national economy and decreasing unemployment with its efficient use. In short, heritage structures provide cultural, economic, environmental and social services which cannot be overlooked in the community. Any natural hazard may create a sudden disruption in those services, which implies a reduction in resilience. In (Bruneau, et al., 2003) resilience is defined for an infrastructure under seismic risk however it can be thought for heritage structures since they state that the aim of improving resilience is to decrease any kind of loss such as fatalities, injuries, and economic losses. After (Bruneau, et al., 2003), resilience is defined in (UNISDR, 2004) as "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures." In the light of this definition, a resilient heritage structure is not only expected to recover from a hazardous event and turn back to its pre-existing performance with restoration activities but also with timely interventions before a hazardous

* Corresponding author. E-mail address: pierfrancesco.giordano@polimi.it

event, such as maintaining the structure time to time or learning from past events and strengthening the structure, it is possible to increase the robustness of structure and decrease the expected functionality losses. However, it should not be forgotten that an aging structure can show better performance after a recovery period since already present damages will be repaired together with the latter ones observed after the event. These considerations are included in the resilience model for aging structures proposed by (Ayyub, 2014).

In addition to this, from the available literature it emerges that the resilience is characterized by four attributes, which are robustness, redundancy, resourcefulness and rapidity to recover. (Bruneau, et al., 2003) define robustness as the capability of systems and elements to endure a certain stress without experiencing deterioration or functional loss; redundancy is the capability to assure functional demands during a disruption, deterioration or functional loss; resourcefulness is the capacity to describe problems, demonstrate priorities and organize resources when the elements or system have been threatened; rapidity is the capacity to satisfy priorities and accomplish goals in time to hold back losses and prevent future disruptions.

3. SHM of masonry towers

SHM is defined as "the process of determining and tracking structural integrity and assessing the nature of damage in a structure" (Chang, et al., 2003). Since it implies non-destructive testing, it is considered very suitable for architectural heritage, where the need of minimum intervention often limits the range of applicable techniques for structural characterization (ICOMOS/ISCARSAH, 2005). Here we focus on dynamic SHM, since it allows to assess global structural condition by measuring the vibrational response in operational conditions, i.e. under the effect of wind, traffic, and micro tremors and estimating and tracking the modal properties of the structure, such as natural frequencies, mode shapes and damping factors. Applications of dynamic SHM on historical structures are still limited (Guidobaldi, 2016). Notable exception is the case of masonry towers, which typically show high sensitivity to dynamic actions thanks to their typical slender configuration and considerable mass. Indeed, it has been demonstrated that even with a small number of accelerometers permanently installed on the structure, the damage detection task can be successfully accomplished. This is done using appropriate statistical process control tools to the time series of natural frequencies of the tower identified by means of automatic Operational Modal Analysis (OMA) techniques (Cavalagli, et al., 2017). The typical methodology consists in two steps. The first one is removing the effect of environmental and operational effects on measured natural frequencies by means of statistical procedure such as Multivariate Linear Regression (MLR), Principal Components Analysis (PCA), or a combination of the two, to obtain the residual error matrix E, defined as

$$E = Y - \hat{Y} \tag{1}$$

where Y is a matrix whose i-th column contains the i-th set of identified natural frequencies and $\hat{Y}$ is a matrix which contains the estimated frequencies. The second step is applying the Novelty Analysis statistical process control tool to detect changes in the distribution of E, which point out the occurrence of structural damage. This method is based on control charts which are based on properly defined statistical distance, such are the T^2 statistic, given by

$$T^2 = r\left(\bar{E} - \bar{\bar{E}}\right)^T \Sigma^{-1} T^2 (\bar{E} - \bar{\bar{E}}) \tag{2}$$

where r is an integer factor called group averaging size, $\bar{E}$ is the mean of the residuals in the subgroup of the last r observations, $\bar{\bar{E}}$ and Σ are the mean values and the covariance matrix of the residuals, respectively, estimated during the so-called training period in which the structure is considered in healthy conditions. The values of T^2 must be contained between statistically fixed control limits. A value of the statistical distance that is positioned outside those limits is called outliner. The limits of T^2 are defined by zero and the value corresponding to a cumulative frequency of 0.95 in the training period. In such a way, there is 0.05 probability to observe an outliner in healthy conditions. Contrariwise, this probability is greater than 0.05 if damage occurs. Refer to (Ubertini, et al., 2016) and (Gentile, et al., 2016) for additional details on the procedure.

4. Bayesian decision analysis

The Bayesian decision theory (Raiffa & Schlaifer, 1961) is a suitable statistical tool for engineering decision making in non-deterministic environments (Benjamin & Cornell, 1970). It deals with the logical selection of sets

of actions when: 1) the consequences of any set of action depend on the state of nature; 2) the state of nature is not known; and 3) it is possible to obtain additional information on the state, at a price. In our case, the state of nature is the structural condition, the consequences are expressed in monetary value, and the additional information is acquired by SHM. The variables of the problem are the set of possible actions $A = \{a_1, a_2, \ldots, a_m\}$, the set of structural states $S = \{S_1, S_2, \ldots, S_n\}$, the set of observation $Dy = \{y_1, y_2, \ldots, y_k\}$, the cost c_{ij} associated to each couple of action a_i and structural state S_j, the prior probability $P(S_j)$ of structural state S_j, and the likelihood functions $P\left(y \middle| S_j\right)$ which link the SHM output to the structural states. Under the assumption that the decision maker will select always the action corresponding to the minimum expected cost, as shown for instance in (Cappello, et al., 2016), it is possible to associate to each possible SHM output y the corresponding optimal action $a_{opt}(y)$, as follows:

$$a_{opt}(y) = \arg\min_i \left[\sum_{j=1}^{n} c_{ij} \bullet P(S_j | y) \right] \quad 3$$

and the cost $C^*_{min}(y)$ associated to the optimal decision

$$C^*_{min}(y) = \min_i \left[\sum_{j=1}^{n} c_{ij} \bullet P(S_j | y) \right] \quad 4$$

where $P(S_j | y)$ are the updated probabilities of structural state S_j once the SHM output is known, which are called posterior probabilities. They are obtained by applying the Bayes' theorem:

$$P(S_j | \boldsymbol{y}) = \frac{P\left(y \middle| S_j\right) P(S_j)}{P(y)} \quad 5$$

where $P(y)$ is called evidence and reads:

$$P(y) = \sum_{j=i}^{n} P\left(y \middle| S_j\right) P(S_j) \quad 6$$

Furthermore, the operational costs expected with SHM C^* and the without monitoring C can be computed respectively as:

$$C^* = \int_{Dy} c^*(y) P(y) dy = \int_{Dy} \min_i \left\{ \sum_{j=i}^{n} c_{ij} \bullet P(S_j | y) \right\} P(y) dy \quad 7$$

$$C = \min_i \left[\sum_{j=1}^{n} c_{ij} \bullet P(S_j) \right] \quad 8$$

The difference between C and C^* is the VoI and represents the reduction in expected cost associated with SHM. In view of the above, once the decisional problem is established, the critical *ingredients* of the analysis are 1) the prior probabilities of structural states; 2) the likelihood distribution for each structural state; and 3) the quantification of action consequences by a monetary cost. A methodology to compute these quantities for masonry towers is proposed.

The prior probabilities of structural state can be obtained by fragility curves, which provide the probability of exceeding a certain limit state as a function of a certain engineering demand parameter. For instance, fragility curves for heritage structures, including towers, can be found in (Lagomarsino & Podestà, 2005).

The likelihood functions can be expressed as probability distribution function (pdf) of a damage parameter in a given structural state. In the case of masonry tower, the damage parameter is the T^2 statistic. In the healthy state, the pdf of T^2, by definition, is characterized by a 0.05 probability to observe an outliner. This probability

will be higher in damaged states. To obtain the distribution in each damaged state, the engineer could: 1) simulate the corresponding damage in a numerical model, such as a decrease in material stiffness in certain elements of the model; 2) perform a modal analysis to compute the decrease in percentage of natural frequencies in damaged condition; 3) take a set of experimental natural frequencies obtained by OMA in the healthy state and decrease them of the same percentage given by the numerical simulation; 4) compute the residual error matrix E using the set of identified and then reduced natural frequencies and the set of estimated natural frequencies by means of the statistical model calibrated in healthy condition; 5) compute the T^2 statistic distribution in the damaged state.

The consequences are computed as suggested in (Omenzetter, et al., 2016), as the sum of: 1) cost of monitoring system design, hardware, software, integration, installation, maintenance, data storage and data analysis; 2) cost of structural, non-structural and content damage; 3) costs as result of consequences to humans (casualties, injuries and trauma); 4) cost of interruption to business and occupancy.

The VoI can be interpreted as the maximum cost the decision maker intends to pay for information from a certain SHM system. It can be used for deciding whether it is convenient to use SHM or ranking different SHM strategies (Pozzi & Der Kiureghian, 2011).

5. SHM for resilience

SHM is a powerful mean to gain knowledge on the state of the structure. Especially, it shows its usefulness when the damage is present but not clearly observable and therefore it may jeopardize the safety of the users. According to (Honfi & Lange, 2015), when SHM is properly used it can conduce to resilience through four actions, directly connected with the attributes of resilience:

- Evolving condition-based maintenance strategies (robustness);
- Providing information on alternative possibilities (redundancy);
- Prioritizing maintenance and emergency actions for better utilization of resources (resourcefulness);
- Alerting first responders in case of emergency (rapidity to recover).

These actions can be intended for heritage buildings and towers to enhance their resilience. To improve robustness, structural interventions are required, and they may be justified by SHM, which allows assessing strengthening needs and avoid unnecessary works, as highlighted in (De Stefano, et al., 2016). For the redundancy concept of resilience, there is not any study connected to architectural heritage, as far as the authors' knowledge. Regarding resourcefulness, if SHM is applied on several building, data collected can be used to make timely interventions and efficiently allocate economic resources to most damaged structures in the aftermath of a hazardous event (Ubertini, et al., 2016). Lastly, rapidity to recover is enhanced when SHM is used since it allows knowing the state of the structure in real time. This is for instance the purpose of the national network of the Seismic Observatory of Structures (OSS) of the Italian Civil Protection Department which has been applied on strategic buildings (Dolce, et al., 2015).

In practice, operators make their choices based on their previous experience rather than solely relying on monitoring results. This can be explained by the lack of adequate tools to calculate the value of SHM (Zonta, et al., 2014). In effect, when SHM is not well designed and implemented it may result in a waste of economic and human resources by 1) triggering false alarm that may result in unnecessary disruptions or 2) failing to warn about damage occurrence. The cost of SHM must be balanced by the benefit it brings in relations to monument management and risk reduction. The VoI is a suitable method for assessing objectively the benefit of SHM (Thöns & Faber, 2013). In this regard, VoI supports SHM and therefore resilience.

6. Conclusions

Architectural heritage encloses the traditional construction knowledge, memories of communities, identity of territories and culture, meanwhile facing with the natural and man-made hazard threats. These risks can affect a region or a country, or they may be localized and affect directly the heritage structures. To preserve and conserve historical buildings there are several ways and one of them is SHM which gives opportunity to make interventions on time to decrease the vulnerability of the structure, minimize the loss afterwards events of incidents and decrease the time to recover as well restore the structural performance. It has been found that SHM is beneficial for an architectural heritage structure since it has a non-destructive nature, gives information to operators and owners of structure before, during, and after a hazardous event, may give alert as early warning.

Moreover, VoI of SHM from Bayesian decision analysis and resilience concepts are combined for cultural heritage structures. It is usually assumed that SHM has several benefits, but VoI is needed to asses for the real benefit of SHM. In this regard, VoI supports SHM and therefore decision making for a resilient structure. Masonry tower has been selected as test bed for future investigations since these structures as a widely diffused historical structural typology on which SHM techniques has been tested. The framework to compute the VoI of SHM to enhance the resilience of historical constructions is established.

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Risk analysis of the built environment: understanding strengths and weaknesses of both quantitative and qualitative methodologies

Mariantonietta Morga [a,*], Federica Pascale [a], Rose Line Spacagna [b], Luca Paolella [b], Giuseppe Modoni [b], Keith Jones [a]

[a] Anglia Ruskin University, UK
[b] University of Cassino and Southern Lazio, Italy

Abstract

Strategies to protect built environment against natural disasters changed over the past decades to focus more broadly on the consequences for the community. Several quantitative and qualitative methods were proposed for risk assessment and estimation of losses, time and sources for the recovery. The suitability of those methods depends on the specific natural disaster and the build and social environment. Moreover, the definition of hazard, exposure, vulnerability and risk depends on the risk assessment level. In this work, a general framework for natural risk assessment at the community level is presented. Than it is customized for earthquake-induced soil liquefaction, which causes extensive damage on built assets and implying huge repair costs and delays of the community recovery, and tested on San Carlo district (Italy) case study, hit by such disaster in May 2012. The results demonstrate the limits of quantitative methods for risk assessment at community level and those of qualitative methods for risk assessment at geotechnical level.

Keywords: Risk assessment, Soil liquefaction, Qualitative method, Quantitative method.

1. Introduction

Natural hazards hit the environment where human communities live. Risk analysis is used to assess their impact on the communities. Multiple definitions of risk were proposed. The most applied one defines risk as a combination of hazard (H), vulnerability (V) and exposure, i.e. elements at risk, (E) (UNDRO, 1979). While the latest factor refers to population or buildings and infrastructures or economic activities and utilities, the vulnerability is the quantity of loss or damage of the exposed element.

The existing literature distinguishes two categories of methods for risk assessment : quantitative and qualitative methods. The former relate risk to physical quantities used to measure hazard, vulnerability and exposure and commonly apply the above risk definition; the latter are based on natural absolute or comparative scales used to measure the different components of the risk. Risk analysis methods based on multidisciplinary approach are called holistic. They employ indices measuring risk obtained by aggregating weighted indicators related to the effects of different aspects of the complex reality. Davidson (1997) stated that the quantitative approaches conduct to replicable results, while those qualitative are holistic and characterized by comprehensive risk understanding.

From the risk management prospective, quantitative risk analysis methods aim to provide generalized advice for land management and planning and inform decisional processes for mitigation (Chang et al., 2014). Their outcome is often a geographical distribution of the risk at different geographic scale, city or region, that enables the stakeholders to identify the weaknesses of the system of elements at risk (Brink and Davidson, 2015). On the contrary, the results of qualitative risk analyses represent the overall functional capacity of a system, thus they are not used to identify the weakest elements of built assets. The major strength of qualitative methods is the capacity of capturing the socio-cultural aspects of geographically distributed systems related to risk. Whereas, quantitative approaches to natural disaster risk analysis border the geographic area to which the analysis refers making impossible to understand the interaction between it and those surrounding. To overcome those limits some scholars proposed hybrid methods integrating aspects of both qualitative and quantitative risk analyses and sometimes attempting to quantify the socio-economic and cultural aspects. Hybrid methods quantify risk thriugh complex indices where factors measuring each contributing aspect are weighted with coefficients obtained by qualitative approaches.

* Corresponding author. E-mail address: mariantonietta.morga@anglia.ac.uk

Nowadays, risk analysis is used to estimate losses of a specific or multiple categories of systems located in an area due to a disruptive event. The issues about both the geographic definition of each system and the identification of the aspects of the interdependent elements at risk are problematic in case of much localized natural hazard, such as earthquake-induced soil liquefaction.

This work aims to highlight the strengths and weaknesses of liquefaction risk analysis with qualitative and quantitative methods at different levels of system complexity.

2. Risk assessment framework

Some natural disasters are cascade effects of others; for example, extreme rainfalls or earthquakes can cause respectively floods or landslides. In those cases, the risk assessment begins by estimating the primary hazards, such as extreme rainfalls or earthquakes, identifying the exposure, and by assessing their vulnerability, i.e. hydrological floodplain vulnerability or slope stability. These elements allow calculating the primary risk, which becomes the secondary hazard by looking to the built environment risk prospective. In fact, these phenomena cause damages to buildings and infrastructures, which are the exposure of the secondary hazard. The vulnerability of buildings and infrastructures is the measure of potential physical damage caused by a specific hazard with a given intensity. The risk of physical damage of built assets is a secondary or cascade risk. Buildings and infrastructures are not the last ring of the chain, which includes service delivery and ends with community. It is possible to state that the assessment of hazard, vulnerability, exposure and risk varies on case-by-case basis depending on the definition of system: what is risk in a case becomes hazard at higher level. At the highest analysis levels, elements at risk are interdependent and form a complex system, for which risk assessment with quantitative methods is inefficient and different metrics to estimate the vulnerability of each single element have to be used. The potential impacts caused by a hazard to complex system are economic, social, environmental and cultural: they produce both direct (immediate effect) and indirect (medium-long term effect, as consequence of the direct impacts) losses, assessed in monetary or non-monetary terms (Mechler, 2005).

3. Risk assessment of soil liquefaction disasters

Soil liquefaction occurs when loose saturated sandy soils are subjected to intense shaking, and then, as result of the applied stress, the soil decreases in strength and stiffness because of the increase in pore water pressure. As consequence, the foundation soil behaves like a liquid (National Academy of Sciences, 2016) and, as past events showed (Tohoku, 2011, Christchurch 2010-2011 (National Academies of Sciences, 2016) and Emilia Romagna, 2012 (Cimello et al., 2013)), loss of shear resistance leads to superstructure collapse. Quantification of expected liquefaction and prediction of its effects are becoming part of the seismic risk assessment because it produces appreciable economic losses and delay of communities recovery.

Soil liquefaction triggering depends on the primary hazard, i.e. ground shaking, specific stationary (SBT) and non-stationary (GWT) soil characteristics (liquefaction susceptibility). Considering the seismic hazard and the soil susceptibility, the soil liquefaction is a primary risk.

Soil liquefaction becomes a hazard affecting buildings and infrastructures: their physical vulnerability combined with such hazard allows estimating the risk of their physical damage. For an area, the risk analysis referred to buildings and infrastructure networks requires the estimate of a seismic input over a time-period and the quantification of the complex system vulnerability (subsoil liquefaction susceptibility and structural vulnerability).

Following the cascade effect, risk of physical damage of built assets is a hazard for their service delivery. Finally, the last level of risk assessment concerns the community, which is harmed by the loss of structure and infrastructure serviceability. This risk can be assessed in terms of deaths, injuries, loss of heritage and incomes. All those measures of community risk are often expressed in terms of economic losses, although such estimate, based on qualitative methods, is not objective. As consequence, the risk assessment of upper level vulnerable systems should include elements based on qualitative methods.

Figure 1 represents the elements involved in the liquefaction risk assessment either by applying quantitative or qualitative approaches. It shows that, as changing the position of the lines bordering the vulnerable system (on the right column of the figure), different definitions of hazard and risk are obtained. The above concepts applied to cities or regions entail the necessity to assess the seismic hazard of that area, the soil susceptibility, the physical and functional response of different structures and infrastructures and the community reactivity. This is

possible by applying quantitative methods that provide a spatial representation of the outcomes. Such kind of analysis does not produce an aggregated value of the risk assessment of regions; therefore, it is of limited use in comparative studies or for comprehensive estimation of losses.

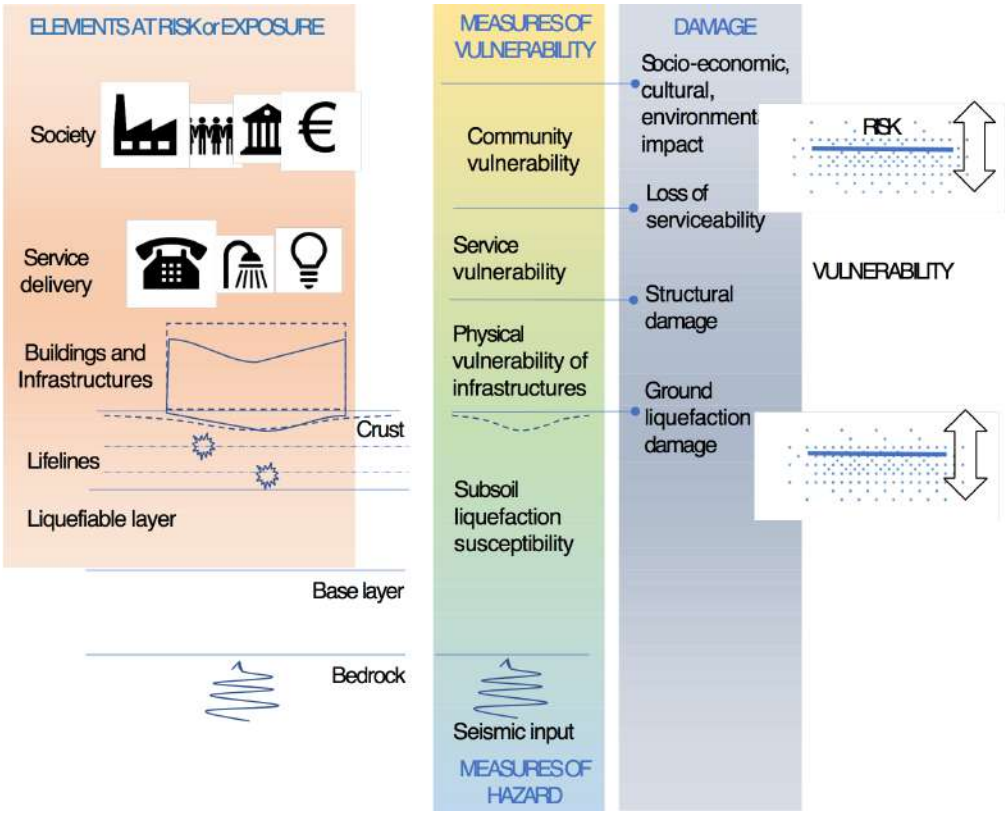

Figure 1: Definition of risk assessment for earthquake induced soil liquefaction.

A large number of geotechnical investigations is needed to characterize the subsoil with sufficient accuracy to estimate its liquefaction susceptibility. Methods based on common in-situ investigations were developed in the last decades. Microzonation maps represent the liquefaction potential calculated through these methods and they are currently used in land management and planning at local level, in particular for risk assessment of structures and infrastructures.

Besides this quantitative assessment of liquefaction hazard, a qualitative one based on events occurred in the past centuries is possible, but meaningless because of long return time and dependency on several non-stationary and uncertain factors. The knowledge of the site geological history allows to identify areas susceptible to liquefaction and plan in-situ tests.

Seismic vulnerability of structures is normally defined for building stocks. For localized phenomena, such as liquefaction, the risk estimation should be done on single structures. In case of infrastructure networks, the failure of single elements might cause disruption of the whole network and accurate microzonation maps are fundamental for risk analysis because it allows identifying the elements at risk and reducing the cost of vulnerability assessment at large scale.

The risk of physical damage of buildings and infrastructure networks is the first element of the risk analysis of service delivery. In this case the system becomes complex because of interdependencies among its elements. At this analysis level, a quantitative method for risk assessment shows limits: the geographic bordering of the analysed area is complicate because service loss can affect elements of built environment outside it.

At the community level, the risk of soil liquefaction disasters is hardly measurable, as this is a localised phenomenon. However, it can have large repercussions on the community in case critical infrastructures are affected, as repairing liquefaction damage can be cost and time–intensive.

4. The case study of San Carlo district (Italy)

The described methodology is applied to a case study: San Carlo district of the municipality of Sant'Agostino (Italy) (Figure 2), which was hit by the 2012 seismic sequence. On 20th May a Mw 6.15 event struck the whole

Sant'Agostino municipality causing damages (186 buildings damaged at different levels only in San Carlo district) and extensive soil liquefaction (sand boils and cracks). At that time, San Carlo district hosted: approximately 1500 inhabitants, housed in 660 buildings (ISTAT, 2018); a school; a church; and an industrial warehouse (Regione Emilia-Romagna, 2018b). San Carlo district,

Reminding soil liquefaction occurs in areas with specific geological features, it is worth highlighting that Galli, et al. (2012) showed the presence of hidden paleochannels in that district (Figure 2, left side) and the topographical survey of the area (Figure 2, right side) evidenced the presence of hidden paleolevees; thus, the area was clearly susceptible to soil liquefaction.

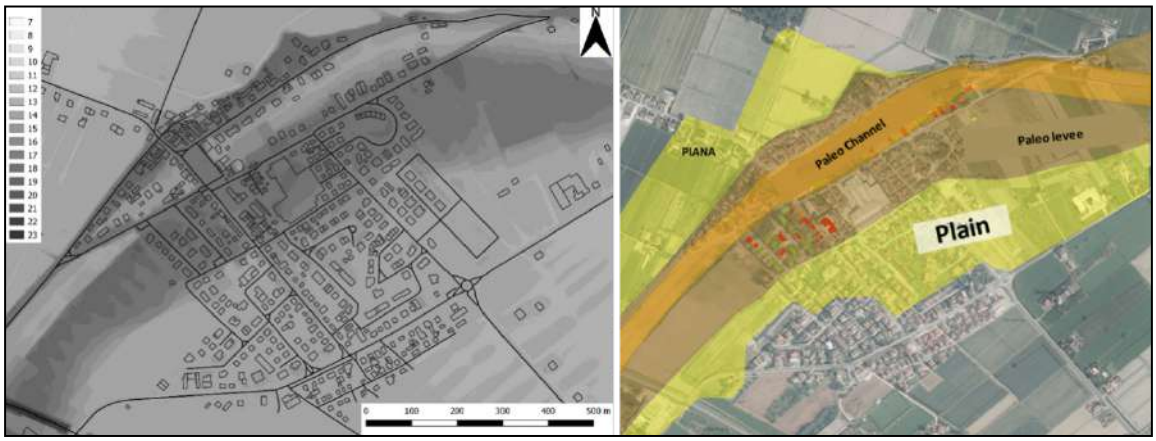

Figure 2: Digital Elevation Model (on the left) and geological map of San Carlo area (on the right).

Liquefaction ground severity (Figure 1) is frequently expressed with indicators summarizing the effects of liquefaction at different depths. One of these is the Liquefaction Severity Number (LSN) that integrates the post-liquefaction deformation over a depth of 20m, divided by the depth to give more importance to shallower liquefaction (van Ballegooy et al., 2014). This value is associated to the expected liquefaction ground damage (see Table 1), which is risk of soil liquefaction considering the primary hazard: earthquakes.

Table 1: LSN ranges and observed land effects (van Ballegooy et al., 2014)

LSN	Related effect
0-10	Little to no expression of liquefaction
10-20	Minor expression of liquefaction
20-30	Moderate expression of liquefaction with some structural damage
30-40	Moderate to severe expression of liquefaction and settlements causing structural damage
40-50	Major expression of liquefaction resulting in severe total and differential settlement of structure
+50	Extensive evidence of liquefaction resulting in severe total and differential settlements affecting structures

This indicator can measure the soil liquefaction hazard threatening structures, if it is computed considering earthquakes having a certain occurrence probability. For San Carlo district, after the 20th May earthquake, 200 values of the LSN are obtained and spatially interpolated, after the CPT data processing (Figure 3).

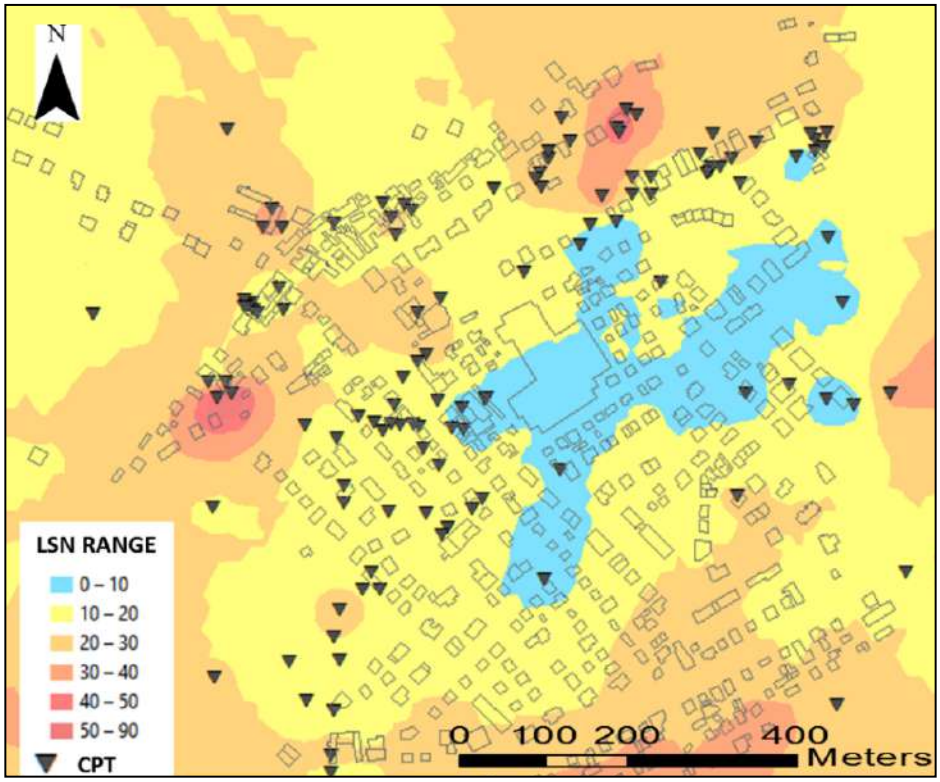

Figure 3: LSN map for San Carlo district.

The comparison between the LSN map (Figure 3) and the observed liquefaction-induced land damages (Figure 4) proves that it is a good proxy of such hazard over a urban or regional scale highlighting the most critical areas. However, the physical risk of structures need a site-specific analysis based on more accurate geotechnical model and method to simulate the combined response of structure and foundation soil.

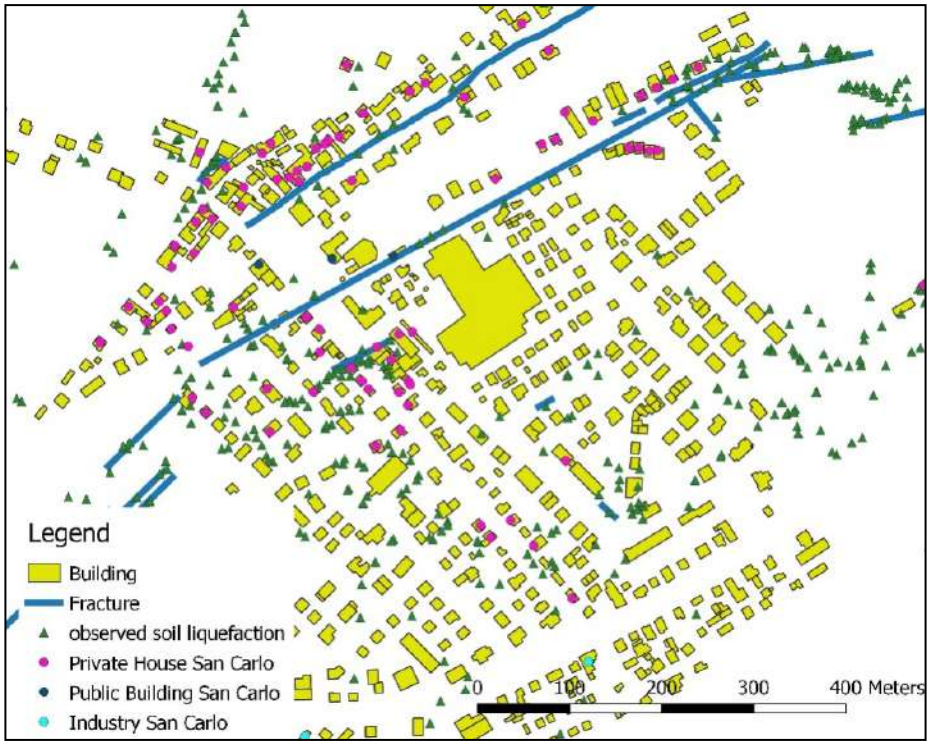

Figure 4: Map of San Carlo district with damaged building and sand boils.

By overlapping the LSN and damaged buildings maps, it is assumed that all those buildings were damaged by soil liquefaction besides ground shaking. According to O.P.C.M. n.14 (2013), in S. Carlo district 21 buildings were in operational level B/C, 3 in level E0, 7 in level E1, 10 in level E2 and 43 in level E3. The operational level B-C and E0 are used for buildings with low damage and not needing repair. The operational levels E1 and E2 indicate heavy building damage and need of repair. Finally, the operational level E3 is used for buildings so heavily damaged to be needing demolition and reconstruction. Those operational levels defined in O.P.C.M. n.14 (2013) are a post-event measure of the building damage and capacity of service delivery; therefore, they are a combination of the damage state and vulnerability.

Table 2: Operational level of damaged buildings in San Carlo district and evacuated living units.

Operational level	B/C	E0	E1	E2	E3
Inhabitants affected	75	9	30	41	163
Living units	43	5	23	19	96

At the community level, several factors must be assessed to estimate the risk. First of all, the effect of the operational level of buildings on their residents: buildings classified to have operational levels E were evacuated. In addition, at the community level the first measure of the risk is the total costs of provisional housing for the evacuated population. After the May 2012 earthquake sequence, the Government of the Emilia Romagna region paid 200€ per person to evacuated families each month as grant aid for the provisional housing and 350€ per person living alone (Regione Emilia-Romagna, 2018a). The grant aid was available for a maximum of twelve months from 1st June 2012 to 31st May 2013 and families could ask it for the time they could not live in their house because of repair or reconstruction works. The first of those works ended on 31st May 2013; therefore, all evacuated families asked for the maximum amount of grant aid. The buildings classified to have an operational level E were 63. Some buildings had more than one living unit and Table 2 show the total number of evacuated people (Regione Emilia-Romagna, 2018b).

The estimated total costs of provisional housing for the population of San Carlo district was 482,000 Euro. These costs are indirect and they are the only one easily to estimate. At the community level, the liquefaction risk assessment concerns the estimation of repair and rebuilding cost of damaged buildings. For San Carlo district, it includes the costs of private houses, public buildings, infrastructures and provisional public buildings, such as prefabricate schools. For that district the total costs of demolition and rebuilding or repair and strengthening of private houses was around 32,000,000 Euro (Table 3), including an increase of the total costs equal to 15% because of soil liquefaction disaster (Emilia Romagna, 2012). As consequence, the shaking-induced damages costed 27,800,000 Euro and the liquefaction-induced damages 4,200,000 Euro. The regional government paid the full costs of repair and rebuilding of industrial and service buildings and partially refunded the costs of damaged equipment and tools. The total cost of public buildings was 4,600,000 Euro (Table 3), which includes both repair and rebuilding of buildings and construction of provisional ones (schools).

Regarding infrastructures, only the repair cost of the damaged road of San Carlo District is known, i.e. 41,000 Euro (Table 3). Additionally the repair of the sport centre damaged by ground shaking and soil liquefaction costed 46,000 Euro (Table 3). All those costs are direct. At the community level, the rough estimation of the soil liquefaction risk of San Carlo district is around 37,000,000 Euro. This is obtained by using a quantitative method and excludes factors related to social impact of the disaster, such as the feeling of insecurity at home or in the work place, the loss of school months, the distress owing to the provisional housing, etc.. For instance, the damages to the historical building of the district, a church, were repaired, but the community distress due to this temporary outage could not be estimated. Those factors can be estimated only by applying qualitative methods for the community risk assessment, which require the involvement of community representatives in participatory research activities.

Table 3: Known direct costs of soil liquefaction disaster in San Carlo district.

	Total costs for repair, strengthening and reconstruction (Euro)
Private houses	32,000,000
Public buildings: infrastructures (schools, public offices)	1,580,000
Public buildings: cultural heritage	2,500,000
Industry and service sector: buildings	530,000
Industry and service sector: instruments and tools	49,000
Infrastructures	41,000
Leisure centre	46,000

5. Conclusions

The study described the complexity of community risk assessment to natural hazards and in particular to earthquake induced soil liquefaction disaster. Elements at risk and hazards for each level of complex system of systems are identified together with the different risk assessment level: from the geotechnical primary risk to the community one. The case study of a small Italian district is proposed. First, the soil liquefaction risk is assessed by a quantitative method, as damage at soil or LSN. Then, the physical and service delivery risk of built assets is presented by using a quantitative method based on post-event data. For this level of risk assessment, the private buildings are classified based on their capacity to deliver their service: housing people. Finally, the community risk is assessed by costing direct and some indirect damages. However, an analysis of the results shows that some factors of the community risk cannot be quantified. Hence, it is concluded that: at community level a disaster risk assessment is possible only with qualitative methods that includes the active participation of the community itself.

Acknowledgements

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