8th ICBR Lisbon | Nov 2018
Building 4Humanity
DESIGN COMPETITION
Category 2:
Resilient Projects (**Unbuilt**)

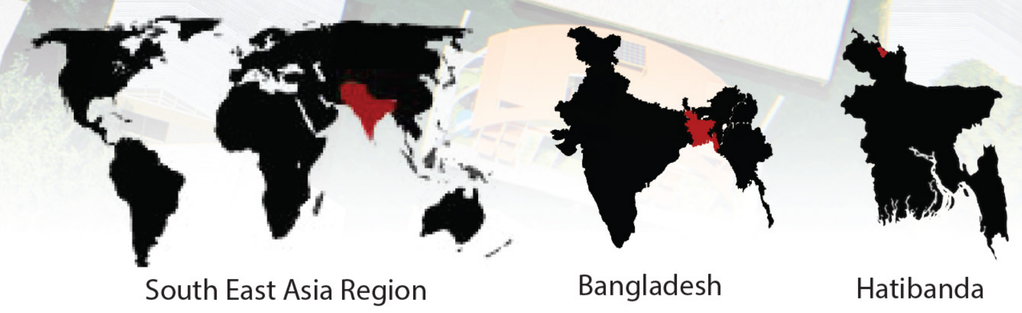
Team Project Coordinator(s): *Salma Begum*
Team Members: *Jayedi Aman, Sheikh Rishad Ahmmad*
Project Location: *Hatibanda, Bangladesh*
Team Code: **B4H-DC2134**

RESILIENT BUILDING/SETTLEMENT PROJECT FOR A FLOOD-PRONE AREA IN BANGLADESH

SUSTAINABLE FLOOD-SAFE HOME

LIQUID LANDSCAPE_AN ALTERNATIVE DESIGN STRATEGY FOR FLOOD AFFECTED PEOPLE

KHUPRI:SOLO SPACE FOR MULTI-FUNCTIONALITY



Problem Statement

Among all natural disasters, flood hazards are the most common and destructive. For decades, examination and experiments have been practicing to manage and mitigate the risk of flood loss. Bangladesh is one of those countries that faces frequent and abnormal flooding problem every year, which causes serious damage to lives and property. June to October of the year is considered as the monsoon period in Bangladesh and in this period, water level rises in the various rivers in the northern part of the country due to heavy rainfall and the flow of water from the upstream hills in India. The Tista, Brahmaputra and Jamuna rivers burst their banks and many villages of northern portion go under water, many low income rural people become homeless and thousands of hectares of crop damages. Therefore, self-sustained buildings and settlements during flood hazards become essential for communities' resilience. The recent flooding over a few months in 2017 throughout Bangladesh has taken a devastating toll on the rural parts of the nation, having wiped out and destroyed approximately 500,000 to 600,000 homes, leaving millions homeless and subjected to temporary homes. These homes were mostly made from wood and tin, leaving them very weak and susceptible to heavy winds, rain, and flooding. Rebuilt homes will likely continue to be poorly built. Hatirbandha is an upazila under division of Rangpur that has faced serious flooding problems lately and need urgent attention. Therefore, Hatibanda area was chosen as the mainstream to design the prototype self-sustained flood safe home focusing the low income people to survive during flood hazards, which can be applied to the other parts of Bangladesh as well as in other tropical countries.

Site

Hatibanda upazila, is one of the remotest and catastrophe prone northwestern upazila under Rangpur District of Bangladesh. Geographically, one of the distinctive features of the district is that this is situated near the river the Teesta on one side and on the other side it has Kharpa river , bordered by India. The most common character is flooding during the monsoon. Every year this area is flooded heavily. Lat year sixty four villages in Hatibanda upazila near the Tista River of northern part has been streamed with abnormal flooding, having most of the houses washed away (Figure 02 & 03).

Figure 02: Location of Hatibandha Upazila near the bank of Tista River, Bangladesh (Source: Google map).

Figure 03: Situation of the rural people of Hatibandha 2014,2016 and 2017 chronologically , as well as of the other villages during flood (source: RDRS, 2018).

Project Aim

The goal of the project is to design and build a prototype model of 'Sustainable Flood-Safe Home'. This home will accommodate a family of 7, as the rural parts of Bangladesh hold an average of 7 members per family. The home will be built in a way to ensure it as resistant against future flooding and high winds.

Description

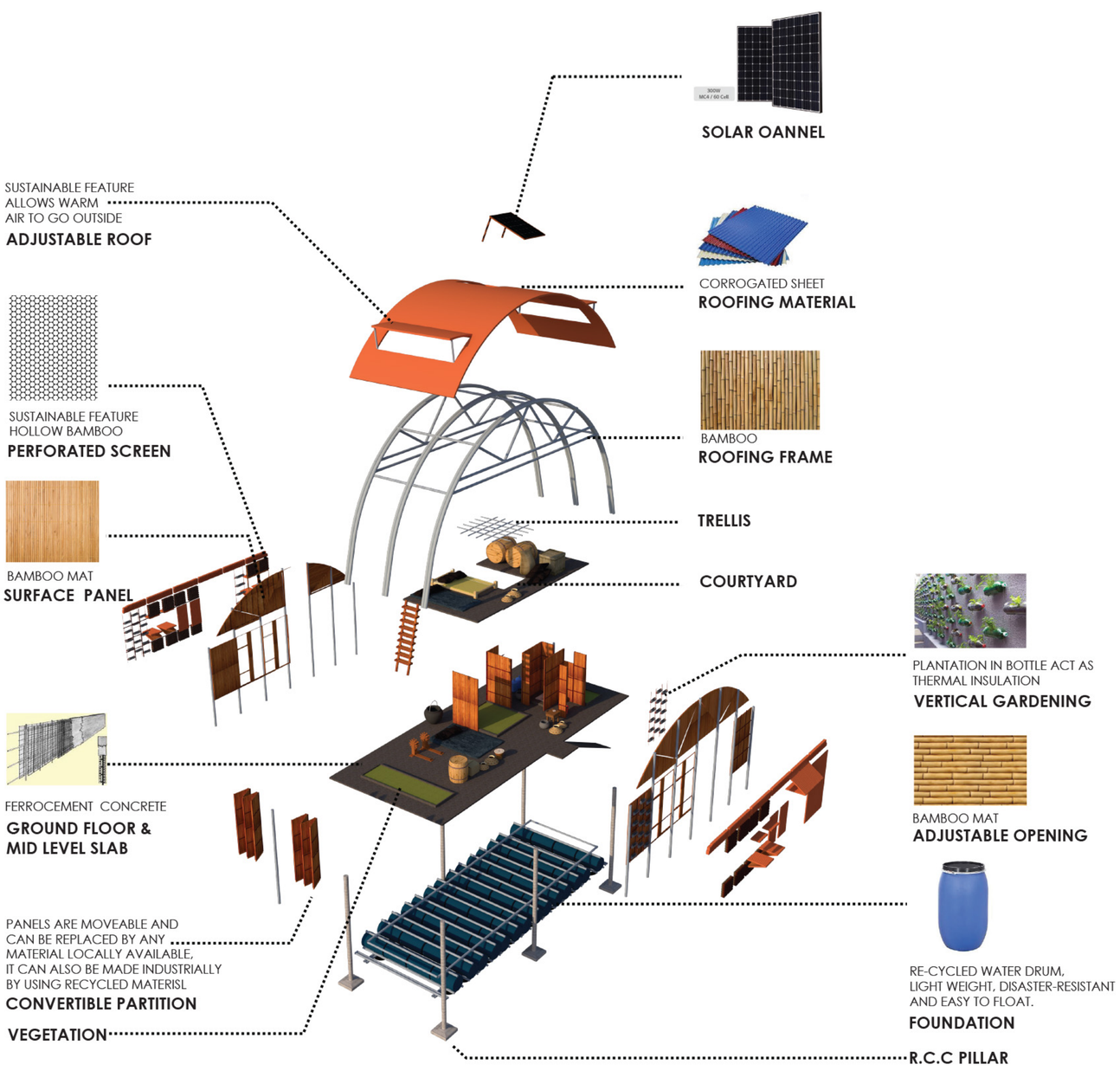
Sleeping area in mezzanine	6.96 sqm
Living /dining/ Multipurpose working area to generate income during the hazard period	12.01 sqm
Courtyard	3.34 sqm
Toilet	0.89 sqm
Kitchen	1.5 sqm
Wash area	0.89 sqm
Attic for storing goods and emergency shelter in mezzanine	3.84 sqm
Garden	4.64 sqm
Extended verandah	16.58 aqm
Total size of single family home	50.65 sqm

Load calculation

Live Load on Ground Floor:	150 lbs/sqm	Dead Load of Dwelling:	300 lbs/sqm
Live Load on First Floor:	100 lbs/sqm	Dead Load of Foundation:	100 lbs/sqm
Live load on Roof:	30 lbs/sqm		
Live load on Open Space:	100 lbs/sqm	Total Dead Load:	400 lbs/sqm
Total Live Load:	380 lbs/sqm	Total (dead+live)Load:	780 lbs/sqm

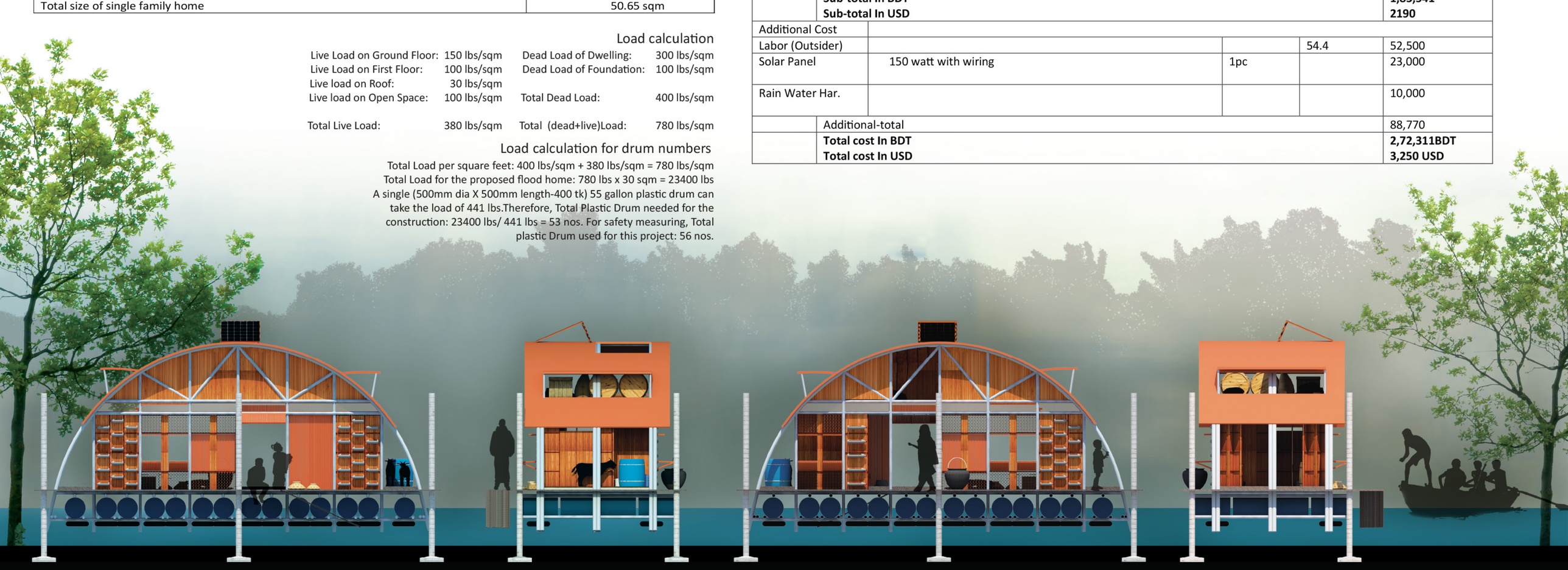
Load calculation for drum numbers

Total Load per square feet: 400 lbs/sqm + 380 lbs/sqm = 780 lbs/sqm
Total Load for the proposed flood home: 780 lbs x 30 sqm = 23400 lbs
A single (500mm dia X 500mm length-400 tk) 55 gallon plastic drum can take the load of 441 lbs.Therefore, Total Plastic Drum needed for the construction: 23400 lbs/ 441 lbs = 53 nos. For safety measuring, Total plastic Drum used for this project: 56 nos.



Specification and tentative cost estimation for one unit

Features	Sustainable Materials	BDT/Sqm	Total Sqm	Total in BDT/USD
Foundation	Plastic Drum+ Recycled Tyre	560	39	22,200
Structure	Bamboo (Chemical mixed	187.9	200	37,580
Flooring	Ferro-cement concrete with sheet	800	42.9	34,320
Roofing	PVC corrugated sheet	650	42.5	27,625
Partition	Bamboo mat (chemical mixed)	1200	25.0	30,000
Base Mech.	R.C.C. pillar	54540	4 nos	21,816
Miscellaneous	Door,window, ladder, screw,etc.			10,000
	Sub-total In BDT			**1,83,541**
	Sub-total In USD			**2190**
Additional Cost				
Labor (Outsider)			54.4	52,500
Solar Panel	150 watt with wiring	1pc		23,000
Rain Water Har.				10,000
	Additional-total			88,770
	Total cost In BDT			**2,72,311BDT**
	Total cost In USD			**3,250 USD**



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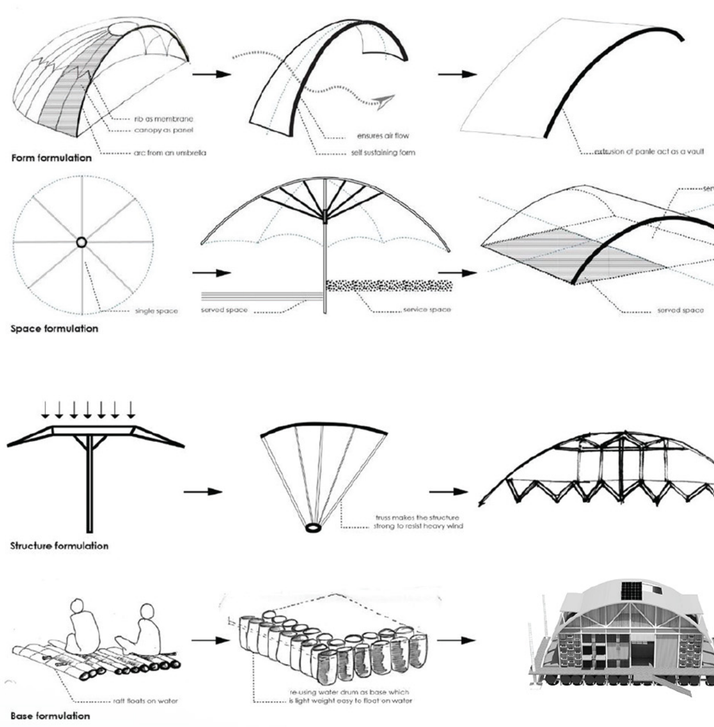
Design Strategies of Sustainable Development

In order to achieve sustainable development some strategies were followed.

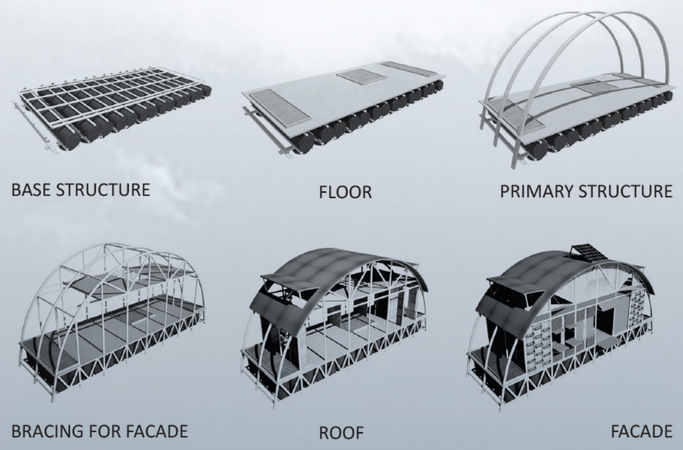
1. Should float in times of flooding
2. Should be eco-friendly and made with sustainable materials
3. Should have self sustaining electricity (ex: use of solar panels)
4. Should have rainwater harvesting and filtration system for regular supply of drinking water
5. Should have a small indoor/outdoor farming unit for food and domestic animal6
6. Should have a small outdoor cooking unit (solar cooker)

Design Concept

The design concept formulation is inspired from the local umbrella that protects from rain, gives a shade under one single entity and the base has been designed being inspired from the local raft "Vella" (made out of banana tree) that easily floats on water. The idea is to combine the both.The approach of this project is a response to the local context and climate. Taking umbrella as a basic element the design has been accentuated by a canopy like structure. Section of an umbrella represents an arc which turns into a vault after extrusion. This vault creates space under one roof and very much resistive to high wind thrust. Also the structural system has been derived from the structural design of an umbrella festooned with truss . So, the mechanism of designed unit works like a floating raft which is easily floatable and also the vault kind of element allow a one single space with multiple level being resistance to high wind pressure. Another important notion was kept in mind while designing is served and service space.



'KHUPRI' is a Bengali word, meaning a small place available for multi uses. Generally, in Bangladesh, Low income people use to live together in a very small place, having low privacy between the dwellers. They are very comfortable to work at home together for earning money, keep domestic animals and produce vegetables at roof level. Considering the living nature of the local people and the cost and space restraint, we considered a single space in the building which can be partitioned or folded time to time regarding the using demand.



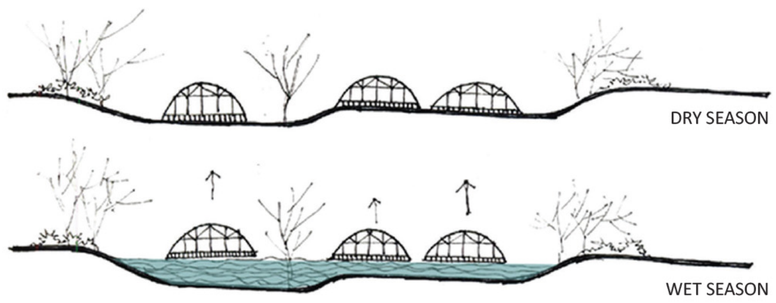
Formal Aspect

The plan of the building is rectilinear having a circulation along the length which connects the two zones of the unit. There are two zones in the project one part contains the served space which contains multipurpose and sleeping area and the other part houses the service which is wash, kitchen, toilet, cattle keeping area, attic and storage in both the levels. In between these two zones a courtyard is designed with tree and trellis for growing food. The two zones are borderd by gardens each side with extended verandah. The whole platform is raised on four columns that helps to raise at times of flooding. It changes its height as the water level goes up. The footings of those columns are strong enough to keep the unit stable upto 3.048m high water level during flood. Entrance of the unit is provided with a ramp made of ferro cement which ensures accesiibility of differently able people.

PRIMARY COLUMNS | RAINWATER HARVESTING | DRUM STRUCTURE

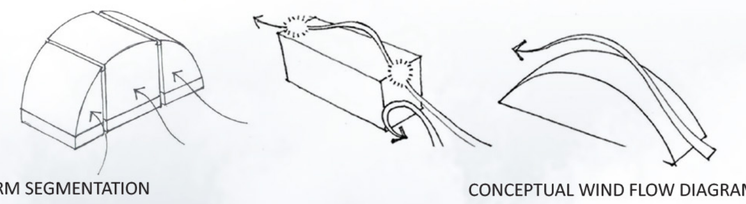
Claiming Local Culture through Climatic response

The site is located in a warm and humid area with the average temperature around 25.2°C. Buildings situated in this area necessitates natural ventilation. In this project natural ventilation and cooling are provided by the volumes of space with courtyard. All the spaces are naturally ventilated through perforated screen and adjustable roof. The adjustable roof allows hot air to go outside and ensures ample light in the space. This is how the building will be keept cool through passive airflow which is a direct response to climate.

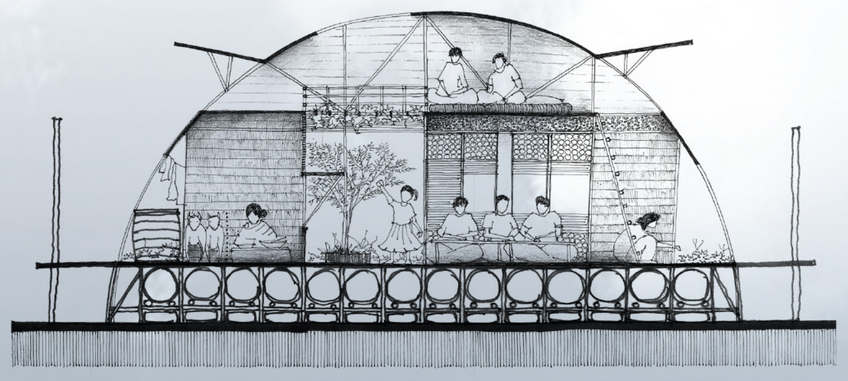


Environmental Sustainability

In this project the adjustable platform designed as a resistance to flood. This is furnished with a rain water collecting drum which is also a water tank; it collects rain water from the surface that runs through a pipe system installed with the structural element. Green façade made of reusable water bottle and vegetation is used as a thermal insulation. The use of treated bamboo, made from natural material which is locally sourced, shows a sensitive response to the environment. A solar panel on the roof will provide the necessary electricity for the user.



FORM SEGMENTATION | CONCEPTUAL WIND FLOW DIAGRAM



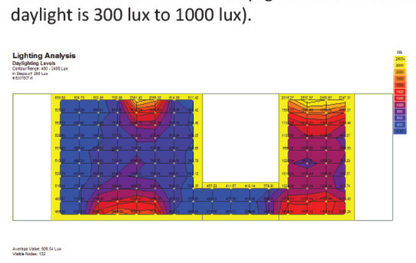
SECTION THROUGH COURTYARD

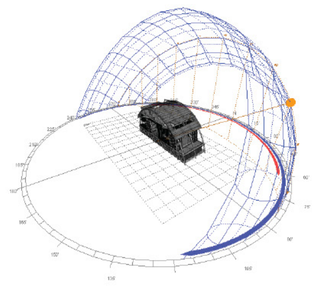
Economic Sustainability

The cost for constructing only one unit will be moderately higher than constructing a number of clusters due to transportation cost of the materials, septic tank cost, deep tubewell for safe water etc. Therefore, we have provided the overall cost for only one unit with detail specification and cost estimation of every material used and summery of cluster cost. So, it has been calculated that the overall cost will be reduced about 25% of overall cost per unit, if clusters of minimum 10 can be made . Another thing is if the community people build the home the labor cost will be only 10% of the construction cost.

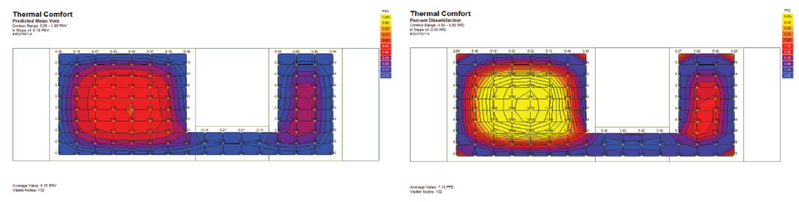
Schematic Environmental Analysis (Simulation)

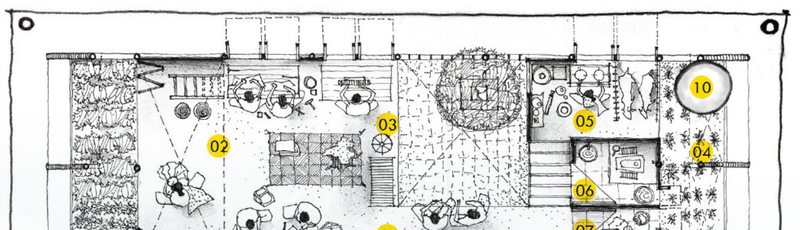
Daylighting and thermal simulation were conducted to validate the proposed design. For daylight simulation, the housing unit was modelled in ECOTECT and analyzed in RADIANCE. On the other hand, thermal analysis was developed in ECOTECT. Both of the simulations were conducted on 24th April (Hottest day 2016). Average value of daylight was found for the room was 926.54 lux, which is considered as comfortable daylight situation for sustainable flood safe home (Acceptable range of daylight is 300 lux to 1000 lux).



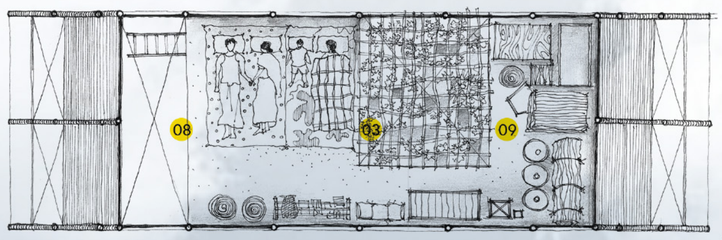


For thermal simulation, Fanger's PMV-PPD model was used. It is considered that predicted mean vote (PMV) should be within (-0.5 to +0.5) and minimum 90% occupants should be satisfied on thermal environment in the room. For the proposed design, PMV and PPD were found as 0.15 and 7.18% respectively. Therefore, it can be said that, the proposed design clearly satisfies the daylighting and thermal condition in the climatic context of Bangladesh.





MAIN LEVEL PLAN



MEZZANINE LEVEL PLAN

01. ENTRANCE SPACE/ECONOMIC ACTIVITY SPACE
02. WORKSPACE/MULTIPURPOSE SPACE
03. COURTYARD 04. GARDEN 05 KITCHEN 06 TOILET 07 WASH AREA
08 SLEEPING AREA 09 ATTIC 10 WATER HARVESTING TANK 11 EXTENDED PLATFORM