

DISASTER RESPONSIVE HOMESTEAD IN COASTAL AREAS FOR EFFECTIVE POST DISASTER MANAGEMENT: A CASE OF DACOPE, BANGLADESH

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ABSTRACT

The effects of natural disaster occurred in coastal areas of Bangladesh have pushed environmental consequences and endangered the existence of community by damaging the infrastructures specially the homesteads. These changes in coastal areas influence the lives of people living in those areas with risks. Rural coastal people are very much dependent on livelihoods in the fisheries, agriculture, livestock, or forestry sectors. Generally, these people live in the areas very near the riverbanks which are very much prone to disasters like cyclones and the impacts with it like risen of river water or flood. In these cases, people are tending to lose their everything including their living houses. A crucial situation is created during and after the disaster and make the post disaster management more challenging. Among other resources coastal household facing a greater challenge every year which is the reason of extra burden for these marginal people and thus after disaster management also becomes difficult. The previous observation on post-disaster recovery efforts have accentuated the need for more contextual approaches to develop disaster resilient rural houses. This study aims to understand the need to disaster responsive contextual houses for the prominent coastline areas and minimizing the post disaster challenges by incorporating measures related to structures and materials for designing the houses. The survey was carried among the homesteads specially farmers and fishermen in the Pankhali union of Dacope Bangladesh. The objectives of the study are intended to initiate resiliency in coastal homesteads specially houses depending on the context as well the circumstances for ensuing management related to the calamities.

Keywords: Coastal Area, Homestead, Context, Resiliency, Responsive Design

1. INTRODUCTION

Bangladesh is considered to be one of the most climate-vulnerable and disaster-prone countries in overall the world. In the event of climate change Bangladesh is known to be one of the most vulnerable countries (Ali, 1999) and 40% of the total cyclone-induced storm surge events of the world is occurred in here (Ryan, 1993). The coastal zone of Bangladesh is a most vulnerable area for such hazards because of low-lying and relatively flat terrain, geographical setting at the edge of the Bay of Bengal, high tidal range, high density of population and fragile coastal protection system (Dastagir, 2014). Climate change has already had diverse adverse impacts on human systems, including on water security and food production, health and well-being, and cities, settlements, and infrastructure (IPCC, 2022). Bangladesh which is predominantly a floodplain country is recognized as one of the most vulnerable countries when impacts of global warming and climate change are considered. The coastal zone of Bangladesh has about 710 km long coastline and is one of the most dynamic deltas in the world (Rahman, 2022). The coastal zone of Bangladesh is characterized by a wide network of river and canal systems, a dynamic Ganges-Brahmaputra-Meghna estuary shared with India, Nepal, Bhutan, and China. Unluckily, the Bangladesh coast is well-known for severe cyclones and storm surges (Paul, 2013). Every year minimum of 1 and a maximum of 7 cyclones and depressions cross the coast of Bangladesh of which one is severe every 3 years (Ronju Ahammad 2013). During the cyclones of 1970, 1991, and 2007 about 500,000, 138,000, and 3,406 people were killed respectively (Routray, 2010). Although the number of casualties caused by recent major cyclones has decreased since 1991, the probability of human loss due to future cyclones remains significant (Mallick, 2014). Deaths and destruction during the cyclones in Bangladesh are primarily attributed to storm surge (A. Mushtaq R. Chowdhury, 1993).

In the last decades, the most disastrous events were Sidr in 2007 and Aila in 2009, which mostly affected the housing sector. A total of 2.3 million households were affected to some degree by the effects of Cyclone Sidr, and about 1 million households were seriously affected (Md. Afjal Hossain, GoB 2008). The impact of Aila on the housing sector was severe, as it destroyed an estimated 243,191 houses and damaged a further 370,587 houses (UNDP, 2012). Khulna and Satkhira districts were amongst the most severely impacted of the eleven affected districts (UNDP, 2012) with damage to between 90 and 100 percent of houses in the four worst affected Upazilas of these two districts (Dacope and Koyra Upazilas in Khulna; Ashasuni and Shyamnagar Upazilas in Satkhira). The cyclone destroyed about 49,000 houses in Dacope Upazila. Coastal people of Bangladesh built their non-engineering houses by using locally available woodcraft, artesian using wood, bamboo, tin, and thatches for living somewhat only (Md Moynul Ahsan a, 2022). Existing houses in the coastal rural areas have vulnerable structure for that destruction of homesteads or houses is inevitable during disasters. Designing and constructing disaster responsive houses in-depth understanding of climate as well as context is needed. With the threats and hazards understanding the existing built form and needs of coastal rural people is essential for designing disaster responsive houses. Careful architectural design and construction details can develop disaster responsive houses in disaster prone areas where the communities are at risk of losing their homes. This uses community skills and knowledge of technical personnel like engineers and architects, to develop the “Building for Safety” options to design and construct houses and infrastructure that are resilient to cyclones and storm surges (Salek M. Seraj; Iftexhar Ahmed, 2004). Communication and consultation between local people and external actors, contextual input from locals and technical input from professionals in can create a homestead design for low- income people in coastal rural areas. This study aims to develop a house or homestead design with the collaboration of local contexts and evaluate its performance to minimize post disaster management in order to decrease the loss due to disasters.

2. METHODOLOGY

In order to grasp the actual information, the first and foremost task was to explore the needs and context of the disaster victims. A survey was conducted in Laxmikhola village, Pankhali Union, Dacope Upazilla, Khulna, Bangladesh. Moreover, climate change consequences in Bangladesh's coastal areas are especially susceptible to tropical cyclones and storm surges, which have been recognized as "hot zones" by the IPCC. Coastal Communities have faced many major disasters in the past years, specifically cyclones. Our selected area is an example of catastrophic destruction caused by cyclones. It is vital to identify the details of existing households like the materials that are generally used, construction details, plan details in order to propose a disaster responsive design. At the same time, climate and context of the overall zone needed to be identified to understand community peoples' lives and needs in depth. To identify, disaster responsive and resilient ways, the methodological section will be described in four parts.

2.1. FIELD SURVEY ON EXISTING CONDITION OF THE AREA:

The field survey was undertaken in Laxmikhola village, Pankhali Union, Dacope Upazilla. This area is very much prone to disasters and almost every year it is affected. Because of the cyclones coastal area undergoes with other issues like river erosion, decreasing of land along with destruction of homesteads of coastal people. Because of cyclones and other issues related to it in Pankhali Union the land is decreasing and width of river is increasing (Figure 1, 2, 3, 4). Along with that number of homesteads beside river are also decreasing.



Figure 1: Condition in 2001



Figure 2: Condition in 2009



Figure 3: Condition in 2013



Figure 4: Condition in 2021

From 2001 to 2021 within these years width of the river increased; erosion of river bank expanded and risen of water level due to cyclones (Figure 5, 6, 7, 8). There were homesteads beside river having broader area along with source of sweet water and with the passing years homesteads near the river bank are almost demolished because of river bank erosion and existing homesteads are having small area of land remaining portions of homesteads after losing almost the total part.

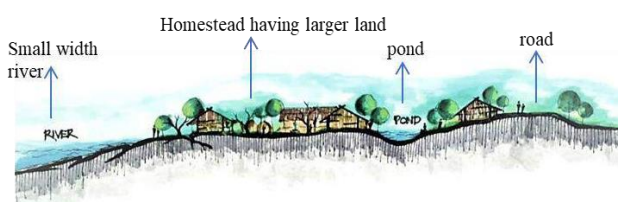


Figure 5: Situation of river and land in 2001

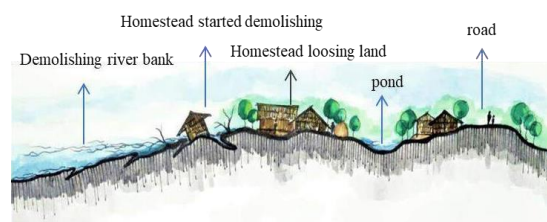


Figure 6: Demolishing in 2009

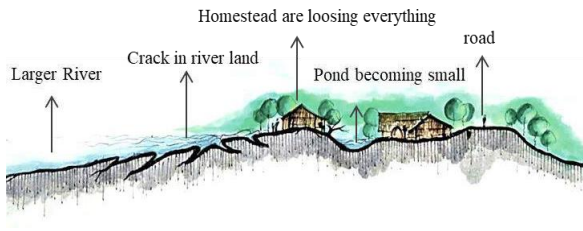


Figure 7: Demolishing in 2013

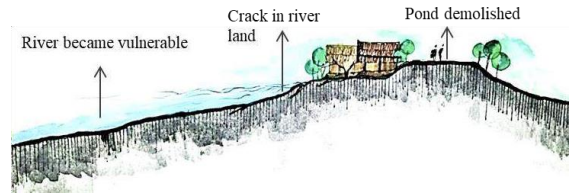


Figure 8: Demolishing of half of homestead in 2021

2.2. EXISTING HOMESTEAD:

In the existing homesteads there can be two categories. One category is the homesteads that have lost almost everything and living beside the river. Then in category two there are homesteads that haven't lost everything as these homesteads are a little away from the river. If the "BADH" breaks down during the upcoming disasters then these homesteads will also face damages. In category one, most of the homesteads are living in temporary shelter and these families living here already assuming it that in next disaster they may lose this shelter also. In these river side homesteads, families are not having bigger lands, having clustered small rooms and cattle house along with a very small courtyard (Figure 9, 10). These homesteads are really in risk of destruction and living very near the river (Figure 11,12,13).

Figure 9: Existing Homestead plan (beside river) Figure 10: Section of Existing Homestead (beside river)

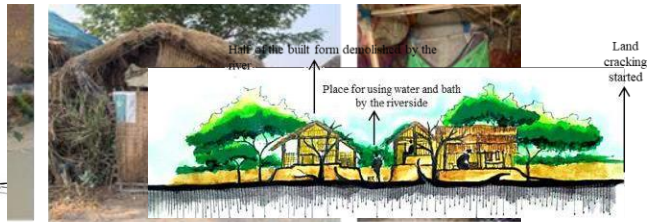
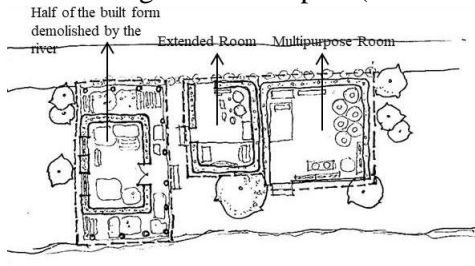


Figure 11,12,13: Homestead beside river and condition

In category two, homesteads are having bigger lands with rooms, cattle house and big courtyard where they generally grow vegetables and do other works (Figure 14, 15). These homesteads are also having risks if the "BADH" breaks in the next another disaster. These Homesteads are having permanent shelter with a fear of losing it due to future calamities (Figure 16, 17,18). Because of the cyclones and river erosion related to it these homesteads are at risks of losing everything.

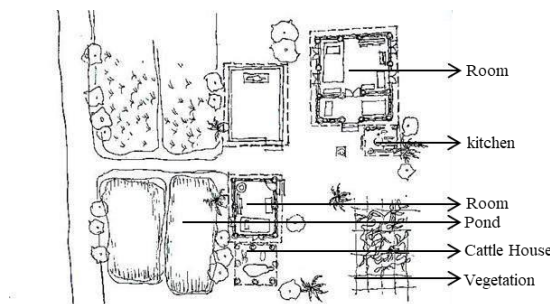


Figure 14: Existing Homestead having permanent shelter

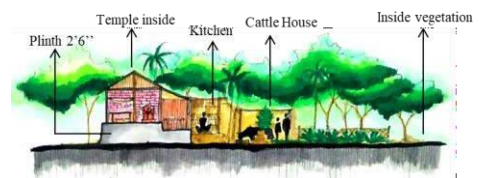


Figure 15: Section of permanent shelter



Figure 16, 17, 18: Homesteads are having permanent shelter

2.3. CONTEXT AND FINDINGS:

Laxmikhola village has a Bazaar(market) in the middle of it. Almost half of the bazaar has been demolished because of rise of water level during cyclone. In the existing period in this bazaar there are some stalls along with living area inside it. In these small stalls in the outer portion people sell their goods and in the inner portion people live in. The whole bazaar is beside the river and in these stalls people both live in and do their business (Figure 19). Generally, people who have lost their lands mainly earn their livelihood be these small stalls. Different kinds of activities are seen in the bazaar, mostly there are vegetables or grocery shops, tea stalls, small food stalls or roadside hotel and a common scenario of these stalls are people playing carrom. (Figure 20). Bazaar is in the roadside beside river; this road also works as “BADH” (Figure 21). The part which is beside river and doesn’t have “BADH” is in risk and the villagers are anticipating that this part will be almost demolished by the next disaster appears and there are already cracks in the land due to rise of water level from the past disasters (Figure 22, 23). People are still living with risk in their homesteads with a hope of surviving and save their last portion of land.

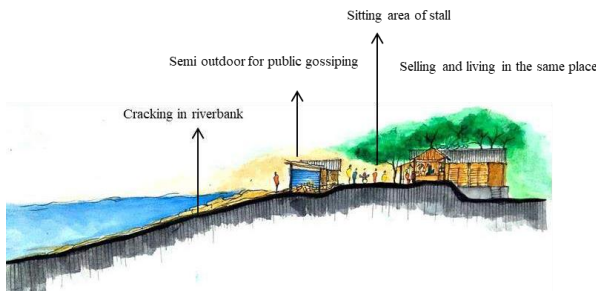


Figure 19: Condition of stalls and shops

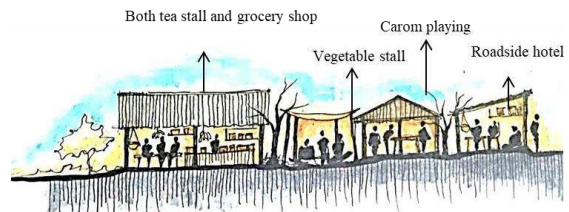


Figure 20: Existing Condition of Bazaar



Figure 21: Bazaar Figure 22: Alarming portion behind shops Figure 23: Birds eye view of existing sight

2.4. MAJOR CONSIDERATIONS:

In considering disaster responsive homesteads, details of rural households must be taken into account as they are more vulnerable to disasters. As well as total homestead size along with land area, primary occupation, and most efficient design option are key elements in determining a disaster responsive homestead. According to BBS report, approximately 70% of rural families have 3-5 members. In order to meet the research goals, all the information, along with the observations of field survey is

extremely important. The proposed design and details for disaster responsive homesteads will be able to meet the demands or needs of disaster victims throughout Bangladesh, not in just Pankhali Union.

3. PROPOSED DESIGN AND DISCUSSION:

There are some basic human requirements which includes housing and everyone has the right for their appropriate health and well-being. In disaster prone areas a secured homestead from natural disaster is very crucial. Communities living in these areas are regularly hit by disasters; disasters severely damage a large number of houses, with half of them destroyed completely. The loss of house and household goods create the condition more vulnerable along with socio-cultural and financial inadequacies. These communities are affected by the disasters a lot and providing disaster responsive homestead design will be a great initiative. The next parts will go through the planning, structures and design features that will make the homestead disaster responsive.

3.1 PLANNING FEATURES:

The design is focused on generating disaster responsive home adopting contextual approaches along with socio-economic and climatic overviews. The outcome of the plan includes participatory engagement of the community and detail study of the existing homesteads. With the contextual approaches this plan incorporates appropriate technology to adopt and mitigate the overall challenges.

3.1.1. SPACE PLANNING:

The proposal of the house design made with two bedrooms, a kitchen, a small cattle room, an attached toilet and a space which can be used as dining area or for other purposes. The whole homestead also includes a courtyard for their day-to-day life works for example farmers can dry seeds or prepare crops or fishermen can prepare net for fishing even they can also do some vegetations in this courtyard. The homestead also has a rain water preserver where the users can reserve rain water for further usage. Rural people of Bangladesh have a fundamental requirement for courtyard, kitchen and cattle house. Many of the homesteads after losing land due to disasters are having lack of all these programs. Incorporating a proper design plan with contextual and climatic approaches can generate a plan dealing with the needs of rural people (Figure 24). In the proposed design plan, there are two spacious bed rooms and these rooms can have enough furniture as per needs (Figure 25). Attached toilet, kitchen and a space can be used easily during the disaster time without going out

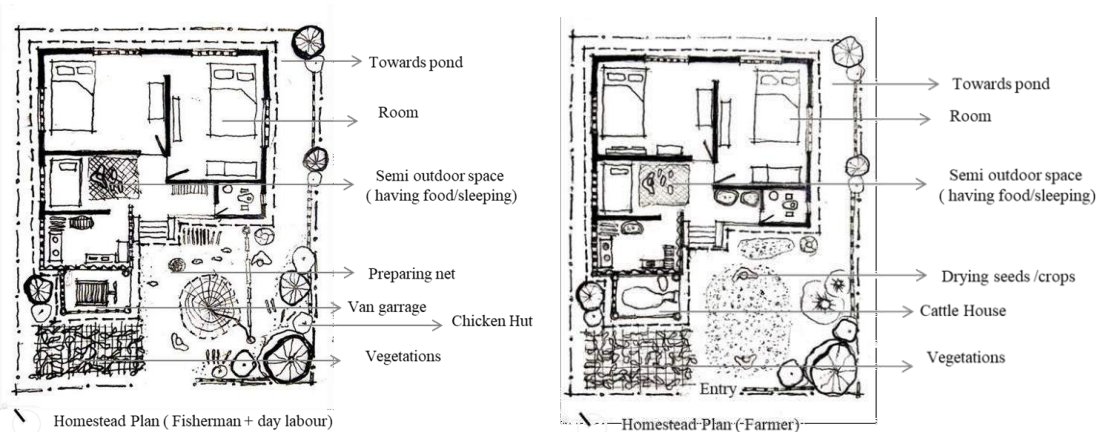


Figure 24, 25: Proposed Homestead Plan

3.2. PLINTH LEVEL:

The plinth level is where the super structure begins and the sub structure ends. Plinth level is very essential to avoid moisture, damp and enter of rainwater or stormwater. In the survey area most of the houses are seen having sufficient high-level plinth but the plinth is made up of mud or soil or material that will be washed away during the disaster. In the proposed design there are mixture of soil, mud and cement at the same time in the plinth underneath the house there are drum tying with the sub-

structure. This technique is incorporated so that when the disaster will appear and water level will rise the plinth having drums will help the house to float when the land will wash away (Figure 26, 27). When the water level will increase the whole structure will rise up and float (Figure 27, 28). The builtform will be attached with an anchor to the land and it'll float in definite area after the land will wash away (Figure 28).

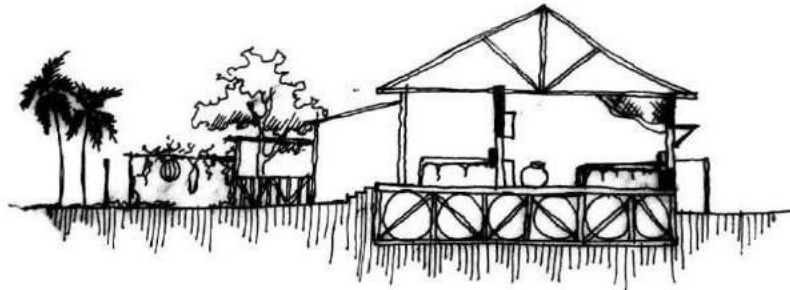


Figure 26: Drums in the plinth level



Figure 27: Rise of water level affecting land and builtform



Figure 28: When the Land washes away drums helped to float and anchor attached to

3.3. CROSS VENTILATION:

Indoor environments generally require cross ventilation to maintain proper oxygen and air quality of a room. Position of apertures is very essential for the entry and exit of air and for maintaining enough ventilation. In the proposed plan, the two bedrooms are having windows providing cross ventilation; this will create a decent air flow in the rooms and at the same time will create a comfortable environment inside (Figure 29). Small space in front of the rooms also having proper ventilation

(Figure 29). In the proposed design the total house including rooms, kitchen, multipurpose space is having proper ventilation which is sufficient for disaster responsive house plan.

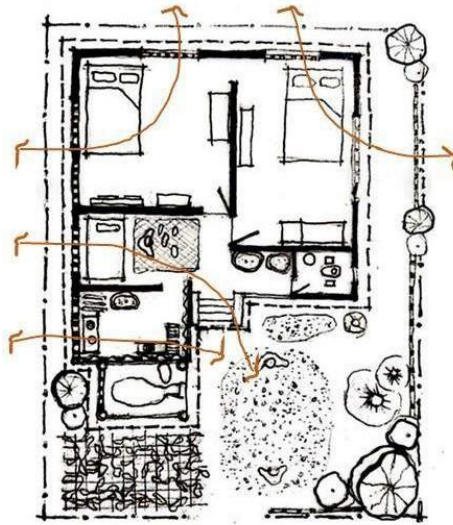


Figure 29: Cross Ventilation

3.3. MATERIALS AND STRUCTURES:

Columns, roof, walls, doors, windows are the elements that create house's superstructure above the plinth level. For disaster responsive house design, materials that are locally collected are essential as these materials can be found in the near areas and can also create structure which can tolerate viability of disasters. In the proposed design, the total structure is made up of Sundari Kath (Figure 30, 31); a type of wood which is locally available in the coastal areas, very hard and durable. This wood is mainly used for the walls, slab and creating the structural joining and locking. During disaster this wood can give durability to the builtform saving it from breaking down. The structural locking and joining of Sundari Kath will help the rooms or whole builtform to tie up with each other and also will lock up the roof structure strongly. In the roof the structural joinings are made up of Sundari Kath (Figure 32, 33, 34); names of the joinings are dragon base, king post and hammer beam truss assembly (Figure 32, 33, 34) and the shading is created by using Tin. The hole plinth level is covered with wooden panels also made of Sundari Kath which will help the drums tie up with the upper portion or builtform. The inner columns of the house are made of Sundari Kath or if Loha Kath is available than it can also be used; the wood panels will used molding it into rounded columns.



Figure 30, 31: 3D Visualization of Proposed Homestead

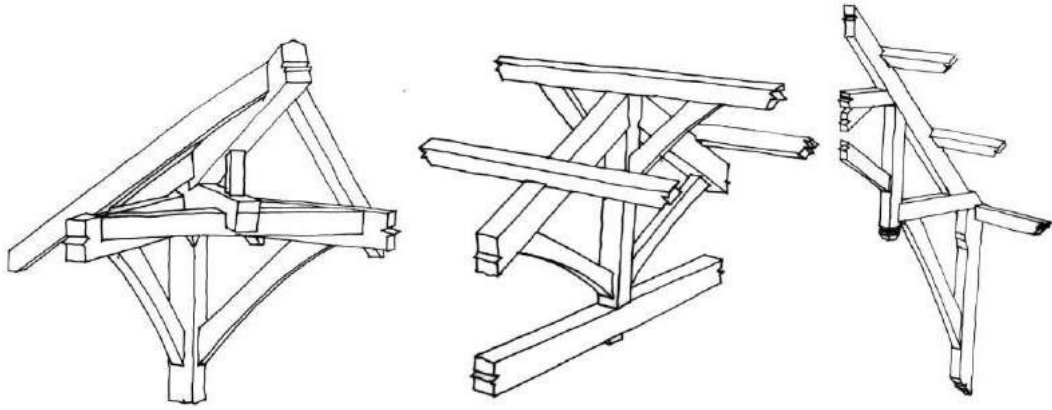


Figure 32: Dragon Base Assembly Figure 33: King Post Assembly Figure 34: Hammer Beam Truss Assembly

3.4. SOLAR PANEL AND RAIN WATER PRESERVER:

In the proposed design, for electricity solar panel has been incorporated (Figure 35); during the disaster from the solar panel the house can have electricity resources. In the coastal areas one of the biggest problems are unavailability of pure drinking water or too much salinity in water. Rain water preserver can help to preserve rain water and will help to use the water for drinking or cooking or any other purposes. Solar panel is attached in the roof and the pipe of rain water preserver is also in the roof from which rain water will be poured and preserved in the rain (Figure 35).



Figure 35: 3D visualization of Proposed Design (solar panel – rain water preserver)

3.4. HOUSE SHAPE:

The house is rectangular in shape. It is having 18 feet width and 24 feet length up to the kitchen section (Figure 36). The house is having drums in the plinth and an area of 18 feet x 18 feet is having drums underneath. The kitchen and cattle house are tied up with the main structure and during the disaster when the water level will rise or cyclone approaches; the main builtform will have to untie the

kitchen and cattle house portion. At that time a square shaped builtform will float and because of the tying anchor in the land the builtform will float into a definite area. Before the disaster the house shape is rectangular having a courtyard, kitchen, cattle house and after the disaster the square portion will only float. The place among the rooms and in front of toilet can be used for cooking or even the cattle can also be kept there.

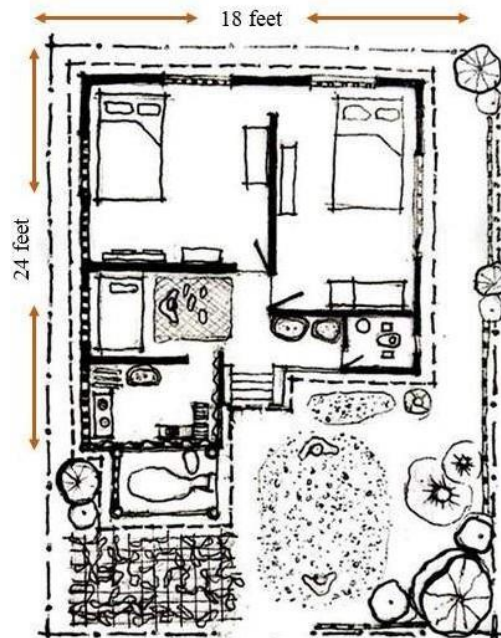


Figure 36: Length and Width of Proposed Homestead

3.5. DISASTER RESPONSIVE HOMESTEAD, POST DISASTER MANAGEMENT AND RESILIENCE:

Incorporating the strategies in the coastal homesteads can significantly moderate the losses during the calamities and at the same time environment will also be saved. To protect the coastal areas from cyclones there need more and more trees. If every year a huge number of trees are cut off to build newer houses in the coastal zone than the situation can get more dangerous during the calamities. By including these ideas coastal people will get certain relief as the chances of losing their houses will decrease. Also, on another hand post disaster management will not be as much crucial because losses will be lower and destruction of homesteads will decrease as during the disaster period and rise of water level the proposed homestead will float into a certain area and environment will also be benefitted as large numbers of trees will not be cut off for making newer houses every year.

The concept of resilience is the ability to prepare and plan for and adapt more efficiently to adverse events which are generally associated with disasters and post disaster management. In the proposed homestead design, the layout of the house, construction details, materials and strategies to stay afloat in rising of water level make it resilient as the planning and adapting schemes are for understating the challenges during and after the adversity.

4. CONCLUSIONS

Based on the field survey conducted on Pankhali Union, it can be stated that communities in the coastal areas suffer a lot due to disasters especially cyclones and rising of water level related to it. Disaster responsive homestead has long been a desire of Bangladesh's disaster affected population. In the proposed design, the incorporation of drums for floating method, using of Sundari Kath, rain water preserver all these have enhanced the responsiveness and resilience of the homestead. This study would let us explore in real context as the existing situations are derived from real circumstances and issues; which would be very vital to generate a disaster responsive homestead. However, from

monitoring and evaluation of the proposed design, recommendation for further research is essential. The materials used in the proposed design would help to increase the longevity of a homestead and at the same time it will moderate the post disaster challenges as the losses will decrease due to the newer approach. At the same time, the user of the proposed design should be aware of the facts and if any maintenance or monitoring is needed before the disaster period or any

time of the year then it should be monitored for more robustness against the disasters and make the disaster responsive homestead design more efficient.

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