

## ADAPTING TRADITIONAL HOUSING DESIGN TO COPE WITH NATURAL HAZARDS: STILT HOUSES FOR FLOOD-PRONE AREAS OF BANGLADESH

R Hafiz, BUET, Bangladesh

### Introduction

Every year thousands of houses are damaged by floods. Bangladesh is located on a delta – as a result, flooding is a common phenomenon in this region. The physical characteristic of the land also funnels up storm to cyclonic intensities. These two hazards cause extensive damage to life and property. The extent of damage can to some extent be correlated to the economic condition of the people and housing design and building materials used for construction.

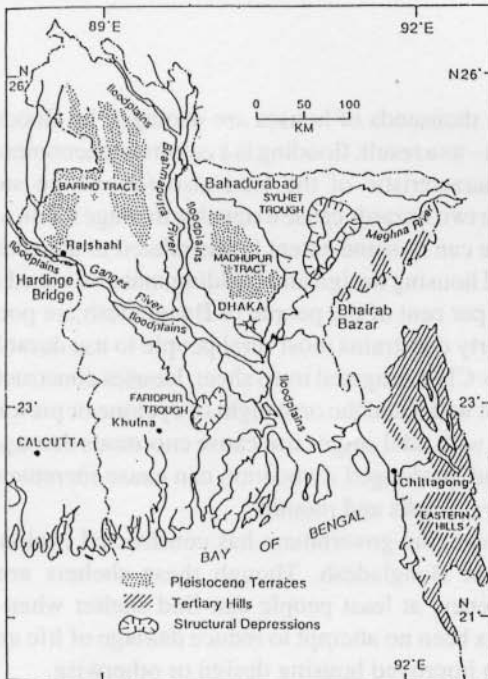
Almost 85 per cent of the people of Bangladesh are poor and live in the rural areas. Poverty constrains most rural people to use durable materials, like brick, concrete or CI (corrugated iron) sheet. Houses constructed with bamboo and thatch cannot withstand the onslaught of cyclone or prolonged inundation. A cyclone along with tidal surges can cause enormous damage in a single day. On the other hand, prolonged inundation can cause incremental damage as it extends over days, weeks and months

In recent years the government has constructed cyclone shelters in the coastal regions of Bangladesh. Though these shelters are not meant for permanent residency, at least people can find shelter when disaster strikes; whereas there has been no attempt to reduce damage of life and property from flooding through improved housing design or otherwise.

This paper assumes that with a little innovation and adaptation life and property can be saved and people will not have to abandon their houses during normal flood. To be specific this paper means to say that stilt houses, which are widely used in the hilly regions of Bangladesh, can be adapted for flood prone, rural areas to cope with the hazard. Though the construction of stilt houses is assumed to be a little higher than the conventional bamboo houses of the rural countryside, in the long run it would be cost-effective, protected against normal flooding and safe and healthy housing in the bargain. Stilt houses offer more benefits than the general houses of the countryside.

The aim of this paper is show that improved housing design can minimize damage caused to housing by floods. In this regard, stilt houses can be adapted to cope with floods in the rural areas of Bangladesh. With this aim in view this

paper begins with appraisals of issues related to flood, socio-economic condition of the people, housing design and the damage caused by flood, conventional stilt houses of hilly regions of Bangladesh and the benefits it provides to users in the hilly regions and seeking ways to adopt it for the flood prone rural areas. The methodology adopted for this paper consists of both primary and secondary levels of investigation.



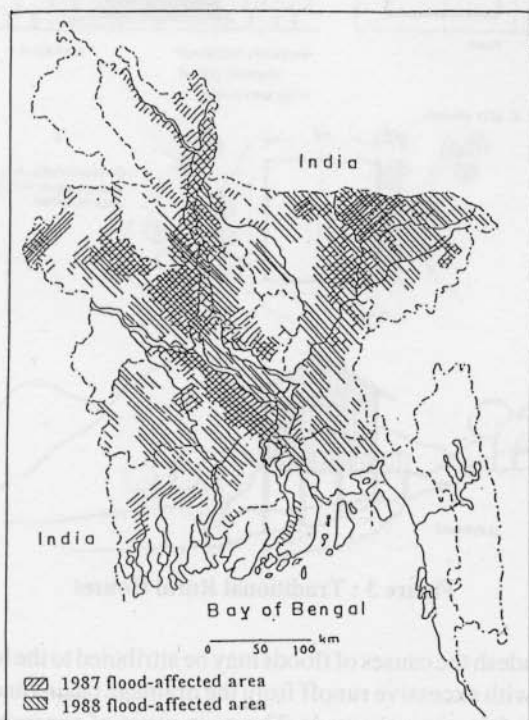
**Figure 1 : Locational and Geomorphic Features of Bangladesh**

### Floods and Bangladesh

Bangladesh is not so much a land on water as water on a land. One-third of Bangladesh's physical space is comprised of water in the dry season. In the rainy season almost 70 percent of the land is submerged. Water is the main source of fish protein, the major provider of crop fertilizer and transport, and unquestionably, the greatest source of national wealth. Bangladesh has also the largest delta system and the largest flow of water to the sea of any country on earth. The delta makes it one of the most fertile lands in the world and that is why it can support its population on a land area of 143,999 square kilometers where density equals to about 4000 to 5000 persons per hectare (Hafiz, 1998).

The country's lifeblood is also one of its major ecological problems. If the Himalayas is assumed to be the roof of the world then Bangladesh lying at their base – is the gateway to the Bay of Bengal and the Indian Ocean. Geographically Bangladesh is a great alluvial floodplain formed by some of the world's great rivers – the Padma (Ganges), the Jamuna (Brahmaputra) and the Meghna and the numerous tributaries of these great rivers.

Bangladesh is also characterized by its very low elevation. Except for the hilly areas (in the south-eastern and north-eastern regions) and Pleistocene terraces (of north-west Barind and north-central Madhupur), nearly 50 per cent of the elevation of land surface of Bangladesh is below 25 feet (8.3 meters). Bangladesh's proneness to flooding can be attributed to its low land elevation, insufficient physical existence of the huge river basin and above all the climatic condition of the region (refer to Fig. 1). Moderate to heavy rainfall characterizes Bangladesh, which is on average 2500 mm annually (Chowdhury, 1998).



**Figure 2 : Flood Affected Areas in 1987 and 1988**

The topographic setting of the region also funnels up storms to cyclonic intensities every year. Perhaps nowhere on earth does so much water and silt flow into such a small land area in such a short space of time as in Bangladesh during the monsoon. The outflow carries about 2.5 billion tons of silt and 2.4 billion cusecs of water every year. While much of the rain and snowmelt that fall on the Himalayas, Kumaon, Nepal, Bhutan and Assam Hills finds its way into Bangladesh, the country makes up only 8 percent of the 600,000 square miles of the Ganges-Brahmaputra river basin within its territory (Hafiz, 1998) (refer to Fig. 2).

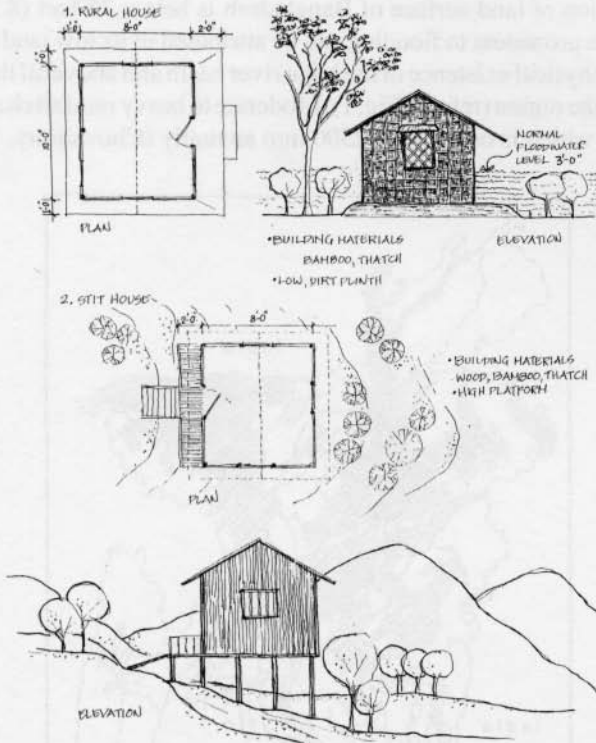


Figure 3 : Traditional Rural Houses

In Bangladesh the causes of floods may be attributed to the low topography of the country with excessive runoff from the drainage basins and the hydraulic characteristics of the river channels. The main cause of excessive runoff is the huge drainage basins of the rivers of Bangladesh, a major part (92 per cent) of which lie outside the country and receive the full force of monsoon rains from

the Bay of Bengal. When excessive rainfall occurs simultaneously over several tributary basins for a prolonged period, the combined runoff from the tributaries is a critical factor in high floods in the main channels downstream. The absence of any large storage areas like natural lakes or reservoirs in upstream areas result in rapid transmission of floodwater downstream. Rainfall alone can cause flooding of vast areas of near level land. Disastrous floods result from a combination of monsoon peak discharges in the mainstreams with prolonged localized rainfall within Bangladesh.

### **Socio-Economic Condition of the People in Rural Areas and Damage to Housing from Flood**

*Socio-economic condition of the rural people:* Bangladesh is mainly a rural-agrarian country with more than 85 per cent people living in the countryside. Economically it is one of the poorest countries of the world with per capita income of \$US 280. Agriculture provides the bulk of income to the rural people. Agricultural activities provide the sustenance for day-to-day living. Food consists of rice, lentils and sometimes fish. Egg and meat rarely form part of the normal diet.

Due to nearly two centuries of external exploitation by Britain and about a quarter of a century internal exploitation by Pakistan, the economy remains underdeveloped and majority of the people remains in poverty. It has been estimated that 51 per cent of the rural people were living below the poverty line in 1964. This situation worsened due to the Liberation War and the percentage of the rural population living below the poverty line increased to 57.8 per cent in 1974, further increasing to 77.8 per cent in 1982. Government and non-Government (NGO) interventions has helped curb this rate and improved to a percentage of 52 per cent in 1990. Even the absolute number of poor living below the poverty line was 50 million, which is absolutely overwhelming (Chowdhury, 1998).

*Nature and design of housing in the rural areas:* Several factors dictate the form, nature and design of housing. These are,

- The income level of the prospective house owner/ builder,
- Availability of building materials,
- Price of building materials,
- Financial assistance available for housing.

Income is a prime factor in housing. Good and durable housing is dependent on good income. Availability of building materials dictates the

nature of housing and its design. Durable materials have to be produced locally, their sufficient supply and affordability ensured to serve the needs of the general people. The availability of building materials is directly related to their price, because even if the supply of building materials are sufficient but their price high then it is probable that most rural people will not be able to buy them. In this connection transportation and communication is important to ensure the price and the supply of building materials to any part of a region.

The level of income for most rural people is very low, therefore the price of durable building materials is high in the context of their income. In rural areas transport and communication system are not well developed. Country boat is the chief means of transport. So in some regions brick, cement, CI sheets, etc. are not available in sufficient quantity. Some people thus depend on materials that produced and available locally, such as bamboo, thatch and mud. These materials are cheap and sometimes available for free. The availability of these building materials dominates design and form of rural houses.

The most conventional design of rural houses consists of split bamboo matting walls, compacted dirt floor and thatch roof, where affordability permits roofs are of CI sheets (refer to Fig. 3). The plinth is of compacted dirt floor. The plinth is raised to 1'-0" to 1'-6". The thatch roof and walls has to be repaired regularly. Dirt floor becomes damp in the monsoon and people cannot sleep on the floor. Wooden bedsteads or bamboo platforms are used to cope with dampness. Dirt floor disintegrates during inundation.

***Damages caused to housing and other areas by flood:*** About 20 per cent of the total land area of Bangladesh is flooded every year. Normal flood is a regular annual feature and part of rural life. Severe floods occur periodically and Bangladesh experienced such flood in 1954, 1955, 1974, 1987, 1988 and 1998. Post-independence floods of 1974 and 1987 inundated about 40 per cent and 45 per cent of land area of Bangladesh and over 75 per cent land area in 1988. The 1998 flood was the most severe in history in terms of duration and intensity of damage. Economic loss has been increasing as structural measures were taken to contain floods. Total damage to the economy range from 1200 million Taka in 1954 to 100,000 million Taka in 1998.

Severe floods cause intensive and extensive damages to various sectors. The impact of severe flood has direct effect on housing. The extent of damage to housing depends on the materials used for construction. Structural damages can be calculated in terms of money, but the experience of severe flooding is traumatic and is incalculable.

The damage caused to housing may be calculated by the nature of housing and they are categorized according to the building materials used for construction.

Permanent houses are categorized as those with reinforced concrete (RCC) framework construction or load bearing brick wall. The floor is of cement finish. These materials are in a sense flood-proof and can withstand floodwater for a long period. Doors and windows are of wood. Longstanding floodwater, however, damages paint and finishes, wooden doors and windows, wiring and plumbing, etc. Since the price of building and finish materials are expensive (compared to that of conventional bamboo and thatch) the cost of damage is also high and may range anywhere between 20,000 Taka to 30,000 Taka.

Semi-permanent houses are those with load bearing brick walls, supporting a sloping CI sheet roof. The plinth is of cement finish over compacted dirt floor with brick lining. A wooden truss supports the roof, with doors and windows of wood. Inundation causes damage to doors, windows, paints, wiring and plumbing. The damage in a semi-permanent house may amount to 10,000 Taka to 20,000 Taka.

Temporary houses with CI roof are constructed of bamboo posts, split bamboo matting walls and CI roof. The floor may either consist of simply compacted dirt floor or cemented floor over a line brick base. Doors and windows are of wood. Damage is caused to the dirt floor, wood doors and windows, and paints and finishes. The cost of damage to such a house may amount to 3,000 Taka and over.

Temporary houses with thatch roof are constructed of bamboo post, split bamboo matting walls or thatch walls and thatch roof with a polythene underlining for protection against rainwater. A bamboo truss supports the thatch roof. Doors and windows are of split bamboo matting. The floor is of compacted dirt. Long standing floodwater causes damage to floors, walls, doors and windows. The cost of damage may amount to about 3,000 Taka.

### **Stilt Houses in the Hilly Regions of Bangladesh:**

#### *Terrain and climatic condition in hilly regions of Bangladesh:*

Bangladesh is chiefly characterized by low-lying flat terrain with some hilly regions in Chittagong and Sylhet. Flat land is scarce. These regions are also characterized by heavy precipitation and flash floods.

*Adaptive design and technology:* Stilt houses have evolved to cope with the extreme condition of the hilly regions of Bangladesh. Scarcity of flat land and flash floods required the floor to be raised high above the ground. A platform over bamboo or wooden posts provided the necessary space to build houses. The house also provides necessary protection from the attack of wild animals to the inmates (see Fig. 4).

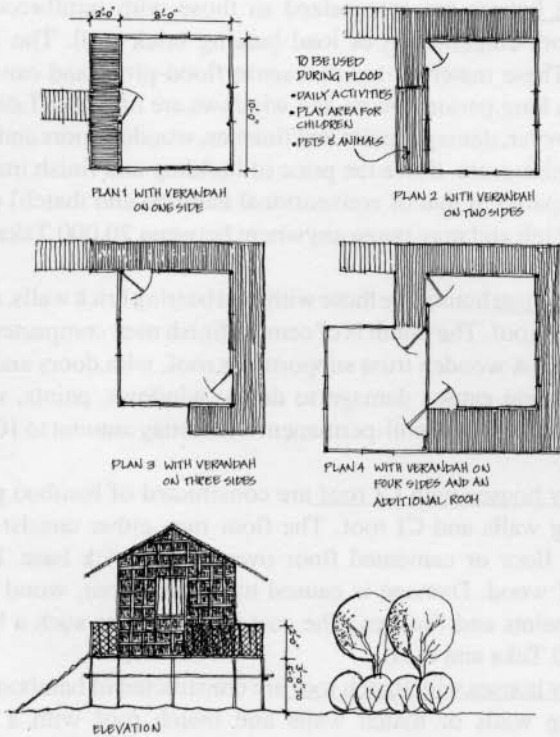


Figure 4 : Proposed Stilt Houses for Flood Prone Areas

**Building materials:** Stilt houses are generally built of bamboo and thatch. These materials are widely available in the hilly regions and within the range of the house builders.

**Benefits of stilt houses:** Stilt houses have evolved in the hilly regions of Bangladesh, as there is general scarcity of flat land. People of these regions have come up with the idea of creating space to build houses in a situation of non-existence of plain land. Stilt houses are built on platforms on hill slopes. A platform is built over bamboo or wooden posts. The platform provides the space required to build the house. The size of the house and number of rooms depend on the size of the platform. Access to the house is by a wooden plank stair or dugout wooden stair. People of the hilly regions are so habituated to stilt houses that they will build such houses even where flat land is available, because the benefits of stilt houses are many. Some of the benefits are described below.



A safe and healthy house: As the floor of stilt houses are raised high above the ground the floor remains dry throughout the monsoon. This is contrary to the conventional rural houses with dirt floors, where damp floor results after a heavy shower of rain. People can directly sleep on the floor, whereas 'chowkis' (wooden bedstead) would be required for damp floor resulting from rain. Damp floor can contribute to sickness, diseases and uncongenial environment inside the house. Therefore stilt houses are very safe and healthy houses.

Space beneath the house: The space beneath the houses can be used as pens for pets and animals. In conventional rural houses separate pens has to be built to keeps birds and animals. In the hilly regions homeowners keep chickens, goats and pigs beneath the houses. Regular cleaning and maintenance keep pests and diseases at bay. Therefore, stilt houses can be termed as multi-functional houses.

Environmentally friendly and aesthetic house: The stilt houses are environmentally friendly houses because it causes very little harm to the environment in terms of use and adaptability of space. The space over which stilt houses are built does not require any change/ alterations or improvement. Verandahs provide extra space for outdoor activities. Moreover the surrounding view can be enjoyed at leisure as the house is raised above the ground.

Protected from attacks of wild animals: In the countryside wild animals like snake, foxes, or other such animals sometimes attack babies and small children. As stilt houses are raised above the ground it is safe from wild animals. Parents with little children can rest in peace at night.

Protected from normal floods: The floor of a conventional rural house is easily inundated after prolonged shower of rains and from flooding. In such cases one or a couple of 'chowkis' may have to be used to hold off floodwater. Or alternatively, a platform or a 'mancha' has to be erected inside the house to protect children and possessions from the rising water. Homeowners not only have to incur extra costs of 'chowkis' or 'manchas', the traumatic experiences of floods are simply too great to quantify. In contrast, stilt houses are free from such hazard and people are saved from traumatic experiences.

### **Adapting Stilt Houses for Flood Prone Rural Areas of Bangladesh:**

It is evident from the above section that the benefits of stilt houses are many and the diagrams of stilt house show that it can be easily adopted for flood prone regions of Bangladesh. The difference between a conventional rural house and a stilt house is mainly the platform. Therefore adding a platform as a base beneath the conventional rural bamboo house can instantly alter and improve the quality of the house and serve the purpose of protecting inmates from the impact of flood. Fig.5 shows the plan and elevation of a stilt house. The

method of construction is simple and known to all builders in the rural areas of Bangladesh.

Building materials for the stilt house are available locally and are quite cheap. Actually there is nothing much to adapt or improve unless more durable materials like brick, concrete and CI sheets are used. Then the procedure will involve more complex building methods. On the other hand, to minimize damages the Grameen Bank material loan of 4 RCC pillars can be used to improve the quality of housing as well as minimize housing damage. The 4 RCC pillars can be used as posts for the platform and the rest of the house built as shown in the Diagram. However, the use of RCC pillars will also involve the use of CI sheet roofing. See Appendix for cost estimate.

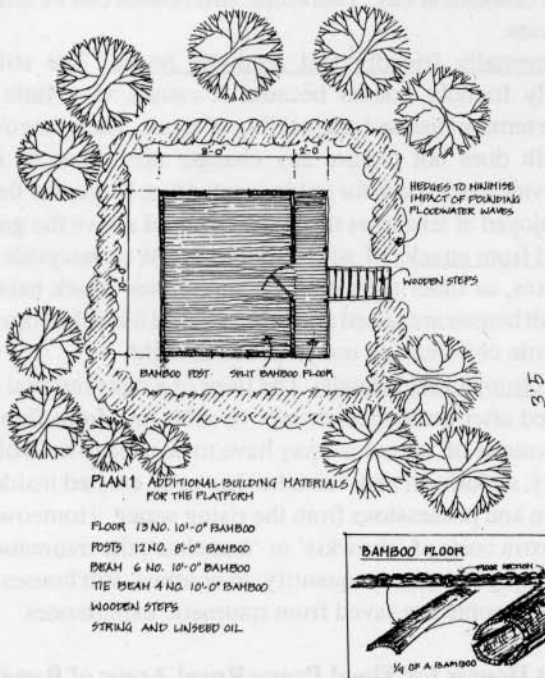


Figure 5 : Proposed Stilt House Plan -1

It is evident that the adoption of stilt house over the conventional bamboo house can minimize damage caused to housing from floods and moreover, houses will not have to be evacuated as water level begins to rise and/ or during normal flood. Staying in the house is very important for the rural poor who want

to save and protect whatever belongings they have in times of crisis. The rural poor will not have to abandon their houses during normal floods and take care of their belonging, pets and animals till the flood tides over.

## Conclusion

It has been seen that improved housing make a significant impact on the lives of homeowners. People of the rural areas constantly fight against natural and social ordeals. An improved house protects and strengthens homeowners against natural and anti-social elements. In this regard the following steps need to be taken to popularize and enable people to adopt and build stilt houses in the flood prone areas of Bangladesh.

**Motivating rural people to build stilt houses:** Since stilt houses are not usually built in the rural areas other than the hilly regions government and non-government agencies have to motivate people to accept and build stilt houses. The benefits of this type of housing have to be publicized repeatedly. The standard set by the stilt houses are simple, therefore people will soon come to accept this housing design if publicized regularly and efficiently. In this regard some pilot projects can be build in flood prone areas all over Bangladesh to demonstrate the benefit of stilt houses. It has been seen from past experiences that people make incremental improvement and investment when they are explained of the benefits of good housing. The Grameen Bank housing scheme is an example of this point. There is thus an urgent need to create immediate awareness for building stilt houses to cope with flood and minimize flood damages.

**Setting up a Rural Housing Authority:** The design of stilt houses offers scope for improvement and protection against flood with some additional costs. In this regard, a Rural Housing Authority needs to be set up to implement and popularize this housing mode. Since there are no housing institutions in the rural areas this Housing Authority can also disburse loan to the local people to enable them to build well-designed houses to cope with natural hazards, in this case floods.

Many rural people do not own land. So provisions should be made to enable people to buy land and build houses on it. It is seen that people make incremental improvements to their houses when they are owner of the land. They even invest their personal savings along with procured loans to improve and expand the living spaces. It is expected that that stilt houses can be a big step towards setting a minimum standard for housing in the rural areas as well as providing protection against the impact of flooding.

## References

- Hafiz, Roxana, (1998); After the Flood: Hydraulic Society, Capital and Poverty, Unpublished Ph.D. Thesis, The University of New South Wales, Australia.
- Chowdhury, Rashed, (1998); Three Essays on Flood Mitigation: The Case of Bangladesh, Unpublished Ph.D. Thesis, University of Tsukuba, Japan.

## Appendix : Cost Estimate and Price Difference:

### Cost of Traditional Rural House

SL.NO.	ITEM	UNIT	RATE	QUANTITY	AMOUNT
1	Earthwork	LS	LS	LS	200.00
2	Bamboo post	rft	3.00	94	282.00
3	Bamboo Wall	sft	1.5	324	486.00
4	Bamboo roof (two layer)	sft	1.5	336	504.00
5	Bamboo beam	rft	3.00	82	246.00
6	String and other materials	LS	LS	LS	200.00
<b>Total Taka =</b>					<b>1918.00</b>

### Cost of Stilt House

SL.NO.	ITEM	UNIT	RATE	QUANTITY	AMOUNT
1	Bamboo post	rft	3.00	178	534.00
2	Bamboo wall	rft	1.5	324	486.00
3	Bamboo floor	rft	3.00	130	390.00
4	Bamboo roof (two layers)	sft	1.5	336	504.00
5	Bamboo beam	rft	3.00	116	348.00
6	String and other materials	LS	LS	LS	225.00
<b>Total Taka =</b>					<b>2487.00</b>

Cost of Traditional Rural House Tk. 1918.00

Cost of Stilt House Tk. 2487.00

Price Difference Tk. 569.00

Price Difference in % 29.67

### SECTION 3 TECHNOLOGIES FOR SAFER HOUSES



