*THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE*

# Multi Hazard Disaster Risk Assessment of Housing at Southern Coast of Bangladesh

**Md. Shamsuzzoha**
Associate Professor and Chairman, Department of Emergency Management, Faculty of Disaster Management, Patuakhali Science and Technology University, Dumki, Bangladesh
**Shibaji Mandal**
Student, Department of Emergency Management, Faculty of Disaster Management, Patuakhali Science and Technology University, Dumki, Bangladesh
**Md. Rasheduzzaman**
Student, Department of Emergency Management, Faculty of Disaster Management, Patuakhali Science and Technology University, Dumki, Bangladesh
**A. K. M. Mostafa Zaman**
Professor and Dean, Faculty of Land Management and Administration, Patuakhali Science and Technology University, Dumki, Bangladesh

***Abstract:***
*The coastal community of Bangladesh has been facing different natural disasters like tropical cyclone, drought, thunderstorm, flood, nor'wester etcetera almost in every year. Large scale damage of property and environmental settings is a common feature of natural disasters in coastal Bangladesh. The aim of the study is to assess the disaster risk on housing and then find out the risks of existing housing pattern. The study is conducted by semi-structured questionnaire survey; personal observation; Focus group discussion (FGD); Key informant interview (KII) and secondary data collection method. The research has been conducted in Patharghata upazila under Barguna district in Bangladesh. The study found that, Cyclone is the top riskiest hazard for housing structure at the study location with score 20.41, where the second prior hazard nor'westers' score is 12.61. Historical cyclone impact analysis revealed that the cyclone impact on housing is a continuous process at coastal Bangladesh. The overall structural condition of houses is not resilient to cyclone. People only use wire nails as a connecting material at a minimum number for wooden frame housing structure and 93% people of the area don't aware about the cyclone resilient housing construction. The traditional way of construction housing is huge vulnerable in the context of tropical cyclone. The more research on cyclone impact on housing the more securing option will come out.*

***Keywords:*** *Hazard, housing, risk assessment, southern Bangladesh*

## 1. Introduction

The Intergovernmental Panel on Climate Change (IPCC) has highlighted that the developing countries like Bangladesh are excessively vulnerable to climate change (IPCC 2007). Climate Change Vulnerability Index put Bangladesh at top in the list of 170 vulnerable countries to the impacts of climate change (Maplecroft 2011). The funnel shape Bay of Bengal in south has made the country as a meeting place of monsoon rains. The major concerning disaster of there are flood, cyclone with storm surge, drought, tornado, flash flood, river bank erosion and land slide (Hossain 2008). Bangladesh is a densely populated country and ranks as one of the world's most disaster-prone country (Choudhury 2007). Due to geographical settings, the country faces various natural disasters which adversely affect the whole environment, including human beings, their shelters, or the resources essential for their livelihood (MoEF 2005). The coastal zone in Bangladesh reveals a rural setting and contains a significant serving of population of Bangladesh. The coastal localities of Bangladesh are mainly disposed to cyclones and storm surge and endangered to severe damages frequently (Tamima 2009). The southern region of the country along the Bay of Bengal is prone to severe tropical storms known as cyclone (Kamal 2012). The coast of Bangladesh is the most hazardous coast in the world because of the people affected from various types of cyclone and storm surges every year. Within last 100 years about 508 tropical cyclones originated in the Bay of Bengal and 17 have hit Bangladesh (Ahamad 2012). Sometimes Bangladesh is considered as a land of natural disaster and the event caused the death of millions of people with threatening other living people (Samira 2012). In recent ages, frequent disasters have triggered extra burden for the marginal people of Bangladesh and it endangering its economic growth as a whole (Islam et al. 2016). In the southwestern part of Bangladesh climate extremes are taking increasingly massive tolls and the households of the area are resisting the negative outcomes of these events. Bangladesh mostly faced historically different calamities in the form of floods, cyclones or drought and the frequency and intensity of these events have enlarged over the last eras. Wisner calculated that the coastal inhabitants are more

exposed to natural hazards such as coastal cyclone, flooding, tsunami and among which coastal cyclone and storm surge are the most frequent hazard (Wisner et al. 2004).

Natural disasters are the main hindrance of the sustainable development of Bangladesh. It's a small country but the disaster types, culture, housing materials are diverse and region wise widely too. In a regular basis, large numbers of rural houses are damaged by natural disasters (DMB 2008). The rural houses are mostly built with the locally available resources like mud, bamboo, wood and thatches. These materials are not strong enough and get damaged due to heavy rain and wind blows (Mahendran & Hussain 2010). House is the most basic need for the people and the major (83%) people of Bangladesh are living in non-engineering housing construction (BBS 2011). Technical guidance and affordability is the main reason of non-engineering houses construction by the local coastal people (Zisan et al. 2013). Pucca housing construction number is increasing in Bangladesh but not a countable number at rural coastal area (Lewis & Chisholm 1996). There is scope for developed cyclone resistance in pucca construction but the necessity is much greater among the millions of people dependent upon traditional materials and construction methods of housing. So, the kutcha construction is needed to improve to minimize the impacts of natural hazards on housing (Zisan et al. 2013). The objectives of the study are to assess the multi hazards disaster risk of housing at Patharghata upazila and to analyze the existing housing condition in terms of disaster.

## 2. Materials and Methods

### *2.1. Study Site*

Total area of Patharghata upazila under Barguna district is about 387.36 sq. km, located in between 22°14' and 22°58 north latitudes and in between 89°53' and 90°05' east longitudes. It is bounded by Mathbaria and Bamna upazilas on the north, Bay of Bengal on the south, Barguna Sadar and the Bishkhali river on the east, the Haringhata river and sarankhola upazila on the west. The administration of Patharghata upazila was formed in 1925. Total number of population is 162025; male 82687, female 79338; Muslim 143466, Hindu 18464, Buddhist 18, Christian 21 and others 56. The upazila has 1 Municipality, 9 Ward, 9 Mahalla, 7 Union, 42 Mauza and 66 Villages. The total number of household is 43085 with average household size 3.8. It also has 24821 ponds, 11 dighee (large pond), 2 river flows, 6 flood camps and 20 cyclone shelters (BBS, 2013). According to the upazila office data, there have some extremely vulnerable area for natural disasters and the areas are Majher Char from Kakchira union; Ruhita, Padma, Jintala, South Patharghata from Patharghata union and Ward No. 2, 7 & 9 from Paurasova.

### *2.2. Research Methods*

This is a qualitative type of research and the research is conducted by primary data mainly from household questionnaire survey. Total three villages (Majher char, 2 no. word and Ruhita) were selected purposively for primary data collection. 100 Sample sizes was selected by using Yamane's equation [n= N/1+N(e)2] within the study location. A semi structured questionnaire design was developed considering the sample population and the research purpose. UNISDR (2002) Risk Assessment equation (R = H x V / C) is used to assess the housing risk in accordance with natural hazard. Total three (3) Key Informant Interview (KII) was conducted from the Patharghata upazila office before starting the household survey. Total three (3) Focus Group Discussion (FGDs) were conducted from the three selected villages with semi structured questionnaire also. Secondary data and information was collected from journal paper, conference paper and published books for make fit the research article. Before collecting primary data, secondary data was collected and reviewed with deep concentration for understanding the clear concept of the research. After finishing primary data collection all data was entered and analyzed by the Microsoft Excel 2010. Finally wrote the report paper with tabular representation of analyzed data in Microsoft Office Word 2010.

## 3. Result and Discussion

### *3.1. Hazard Assessment*

Before the risk could be determined, it was essential to first conduct a detailed hazard, vulnerability and capacity assessment as required in the risk assessment equations. The assessment of climate change induced hazards is an integral part and it is the first steps of disaster risk assessment process for coastal community non-engineering housing. Hazards come to disaster when they harm people and damage property beyond the ability of the community to manage. Seven types of major hazards were identified at Patherghata upazila include River bank erosion, Flood, Cyclone, Nor'wester, Improper rainfall, Soil salinity, Water crisis. These types of hazards have the potential to negatively affect the housing structural condition in the study area. If these type hazards are not properly prevented or managed, it would be a great problem in near future. The hazard assessment results suggest that there is high probability for cyclone (8.2) to occur in the coastal community to housing (Table 1). The community established disaster histories generally represent only the last few years but expert members found cyclones from as early as 1965 and 1970 respectively. After that in the year of 1988, 1991, 1997 and 2007 respectively devastating cyclone occurred in the study location and they all have large impacts on housing structure. After adding the all score of each hazard, the results clearly expressed that the management needs to develop plans and strategies to prevent the occurrence of these hazards.

| Hazards | Possibility of occurring next | Expose to housing structure | Severity of house damage | Lasting hour | Occur anytime/ predictable | Total scores |
|---|---|---|---|---|---|---|
| River bank erosion | 5 | 1 | 1 | 5 | 5 | 3.4 |
| Flood | 5 | 5 | 1 | 1 | 5 | 3.4 |
| Cyclone | 10 | 10 | 10 | 1 | 10 | 8.2 |
| Nor'wester | 5 | 5 | 10 | 1 | 5 | 5.2 |
| Improper rainfall | 10 | 1 | 1 | 10 | 5 | 5.4 |
| Soil salinity | 5 | 1 | 1 | 10 | 5 | 4.4 |
| Water crisis | 5 | 1 | 1 | 5 | 5 | 3.4 |

*Table 1: Hazard assessment index on housing at Patharghata upazila*

*3.2. Vulnerability Assessment*

The vulnerability assessment shows broad reflection about vulnerability and the adverse impacts of different hazards. Basically, the non-engineering rural housing is the mostly vulnerable due to tropical cyclone. Because, all are constructed by the locally available construction materials and without any guidance and it has not any resistant capacity towards disasters. Housing diversity, housing structural vulnerability, housing resiliency, housing sensitivity toward hazards, economic condition of house owner, early warning, emergency preparedness and rehabilitation service are the basic criteria for analyzing the vulnerability in the study area. The study found that the local communities are highly vulnerable to the damaging effects of hazards such as, Cyclone> Nor'wester> Flood> River bank erosion> Improper rainfall> Water crisis> Saline water intrusion.

The local experts mentioned that housing structural damages by tropical cyclone generally higher considered to others hazards. Other remarkable hazard which is nor'westers also causes damage of houses, infrastructure and agricultural crops. So, it is clear that the tropical cyclone is the major hazard occurred in the study location with severe damage within various sectors. Table 2 indicates that the first priority to cyclone vulnerability with score (5.3) and second one is nor'westers (3.8).

| Hazards | Housing diversity | Housing structural vulnerability | Housing resiliency | Housing sensitivity toward hazards | Economic condition of house owner | Early warning, emergency preparedness and rehabilitation service | Total scores |
|---|---|---|---|---|---|---|---|
| River bank erosion | 1 | 1 | 1 | 5 | 1 | 1 | 1.7 |
| Flood | 5 | 1 | 5 | 1 | 1 | 5 | 3.0 |
| Cyclone | 1 | 10 | 5 | 10 | 1 | 5 | 5.3 |
| Nor'wester | 1 | 10 | 5 | 5 | 1 | 1 | 3.8 |
| Improper rainfall | 1 | 1 | 5 | 1 | 1 | 1 | 1.7 |
| Soil salinity | 1 | 1 | 5 | 1 | 1 | 1 | 1.7 |
| Water crisis | 1 | 1 | 5 | 1 | 1 | 1 | 1.7 |

*Table 2: Vulnerability assessment index on housing at Patharghata upazila*

*3.3. Capacity Assessment*

The third stage is to capacity assessment in local level through identifying different types of capacitates such as physical, social, economic, environmental and human. Communities capacities depends on some factors such as community relationship with GOs and NGOs, disaster preparedness plan for housing, existing government resources to minimize disaster risk, government services to house owner before, during and after disaster awareness regarding house damage, legislation about DRR and DPP.

| Hazards | Community relationship with GOs and NGOs | Disaster preparedness plan for housing | Existing Gov. resources to minimize disaster risk | Gov. services to house owner before, during and after disaster | Awareness regarding house damage | Legislation about DRR and DPP for housing | Village organization with DRR fund | Total score |
|---|---|---|---|---|---|---|---|---|
| River bank erosion | 5 | 1 | 5 | 1 | 5 | 5 | 5 | 3.9 |
| Flood | 1 | 5 | 1 | 1 | 5 | 1 | 5 | 2.7 |
| Cyclone | 1 | 1 | 5 | 1 | 1 | 1 | 5 | 2.1 |
| Nor'wester | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1.6 |
| Improper rainfall | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1.6 |
| Soil salinity | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1.6 |
| Water crisis | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 1.6 |

*Table 3: Capacity assessment index on housing at Patharghata upazila*

Communities' capacity is considered as an essential first step for resilience building. The studies examined the existing capacities against different natural disasters that were practiced by the individuals or communities. The research has found some capacities that were acquired by the rural communities to cope up with different natural climatic shocks. For assessing communities' capacity, seven indicators were considered. Within the seven indicators they were divided into different sub variables for assessing the communities' capacity in the study area. The coastal communities in the study area are capacitated in terms of increasing resiliency and the study found that the top priority was given to the cyclone capacity (2.1). But the highest capacity contains by the hazard river bank erosion (3.9). Flood capacity contains in second position with score (2.7) and the cyclone contains the third position with its capacity in the context of coastal housing. Because of the frequency and intensities, the study found that communities were developed additional capacities against cyclone but not in housing construction on the study area. Experiencing the past extreme events, they are also developed in different sectors such as infrastructure, technology, health, livelihood, culture, skills etc. However, it indicates that within the less priority to community capacity one is nor'westers (1.6) (Table 3). It has large impacts on housing as well as standing crops. There is no formal or informal capacity for reducing the risk of thunderstorm. Majority of people mentioned that they did not take any preventive measures when a cyclone occurred. Again, there are no specific rules and policies for coping with cyclone. Cyclone that affected the communities most of its coping capacity in terms of housing structure is so much lower. As a result, the communities the priority response for different capacities for each hazard is shown in Table 3. These results therefore suggest that the management of identified hazards also need to re-work their plans in order to lessen the risks on housing.

*3.4. Disaster Risk Assessment*

Hazard and vulnerability variables are considered as important factor in risk analysis, but they include capacity to respond to the identified hazards. Through using the UNISDR (2002) equation, the results found that the risk of cyclone is the highest value in the study area. Cyclone capacity is not much rich comparing to others disaster and due to its maximum hazards and vulnerability score, it gets the highest value shows in the Table 4.

| Hazards | Total score (H) | Total score (V) | Total score (C) | Value of risk (H*V/C) | Ranking |
|---|---|---|---|---|---|
| River bank erosion | 3.4 | 1.67 | 3.86 | 1.47 | VII |
| Flood | 3.4 | 3.00 | 2.70 | 3.78 | V |
| Cyclone | 8.2 | 5.33 | 2.14 | 20.41 | I |
| Nor'wester | 5.2 | 3.83 | 1.57 | 12.68 | II |
| Improper rainfall | 5.4 | 1.67 | 1.57 | 5.73 | III |
| Soil salinity | 4.4 | 1.67 | 1.57 | 4.67 | IV |
| Water crisis | 3.4 | 1.67 | 1.57 | 3.61 | VI |

*Table 4: Disaster risk assessment index on housing at Patharghata upazila*

The analysis output shows that the level of risk varies due to its existing capacities. The cyclone indicates the first ranking of risk on housing with giant score (20.41). But the second highest risk is nor'westers (12.68) only because of low capacity instead of being high hazard and vulnerability value. The risk of river bank erosion is negligible in the study area and its score (1.47), only because of its high score of capacity (3.86). It is also marked that community capacity is low in terms of non-engineering housing construction and gaps are significant to cope with different disasters. There is no existing effective emergency management (mitigation, preparedness or response) system that would save them from natural climatic shocks.

*3.5. Present Housing Conditions at the Study Area*

Basically, the coastal people live in non-engineering housing structure. They design their house by traditional way. In the study region 13% house is constructed by the design of house owner and another 87% is constructed by the design of carpenter. They do not consider any external factor while design their houses before construction. They just follow the way of building house which are practiced by the locality and using the local materials traditionally. 23% of the total people of the study area are living in single story house and other 77% of total respondents are living in two storied building. From the earlier housing damage analysis, it is clear that the two-story housing is more vulnerable than the single-story building. The tendency of damage of two story construction system influences the increasing vulnerability due to cyclone.

Generally, people use metal like wire nail for connecting the wooden frame. They use tin for roof in almost every house. They also use tin for wall in several cases. All the other materials mainly the wood, bamboo or cane they use for housing are collected from local forest. But Rust is the common problem for these metal type materials uses. Within the respondents' houses metal rust exists in 20% of total houses roof tin, 10% of total wall tin, 10% of roof and wall tin, 17% of total connecting wire nails, 14% of total roof tin and connecting wire nails, 7% of total wall tin and connecting wire nails. Rests of the 22% houses of total respondents are free from metal rust, where the maximum are newly constructed houses.

| Sl. No. | Events | | Total percentage (%) of houses |
|---|---|---|---|
| 1. | Designer | Owner of house | 13 |
| | | Carpenter | 87 |
| 2. | Story type | One storied | 23 |
| | | Two storied | 77 |
| 3. | Floor | Dirt/Kancha | 93 |
| | | Pucca/Brick (only outer side) | 07 |
| 4. | Roofing materials | Corrugated tin sheet | 97 |
| | | Straw | 03 |
| 5. | Number of housing at home | One | 60 |
| | | Two | 27 |
| | | Three or more | 13 |
| 6. | Existence of big trees upon house | Yes | 83 |
| | | No | 17 |
| 7. | Face direction of house | South | 67 |
| | | East | 23 |
| | | West | 10 |
| 8. | Existence of big trees at southern side | Yes | 13 |
| | | No | 87 |
| 9. | Awareness about cyclone resistant house construction | Aware | 07 |
| | | Don't aware | 93 |
| 10. | Housing strength against cyclone | High | 03 |
| | | Medium | 37 |
| | | Low | 53 |
| | | Null | 07 |

*Table 5: Existing Housing Condition of Patharghata Upazila*

Table 5 shows that 93% of the total respondents' houses have dirt/kancha floor, because of the economical insufficiency of rural inhabitants. It's also the tradition to construct dirt or kancha floor for wooden frame housing structure in Bangladesh. Other 7% of the total respondents' houses floors are in pucca/brick condition outer side of the basement. 57% of the total respondents' houses structure and fencing of the study area are made by wood and wooden materials. 33% of the total is made by the combination of wood and tin, 7% of total made by wood and bamboo, another 3% made only by the Bamboo and Sedges. There was a time when people used to use straw for roof of housing in coastal Bangladesh. But in recent time the use of straw is reduced because of availability of the corrugated iron sheet with affordable price. 97% of the total respondents of patharghata upazila use corrugated iron sheet for roof construction and rest of others still uses straw.

Rotten wood, termite or wood louse attack is the common problem of any wooden frame housing structure in the context of Bangladesh. Among the respondents' houses 28% has not any rotten wood, wood louse or termite attack but 72% houses have wood-louse attack, termite attack and rotten wood into their roof structure, fencing, door and windows frame, beam and column. Basically wood-louse attack is a usual feature for every wooden part of houses in aspects of our country, because of the quality of wooden materials use in rural area.

An important matter at Majher char area that, every house is separately placed from another. While it is generally noticeable more than one house is placed and made the concept home in rural area. 60% of the total respondents' houses are placed as single house at home. But two houses are placed at 27% of the total respondents' home. Other 13% homes contain three or more houses. According to the data 84% houses were damaged previously due to direct storm and rest of the others houses damaged by falling other house. So, the number of houses and the distance is considerable factor in terms of cyclone disaster.

According to the personal observation and questionnaire survey it is calculated that 53% of the total houses have no any surroundings materials which can make damage of house during cyclone. Among the other 47% houses rejected housing structure exists near side the 7% houses, haystack placed near 23% houses and chicken panel exists at 17% houses. It's a big risk to existence of such materials near to house, because during a cyclonic storm these type of structure or materials easily can carried away by the wind and can damage housing structure and property.

In rural areas of Bangladesh more or less trees are available in everywhere. After construct housing structure people plant trees surrounding the house. But they usually don't think about the position of those trees which will create risky situation for house or not. Big trees or branches of big trees are existing upon 83% of the total respondents' houses.

Houses face direction is a significant factor in the context of cyclone hazard. Because, generally the openings of houses like doors, windows are placed in frontal side. 67% of the total houses of the area are constructed with southern face direction, 23% houses with eastern face direction and other 10% with western face direction. It is calculated according to the survey data that, most of the houses damaged previously were southern face direction. Though the southern face direction is vulnerable to cyclonic storm, 67% people of the area constructed their house with this face direction which is not good for housing in the area in terms of cyclone disaster.

According to the respondent's opinion about their houses 3% of the total houses have high strength against cyclonic storm. 37% houses have medium strength, 53% houses have low strength and other 7% have no strength against cyclones.

Trees act like primary barrier against excessive wind speed and save lives and properties from loss and damage. In the aspect of Bangladesh coastal forest previously played significant role to protect resources from cyclones. Considering a small case, if big trees exist at the southern side of any housing structure then it will protect the house from sever wind speed to a specific scale. 87% of the respondents' houses have not enough trees at the southern side and other 13% houses moderately have big trees at southern side. From the survey data calculation, it is noticed that 63% houses were damaged where exist insufficient number of big trees at southern side of the houses but rest of the others had trees at southern side. It shows that, the big trees act like a bio barrier during cyclonic storm. In the study region 93% people don't aware about building cyclone resistant housing structure. They think that, if any cyclone occurs with moderate or severe wind speed then they have nothing to do. Other 7% aware about issue but they don't have any proper guidance to build cyclone or wind resistant housing structure.

*3.6. Risks of Existing Housing Pattern*

The location of the house building is an important fact and it does matter to protect the house from any particular extensive event. When the housing structure being located in a vulnerable area for specific hazard, the hazard impacts would be considering and build a stronger than normal.

Normally cyclone forms in the deep sea and in the context of Bangladesh cyclonic storm always approach from the south direction towards the coast. So, the wind velocity of cyclone with rotating motion directly attack the housing structure from the south direction if there are not any bio-barrier like big trees exist. It is clearly discussed that 87% houses of the study region have not enough big trees exist as a bio-barrier to prevent cyclonic storm. Only 13% houses have enough big trees at the southern side. So, it's obviously the risky situation for the houses of the area.

On another aspect, most of the house owners planted diversified trees around the houses without maintaining a limited distance from their housing structure. During a cyclonic storm, a broken tree close to the house may damage the house; hence the distance of tree from the house may be kept 1.5 times the height of the tree. Table 5 shows that, 83% of the respondent's houses have big trees or branches of big trees just upon its roof. Only 17% houses have no trees upon the roof but the trees around the houses were not planted with the consideration of minimum risk-free distance from housing structure. So, above all the houses are in risky situation regarding the issue specifically for cyclone disaster.

Existence of metal rust of any housing materials is also risk for housing in terms of cyclone wind. In Patharghata region, there metal rusts exist almost 78% houses. Traditionally people of the area use corrugated tin sheet, wall tin and connecting wire nails as metal in their house. Metal rust reduces the metal strength as well as total housing strength. So, it's another point of risk for housing structure in the area.

72% of total houses of the area have rotten wood, termite or wood louse attack which reduces the strength of structure or fencing wood of houses. Strong wind then easily can damage houses if any moderate cyclone occurs. For housing strength with wooden materials these issues create risk obviously for cyclone disaster.

An important factor or risky issue on the side of housing construction is that, there has not any kind of connecting material or way between column and basement. Housing structure only just placed upon the floor but not any link or attachment. During the time of cyclonic storm, the overturning type house failure occur most commonly due to this reason.

It is discussed that, 47% of the total houses have external structure on surroundings which are uses in different purpose or not in use. These types of structure can play a devastating mood during cyclone, because with moderate wind speed it loses its position and may throw by the wind speed towards housing structure. So, there always have a risk for damaging house only in the time of any cyclone.

Maximum houses of the study area are constructed with south direction. Every house has maximum openings like door and windows on the facing side. The more openings of a house on south direction the more risks for house damage by cyclonic storm. Only the wire nail is use for the connection of wooden frame and fence in Patharghata area. People of the area don't use any other metal to connect strongly between two parts of housing structure which can increase the housing strength against cyclonic storm.

Lack of awareness or no awareness about resilient house building against cyclone is the riskiest thing for house damage during cyclone of the area. According to the Table 5, 93% house owner in the area are not aware, they think if cyclone occurs in any time then house will damage and hence they have nothing to do. The people who aware about building house against cyclone don't know about proper way of building house and appropriate materials to use.

**4. Conclusion**

In the context of Bangladesh, every year many people of the coastal belt lose their valuable properties and lives due to natural disasters. Patherghata upazila under Barguna district is the nearest upazila to Bay of Bangle. By the assessment of multi hazard risk it is clear that, the tropical cyclone is mostly risky hazard for the people and their housing structures in the area. The second highest risky hazard for housing structures of the area is nor'wester. Hazard and vulnerability score is highest for cyclone but not the capacity. Highest score of capacity is for river bank erosion and that's why it contains low risk. The people of the coastal community are traditionally practiced wooden frame non-engineering housing construction. But, the traditional methods have a number of risks in terms of tropical cyclonic storm winds. The site selection and house facing placement are not well enough to make security. Even 93% house owner of the area are not aware about cyclone resilient housing construction. Because of the non-engineering housing construction in the study area there should have considered all points which are being affected by wind storm during cyclone.

**5. References**


i. Ahamed, S., Rahman, M. M., Faisal, M. A. (2012). Reducing Cyclone Impacts in the Coastal Areas of Bangladesh: A Case Study of Kalapara Upazila. Journal of Bangladesh Institute of Planners, 5, 185-197.

ii. Bangladesh Bureau of Statistics, BBS (2011). Statistical Year Book, Statistics and Information Division, Ministry of Planning, GoB, Dhaka, Bangladesh.

iii. Bangladesh Bureau of Statistics, BBS (2013). Barguna District Statistics 2011, Statistics and Informatics Division (Sid), Ministry of Planning, Government of People's Republic of Bangladesh.

iv. Choudhury, A. M. (2007). "Natural Disasters, Adaptation and the People of Bangladesh" in Biswas, S. K. (eds), Bangladesh Quarterly, Vol. 27 (No.4), Srijoni Printers, Dhaka, Bangladesh, 38.

v. Disaster Management Bureau, DMB (2008). Cyclone Sidr in Bangladesh: damage, loss, and needs assessment for disaster recovery and reconstruction, A Report Prepared by the Government of Bangladesh Assisted by the International Development Community with Financial Support from the European Commission, 30-31, available at: http//www.dmb.gov.bd/reports.

vi. Hossain, S. M. N. (2008). Addressing the Problems of Flood Management at Sirajganj District: A Planning Perspective on Regional – Local Context. An Unpublished BURP thesis, Department of Urban and Regional Planning, Jahangirnagar University, Savar, Dhaka.

vii. IPCC (2007). Climate Change: Synthesis report. http://www.ipcc.ch/pdf/assessmentreport/ar4/syr/ar4_syr.pdf

viii. Islam, M. S., Hossain, T. R., Podder, R. K., & Moles, O. (2016). Environment-friendly Sustainable Rural House Designs for Different Geographic Regions of Bangladesh. Seminar on Eco-Friendly Housing and Construction Technology: Bangladesh Context Housing and Building Research Institute (HBRI), Dhaka, Bangladesh, 1–14.

ix. Kamal, M. (2012). Living with Cyclone: coping and recovery strategies, a case study from the coastal area of Bangladesh, Faculty of Social Science, Lund University, 1-61.

x. Lewis, J., & Chisholm, M. P. (1996). Cyclone-Resistant Domestic Construction in Bangladesh. The Proceedings of H&H DHAKA96 workshop held at BUET, Dhaka, 29-38.

xi. Mahendran, K., & Hussain, A. Z. (2010). Disaster Resistant Rural House Design for Low Income People. International Journal of Applied Engineering Research, Dindigul, 1(1), 77-82.

xii. Maplecroft (2011). World's fastest growing populations increasingly vulnerable to the impacts of climate change- 4th global atlas reports. http://maplecroft.com/about/news/ccvi_2012.html.

xiii. MoEF (2008). Bangladesh Climate Change Strategy and Action Plan. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

xiv. MoEF (2005). National Adaptation Program of Action for Environmental Management. Ministry of Environment and Forest, Govt. of People's Republic of Bangladesh, November 2005.

xv. Samira, S. (2012). Recovery of Household-Level Assets: Towards A Cyclone Resilient Community. Postgraduate Programs in Disaster Management (PPDM) BRAC University, Dhaka, Bangladesh, 1-97.

xvi. Tamima, U. (2009). Population Evacuation Need Assessment in Cyclone Affected Barguna District. Journal of Bangladesh Institute of Planners, 2, 145-157.

xvii. Wisner, B., Blakie, P., Cannon, T., Davies, I. (2004). At Risk. London and New York: Routledge.

xviii. Zisan, M. B., Alam, M. R., Hasan, M. M., & Akter, S. S. (2013). Cyclone Resistant Low Cost Housing in Coastal Area of Bangladesh. International Journal of Science, Environment and Technology, 2(1), 48 – 55.