Research Title

Enquiries on Vulnerability to Natural Hazards (Cyclone, Storm surges) in Coastal Region of Bangladesh

自然災害に対する脆弱性に関する考察—バングラデシュの沿岸地域の自然災害（サイクロンと高潮）を事例として

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A Thesis

Submitted to the faculty of Graduate School of Social Design Studies, University of Rikkyo in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In

Business Administration in Network and Social Organization

Graduate School of Social Design Studies

University of Rikkyo, Tokyo

Japan

2013

Dedicated to

My Mother and Father

ACKNOWLEDGEMENT

I have the immense pleasure to express my deepest sense of gratitude, sincere appreciation, indebtedness and best regards to my PhD thesis supervisor, Yukie Osa PhD, and Dr. Kyose Kasahara Professor, Graduate School of Social Design Studies, University of Rikkyo, for their enthusiastic guidance, supervision, valuable instruction and constant inspiration and encouragement throughout the research work and in the preparation and completion of the thesis.

I have also the immense pleasure to express my deepest sense of gratitude and best regards to Sai Kurasawa, Professor, Graduate School of Social Design Studies, University of Rikkyo, for his enthusiastic guidance, supervision, valuable instruction and constant inspiration and encouragement throughout the research work and in the preparation and completion of the thesis.

I am ever grateful to Dr. Keiko Ikeda, Professor, Shizuoka University, Professor Haguhara, Professor Rei Makita, Ph. D, Graduate School of Social Design Studies, University of Rikkyo, for providing me with suggestions and valuable advice.

My special thanks are due to Professor Dr. Nurul Islam Nazem, Professor Dr. A. Q. M. Mahabub, Department of Geography and Environment, University of Dhaka and Dr. Razib Shaw, Professor Graduate School of Environmental Science, Kyoto University, for their valuable advice and assistance. I also wish to thank all of my respondents and the local people of the study area for their co-operation and hospitability.

I wish to express my deep appreciation to Chaz Frezar and James mellor for their co-operation in my thesis grammar correction and formatting, and my special thanks also go to Ito Yasutoshi, Fujieda and Makino san for their continuous support in the preparation of this thesis.

Finally, I am grateful to my parents and brothers for their moral support and encouragement and of course to Rikkyo University for their financial support.

March, 2013 **Mansur Ahamed**

Executive Summary

The coastal morphology of Bangladesh influences the impact of natural hazards on the area. Especially in the southwestern area, natural hazards increase the vulnerability of the coastal dwellers and slow down the process of social and economic development. There is a serious need for an effective disaster management plan to minimize the loss of lives and property. Unfortunately, the present cyclone warning signal is not only highly ineffective but sometimes also confusing. There is no comprehensive disaster management strategy. Some of the local NGOs in collaboration with government agencies undertake certain activities, but these too have been limited to mostly relief and rehabilitation. Cyclone preparedness plans are hardly found among these agencies. While it is not possible to prevent natural disasters, protective measures to reduce the vagaries of disasters can be enhanced. Due to the unusual climatic behavior in recent years, people in coastal areas face serious vulnerability, especially in the context of human settlements, and consequently move out to the cities to combat the situation. These people need innovative strategies for survival. This thesis paper asserts, like many other newly devised coping strategies, that reducing vulnerabilities is important and suggests where innovation & adaptation are necessary to save communities from their vulnerability to climate change.

It is not enough to simply be prepared for a disaster. Countries likely to face future cyclones need a longer-term framework that strengthens local peoples' capacity to adapt to climate change, particularly for weather-related disasters such as cyclones and storm surges. So, it is necessary to analyze community's vulnerability vis-à-vis the climate scenario in Bangladesh coastal areas.

Objectives of the Study

The specific objectives of the study are as follows:

1. To trace the causes of vulnerabilities that emanate from natural hazards
2. To assess the ability of a community to address and introduce measures to reduce its vulnerabilities and adapt to climate change

3. To deduce options for action related to adaptation and mitigation measures

Hypotheses

To meet the objectives of the study, several hypotheses were formulated to address the research questions. These are as follows:

- First, whether the amount of income and the sources of income or the livelihood activities of the population, and its level of education and its qualifications, can indicate the capacity of the people to afford physical mitigation and their capability to recover from disaster.
- Second, whether the age and sex of household members; households with more children, more elderly members or more women will experience more difficulties during evacuation and will require greater resources like food and water after a disaster.
- Third, whether the frequency of experiencing hazards may lead to a *taken-for-granted attitude* toward hazards.
- Fourth, whether the residents make use of indigenous or local knowledge to foretell the impending cyclone, and the use of local or indigenous knowledge is functional.
- Fifth, whether the government early warning system and social networking (human capital) are effective.

Methodology

The main criterion in choosing the coastal districts of Cox's Bazar, Noakhali, Bhola, and Barguna as the study areas was the degree of their vulnerability to coastal hazards, especially to cyclones and tidal surges. Therefore, the influence of seasonal cyclones, tidal surges, and the extent and depth of flooding were considered as important variables in determining the vulnerability of this area.

First, the national, international and NGOs' information were corelated with local statistical data, to determine which districts & *upazilas* were more vulnerable to cyclones and tidal surges. Then, two unions which were most affected by cyclones and tidal surges were selected in each *Upazila*.

The study utilized both primary and secondary data collection. Secondary data was gained from desk research. Primary data was collected using a combination of approaches that included household questionnaires, key informant interviews, and community-level Focus Group Discussion (FGDs). The first two approaches gathered quantitative data while the last captured qualitative responses from a sample of the target population as participants. Some data, especially those relating to housing conditions, toilet facilities and other housing characteristics, were collected by observation as far as possible.

A structured questionnaire was used to gather primary data from randomly sampled households. The questionnaires focused on determining the source of risks and vulnerabilities of the target population by studying their social, economic, environmental and physical conditions [Appendices, 3]. Their behavior towards risk, mitigation and coping mechanisms against calamities and natural disasters was likewise inquired into.

To triangulate the data gathered from secondary information and primary data, commonly held social knowledge, people's experience and coping strategies, a FGD guide was designed to get qualitative data [Appendices, 4]. One FGD was conducted for each union level (community level) and participants were union chairmen, union members, school teachers, health employees, NGO workers, farmers and prominent union people.

A multi-stage sampling design was followed for selecting the final sampling unit (FSU). In the survey, the whole coastal area was divided into 19 ecological administrative zones (ICZMP, 2006). Initially, districts (each an administrative unit) were selected as primary sampling units (PSU). From each selected district, four sub-districts were selected as the secondary sampling units (SSU). This is the second stage. From the selected sub-district, eight unions were selected as the penultimate sampling units (PUSU). This is the third stage. At the fourth and final stage, households were selected from eight unions, and all members of the selected households were subjected to a detailed interview.

The first and the second stages adopted a purposive sampling method while at the third and fourth stages, systematic sampling methods were employed.

Like many other studies, the present study has its limitations. Time limitation was one of the main barriers to complete the vast present research. Due to time shortage; the sample size (385 in number) was also kept small.

Theoretical Framework

Vulnerability consists of three components: natural hazards, fragility factors and adaptive capacities of individuals and households. All three components are shaped by global processes. Global warming, due to the increased industrialization and higher emission of greenhouse gases, increases the number of cyclones. Structural adjustment programs taking place in developing countries increase the number of poor people and widen the gap between the rich and the poor. Thus, political ecology affects the processes that occur in the physical environment and social forces that define the vulnerability to natural events. The outcome of a natural hazard, measured by socioeconomic loss and people's capacity, is dependent on the fragility and adaptability of individuals, households or regions. Lower fragility and higher adaptive capacity buffer the negative impacts of hazard events. Very young or very old people, women, the poor, and those who do not have adequate skills are most fragile to natural hazards. Individual households with greater social capital, better management skills and more accumulation of resources are less likely to suffer from short and long term consequences of natural hazards.

Fragility and adaptability are also related. Enhancing adaptive capacity will result in lower fragility and lower fragility also increases adaptive capacity. Better socioeconomic status and health conditions of individuals and households will in turn lower the fragility to natural hazards and increase the adaptive capacities.

Analysis of Collected Data at Household and Community Levels

Household Size and Other Characteristics

The household composition and size were contributory factors to a family's vulnerability. Households with many family members and a higher number of dependents are faced with a bigger

challenge when recovering after a disaster. Households with more children (below 5 years), more elderly members (60+ years) or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster. The most striking feature of the study is that the average household size is large at 6, which is considered as vulnerable. It is also noticeable that there are high numbers of children below 5 years and elderly of 60+ years hence adding to the vulnerability of households.

Household Occupation and Income

The majority of the respondents' (44%) income per month was 5,000 to 8,000 taka. Only 13.2 % of the respondents' monthly income was more than 10,000 taka. However, the monthly average household income was 7,393 taka. On the other hand, household expenditures, which were largely used for food, averaged at 5,215 taka. In addition, children's education cost as average of 903 taka, and the cost of medical treatment averaged 781 taka. As average monthly household expenses were 7,014 taka this did not leave much for households to generate savings.

The amount of income can indicate the capacity of the people to afford physical mitigation and recover from disasters. Larger income means that people can build better houses, build savings or purchase insurance to cushion the impacts of disasters. Income has significant influence on the adaptation of coping measures. For example, lower income groups have a very small and risky portfolio of assets. The most striking feature is that 16.2% of the households had a monthly income of less than 4,000 taka. This portion is considered as more vulnerable because less than 4,000 taka is not sufficient for a household. 56.1% of the households had a monthly income of 4,001-8,000 taka and considered to be of medium vulnerability. 27.7% of the households, whose monthly income was more than 8,000 taka, are considered as less vulnerable. A noticeable point is that scant financial recourses hinder the fast recovery of the households from external shocks and crises like calamities and disasters.

The foremost cause of vulnerability was the source of income of the household. Those dependent on self-employment, wage labor, and fishing were the most vulnerable groups. The income derived from such activities was marginal and often uncertain. Some sources of income were very vulnerable to disasters such as cyclones. For instance, open sea fishing was dependent on the size of waves in the sea, which normally grows bigger during a cyclone and monsoon season. So, fishermen (26%), day laborers (18.2%), and farmers (24.4%) are considered as having more vulnerable households due to their occupations. In contrast, government employees, private-sector employees and teachers are considered as having less vulnerable households.

Household Education

In terms of education, 39.2% of the households never went to school. Rates of completion for primary school, high school and college education were 37.9%, 16.1% and 6.5% respectively. The university graduation rate was very low.

Level of the education of the household head was a factor in their increased susceptibility to crises and shocks. The study reveals 39.2% of the respondents as illiterate. This portion of households is more vulnerable because illiterate persons seldom gain good employment. As a result, their income is low and their households always more vulnerable. Households with primary school education, 37.9% of the total, are considered to exhibit medium vulnerability as they have a higher awareness of disasters. However, incomes and occupations of such households are still vulnerable.

22.9% of the respondents with high school and college education are considered as less vulnerable because their household incomes and occupations are good. Moreover, this portion's households are more conscious of disasters.

Housing and Other Facilities

Housing units in all the survey areas were commonly made of mixed materials. Most of the houses had roofs made of tin (62.9%), thatch (20.5%), tin & thatch mixed (14.3 %) and politians (2.1%). Walls were made of tin (31.7%), bamboo (22.9%), wood & tin (16.4 %), mud (19.2%) and wood

(4.4%). However, a larger proportion of those who were poorer had dwellings that were made of light materials. This type of housing, with walls made of wood and bamboo and thatch roofs are very vulnerable to strong winds. The poorer segments of the respondents who had this type of housing were the fishermen, tenant farmers and wage earners.

The study also found that most of the respondents (66.5%) had lived in their current residence more than 10 years. 17.4% of the respondents had lived in their current residence 1 to 5 years. Only 2.9% of the households had lived in their current resident for less than one year.

Household Saving and Insurance Characteristics

The study reveals that 62.6% of the respondents said that there was no surplus of savings last year. Only 37.4% of the respondents replied that they had savings.

77.4% of the respondents replied that they did not have any insurance coverage. Only 22.6% of the respondents replied that they had insurance coverage. Of the respondents who had insurance coverage, most of them (21%) had life insurance coverage. Only 1.3 % of the respondents had health insurance coverage.

Household savings were used by 10.6% of the respondents to buy assets, 9.1% for business, 9.1% for education, and 8.3% replied to cope with an emergency. Though, 62.6% of the respondents did not have any savings.

13.5% of the respondents said that they kept money at the bank, 9.9% of the respondents replied they kept money with an NGO, 12.5% of the respondents replied that they kept their money within a cooperative society, and only 1.6% of the respondents replied that they kept money in their own house.

Insurance is very essential for disaster risk reduction. The study reveals that 77.4% of the respondents have no insurance coverage. This portion of respondents is considered as more vulnerable. In contrast, 22.6% of the respondents have insurance. This portion of respondents is considered as less vulnerable. However, most of them belong to life insurance coverage.

The study reveals that 62.6% of the respondents have no savings. This portion of respondents is considered as more vulnerable because in an emergency period they have no savings to recover from the situation. 37.4% of the respondents who have savings are regarded as less vulnerable, as they are more able to cope with an emergency period.

Presence of Hazards

In the survey areas 97.1% of the households had experienced cyclones and 76.4 % of the households had experienced tidal surges. Within last 10 years an average of 2.21 tidal/ storm surges and 2.41 cyclones affected these areas. Fortunately, in all of the survey areas, injuries or deaths due to natural disasters had been negligible even though most of the respondents lived close to bodies of water like rivers and the sea.

Evacuation Centre and Characteristics

The study reveals that the majority of the respondents (94.4%) replied that there was an evacuation centre for use during emergency periods. Nonetheless, in last 5 years, 74.8% of the respondents had evacuated to shelters during cyclones. On the other hand, in the same period, 25.2% of the respondents had never evacuated to a cyclone shelter.

The study reveals that 64.4% & 35.1% of the respondents replied that toilet facilities and potable water were available in evacuation shelters. Though, in the cyclone shelters there were no kitchen facilities. The majority of the respondents (54.8%) replied that potable water should be improved in cyclone shelters. Also, 33.8% of the respondents said that toilet facilities should be improved in cyclone shelters. The study found that a majority of 74.5% of the respondents went to cyclone shelters during cyclones. The respondents took shelter along embankments/ roads, neighbor's houses, and in public schools (8.6%, 4.9% and 3.9% respectively) during cyclones. 65.2% of the respondents said that most cyclone shelters were within 1 kilometer of their house. Additionally, the study reveals that when the cyclone shelter was far from their house, they took shelter at their neighbors' houses, or by the embankment/ road/levee etc.

Warning System

The study reveals that the response to cyclone warnings varies among the coastal people. Most of the respondents in the surveyed areas received disaster warning information from their radios, neighbors, kin, and the Disaster Management Committee (DMC). The main source of warning for disasters were DMC (60.8%), radio (22.3%), neighbors (13.2%), and television (2.9%) respectively. A small proportion received early warnings from mobile phones. However, it is important to note that, in the study areas, most of the households did not own a television, radio or mobile phone. Additionally, about half of the respondents did not understand the forecast, and some understood only superficially or got some signals. Similarly, the majority of fishermen did not have a radio in their fishing boats, and rarely listened to weather forecasts.

Preparedness

In terms of preparedness and mitigation, the respondents had several practices. In the surveyed areas most of the respondents had seemingly standard practices as far as preparedness was concerned. They tied rope to secure their houses when a cyclone was coming (16%); moved to a safer place (19%), moved assets to safer place (36%), prepared emergency kits (20%), and stockpiled food (9%). No one went to repair the embankments or levees.

Coping Mechanisms

The respondents in the survey had varying ways of coping with disasters. Most of the households (41%) coped with the effects of disasters by using personal savings or borrowing money from relatives (32.7%), receiving relief from the government (18.4%), borrowing money from an NGOs (17.7%), receiving relief assistance from an NGOs (15.3%), asking children to work (6%), borrowing money from the bank (3.1%) and selling or mortgaging assets (2.9%). A small proportion stopped the schooling of children and temporarily migrated to other areas, or reduced expenses on food and other types of household consumption.

The study's noticeable point is that a higher proportion of rickshaw drivers and small businessmen used this kind of relief assistance when compared to fishermen and day laborers. In contrast, government employees and private-sector employees did not do so. Another fact worth noticing from the data is that 61% of fishermen, 32% of farmers, 32% of day laborers, 33% of rickshaw drivers and 29% of small businessmen used borrowing money from relatives as a coping mechanism. So, the study data found that fishermen had a higher tendency to borrow money from relatives as a coping mechanism, while government employees and private sector employees had a lower tendency to borrow money from relatives as a coping mechanism.

The study found that the illiterate respondents and the respondents with higher education tended not to use relief assistance from the government as a coping mechanism, while the respondents with middle education have a much higher tendency to rely on such relief assistance. The most striking feature of the table is that 21% of the illiterate respondents, 19% of the respondents with primary school education, 17% of the respondents with junior high school education and 5% of the respondents with high school education used borrowing money from NGOs as a coping mechanism, whereas none of the respondents with college or university education used NGOs in this way.

So, the study found that illiterate respondents had a much higher tendency to borrow money from NGOs than the respondents with higher education when coping with disasters.

Social Capital and Informal Risk Sharing within the Community

The study reveals that 68.6% of the households trust their neighbors very much. 24.2% of the households trust their neighbors somewhat, and 6.2% only a little. On the other hand, the households helped each other during cyclones and post-cyclone periods somewhat (40.5%), a little (29.9%), and very much (24.2%) respectively.

Conclusion

It was an exciting opportunity for the researchers to conduct this study in the remote disaster-prone areas of Bangladesh. The livelihood patterns and the struggles of the people living there were simply

an eye-opener for the researchers, leading them to understand the actual vulnerability scenario in these areas. A training program for disaster risk reduction (in the form as suggested in this study) would enable them to mitigate their risks to a great extent. But any catastrophic disaster like cyclones would simply perish them if improvement measures are taken there within their affordability. Only external assistances can ensure their secured living in these areas. But much evaluation is needed about the form of these assistances (both for structural and non-structural measures) and how these can be applied in these vulnerable areas. At the same time a concerted focus should be given on the overall socioeconomic and cultural development of the people (as stated in the recommendation), without which any kind of disaster management initiative would prove to be futile in the long run.

ABBREVIATIONS

ADB	Asian Development Bank
ADAB	Association for Development Agencies in Bangladesh
ADP	Annual Development Plan
ADPC	Asian Disaster Preparedness Centre
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advance Studies
BDRCS	Bangladesh Red Crescent Society
BRAC	Bangladesh Rural Advancement Committee
BUET	Bangladesh University of Engineering and Technology
CARE	Cooperation for Assistance and Relief Everywhere
CCC	Climate Change Cell
CCDB	Christian Association for Development in Bangladesh
CDS	Coastal Development Strategy
CEGIS	Centre for Environment and Geographic Information Services
CZ	Coastal Zone
CZP	Coastal Zone Policy
CUS	Center for Urban Studies
DFID	Department for International Development
DMB	Disaster Management Bureau
EEZ	Exclusive Economic Zone
FAO	Food and Agricultural Organization
FEMA	US Federal Emergency Management Agency
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GRP	Gross Regional Product
GoB	Government of Bangladesh
GoJ	Government of Japan
HH	Head of Household
ICRD	Integrated Coastal Resources Database
ICZM	Integrated Coastal Zone Management
ICZMP	Integrated Coastal Zone Management Plan
IFRC	International Federation of Red Cross and Red Crescent Society
IMR	Infant Mortality Rate
IPCC	Intergovernmental Panel on Climate Change

ISDR	International Strategy for Disaster Reduction
MoFDM	Ministry of Food & Disaster Management
MoEF	Ministry of Environment & Forest
MoWR	Ministry of Water Resources
NGO	Non-governmental Organization
PDO	Program Development Office
PDO-ICZMP	Program Development Office for Integrated Coastal Zone Management Plan
SOB	Survey of Bangladesh
SPARRSO	Space Research and Remote Sensing Organization
UHC/THC	Upazila Health Complex / Thana Health Complex
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
WARPO	Water Resource Planning Organization
WB	World Bank

GLOSSARY

Char: Bangladesh has been formed by sedimentation and accretion of the Brahamaputra/Jamuna, Ganges/ Padma and Meghna rivers as they flow from the Himalayas to the Bay of Bengal. The chars are areas of new land formed through the continual process of erosion and deposition in the major rivers and coastal areas. The whole of the char land is unstable and prone to annual flooding since very little of the land is more than 20 meters above sea level, leading to a process in which land can become submerged and then later re-emerge (Martin and Taher, 2001).

District: An administrative unit comprising a number of thanas under the charge of a Deputy Commissioner.

Golpata: Plant grown in Sundarban, used as housing material (Nypa Fruticans)

***Katcha*:** A term locally used for earthen infrastructure or structures made with mud, bamboo and thatch.

Khas land: Indisposed government land

Mauza: Smallest revenue geographic unit having Jurisdiction List (JL) number (BBS, 2011).

Mahalla: Lowest urban geographic unit having identifiable boundaries (BBS, 2011).

***Pucca*:** Solidly built, cemented (Disaster Reduction and Development, JICA 2003).

Salish: Informal institution comprising community leaders for conflict resolution

Samaj: Village community (Traditional social coalition)

Sundarbans: Mangrove forest located in the southwest coast

***Taka*:** The monetary unit of Bangladesh (1 US $ = 82 taka).

***Tangghar*:** The term has been used (as local language) which means slum or squatter type houses.

Thana: Administrative area within metropolitan city (BBS, 2011).

Union Parishad: Local Government at the union level

Upazila: Administrative unit under a district comprising several unions (BBS, 2011).

Village: Lowest rural geographic unit either equivalent to a mauza or part of a mauza (BBS, 2011).

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CHAPTER : 1

INTRODUCTION

1.0. Introduction

Bangladesh is trapped between the Himalayas in the north, and the elongated Bay of Bengal to the south (BBS, 2004). The geographic location, land characteristics, multiplicity of rivers and the monsoon climate render Bangladesh highly vulnerable to natural hazards. The coastal morphology of Bangladesh influences the impact of natural hazards on the area. Especially in the south western area, natural hazards increase the vulnerability of the coastal dwellers and slow down the process of social and economic development (MoFDM, 2010). Natural and human induced hazards such as floods, cyclones, droughts, tidal surges, tornadoes, earthquakes, river bank erosion, landslides, infrastructure collapse, high arsenic contents of ground water, water logging, water and soil salinity, epidemic, and various forms of pollution are frequent occurrences.

Bangladesh, a densely populated country, faces these potential threats and the possible displacement of a large number of populations especially from the coastal zone. It is a challenge to accommodate millions whose future is poised to be swamped under a rising sea (Haq, et al., 1999). Many environmental and developmental problems will be exacerbated by potential climatic change. It is predicted that climate change and its consequences may devastate the habitat of millions.

Climate change is a global phenomenon, but its impact is reflected locally. Bangladesh is one of the few countries with the worst exposure to extreme climate conditions caused by global warming; due largely to worldwide excessive carbon emissions (IPCC, 2009). The unfavorable consequence of global warming and the circumstances of climate change exert tremendous pressure on the environment in Bangladesh (Haque, 1997). Climate change poses a significant threat to Bangladesh. The speculation of high temperature, variable precipitation, extreme weather events and a rise in sea level are possible threats to the country. Any adverse change of climate in the country will have a severe impact on the livelihood of the people in future. The country is hit by natural disasters in almost all walks of life. Agriculture, human settlements and other natural and social fabrics of society

are under the threat of climate change. Society and its people are generally poor and face vulnerability from global climate change. In recent years, such vulnerability seems to be increasing (Hasan, 2008).

Climate change adds a new dimension to community risk and vulnerability. Although the magnitude of these changes may appear to be small, they could substantially increase the frequency and intensity of existing climatic events (floods, droughts, cyclones, etc). Current indications are that not only will floods and cyclones become more severe; they will also start to occur outside of their 'established seasons' (MoFDM, 2010). Therefore, it is of the utmost importance that mitigation and adaptation strategies are implemented for communities in almost all sectors of development.

1. 1. Background of the Study

It is widely known that Asia and the Pacific are among the most disaster prone regions in the world. Every year, disasters of all kinds cause huge loss of lives and property in the region causing a severe set-back to the development process. The region accounts for only 30% of the world's landmass but receives disproportionately higher disaster impacts (ISDR, 2008). Among the countries of this region Bangladesh is particularly prone to natural disasters. Hazards like floods, tropical cyclones, storm surges, tornados, riverbank erosion, and earthquakes pose serious problems and cause huge damage to life and property every year. Bangladesh is located on a delta. As a result, flooding is a common phenomenon in this region. The physical characteristics of the land also funnel up storms to cyclonic intensities. Figures to death and loss of property from these cyclones are the highest in the world (Haque, 1995).

Because of the funnel (concave) coast of the Bay of Bengal, Bangladesh very often becomes the landing ground for cyclones formed in the Bay of Bengal. The Bay cyclones also move towards the eastern coast of India, towards Myanmar and occasionally into Sri Lanka. But they cause the maximum damage when they come into Bangladesh (Islam & Peterson, 2009). This is because of the low flat terrain, high density of population and poorly built houses. Most of the damage occurs in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore Islands of

Bhola, Hatiya, Sandwip, Manpura, Kutubdia, Maheshkhali, Nijhum Deep, Urir Char and other newly formed Islands (Banglapedia, 2011).

During the period from 1991 to 2000, Bangladesh suffered from 93 large-scale natural disasters that killed 0.2 million people and caused loss of properties valued at about US$59 billion in the agriculture and infrastructure sector (Climate Change Cell, 2009).

The cyclone of 1970 and subsequent flood took away the lives of over 300,000 people and damaged the equivalent of about US$42.5 billion in crops and property; the catastrophic cyclone of 1991 killed over120, 000; and the 2004 floods that inundated over 34% of the country resulted in 747 deaths. The cyclones of 1876, 1919, 1961, 1963, 1965, 1970, 1985, 1988, 1991, 1994, 1995, 1997, 2007, and 2009 were also of a severe nature (Habiba, et al., 2010). In 2007, cyclone *Sidr* made landfall on southern Bangladesh, causing over 2,000 deaths and severe damage (the cyclone toll mounted to 2,388); in 2009, cyclone *Aila* caused 330 deaths, made 1 million people homeless, and left damages that totaled US$40.7 million. In Bangladesh, an estimated 20 million people were at risk of post-disaster diseases due to Aila (Habiba, et al., 2010).

Earlier studies dealing with households are narrowly focused on famine and food security (Richard, 1986; Corbet, 1988; Rocheleau, et al., 1995; Wisner, et al., 2006). Little attention has been paid to coping with other types of natural disasters (Adams, et al., 1998). In Bangladesh, human response to disaster has mostly placed emphasis on riverine hazards; such as how different groups of people and communities respond to flooding (Rasid and Haider, 2003; Brouwer, et al., 2007); indigenous adjustment strategies to flooding (Islam, 1980; Haque and Zaman, 1889, 1993, 1994; Khandker, 2007; Paul and Routray, 2010); adjustment strategies to agricultural coping patterns (Islam,1980; Rasid and Mallik, 1995); and coping with river bank erosion (Haque and Zaman, 1989; Mamun, 1996; Hutton and Haque, 2004). A few studies have also been conducted on agricultural and non-agricultural adjustment and mitigation measures for droughts (Brammer, 1987; Paul, 1992, 1998; Rahman, 1995). In addition to literature coping with riverine hazards, literature on cyclones and induced storm surges is also available in Bangladesh. Some have focused on numerical modeling and forecasting of

cyclones and storm surges (Azam, et al., 2004; Dube, et al., 2004; Jakobsen and Azam, 2006; Islam and Peterson, 2008); adaptation measures for climate-change induced sea level rise, cyclones, flash floods and storm surges (Ali, 1999; Choudhury, et al., 2004; Karim and Mimura, 2008); cause of cyclones and storm surges, impacts and mitigation measures (Islam, 1971, 1974, 1992: Chowdhury, et al., 1993; Paul, 2009b) , while some others have identified the cause of reduced deaths and injuries in recent cyclones in Bangladesh. A few studies have also focused on cyclone warning, dissemination of forecast information and adaptation responses (Haque, 1995, 1997); cyclone disaster reduction, preparedness and management issues (Schmuck, 2003; Paul and Rahaman, 2006; Khan, 2008); and the gender dimensions of climatic hazards (Cannon, 2002).

1. 2. Statement of the Problem

The coastal zone of Bangladesh hosts over 35 million people who are exposed to cyclones, storm surges, rough seas, salinity intrusion and permanent inundation due to a possible rise in sea levels. There are 72 offshore islands with an area of 4,200 square km where over 3 million people are extremely vulnerable. About 18 percent of households in the sundarbans impact zone are dependent on sundarban resources (shrimp fry collectors, honey collectors, golpata collectors, shell/crab collectors and medical plant collectors) and are vulnerable to the weather extremes and salinity intrusion. Around 0.5 million households' (family members 2.7 million) primary income source is fishing and they lose working days because of rough weather in the sea (MoFDM, 2010).

Different natural disasters, including the result of extreme climatic events in terms of intensity and frequency of cyclones, floods and droughts, have increased globally in recent years (IPCC, 2001a, 2001b; Khan and Rahaman, 2007). A further increase in global temperature might lead to an increasing trend of tropical cyclones with the ability to cause significant damage in the twenty-first century (Emanuel, 2005). Cyclones and induced surges are considered the world's foremost natural hazards and even surpass earthquakes (Finkl, 1994; Dube, et al., 1997; Zerger, et al., 2002; Benavente, et al., 2006). Unfortunately, the Bangladesh coast is well-known for severe cyclones and induced

surges (Blakie, et al., 1994; Ali, 1999; Paul, 2009a). At least one major tropical cyclone strikes the Bangladesh coast each year (Mooley, 1980; Haque, 1997) with powerful tidal surges that impact hundreds of thousands of lives and make it more unsafe than many other regions of the world (Murty and Neralla, 1992).

The impact of climate change is visible in Bangladesh in the form of temperature extremes, erratic rainfall, and an increased number of intensified floods, cyclones, droughts, as well as the prevalence of rough weather in the Bay (IPCC, 2009). The number of cyclones reaching the coast and storm surges increased substantially. For example, super cyclone *Sidr* hit on 15 November, 2007; Cyclone *Nargis* on 2 May, 2008 hit Myanmar; Cyclone *Rashmi* occurred on 27 October, 2008; and Cyclone *Aila* hit Bangladesh on 26 May, 2009. The number of days with cautionary signal no. 3 or more increased substantially, reducing the number of fishing days for coastal fishers (MoFDM, 2010).

Cyclones and storm surges are serious hazards along the coast of Bangladesh (Shaw, et al., 2009) [See the chronology of major cyclonic storm, 3. 4]. Cyclones may be more frequent in the Atlantic or Pacific, but the Bay of Bengal's shallow coastal waters, high tides and densely populated low-lying areas make surges particularly deadly here (Dube, 2008). This is particularly true for countries affected by tropical cyclones and storm surges. Although climate changes will not necessary lead to more cyclones forming, the evidence is now quite strong that higher sea surface temperatures will increase their intensity (Saleemul, 2008). Given the situation above, one of the most serious challenges for Bangladeshis is to devise a suitable strategy for adaptation to climate change, particularly in the coastal region, although such challenges are formidable. The adaptation programme the Government of Bangladesh has envisaged covers some sectoral and multisectoral areas of interventions (GoB, 2008). Among sectoral issues, policy mainstreaming in agriculture, health, industry, fisheries etc, was covered. In the multi-sectoral areas of intervention, enhancing capacity building and the construction of flood shelters were emphasized.

With the effects of natural hazards rising in terms of loss of life and injuries in poorer nations (ISDR, 2002; World Bank, 2005; CRED, 2007), institutional disaster reduction approaches (ISDR, 2004; UNDP, 2004; DFID, 2005) and approaches adaptable to individual social and livelihood experiences are required. Vulnerability factors have been central to the development of disaster research (Khan, 1974; Hewitt, 1997; Twigg and Bhatt, 1998; Wisner, et al., 2006; IFRC, 2006). However, despite good progress in cyclone preparedness, exemplified by the existing comprehensive disaster management policies of the Government of Bangladesh, localized vulnerability factors in cyclone hazards arguably remain only partly considered (Alam, et al., 2003).

Almost every year small to medium range cyclones form in the Bay of Bengal and hit the coast. This causes considerable damage to people and their livelihoods. But periodically the mightiest cyclones associated with high tidal surges engulf the entire coastline and even sometimes approach further north. Thus, not only property loss but also the death toll goes beyond imagination. Given the periodic catastrophes affecting the Bay of Bengal coast, there is a serious need for an effective disaster management plan to minimize the loss of lives and property. Unfortunately, the present cyclone warning and signal system is only not effective enough, but sometimes also confusing (Hasan S, 2000). We also do not have any comprehensive disaster management strategy. Some of the local NGOs in collaboration with government agencies undertake certain activities, but these too have been limited to mostly relief and rehabilitation. Cyclone preparedness plans are hardly found among these agencies (Hasan MT, 2010). While it is not possible to prevent natural disasters, protective measures to reduce the vagaries of disasters can be evolved.

Enhancing local level adaptation to cyclonic hazards through established coping is assumed to be crucial for resilience to any suspected increase in cyclonic hazards. Endogenous cyclone response experiences could be more central to cyclone interventions in Bangladesh. The broad analysis of the study is consistent with other findings concerning vulnerability and disaster response in the country (Haque and Zaman, 1994; Hutton and Haque, 2004, Edgeworth and Collins, 2006). The findings of

this research will complement disaster mitigation studies in Bangladesh with further details and thoughts proved based on the realities of how people survive in the cyclonic coastal belt.

Due to the unusual climatic behavior in recent years, people in coastal areas face serious vulnerability especially in the context of human settlements and consequently move out to the cities to combat the situation. These people need to have innovative strategies for survival. Like many other newly devised coping strategies, reducing vulnerabilities is important and innovation & adaptation are necessary to save communities from their vulnerability to climate change.

Coastal areas are threatened under climate change because of factors related to the vulnerability of society and the sensitivity of the environment. Protection, reducing vulnerability and adaptation may mitigate the adverse consequences. This research reviews and assesses the options for reducing vulnerability and adaptation to climate change. The study concludes that adaptation to climate change is vital and should be promoted through active government policy.

It is not enough to simply be prepared for a disaster. Countries likely to face future cyclones need a longer-term framework that strengthens the local people's capacity to adapt to climate change, particularly for weather related disasters such as cyclones and storm surges. Thus, it is necessary to undertake yet another study to analyze the community's vulnerability vis-à-vis the climate scenario in the coastal areas of Bangladesh.

1. 3. Objectives of the Study and Research Questions

The aim of the present research is to find out the causes and implications of climate change in relation to communities' vulnerability in Bangladesh. However, the specific objectives of the study are as follows:

1. To trace the causes of vulnerabilities that emanate from natural hazards
2. To assess the ability of a community to address and introduce measures to reduce its vulnerabilities and adapt to climate change
3. To deduce various options for necessary action related to adaptation and mitigation measures

Commonly location alone generally defines vulnerability of a place toward hazards (Islam, 2008). However, this study investigates how vulnerability is exhibited by the community, or how vulnerability is defined from their own cultural context using their perceptions of cyclones. The major research questions are:

- Will decreasing the sensitivity and increasing the adaptability reduce the vulnerability?

Similarly secondary research questions are:

- What factors influence the reduction of vulnerability or promote hazard adjustment by households/individuals, and the community?
- What patterns of adjustments do the people employ to lessen their vulnerability toward the cyclone hazards?
- How do the people consider vulnerability can be reduced and the community can be resilient or safe?
- What indigenous values and wisdom promote or reversely hinder community efforts for reducing vulnerability?

1. 4. Hypotheses/ Assumptions

A hypothesis is a statement or proposition that can be refuted or supported by empirical data (Islam, 2011). Hypothetical statements assert possible answers to a research question.

To meet the objectives of the study, several hypotheses were formulated to address the research questions. These are as follows:

- First, whether the amount of income and the sources of income or the livelihood activities of the population and its level of education can indicate the capacity of the people to afford physical mitigation and their capability to recover from disaster.
- Second, whether the age and sex of household members; households with more children, more elderly members or more women will experience more difficulties during evacuation and will require greater resources like food and water after a disaster.

- Third, whether the frequency of experiencing hazards may lead to a *taken for granted attitude* toward hazards.
- Fourth, whether the hazard adjustments vary throughout the coastal areas in Bangladesh.
- Fifth, whether the residents make use of indigenous or local knowledge to foretell the impending cyclone, and the use of local or indigenous knowledge is functional.
- Sixth, to what extent the government early warning system and to what extent social networking (human capital) is effective.

1. 5. Rationale of the Study

In response to devastating and unprecedented cyclones and tidal surges in the coastal areas at various times including the cyclones *Gorky*, *Sidr*, *Aila*, *Resmi*, etc. there is an urgent need for an environmental, economic and perception study in order to assess the impact and to understand the people's coping strategies. The causes of disaster are natural and beyond the control of the people; however, appropriate ways and means in preparedness, coping and mitigating strategies need to be adapted and be sustained in the long term, thus, understanding the nature and magnitude of risks and vulnerabilities of the people in the covered areas are crucial elements in Disaster Risk Reduction (DRR) and Disaster Risk Management (DRM).

In view of the low land area-population ratio of this country, people migrate towards the coastal areas where land is comparatively cheap and situations are more favorable to make a living. The lack of proper study, basic knowledge, the people's limited means and the gaps in their perceptions of housing problems magnify the distress caused to them when a cyclone or tidal surge has destroyed their livelihoods, resources base and infrastructure. The lack of appropriate knowledge in coping strategies is a fundamental hurdle towards mitigating the damages due to cyclones and tidal surges in the coastal areas. In this case, this study will help policy makers take immediate measures through integrated planning and the building of awareness among the people in the coastal areas of Bangladesh.

The rationale for the study lies in the fact that an appropriate and sustainable resilience system in the coastal area can combat the problems related to climate change. Secondly, it may reduce urban-ward migration. Thirdly, the people in coastal areas will have more confidence to live in coastal areas given the interfaces of vulnerability adaptation to new styled innovation which suits the climate change conditions. Fourthly, the vulnerable populations and sectors of the society living in these hazard-prone areas have inherent ways, means, and traditional practices to cope with and mitigate the aftermath of disasters, these are not enough without a coordinated and holistic approach from key stakeholders (government, private, civil society, NGO, etc.). This study should bring about positive influence with the support of these stakeholders. Fifthly, despite the presence of local governments, humanitarian organizations and NGOs in coastal areas, residents in hazard-prone areas remain highly vulnerable due to income, household size, etc. and are exposed to inherent hazards. This study will help policy makers create initiatives for strategic, responsive and innovative interventions to safeguard the human, economic, social and physical capital of the affected population. Sixthly, the effects of global warming and climate change continue to challenge on-going efforts on Disaster Risk Reduction (DRR) in these coastal areas, and the country in general, thus, there is a need for continuous program innovations to adapt to the changing times.

The study will also provide an opportunity for the researchers to conduct further studies in the disaster-prone areas of Bangladesh.

1. 6. In Addenda

The theory of social capital is of great importance in this research. Social capital is a sociological concept, which refers to connections within and between social networks.

1. 6. 1. Definition of Social Capital

During the last decade or so, social capital has become one of the most popular concepts in the social sciences. Originating in the work of French sociologist Emile Durkheim in the 19th century, its application has expanded to multiple fields. Social capital is often seen as the third form of capital, the

first two being financial and human. Portes (1998) defines economic capital as "people's bank accounts", human capital as "inside their heads", and social capital as "the structure of their relationships".

Lyda Judson Hanifan's (1916) article regarding local support for rural schools is one of the first occurrences of the term "social capital" in reference to social cohesion and personal investment in the community. In defining the concept, Hanifan (1916) contrasts social capital with material goods by defining it thus:

"I do not refer to real estate, or to personal property or to cold cash, but rather to that in life which tends to make these tangible substances count for most in the daily lives of people, namely, goodwill, fellowship, mutual sympathy and social intercourse among a group of individuals and families who make up a social unit...If he/she may come into contact with his neighbor, and they with other neighbors, there will be an accumulation of social capital, which may immediately satisfy his social needs and which may bear a potentially sufficient to the substantial improvement of living conditions in the whole community. The community as a whole will benefit by the cooperation of all its parts, while the individual will find in his associations the advantages of the help, the sympathy, and the fellowship of his neighbors (Hanifan, pp. 130-131)."

Bourdieu gave the first systematic contemporary analysis of social capital. He defined social capital as: "...the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition" (Bourdieu, 1985, p. 248).

Following Bourdieu, Coleman, in his seminal work, defined social capital through its functions:

"Social capital is defined by its function. It is... a variety of entities with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors – whether persons or corporate actors – within the structure (Coleman, 1988, p. 98)."

Both Bourdieu and Coleman mention social network or structure as the foundation of social capital. Bourdieu puts more emphasis on formal networks, whereas Coleman's ideas of social capital emphasize informal networks.

Putnam added the importance of trust and norms to social networks. He stated, "Social capital...refers to features of social organization, such as trust, norms, and networks that can improve the efficiency of society" (Putnam, Leonardi, & Nanetti, 1993).

In recent years more and more researchers define social capital as consisting of those resources available through social networks (Lin, 2001; Portes, 1998).

Social capital is a broad term that encompasses the 'norms and networks facilitating collective actions for mutual benefits' (Woolcock, 1998, p 155). This broad definition of the term makes it susceptible to multiple interpretations and usage which span multiple theoretical traditions (Portes, 1998). At one end social capital can be seen as a notion that is based on the premise that social relations have potential to facilitate the accrual of economic or non-economic benefits to the individuals (White, 2001) and on the other end social capital can be seen to reside in the relations and not in the individuals themselves (Coleman, 1988).

Clearly, the definition of social capital varies, but researchers tend to separate group-level structure social capital that emphasizes resources available through social relations and structures, such as interpersonal trust, norms and values, civic engagement, rule of law, and governance; and individual-level social support that flows in through social networks. This variation in a definition leads to methodological differences in measuring social capital (Grootaert & Van Bastelaer, 2002; Kawachi & Berkman, 2000).

Social capital is context dependent and takes many different interrelated forms, including obligations (within a group), trust, intergenerational closure, norms, and sanctions with underlying assumption that the relationships between individuals are durable and subjectively felt (Bourdieu, 1983, p 249). The relationships themselves form the complex web of interactions and communications (Fukuyama, 1995; Lin, 2001; Putnam, 1993; white, 2001).

There are many possible representations of social capital. Broadly, social capital can be seen in terms of five dimensions (Bourdieu, 1983; Coleman, 1988).

- First, networks: lateral associations that vary in density and size, and occur among both individuals and groups.

- Second, reciprocity: expectation that in short or long term kindness and services will be returned.
- Third, trust: willingness to take initiatives (or risk) in a social context based on assumption that others will respond as expected.
- Fourth, social norms: the unwritten shared values that direct behavior and interaction.
- Fifth, the personal & collective efficacy and the active & willing engagement of citizen participation within a community.

These five dimensions manifest themselves in various combinations and shape interactions amongst the members of a group, organization, community, society or network and can be studied through various perspectives.

From a methodological perspective, researchers define three types of social capital:

- ✧ Bonding social capital: ties people who are similar in terms of their demographic characteristics.
- ✧ Bridging social capital: ties people who do not share same demographic characteristics.
- ✧ Linking social capital: ties people in positions of authority (Grootaert, Narayan, Jones, & Woolcock, 2004).

All three functional types of social capital are important for the socioeconomic well-being and health of individuals and groups. One type might offer benefits that are not available through other types. Linking social capital may offer more opportunities to access social services, whereas bonding social capital facilitates the adoption of healthy behavior, and bridging social capital facilitates information exchange.

It is worthwhile mentioning that social capital may also have a negative impact on those both within and outside a community:

- ✧ Adverse effects on outsiders: excluding outsiders and maintaining inequalities between groups (Waldinger, 1995).

- ✧ Adverse effects on insiders: reducing individual privacy and autonomy, making it hard to get out of "bad" groups such as drug dealers, gangs, and reducing the inflow of new ideas (Productivity Commision of Australia, 2004; Bourgois, 1995; Portes, 1998).

These negative effects of social capital may severely affect households who, by virtue of escaping harsh climatic conditions, are forced to move to different countries: help in new places may not be available. For this reason, unless they face severe hazards, households do not tend to move to places where they do not have any social ties and support.

1. 6. 2. Social Capital and Economy

Links between social capital and development have been examined in a range of contexts. Higher levels of social capital appear to be beneficial to economic development, effective political institutions, and the reduction of political problems (Fukuyama, 1995; Putnam, 1995). Though, most of the researches on social capital focus on the benefits of social capital. While Putnam`s focus is on the benefit accruing to the community, Coleman and Bourdieu provide conceptualization at individual level. They believe that social capital exists between individuals and can be studied at the individual level. Social capital resides in the relations among the nodes and 'just as physical and human capitals facilitate productive activity, social capital does as well' (Coleman, 1988; White, 2002). It exists between individuals and by extension can be accumulated by the individuals. Such a view of social capital rests on the premise that 'my connections can help me' (Cross and Cummings, 2004; White, 2002, p 260), it is all about establishing relationships purposefully and employing them to generate intangible and tangible benefits in short and long terms. The benefits could be social, psychological, emotional and economical (Lin, 2001). The following are examples of researches conducted in both developing and developed countries that have explored the relationship between social capital and socioeconomic development:

- ✧ Guiso, et al. (2000) found that in Italy, in areas with high levels of social trust, households invested less in cash and more in stock, used more checks, had higher access to formal credits.

Firms also benefited from higher social trust: they had more access to credits and were more likely to have multiple shareholders (Guiso, Sapienza, & Zingales, 2000).

- ✧ Social capital measures (e.g. family network) associated with higher secondary school graduation rates, college enrollment, socioeconomic status, and avoidance of criminal activities among children of teenage mothers in the U. S. (Furstenberg & Hughes, 1995).
- ✧ Higher social capital was shown to have a positive impact on watershed conversation and in cooperative development activities in Rajasthan, India (Krishna & Uphoff, 1999).
- ✧ More trust, reciprocity, and sharing in neighborhoods of Dhaka, Bangladesh predicted a higher likelihood of a neighborhood having a voluntary solid waste management system (Pargal, Huq, & Gilligan, 1999).
- ✧ Social capital measured by the number of memberships in associations, diversity of memberships, the number of meetings, and cash and time contribution to associations were positively related to asset accumulation and access to credits in Indonesia (Grootaert, 2000).

The role of social capital in the economic well-being of households may be even greater in developing countries where almost all of the transactions between individuals are performed based on individual trust and trust in informal institutions. Formal institutions (e.g. courts) that typically regulate transactions may not function properly or may be too expensive (Durlauf & Fafchamps, 2004).

Researchers have identified the following mechanisms through which social capital facilitates economic development:

- ✧ Social capital facilitates transactions among individuals or groups. Common rules and trust allow people to interact efficiently.
- ✧ Social capital makes information and knowledge exchange more efficient. Large networks ensure a greater flow of information, whether it is about hazards, market prices, social services, or government aid.

- ✧ Participation in social networks and the development of trust make collective action easier. Developmental programs often have to rely on collective action.
- ✧ High levels of social control puts pressure on individuals in a network and force them to engage in positive behavior that is mutually beneficial (Grootaert & Van Bastelaer, 2002).
- ✧ Social capital increases access to social services (Productivity Commission of Australia, 2004; Kawachi, Kennedy, & Glass, 1999).

These mechanisms do not relate only to economic development and household economic welfare. They are relevant to the association of social capital to neighborhood relations as well. In addition, socioeconomic status may become an intermediary link in the relationships of social capital to the neighborhood.

1. 6. 3. Social Capital and Community Based Disaster Management (CBDM)

Social capital has two significant perspectives: 'bonding' social capital that literally bonds each member with strong ties in a particular group or society, and 'bridging' social capital, which is cross-cutting ties beyond that group. Bonding social capital leads to reciprocity and people helping each other, but on the other hand may also create negative results or impacts as a result of exclusion from other groups. Bridging social capital in contrast, is the voluntary cross-cutting of networks, associations, and related norms based in everyday social interactions leading to the collective good of citizens. Although both are important aspects of social capital, bridging social capital is said to create synergies for better outcomes (Lin, 2001; Phillips, 2002).

Disaster management, especially CBDM, has been a target of social capital analysis in generating community awareness for better mitigation and reduction of disaster risks (Nakagawa, 2009). In Japan, social capital is often mentioned in official government reports and their websites indicating that it leads to better community resilience against disaster or better community development. But in many cases their use of the term is quite broad and general, and often lacks concrete explanations

regarding what kind of social capital, and its actual application in different disaster management cycles (Nakagawa & Shaw, 2004).

Table: 1. 1). Types of social capital

Disaster Response	**Disaster Recovery/ Rehabilitation**	**Disaster Reconstruction/ Mitigation**	**Disaster Mitigation / Preparedness**
Trust: strategic	Trust: strategic	Trust: strategic and generalized	Trust: strategic and generalized
Norms: reciprocity	Norms: reciprocity & public or civic-minded	Norms: public or civic-minded	Norms: public or civic-minded
Network: within community	Network: within and outside community	Network: within and outside community	Network: within and outside community

It is clear from the table that each component of social capital (trust, norms and networks) has two dimensions. One is to make the group/community more cohesive (bonding) and the other is to connect to entities and resources outside of the group/community (bridging). 'Strategic' trust or knowledge based trust is a trust based on experiences, and 'generalized' or 'moralistic' trust is a trust based on values or morals (Uslander, 2002). Social norms are also separately noted as reciprocity that is generally characterized by give and take and civic-mindedness, which is more altruistic. A network is distinguished as being inward and outward. The above two differences in social capital components are not to describe it as dichotomous; rather, these are a continuum. As disaster management cycles move from response to reconstruction and mitigation, more bridging social capital would be required (Nakagawa, 2009).

1. 7. Theoretical Framework in This Study

Social problems and issues are very complex and interrelated, for which it is not always possible to undertake comprehensive and satisfactory analysis of an observed phenomenon. In order to explain, interpret, prove or analyze any process or phenomenon, social scientists usually develop an analytical

framework by combining some established theories into an integrated framework of analysis (Islam, 2011).

1. 7. 1. Linking Vulnerability Paradigm & Model with Theoretical Framework

The Bogardi, Birkmann & Cordona (BBC) framework is used in this research to structure the vulnerability assessment of different social groups to potential hazards at the selected areas using questionnaires as well as the data gathering tool. The approach that was developed and tested in this study is aimed to explore various characteristics of vulnerability of different social groups, basic infrastructure services, economic sectors and environmental services to cyclones, storm surges, and coastal hazards. The assessment was based on the household questionnaires as the data gathering tool. In addition, this study also assessed the critical infrastructures which are also vulnerable to cyclone & storm surge hazards.

Vulnerability consists of three components: natural hazards, fragility factors and the adaptive capacities of individuals and households. All three components are shaped by global processes. Global warming, due to the increased industrialization and higher emission of greenhouse gases, increases the number of cyclones. Structural adjustment programs taking place in developing countries increase the number of poor people and widen the gap between the rich and the poor. Thus, political ecology affects the processes that occur in the physical environment and social forces that define the vulnerability to natural events. The outcome of a natural hazard, measured by socioeconomic loss and people's capacity, is dependent on the fragility and adaptability of individuals, households or regions. Lower fragility and higher adaptive capacity buffer the negative impacts of hazard events. Very young or very old people, women, the poor, and those who do not have adequate skills are most fragile to natural hazards. Individual households with greater social capital, better management skills and more accumulation of resources are less likely to suffer from short and long term consequences of natural hazards.

Fragility and adaptability are also related. Enhancing adaptive capacity will result in lower fragility and lower fragility also increases adaptive capacity. Better socioeconomic status and health conditions of individuals and households will in turn lower the fragility to natural hazards and increase the adaptive capacities.

1. 7. 2. Linking Theory of Social Capital with Theoretical Framework

Societies are unique in their social relationship, thus also in their social capital. A dimension of social capital that is important in one society may not be relevant in another. This is certainly true for rural coastal communities in Bangladesh. Formal organizations are not typically important in their everyday lives, but local norms and values, and trust can have significant influence in their lives. Yet, access to formal organizations- credit, insurance, etc. may be important during times of stress. In addition, informal networks and resources flowing through these networks may be very important, especially for the poor.

The main argument is that each stage of a disaster management cycle needs a different kind of social capital. The response period requires bonding social capital. However, when the disaster management cycle moves from recovery to reconstruction, then need for bridging social capital increases to fulfill necessary pre conditions. During the response period, the priority issue is to reduce human loss. For this, strong ties in the community (in other words, bonding social capital) is necessary, to ensure timely and proper response. However, in the reconstruction and mitigation stages, bridging social capital would be much more necessary, as external agencies assist to rebuild the community. It also requires a high level of subsidiary in decision making to ensure that the community receives full benefits from the assistance provided. Such capacity would be possible only with a strong bridging of social capital and a democratic environment.

Therefore, it is assumed that social networks affect household preparedness. Each of three types of networks (family networks, neighborhood-based networks, and networks based on interactions

through community-based services) influences household preparedness behavior. This effect, however, is not universal because it varies across the preparedness outcome. Government aid agencies and private non-profit international donor organizations also occasionally fund specific community-based preparedness programs. These programs for the most part seek to build the capacity of government agencies and of local civil society organizations but they may also entail awareness campaigns.

Finally, household characteristics and community context variables including attention to media (broadcast and print), age, gender, ethnicity, education, the occupation category of the breadwinner, income, the presence of school age children in the household, religion, location (in relation to disaster exposure), previous disaster experience, home ownership and length of residence in the community have all been related to preparedness in previous studies (see, for instance, Drabek, 1986; Howell, 2003; Tierney et al., 2001). These factors shape households' access and receptivity to preparedness information from various sources and how information is perceived, interpreted and remembered.

Moreover, the importance of social capital and support becomes greater for coastal communities. Disaster risk reduction depends on reliable information flow about weather, market, and government policy, and assurance of resources being available through connection with local government. All of these can be secured only through expanding their social ties and establishing a flow of mutual support through these networks. Reciprocity and hospitality are two features that are common among coastal communities. These features facilitate broader social ties and support that are crucial to the successful reducing of vulnerabilities. An example of social capital could be the voluntary participation of members over lunch break to discuss various social/ organizational aspects which benefit all the participants.

Thus, all elements of vulnerability and the outcome are interrelated with each other, forming a circle in the theoretical framework (Figure 1.1).

Theoretical framework

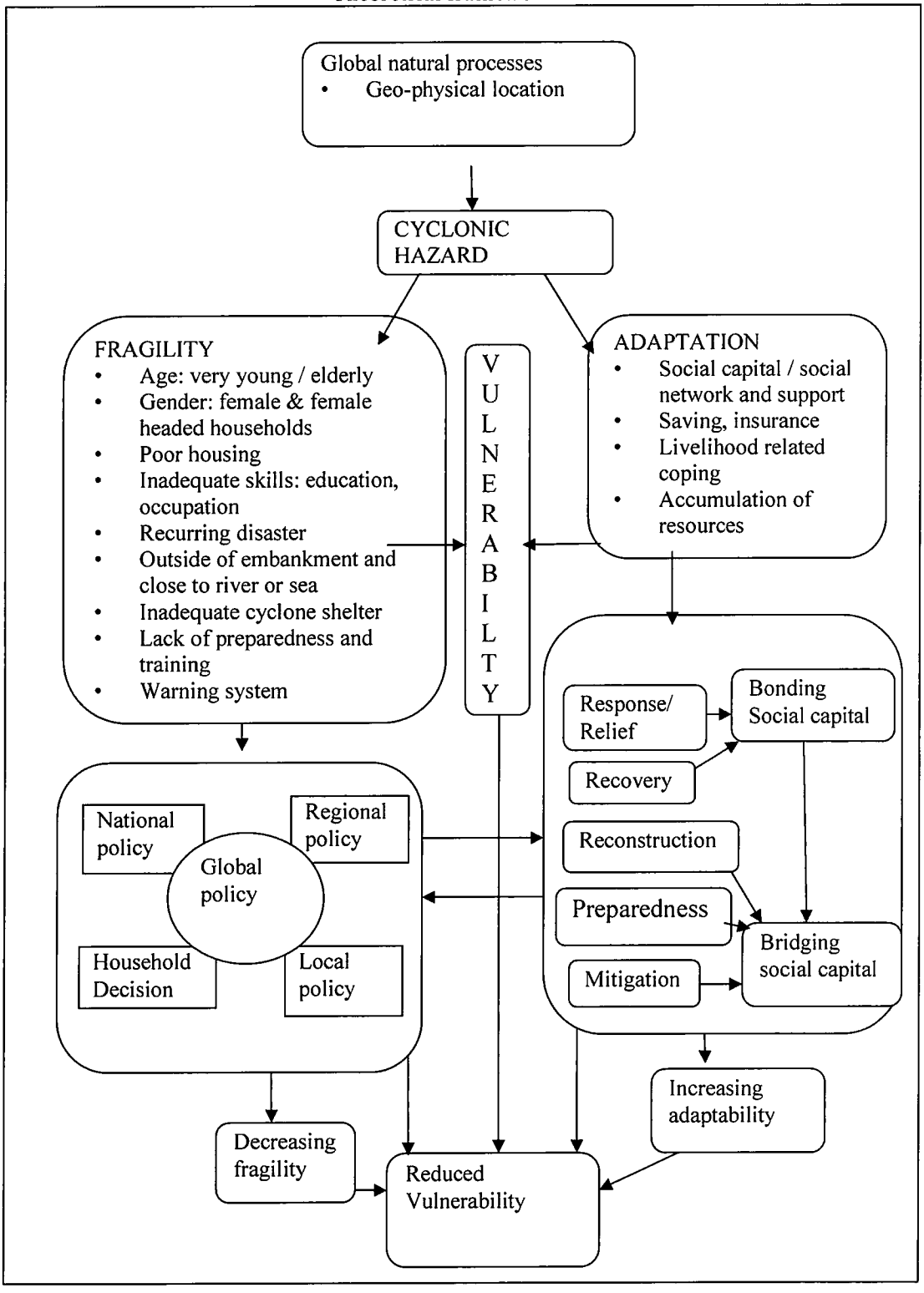


Figure: 1. 1). Theoretical framework

1.8.Strengthen of the Research

It was an exciting opportunity for the researcher to conduct this study in the remote disaster-prone coastal areas of Bangladesh. Because the study areas were isolated and people were more vulnerable to cyclones & storm surges, it was incredibly challenging to gathering primary data. It was an experience unlike any I have ever had before. The livelihood patterns and the struggles of the people living there was simply an eye-opener for the researcher, leading to understand the actual vulnerability scenario in these areas.

Based on the perception of major hazard events, the most striking feature is that hazard may be conceived as composed of a series of linked stages beginning with human needs and ending in adverse consequences. In view of reducing vulnerabilities to natural hazards, the study explored different pre-disaster, during disaster and post-disaster coping measures, and their effectiveness to mitigate the impacts of cyclones and induced surges on coastal Bangladesh. An attempt has been made to explain how different variables such as age, gender, income, education, occupation, and other exogenous factors influence the adoption of coping measures.

In this study, the dependent variable vulnerability is defined and measured by various indicators, which incorporate income, expenditure, education, occupation, capability, social network and support, saving, insurance, evacuation patterns, intensity and frequency of cyclone, warning system, preparedness and coping mechanisms. Income includes monthly income of the head of the household. Related to income, the concept of assets is also introduced and incorporates value of the total assets of the household. Expenditure refers to the monthly household expenditure on basic needs. Capability is measured by health status, education level, access to safe water and access to sanitation. On the other hand, several independent variables were used as socio-demographic correlates of vulnerability, such as geographic location, gender, age, household size and ownership.

CHAPTER : 2

REVIEW OF LITERATURE ON REDUCING VULNERABILITY TO NATURAL HAZARDS

2.0. REVIEW OF LITERATURE ON REDUCING VULNERABILITIES TO NATURAL HAZARDS

2. 1. Introduction

Disasters are inevitable. It is estimated that between 1980 and 2000, approximately 75 percent of the world's population lived in areas affected by an earthquake, flood, tropical cyclone, or drought (UNDP, 2004). Per day 184 deaths are recorded in different parts of the world as a result of such disasters (UNDP, 2004). With an average of more than one disaster each day, over 200 million people are affected by disasters each year (IPCC, 2007a).

However, it is frequently asserted that vulnerability to natural hazards is directly related to a community's level of development. Where communities are socially and economically marginalized, vulnerability is greater and effective community-based disaster management is limited. Conversely, where a community is characterized by social and economic development, it is expected that vulnerability is minimized and the community's capacity to manage the event is greater (Bolin and Stanford, 1998; Blaikie, et al., 1994). It has been well accepted that disaster occurs and becomes a disruptive hazard when it interacts with various forms of vulnerability (Hewitt, 1983). Vulnerability and natural hazards are interrelated. There cannot be a disaster if there are hazards but vulnerability is nil or vice versa. Vulnerability is the potential of victims, casualties, damages or destructions caused by a hazard whereas risk is the probability of loss for a predictable magnitude of hazard (Wisner, et al., 2006).

It is important to consider that the social production of vulnerability has the same degree as hazard when evaluating disaster risk. Vulnerability is the dependent component of disaster that is influenced by aspects of degree of risk, susceptibility, resistance and resilience. These aspects may increase the probability of disaster and the potential for human or material loss. Social processes generate unequal exposure to risk by making some people more prone to disasters than others, and these inequities are fundamentally a function of the power relations operative in every society (Wisner, et al., 2006).

The review of literature has been presented here in several groups as mentioned below:

2. 2. Hazard Paradigm

A hazard refers to a potential harm which threatens our social, economic, and natural capital on a community, region, or country scale. A hazard has the potential to cause fatalities, injuries, property damage, infrastructure or agricultural loss, damage to the environment, interruption of business, or other types of harm (Pine, 2009). A hazard may be measured by its physical characteristics, likelihood, or consequence. For example, many coastal communities experience flooding. Water from heavy rains, levee breaches, or a dam break would be the source of a hazard. Cutter (2001) notes that hazards evolve from the interaction between natural, human, and technological systems, but are also characterized by the areas of their origin. For example, the hazard may arise from a hurricane, but flooding may be magnified not only from excessive rainfall but also by long term non-sustainable agriculture or forest practice.

FEMA (1997) describes hazard as "event or physical conditions that have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural losses, damage to the environment, interruption of business, or other types of harm or loss".

UN/ISDR (2004) defines hazard as to signify a potentially damaging physical event, phenomenon and /or human activity which may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can be single, sequential or combined in their origin and effects. Garatwa and Bollin (2002) distinguish between truly natural hazards (such as earthquakes) and socio-natural hazards (such as forest fires, floods and landslides), which are triggered or aggravated by a combination of extreme natural events and human intervention in nature.

2.2. 1. Hazard Classification

Hazards are often grouped into three main classes according to their causes: natural, technological and anthropogenic or social disasters (Table: 2. 1). As mentioned above and pointed out in the definition,

hazards may have interrelated causes and the allocation of a hazard to one class is often difficult. For example, a landslide might be triggered by heavy rainfall but its severity might be determined by deforestation. Often one hazard is triggered by another. For example, volcanoes may cause movements of rock masses, which in turn cause tsunamis. Or an earthquake may provoke the structure of buildings and infrastructures such as dams, which may result in other hazards such as floods. Additionally, it is highly likely that in the near future the number of hazards triggered by disputes about access to limited natural resources such as water will increase significantly.

Table: 2. 1). Classification of groups and types of hazards

Hazard group	Hazard type	Examples
Natural	Geological	Earthquake, volcanic eruption, landslide, subsidence
Potentially socio-natural	Meteorological	Cyclone, lighting and fire, tornado, drought, avalanche, hail-storm, cold spell
	Oceanographic	Tsunami, storm surge
	Hydrological	Flood, flashflood
	Biological	Epidemic, crop blight, insect infestation
Technological	Explosion	Nuclear explosion
	Release of toxic materials	Chemical emission
	Severe contamination	
	Structural collapse	Urban fire
	Transportation accident	Air, rail and road accident
	Manufacturing accident	Industrial accident
Social / anthropogenic hazards	Crowd-related	Riot, crowd crush
	Terrorist activity	Bombing, shooting, hijacking
	Political conflict	International and civil war, revolution and coup

Source: Birkmann J, 2006; Sing RB, 2006.

2.3. Natural Disasters

Disasters are measured in terms of lives lost, injuries sustained, or property damaged and must be

distinguished from routine emergency events that can result in property damage or fatalities. The United Nations (1992) defines a disaster as, "a serious disruption of the functioning of society, causing widespread human, material, or environmental losses which exceed the ability of affected society to cope using only its own resources." Pearce (2000) defines disaster as, "a non routine event that exceeds the capacity of the affected area to respond to it in such a way as to save lives; to preserve property; and to maintain the social, ecological, economic, and political stability of the affected region".

"Disasters are the outcome of hazard and vulnerability coinciding", whereas hazards, in this context, are naturally occurring phenomena with the potential to harm individuals or human systems and vulnerabilities are exposures to risk with the inability to avoid or absorb potential harm (Pelling, 2003). A disaster is the confluence of human vulnerabilities and natural hazards. Natural hazards have the potential to harm some people and to have negligible, mixed, or even positive effects on others. Such uncertainty in the outcome is linked to varying degrees of vulnerabilities between various factors, including social, economic, and political processes, inequalities, demographics, protective mechanisms, and land use (Blaikie, et al, 1994).

Natural disasters are not purely natural, because natural processes are increasingly anthropogenic. Disasters are natural and human caused events that have an adverse impact on a community, region, or nation (Pine, 2009). Human contributions to global warming through greenhouse gas emissions have increased the incidence and severity of floods and hurricanes (Picou and Marshall, 2007). An event such as Hurricane Katrina, which decimated New Orleans, was caused and made worse by an assortment of natural and unnatural processes involving loss of wetlands, levee breaches, topography, poverty, poor government planning and response, as well as global warming.

2.4. Risk Paradigm

The risk of disaster is typically described in terms of the probabilities of events occurring within a specified period of time, e.g., five, ten, or twenty years, a specific magnitude or intensity (or higher),

or a range such as low, medium, or high risk. For example, the risk of floods is commonly described by FEMA in terms of 100 and 500 year floods, indicating the average frequency of major flooding over those periods of time and the maximum area that has been inundated each time. Risk has the common meaning of danger (involuntary exposure to harm), peril (voluntary exposure to harm), venture (a business enterprise), and opportunity (positive connotation, it is worth attempting something if there is potential for gain). In business context, it refers to probability considerations, but is primarily concerned with uncertainty.

Table: 2. 2). Risk elements in different disasters

Hazard	**What is at risk**
Flood	Everything located in flood plain: crops, livestock, machinery, equipment infrastructure, weak buildings, their contents, people, and local economy.
Earthquake	Weak buildings, their occupants and contents, machinery, equipment, infrastructure.
Tsunami/ Cyclone	Anything close to coastal areas including, crops, livestock, people, combustible roofs, water supply.
Landslides	Anything located on or at the base of steep slopes or cliff tops, roads and infrastructure, buildings on shallow foundations.
Drought	Life and health of those involved in the drought-prone areas: livestock, crops, local economy.

Source: Sing RB, 2006; Pine JC, 2009.

Risk depends on three components: hazard, exposure and vulnerability, as visualized by Crichton (1999) in the "Risk Triangle". This concept has been widely applied to research on natural disasters (e. g. Peduzzi, et al., 2002; Granger, 2003). Risk is considered as the probability of harmful consequence or expected losses resulting from exposure to a given hazard (a given element of danger or peril), over a specific time period (Coburn, et al., 1994b; UN/ISDR, 2004). The mathematical definition of risk is the probability of harmful consequences, or expected loss resulting from interaction between hazard and vulnerable/ capable conditions, and is expressed by the equation:

Risk = Hazard * Vulnerability - Capacity

Risk is an objective hazard that exists and can be measured independently of social and cultural processes. Risk is an integral part of life. It combines the characters meaning 'opportunities' and

'danger' to imply that uncertainty always involves some balance between profit and loss. Since risk cannot be completely eliminated the only option is to manage it. There are three stages of risk assessment:

1) Identification: identifying what risks are possible

2) Estimation: probability of occurrence and estimation of possible damage

3) Evaluation: weighing the decision of which mitigation efforts should be undertaken

2.4. 1. Total Risk and Acceptable Risk

Any strategy for cyclone risk mitigation or for that matter mitigation of any disaster risk would depend on correct estimation of total and acceptable risks. The concept of 'total risk' connotes the sum total of all probable harmful consequences or expected losses from a disaster such as deaths, injuries, damages to movable or immovable property, livelihoods, infrastructure, disruption of economic activities or environment damage. It may not always be easy to project such damage because environmental or psychosocial damage would be difficult to quantify, but based on correct risk assessment of disasters, it should be possible to construct different scenarios of total risks according to the intensity, location or time of disasters. Once realistic assessment of total risks is available, the countries and communities should make strategic decisions on how much of these risks can be prevented outright, how much can be mitigated and to what extent by the various agencies (Dhar Chakrabarti, 2009).

The residual risks that can neither be prevented nor mitigated in a cost effective manner in the given social, economic, political, cultural, technical or environmental conditions can be regarded as 'acceptable risk'. Therefore, the level of 'acceptable risk' would vary from place to place and also from time to time. Once the level of 'acceptable risk' is decided, countries and communities must be prepared to face these risks so that damage to life, livelihood and property from these risks can be reduced to their minimum. Ideally, the level of preparedness should be equal to the level of 'acceptable risk' (Shaw, et al., 2009).

2.4. 2. Framework for Cyclone Risk Preparedness and Mitigation

The framework for cyclone risk mitigation presented by Dhar Chakrabarti (2009) mentions two important cyclone mitigation methods; these are structural and non-structural mitigation:

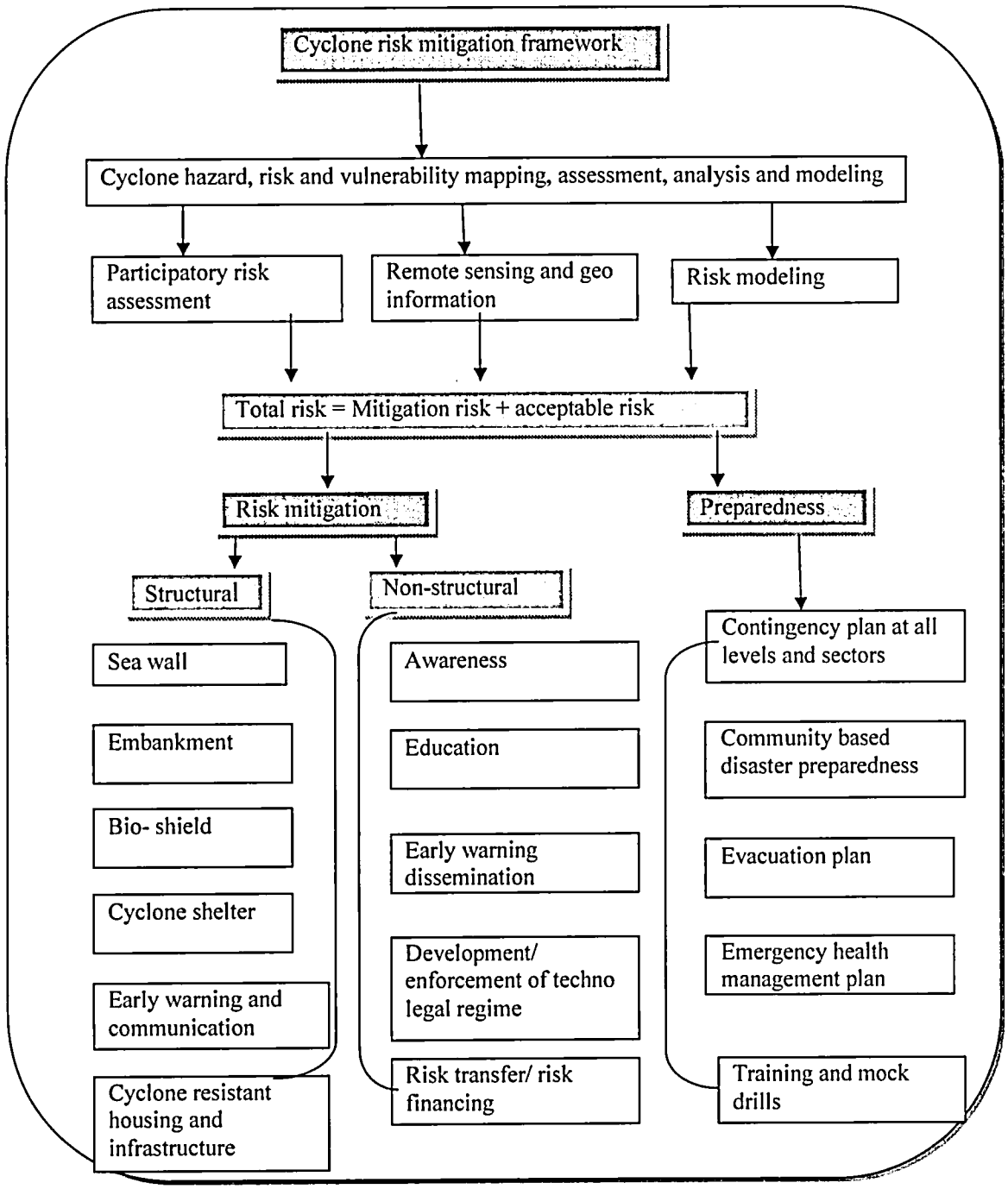


Figure: 2. 1). Cyclone risk preparedness and mitigation

Source: Dhar Chakrabarti, 2009.

2.4. 3. Risk Perception

Accurate risk perception is a necessary stimulus for responding to warnings, engaging in protective activities such as installing hurricane wind protection, and evacuating when advised. Public risk perception is related to previous experience with hazard events. Paradoxically, previous experience may actually reduce perceived risk, especially when the public has experienced a "miss" rather than a hit following energetic preparation. Persons with hurricane "experience" may believe that they are better equipped to deal with future cyclones. In contrast, experiencing significant hurricane damage is associated with realistic risk perception (Shultz, Russell & Espinel, 2005).

2.5. Vulnerability Paradigm

The term vulnerability possibly has its origins in food security literature, and has been applied in the last decade or so to research on climate change and its effects (Vincent, 2004). Given the recognition that vulnerability is relevant across various outcomes and levels, a general definition sees vulnerability as the risk that a "system", such as household, region or country, would be negatively affected by "specific perturbations that impinge on the system" or to the probability of a "system" undergoing a negative change due to a perturbation (Gallopin, 2006, p. 294).

Vulnerability is considered as an internal risk factor which relates not only to exposure of the communities in general or the physical susceptibility of the exposed element, but also to the social weakness and lack of resilience of disaster prone communities. Cardona (2004) noted that vulnerability is an internal risk factor of the subject or system that is exposed to a hazard and corresponds to its tendency to be affected and susceptibility to damage. Hence, the capacities and adaptation of the fragile communities to absorb the impact are necessary to pay attention to in vulnerability and risk assessment. Lack of knowledge, information and communication, preparedness, political instability, and healthiness contribute to greater risk. Different scientific disciplines have different specific definitions of vulnerability because they focus on different components of risk (Alwang, et al., 2001).

The concept is very much in its initial stage of formulation and there is no all-agreed definition of vulnerability. However, the main elements in the definition of vulnerability have evolved as below: According to Gabor and Griffith (1980), vulnerabilities are the threats (to hazardous materials) to which people are exposed (including chemical agents and the ecological situation of the communities and their level of emergency preparedness). Susman, et al., (1983), summarize it as "the degree to which different classes of society are differentially at risk." Smith (1992) stated that "Human sensitivity to environmental hazards represents a combination of physical exposure and human vulnerability, the breadth of social and economic tolerance available at the same time." Watts and Bohle (1993) claim that vulnerability is best defined as "an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of potential harmful perturbations." Blaikie, et al., (1994) see vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard." IPCC (2001) expresses that vulnerability is "a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." Pritchett, et al., (2002) and Mansuri & Healy (2001) conceptualize vulnerability to poverty as "the probability that a household would experience at least one episode of poverty in the near future or over a given number of time periods." The International Strategy for Disaster Reduction (ISDR, 2004) defines vulnerability as "the set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impacts of hazards". Dercon (2005) argues that, in economics, vulnerability has often been defined as "the risk of households falling into or remaining in poverty because of their idiosyncratic hazards (due to characteristics of the individual household) or covariate/ aggregate hazards (external to the household)." In a view of Zhang & Wan (2006), most researchers define vulnerability to poverty as "the probability of a household or individual falling into poverty in the future."

From these common definitional elements it is clear that vulnerability relates to an undesirable outcome (e.g. vulnerability to poverty, vulnerability to food insecurity or vulnerability to natural

hazards) and that such vulnerability is due to "exposure to hazards", which cause "perturbations" (Alwang, et al., 2001). These hazards can have many origins: environmental, socioeconomic, physical and political. It is also clear that "system" can imply different spatial levels of analysis that exhibit vulnerability, from micro (household), to meso (regional) and (countries, global) macro levels (Naude, et al., 2009).

There are several criteria that an efficient measure of vulnerability should ideally satisfy:

- First, vulnerability is an *ex ante* notion, so that any measure of vulnerability should have a "predictive quality" (Cannon, et al., 2003).
- Second, measure of vulnerability should define vulnerability in relation to a socially acceptable level of outcome (Alwang, et al., 2001, p. 33).
- Third, vulnerability indicators should ideally contain information on the causes of vulnerability and the relative importance of idiosyncratic and covariate risk (Gunther & Harttgen, 2006).
- Fourth, a good measure of vulnerability should refer to a particular cause of vulnerability, i.e. be hazard-specific (Cannon, 2007).
- Fifth, to measure vulnerability appropriately, one needs to consider the dynamics of vulnerability not only before a hazard occurs, but also during and after (Birkmann, 2007).

In addition to broadening the concept of vulnerability, the method and scope of measurement of vulnerability towards various hazards have also seen advances in recent years. In particular, the concept of vulnerability is recognized as being relevant on the level of socioeconomic groups, places and across time (Turvey, 2007). Various efforts are now underway attempting to measure vulnerability not only on a household level, but also on the level of countries, regions and local areas (Naude, et al., 2009).

Alwang, et al. (2001), point out that the concept of vulnerability should meet the following five general principles:

① It is forward–looking and could be defined as the probability of experiencing a future loss relative to some benchmarks of welfare

② Vulnerability is caused by uncertain events

③ The degree of vulnerability depends on the characteristics of risks involved and household ability to respond to the risks

④ Vulnerability depends on the time horizon, i.e. a household might be vulnerable to risks next month, the next year, and so on

⑤ Both the poor and non-poor could be vulnerable because of their limited access to assets and abilities to respond to risks.

There is a broad array of terms used to describe vulnerability. Resilience is another term used in contrast to vulnerability. It is defined as "the ability of an actor to cope with or adapt to hazard stress and return to the previous stable condition without incurring any long term negative consequences (Lal, et al., 2001; Pelling, 2003)." Sensitivity, susceptibility, resistance, capacity, and potentiality are some of the constructs used to describe vulnerability, but the following are the components of vulnerability that are most commonly used in scholarly literature:

✧ Exposure: the degree of climate stress. Exposure can be both short-term and long-term. Frequency, duration, and intensity are some of the features of exposure.

✧ Sensitivity: the degree to which the system is affected by climate stress directly or indirectly and negatively or positively (White, et al., 2001). Some authors use "resistance" instead of "sensitivity" to describe the individual's or group's capacity to withstand the impact of a hazard (Pelling, 2003). Methods to reduce sensitivity can be a change of economic, social and political circumstances. The number of possible hazards is large and the manifestation of a particular hazard varies. Consequently, sensitivity should not be viewed as general and applicable to all hazardous events. Sensitivity is a hazard specific phenomenon and an acknowledgement of its unique features will help to define successful policies to prevent or mitigate disasters.

- ✧ Adaptation or coping: an adjustment of a system to climatic stress, potential damages, or consequences (O`Brien, et al., 2004). The function of adaptation is to reduce social vulnerability and promote sustainable development by making changes in ecological, social, and economic systems (Smit & Pilosofa, 2001). Adaptation depends greatly on the adaptive capacity or adaptability of an affected system, region, or community to cope with the impacts and risks of climate change. Adaptability includes technological options, availability and access to resources, human and social capital, decision making process and the structure of critical institutions (Brooks, 2003; O`Brien, et al., 2004). As in the case of sensitivity, adaptation is hazard specific; it varies depending on exposure (Leatherman & Thomas, 2001).

In summary, Hewitt (1995) mentions there are several important features of vulnerability:

- ➢ Vulnerability is variable (contextual): it varies across geographical space and social groups.
- ➢ Vulnerability is scale dependent: vulnerability at the local level may not be the same as vulnerability at the regional or national level.
- ➢ Vulnerability is dynamic: it varies depending on changes in social structure and forces over time.

The vulnerability paradigm is appropriate for studying the risks coastal communities face today and the impact of natural hazards on their livelihoods. Severe climatic events were always a threat to coastal communities. Insecurity, poverty, and lack of state support became a reality of everyday life. O' Brien and Leichenko (2000) called this situation a "double exposure": a population confronted by consequences of both climate and social changes.

Various adaptive strategies have surfaced to cope with severe climatic conditions. Understanding the impact of these adaptive strategies in reducing vulnerability to hazards and their outcomes is important in securing the livelihoods of coastal communities.

Generally, household assets or endowments play an important role in coping strategies or resilience and therefore much effort has gone into measuring these. These assets include natural assets (e.g. land), physical assets (e.g. infrastructure), financial assets (e.g. insurance, savings), human assets (e.g. know-how, health) and social assets (e.g. networks). The role of assets in coping has also been studied in other disciplines, and is prominent in the sustainable livelihood approach. Policies and programmers to promote sustainable livelihoods therefore have much in common with policies and programmers to reduce vulnerability (Cannon, et al., 2003). Outside economics, much advance has been made in measuring vulnerability towards natural hazards (Birkmann, 2006).

In this dissertation, a common approach is to measure vulnerability as the degree of risk a particular household/community/region/country faces. Thus, risk is seen as a function of hazard and vulnerability.

2.6. Characteristics and Formation of Cyclones

Tropical cyclones are low pressure weather systems that develop over the warm waters of the oceans, typically between the latitudes of 30 degree north and 30 degree south. Cyclonic systems rotate counter-clockwise in the northern hemisphere and clockwise in the southern hemisphere. Tropical systems evolve through a life cycle that includes the successive stages of tropical waves, tropical disturbances, tropical depressions, and tropical storms (table, 2. 3). Depending upon geographic locale, tropical cyclones with wind speeds surpassing 74 miles/hour (118km/hour) are termed "hurricanes" in the North Atlantic, the Caribbean, the Gulf of Mexico, the Eastern North Pacific, and the West coast of Mexico; "typhoons" in the Western Pacific; and "cyclones" in the Indian Ocean and Australasia (Shultz, M. et al., 2005).

Table: 2. 3). Stage of development of a tropical cyclone

Stage	Description
Tropical wave	A trough of low pressure in the trade wind easterlies
Tropical disturbance	A moving area of thunderstorms in the tropics that maintains its

	identity for 24 hours or more
Tropical depression	A tropical cyclone in which the maximum sustained surface wind is <61 km/hour; or <33 knots.
Tropical storm	A tropical cyclone in which the maximum sustained surface wind ranges from 62 km/hour; or 33 knots to 117 km/hour; or 64 knots.
Hurricane/ typhoon/cyclone	A tropical cyclone in which maximum sustained surface wind is more than 118 km/hour; or more than 64 knots.

Source: National Weather Service, & National Oceanic and Atmospheric Administration, 2005.

Tropical cyclone formation requires six concurrent conditions (CRED, 2005):

① warm ocean waters of at least 26.5degrees C to a minimum depth of 50 meters (165 Feet)

② an atmosphere that cools rapidly with vertical height, transforming stored heat energy from warm ocean waters into thunderstorm activity that fuels the developing tropical system

③ moist layers at mid-troposphere elevations 5 km to enhance thunderstorm formation

④ significant Corioli's force to rotate the cyclone

⑤ the presence of a near surface, organized, rotating system characterized by spin (vortices) and low level inflow (convergence)

⑥ minimal vertical wind shear strong cross winds at varying altitudes that can slice apart the towering vortex of cloud mass

2.7. Disaster Response and Perception

Research on hazards and natural disasters has varied through the years in terms of its context, focus, concern, and importance. It has drawn different perspectives from other disciplines (such as Sociology, Anthropology and Psychology) and has employed an interdisciplinary way of looking at extreme events and how they affect human systems. Most of the early works were initiated under the nature-society interaction paradigm by looking into the course of natural events and how they affect human systems. White (1942) in his doctoral dissertation, *Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States*, examined the human adjustments made by the occupants of floodplains in the United States. He adopted a more inductive approach to examining human adjustment to flood hazards. The results showed that despite the protective

measures afforded by dams and levees, losses from flooding increased. In the process of adjusting to hazard events, human societies developed physical structures to protect themselves from the hazards of extreme events but at the same time located themselves in harm's way by an over-reliance on the physical and technological structures that they have built (White, 1952).

In the 1960s, the initiatives of Gilbert F. White and his students at the Chicago School gave hazard research a different direction. White formulated his research paradigm based on his observations and looked at hazard as derived from the interaction between nature and society but strongly affected by feedback in the form of human adjustments. Based on his past researches and studies, White ,in his *Natural Hazards:Local, National, Global (1974)* incorporated five components of his research paradigm: (a). assessment of human occupancy of hazard zones; (b). identification of the full range of human adjustments to hazard; (c). perception and estimation of the occurrence of hazards; (d). examination of the choice of human adjustments adopted to reduce damage from hazard events; and (e). estimation of adjustments to anticipated social consequences.

Natural Hazard in Human Ecological Perspective: Hypotheses and Models by Kates (1971) incorporated a natural hazards model using the human ecological perspective. He posits that the complex nature of natural hazards phenomena may be viewed as a series of linked hypotheses encompassing man-nature interaction; the techno-social stages of development of human responses to natural hazards; the nature of natural hazards that may influence the form of human adjustments; levels of decision making from the individual to the corporate as well as their individual differences; perceptions of the hazards and the differences in those perceptions; and the awareness of the adjustments and the process of evaluating them with respect to the environmental suitability of the chosen form of human adjustment.

Hewitt and Burton expanded hazards research to incorporate the "all-hazards-at-a-place" framework in *The Hazardousness of a Place: a Regional Ecology of Damaging Events* (1971). They stipulate that

"a natural hazard of any sort is a function both of the physical event itself and of the state of human society, especially including the adjustments adopted to cope with the hazard and the state of preparedness". They further argue that in most cases a person's adjustment to his environment involves mental processing of environmental information. This gives value to the consideration of people's perception of a hazard.

The collaborative research on hazards led by White (1974) presented several case studies from different places in the United States as well as from other countries. These range from individual to community responses toward hazard events associated with hurricane, flood, drought, earthquake, volcanic eruption, and frost among others.

Baumann and Sims conducted a study among five sites (three in the US- Florida, Mississippi and Texas; two in Puerto Rico) to investigate responses toward hurricane hazards using a cross-cultural perspective in *Human Response to the Hurricane in Natural Hazards: Local, National, Global* (1974). The study locations represent two different sites in terms of religion, economic standing, level of literacy and culture. The United States represented the predominantly Protestant group with more educated people with generally high economic standing. Puerto Rico, on the other hand, represented the economically poor, Catholic group with low levels of education. The authors acknowledge the importance of understanding the psychological and cultural dimensions of a society in dealing with hazardous events. They conclude that those who feel more secure and have control over the events in their lives are more active in coping with the threat of hurricanes, while those who acknowledge the power over their lives according to their belief system, tend to be more fatalistic, more accepting and, therefore, more vulnerable.

Consequently, in a related study, *Attitudes toward Hurricane Hazard on the Gulf Coast in Natural Hazards: Local, National, Global* by Baker and Patton (1974), attitudes toward hurricane hazards of residents along the Gulf Coast were examined. They hypothesized that the following three dependent

variables: (a). evaluation of the hurricane hazards in their locality by respondents; (b). the respondent's prediction of a future occurrence of hurricanes; and (c). mitigating hurricane related damages, are each associated with site, literacy, income, age and tenure (independent variables). Their study reveals that literacy and site are the two variables that are strongly associated with attitudes toward preventability of hurricane damage. "Better educated respondents are more likely to have a positive attitude toward damage prevention adjustments".

The study *India and the Ganges Floodplains in Natural Hazards: Local, National, Global* conducted by Ramachandran and Thakur (1974) on flood hazards in the Ganges floodplains of India, made use of perception survey regarding the awareness and adjustments of the residents in the area. Awareness of flooding was high, although opinions regarding magnitude and frequency differed. Most respondents expressed the disadvantages of living in the floodplain, but very few expressed intent to move somewhere outside their present community. Based on the respondents' perception, the authors concluded that despite the hazards of flooding, adjustments toward the hazard were more corrective rather than preventive, and loss bearing has become a choice that is universally adopted in the study area.

Another flood hazard study, *Flood Hazard at Shrewbury, United Kingdom in Natural Hazards: Local, National, Global* (Harding and Parker, 1974) reveals a low awareness of flood hazards by respondents in the floodplain at Shrewsbury, United Kingdom, as opposed to those at the Ganges floodplains of India. However, there was a high level of awareness on the part of the community and the government, as reflected by the strategies they have employed. The country has adopted nonstructural adjustments such as flood warning and emergency plans, and control of development combined with urban renewal programs.

The publication of *The Environment as Hazard* (Burton, Kates and White, 1993) ushered in new perspectives and emphases in hazards research in the succeeding decade. Research on risk and its

perception added a new dimension to the human aspects of hazards and disasters as well as to hazard policy formulation. Most studies examine the judgments people make about hazardous events and their exposure to them.

Perception of Risk (Paul S, 1987) surveyed and compared risk perceptions of lay people and those of experts. People were asked to characterize and evaluate hazardous activities to assess their attitudes and perceptions toward them. Accordingly, "the basic conceptualization of risk [of lay people] is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments".

A Contextual Model of Natural Hazard, by Mitchell, et al (1989) presented research based on their assessment of human responses toward the severe storm that affected Southern England in October 1987. Results of this study reveal that many affected residents view the hazard as a socio-political phenomenon rather than a human ecological one. In a developed country, such as Great Britain, it is expected that natural hazards could be managed effectively. However, in this case, a low probability event that affected a vulnerable population did not significantly affect changes in the country's hazard management programs. This shows that even in developed countries, pressing conditions for improved management of hazards are not readily addressed, a situation that is expected to be most common in developing countries.

Societal Response to Hazards and Major Hazard Events: Comparing Natural and Technological Hazards (Kasperson and Pijawka, 1985) studied societal response to hazards and major hazard events by comparing natural and technological hazards. They presented a series of models by which to assess responses to hazards and argue that "although characteristics of disaster agents may vary, natural and technological disasters may be examined within the same conceptual and analytical framework". Based on their analyses of major hazard events, some of their significant conclusions are: hazards may be conceived as composed of a series of linked stages beginning with human needs and ending in

adverse consequences; ideally, hazard management consists of a sequence of four major activities: assessment, control analysis, selection of management strategy, implementation, and evaluation; technological disasters tend to elicit a different pattern of public response than do natural disasters; and the emergence of a community to ameliorate effects during the post disaster period appears substantially less likely for technological than natural disasters.

Human Adjustments to Volcanic Hazards in Puna District, Hawaii, (Murton and Shimabukuro, 1974) is a study of perceptions that reveals the failure of the respondents to consider volcanic eruptions as hazardous. In fact, despite eruptions, living within the area was perceived to be more advantageous than living in some place away from volcanic activity. Respondents, who were aware of the hazards of volcanic activity, stressed that people were in no danger, only land and property. This dichotomy in people's minds between danger to human life, and danger to land and property, seems to be fundamental.

Public Perception of Hurricane Hazards: Examining the Differential Effects of Hurricane Diana, (Beatley and Brower, 1986) tells us that comparative studies of perceptions of people in different communities have shown interesting results. One study that deals with public perception of hurricane hazards in North Carolina, examined differential effects of a hurricane on two communities that differ in experience with respect to the storm (one having the direct impact, whereas the other just received media reports of the storm and its impacts). This study further revealed that the greater the (self reported) hurricane experience of the respondent, the less likely was the respondent to see the need to evacuate during the next hurricane. In addition, those who had lived for longer periods on the coast were less likely to be concerned about evacuation. However, as in the case of two coastal communities in Bangladesh, reasons for not evacuating were the fear of looting and losing their belongings, and the lack of local shelters. This reflects the need for an integrated disaster mitigation strategy to encourage people to migrate to less vulnerable regions (Haque and Blair, 1992).

Tropical Cyclones: Coastal Bangladesh, (Islam, 1974) is a study on cyclone and storm surge perception in Galachipa, Bangladesh. It reveals that socioeconomic factors such as occupation and education do not cause any variation in perception. More importantly, economic pressures and social preferences are the prevailing reasons for residents to remain in their homes after experiencing a cyclone rather than moving to less vulnerable areas.

'*Human a Response to Natural Hazards'* by White is a 1974 investigation in 14 countries around the world where residents in hazardous areas were asked what could be done. Bangladesh was one of the study sites. Islam (1974) prepared a Bangladesh country paper entitled '*Human adjustment to cyclone hazards: A case study of Char Jabbar*'. More recently, Haque (1995, 1997) and Haque and Blair (1992) analyzed climatic hazard warning processes, hazard preparedness and coastal people's reactions to warnings based on quantitative surveys following the April 29, 1991 cyclone. These studies reveal that, although a hazard warning process was successful in principle, disbelief of warnings, fear of burglary, and lack of cyclone shelters were among the factors identified by affected people as resulting in greater loss. Communities vulnerable to cyclones also face a broader risk landscape. In the context of this study, crime; including boat theft and resultant loss of livelihood, serves to exemplify some of the other issues that can threaten a household.

In another study, *In the Eye of the Storm: The Social Construction of the Forces of Nature and the Climatic and Seismic Construction of God in the Philippines*, (Bankoff, G., 2004), the author posits that disasters "are not simply geographical or meteorological occurrence but are psychological matters as well". He suggests that in order to understand societal response to hazard events, one must look at these responses from "the context of the operating schema of the individuals experiencing such phenomena". Further, in some societies like the Philippines, natural hazards occur so frequently that the constant threat they pose has become integrated in the people's psyche, thus, they have become accustomed to them.

Hazards, (Montz, et al., 2003), studies the link between the nature of societies and disasters which has been clearly established in hazards studies, and shows how research on natural hazards and disasters has become multifaceted. However, certain basic questions remain the same even while structures of societies become more complex with advancements in science and technology. Growth in the understanding of extreme natural events is evident in the significant increase in hazards research from different disciplines and perspectives. However, despite the accumulated knowledge on the nature of hazards and their contributing factors, the potential for hazards and vulnerability have increased in many places.

Citizen Response to Disasters: A Survey of Literature and Some Practical Implications by Helsoot and Ruitenberg (2004) studies how motivation for preparing for a disaster is influenced by the perception of risk, the perception of ability to respond, and of the possibility of succeeding in helping oneself or others. If a citizen does not perceive that he/ she can do anything about the event, then that person will not try to prepare, as preparation is "dismissed as futile". This study also focused on how timely and effective action depends on two components: perception of the certainty of the threat, and certainty that there will be severe and immediate consequences. Citizens only prepare for threats they perceive as imminent and whose risk is worth preparing for. This helps them feel in control of the perceived threat.

Snow Avalanche Hazards, Southern Glacier National Park, Montana: The Nature of Local Knowledge and Individual Response by Butler (1987) is a study on snow-avalanche hazards which shows that experience and high levels of education do not always lead to accurate valuing of the hazard. He conducted a perception study on the knowledge of residents of East Glacier Park in Montana regarding snow avalanche events (their familiarity and experience of the hazard) along US Highway 2 as well as the adjustments and individual responses of respondents toward these events. His study reveals that despite the high level of awareness of the hazard, the threat is not keenly perceived and that the necessity to travel through an avalanche-prone region like US Highway 2,

"overrides any perceived necessity for behavioral adjustments". This is attributed to the lack of an effective warning system in the area as well as the failure of most respondents to change their driving habits despite their awareness of the hazard.

Why Relatively Fewer people died? The Case Study of Bangladesh's Cyclone Sidr by Paul, B.K. (2009a) reports that with the exception of Cyclone Sidr, Bangladesh has experienced two other devastating cyclones during the last four decades. The unnamed 1970 cyclone killed an estimated 500,000 people and cyclone Gorky, which occurred in 1991, killed 140,000 people. Although Bangladesh experienced at least 20 severe cyclonic storms since 1970, only the 1970 and 1991 cyclones have received considerable attention among hazard researchers. Because of the time lag between collection of data and publication of relevant papers in professional journals, it is difficult to estimate how much attention cyclone *Sidr* has received.

Countries Must Prepare for and Adapt to Cyclone Impacts by Saleemul H (October, 2008) mentions that this is particularly true for countries affected by tropical cyclones and storm surges. The programme helps identify likely long-term effects of climate change by using climate change models and identifying the most vulnerable locations and populations. It then helps the most vulnerable communities to think about longer-term adaptation measures through meetings and workshops run by NGOs. There is a natural link between preparing for natural disasters and adapting to climate change, particularly for weather-related disasters such as cyclones and storm surges.

Hurricane Risk Perceptions among Florida's Single Family Homeowners, (Peacock, et al., 2005) conducted a perception study among single family homeowners in Florida to assess if proximity of location to wind vulnerability zones affects perception of risk. They also investigated the major factors involved in hurricane risk perceptions such as previous experience; knowledge of hurricanes and hurricane risks; and socioeconomic variables. Results show that location, among other factors, was

listed as the most important factor affecting hurricane risk perception. A significant finding of the study was that experience of a hurricane generally outweighs general knowledge of the hazard.

2.8. Disaster Assessment

With the increasing evidence of human capacity to alter and influence environmental conditions, there came a shift from the focus on nature's effects upon people to the identification of the role of humans in changing the natural landscape (Thomas, 1956). White and Haas (1975) examined research trends in their *Assessment of Research on Natural Hazards in the United States*. The work reveals that most research concentrated largely on technologically oriented solutions to problems of natural hazards, to the exclusion of social, economic and political factors that govern human societies. The assessment also led to the establishment in 1976 of the Natural Hazards Research and Applications Information Centre at the University of Colorado in Boulder. The Centre serves as a national and international clearing house for information on natural hazards and human adjustments to them. The studies conducted in the succeeding decades incorporated more social analysis in the research questions based on the premise that social factors were instrumental in governing behavior during an extreme natural event.

Human System Responses to Disaster: An Inventory to Sociological Findings (Darbek, 1986) provides a historical example of a compilation of knowledge available in that era; one is able to ascertain the depth and breadth of focus on the human factor to a plethora of incidents. As the author explains, delineations by individuals and system level responses were utilized for the purposes of the view. However, for the current research, the text's findings are predominantly on the behavioral aspects and thus require merely acknowledgement.

2.9. Risk and Vulnerability Perception

The decade of the 1990s was a significant period in hazards research. The United Nations declared it the International Decade for Natural Disaster Reduction. This period saw the convergence of

multidisciplinary research and frameworks in dealing with hazardous events in the attempt to come up with recommendations to reduce the cost of disasters. Natural hazards studies also took on a more humanistic attitude with more research done on vulnerability, risk and mitigation. These studies also covered response to warnings, assessment of actions during extreme events, and post disaster relief and recovery.

Vulnerability has become a key paradigm in hazard research. The vulnerability of people to tropical cyclones is a function of the incidence of the phenomenon as well as their exposure (Pielke and Pielke, 1997). Incidence refers to the number of cyclones, their intensity and the paths that they take. If a community lies along the tracks of these cyclones, they become at risk with a potential for loss of life and property. Societal vulnerability as defined by Pielke and Pielke (1997) is therefore "determined through the societal and climatic aspects of the hurricane phenomenon".

Understanding Vulnerability: An Introduction in Understanding Vulnerability by Twigg (1998) is a study on vulnerability, which focused on its reduction and the strengthening of the people's capacity toward resilience as part of mitigation and management strategies. These studies have also shown that an increasing number of people have become vulnerable to hazards because of changes in their socio-demographic conditions as well as their cultural and political circumstances. This condition is more prevalent in developing countries where economic pressures have forced many of the poor to locate themselves to flood-prone areas and unstable sloped hills and other elevated regions.

Vulnerability to Tropical Cyclones: Evidence from the April, 1991 Cyclone in Coastal Bangladesh, (Haque and Blair, 1992), is a study on vulnerability and the decision to evacuate during an extreme event, which showed that, due to socioeconomic factors, most inhabitants (mostly the men) in flood-prone regions of Bangladesh refused to leave their dwellings until it was too late for them to seek safety. Reasons for failure to evacuate were looting, disbelief in warnings, poor conditions and

overcrowding of shelters, as well as a fatalistic attitude that the cyclone was the will of *Allah* and that they could not do anything to counter the event.

Constructing Vulnerability: The Historical, Natural and Social Generation of Flooding in Metropolitan Manila, (Bankoff, G., 2003), studies the vulnerability of the Filipinos towards flood hazards. He argues that the lack of mutuality between the environment and human activity over time has led to the vulnerability of most Filipinos to the risk of flooding. Flooding has become a chronic risk, particularly to most residents of Metropolitan Manila whenever a tropical cyclone hits the country. Therefore, the understanding of the nature of floods in the Philippines requires an appreciation of the storms that impact the country.

'Post Cyclone Adjustment Process: Basic Needs Perspective' by Alam (2003) analyzes and differentiates the post cyclone adjustment process in the location of Sandwip Island by dividing it into three hazard risk zones on the basis of the surge height of the 1991 cyclone: badly affected area; moderately affected area; and less affected area. The study showed that during relief and rehabilitation stages, external agencies were found not to understand exact requirements in the three hazard risk zones. Different NGOs took part in relief and rehabilitation programs in the post cyclone period, highlighting their activities in different books, papers and manuals (CARE, 1991; CCDB, 1991; BRAC, 1991; ADAB, 1992). There remains, however, a conspicuous absence of research into the whole context of vulnerability and local coping with cyclone hazards.

'*Cyclone Disaster Vulnerability and Response Experiences in Coastal Bangladesh*' by Edris, A & Collins, E (2008) examines people's response and the impact of disaster through in-depth interview and observation. The field research compared a combination of participants' observations and non-participants' external interactions with coastal communities. This study identifies the contexts within which people are vulnerable to cyclone hazards and consequent local responses to living with cyclone disasters in the coastal zone of Bangladesh. Additionally, it examines the origins of

vulnerability to cyclone hazards given local people's experiences on the Bangladesh coast and identifies adaptation strategies and coping before, during and after cyclone disasters.

*Vulnerability Maps Could Help Cut Cyclone Death Tolls by Dube S (2008)*mentions that cyclones and storm surges are serious hazards along the coast of Bangladesh. Cyclones may be more frequent in the Atlantic or Pacific, but the Bay of Bengal's shallow coastal waters, high tides and densely populated low-lying areas make surges particularly deadly there. Countries vulnerable to cyclones and storm surges are aware of the issues and very detailed vulnerability maps are available for many developed nations, like Australia and the United States. But countries like Bangladesh and Myanmar lack the data and technology to produce such maps. The maps have informed long-term disaster management plans in the area. District authorities can use them to identify the areas at most risk of flooding and wind damage, determine priorities for mitigation and regulation strategies, and guide relief and insurance policies. So, vulnerability mapping would require considerable investment in technology and computing resources as well as in collecting detailed data at small spatial scales.

2.10. Disaster and Role of Media

A review '*Competing Constructions of Calamity: The April, 1991 Bangladesh Cyclone*' by Dove and Khan (1995) debates the April 1991 cyclone outcome using content analysis from Bangladesh government and media, the international media and the views of the scholastic community. The Bangladesh government and media underlined the natural origins of the disaster, worsened by the irrational behavior of individuals and the limited resources of the nation. There was also a move to try to link the cyclone to global warming and the greenhouse gas emissions of industrialized countries. Non-Bangladeshi accounts tended to focus instead on the poverty of the individuals, and the structural inequality of society, which compels people to live in hazardous areas. However, the view of the authors of this paper, and also implicit in recent policy agendas, such as the Hyogo Framework (UNISDR, 2005b), is that multiple 'vulnerabilities' can often be counteracted by the resilience and adaptability of active survivors.

2.11. Shelter-related Coping, Response and Perception

'*Socioeconomic and Environmental Effect of the 1991 Cyclone in Coastal Bangladesh: Local Level Analysis*' by Ohiduzzaman (1993) points to the severity of cyclones, a lack of cautiousness and an improper disaster management system as the main determining factors delineating the extent of cyclone damage. In addition, people resist moving to the cyclone shelters during an event. The reasons are thought to be disbelief of warnings among coastal dwellers, the utilization of incorrect methods in the warning system, the distance of cyclone shelters from settlement, mismanagement of weather forecasts and a lack of proper management of the cyclone shelters (Haidar, 1992; Alam and Eusuf, 1994).

'*Multipurpose Cyclone Shelter Program: Report Prepared for the Planning Commission of Bangladesh*' by Bangladesh University of Engineering and Technology (BUET) and Bangladesh Institute of Development Studies (BIDS) (1993) states that for effective employment and management of cyclone shelters, multi-purpose versions have been built in carefully selected locations, identifying uses for both normal and disaster periods. They point out; two versions of multi-purpose shelters that are used during non-disaster periods demonstrate an excellent dual disaster and development function. However, the underlying causes of the non-use of shelters have not always been fully identified.

'*Post Project Monitoring Study on the Construction of the Multipurpose Cyclone Shelter*' by Nizamuddin, K (1997)tries to understand the behavior of the coastal people during cyclone hazard periods, including why they are not able to reach the shelter centre in time. He points out that some defense is provided by an artificial embankment, but this is not sufficient to protect the spread of housing in this zone. In many areas, there is no embankment. Furthermore, mangroves that offered some shelter have been removed to make way for shrimp and salt farming enterprises. Such levels of direct exposure to cyclone hazards mean that the shelters are all the more crucial as an intervention, as one of a few ways in which people can gain protection.

2.12. Disaster and Health

'*Environmental Health and the 1991 Bangladesh Cyclone*' by Hoque, et al. (1993) studies environmental health using a quantitative questionnaire survey after the 1991 cyclone that targeted affected people and health personnel. Water and sanitation problems are identified as two major problems, with lack of environmental health knowledge observed among affected people and the health service providers.

'*Health Related Responses to Natural Disaster: The Case Study of the Bangladesh Cyclone of 1991*' by Rahaman and Bennish (1993) is a study which indicates that health relief and rehabilitation after the 1991 cyclone were appropriate and effective. As such, despite limitations, it was possible to control the spread of communicable diseases and mortality post cyclone.

Mortality rates and health impacts were more widely examined following Cyclone *Gorky* by several hazard researchers (e.g., Bern, et al., 1993; Chowdhury, et al., 1993; Ikeda, 1995). A series of surveys were conducted by both domestic and foreign agencies to collect relevant ephemeral data after the 1991 event. For example, the Bangladesh Rural Advancement Committee (BRAC) sponsored four separate studies following the 1991 cyclone (BRAC, 1991). Nearly 1 year after this cyclone, a field survey was carried out by a research team organized by Japan Overseas Corporation Volunteers (JOCV). Although the primary objective of these surveys was not collecting data on human casualties, some of these surveys recorded such data along with other relevant information. Based on data from these surveys, published papers assessed the extent of human loss and the risk factors associated with deaths caused by cyclone *Gorky*.

2.13. Disaster Awareness and Warning System

'*Vulnerability of Bangladesh to Climate Change and Sea Level Rise through Tropical Cyclones and storm surges*' by Ali (2006) examines the climatology of cyclones in the Bay of Bengal for the past 110 years, as well as trends in cyclone frequency and intensity. '*Indigenous Early Warning Indicators*

of Cyclones: Potential Application in Coastal Bangladesh' by Howell (2003) points out, there is an evidence that the coastal inhabitants depend on indigenous early warning indicators of cyclone hazards based on an observation of unusual weather, sea patterns and animal behavior.

2.14. Gender Vulnerability in Natural Disasters

Gender theory explores differences in the varying roles that females and males perform in their household livelihood systems. Chen (1991) argues that women's activities are more multidimensional than men's. Some of the activities are the sole responsibility of women, and women's role in creating and keeping networks is greater than men's. However, viewing labor division as the only factor in health inequalities among men and women carries serious flaws. It does not acknowledge social structure explanations of women's vulnerability such as power, access to resources, discrimination against women, and domestic violence.

Environmental challenges such as land degradation, drought, flood and cyclone just to name a few, limit the abilities of women to handle their household responsibilities and increase their work burdens, negatively affecting their health status. The literature reveals a pattern of gender differentiation throughout the disaster process. The differences are largely attributed to childcare responsibilities, poverty, social networks, traditional roles, discrimination, and other issues related to gender stratification. More women die during natural disasters compared to men because often they are confined to homes and do not escape on time. Women experience more emotional problems during and after disasters compared to men. It is often on women's shoulders to rebuild their and their children's lives because men tend to work outside of their homes (Fothergill, 1996).

Traditionally, women were responsible for daily processing and other household duties. They are now important contributors to the household's economy and this may increase women's sickness risk. Demand for labor during disasters may result in the delay of seeking care for health problems.

Whether or not coastal community's males and females experience disasters differently and have varying health outcomes have not yet been studied.

Using two population based surveys, Sommer, A., Mosley, W.H. , in their *East Bengal Cyclone of November 1970: Epidemiological Approach to Disaster Assessment* (1972), studied health impacts associated with the 1970 cyclone. For this first survey, 18 site interviews were completed to study the characteristics of populations affected by the cyclone, and the deaths and injuries that followed. The second survey was administrated 2 months later when 2,973 households were interviewed to examine the impacts of age and gender on cyclone mortality rates in the nine most affected areas. The study also reported that in the 1970 Bangladesh cyclone, the highest death rates found were among children and the elderly, and that women fared worse than men in all except the youngest age groups.

Gender Difference in Human Loss and Vulnerability in Natural Disasters: A Case Study from Bangladesh by Ikeda, K (2005)reportes that the excessive female deaths caused by the 1991 cyclone (relative to male mortalities) are primarily due to gender specific rules and restrictions to women's spatial mobility imposed by the norm of *purdah* or veil. *Purdah* not only correlates with female lack of social power and autonomy as well as basic rights, but also hinders spatial mobility in times of cyclones, which is the primary reason for the disparity in cyclone mortality rates between males and females in Bangladesh. Because of gendered division of space, women have less access to information and knowledge regarding any disaster compared to males. Therefore, the combination of impeded mobility and lack of information created by the cultural and religious practice of *purdah* in Bangladesh places women at a higher risk of mortality in all situations.

Ahsan, R.M., Khatun, H., (2004), Neumayer, E., Plumper, T., (2007), is a study which reported that, a relatively greater strength among males allows them to run faster, swim longer, and hold onto steady objects for longer periods of time relative to females. Women are relatively smaller and generally weigh less than men, suffer more from malnutrition and ill health, and therefore they are more easily

swept away by water or by high winds associated with cyclones. However, several researchers (e.g., Chowdhury, et al., 1993; Ikeda, 1995), questioned the legitimacy of such logic and conclude that biological differences between men and women do not account for observed differences in mortality rates. Pre-existing social and religious patterns of gender inequality are the root cause of this difference.

2.15. Housing and Household Attitude

According to *Battling the Storm: Study on Cyclone Resistant Housing* by Haq, Bashirul (1999) Bangladesh is one of the few countries with the worst exposure to extreme climate conditions caused by global warming, due largely to worldwide excessive carbon emissions. The unfavorable consequence of global warming and the circumstances of climate change is exerting tremendous pressure on the environment in Bangladesh. The approach of this study is to look at existing houses and the process of building and maintaining these houses in the face of frequent cyclonic storms and storms surges, and gather information on shared knowledge and collective experiences of the people in all aspects of house building. The aim of this study is to find ways to make traditional structures more cyclone resistant and less prone to wind damage.

The Chronically Poor in Rural Bangladesh by Motiur, M.R., Matsui, N., and Yukio, I. (2009)examines rural poverty in Bangladesh. Based on detailed empirical research and surveys of households in Bangladesh, it provides an accurate portrait of the everyday situations faced by the rural poor in Bangladesh today, covering all aspects of household behavior. All the key issues are explored, including health, nutrition, housing conditions, human capital, household assets and liabilities, gender issues, livelihood strategies, distribution of household income and expenditure, social capital, the intergenerational mobility of the chronically poor, women`s mobility, shocks and coping strategies, and vulnerability to poverty.

2.16. Disaster Preparedness

Hurricane Preparedness: Facing the Reality of More and Bigger Storms (Gavin, 1996) provides an explanation of "Hurricane Evacuation Studies". According to Gavin, the study was "the population protection element of the Federal Emergency Management Agency's Hurricane Preparedness Plan". The book is of interest to the current study's literature review because of the historical manifestations of empirical data that were aggregated during the latter part of the twentieth century.

Hurricane! Surviving the Big One: A Primer for Libraries, Museums, and Archives, (Trinkley, 1998) provides a step by step procedure for the units that are listed in the book title. The work is relevant as a resource because of its emphasis on the importance of preparedness planning. Two points worthy of note are that administrators need to be mindful that personnel will have different reactions to disasters and that each individual should be cognizant of their own role in the preparedness process.

The book focuses in particular on the poorest of the poor households, the chronically poor, and seen by many in the development community to be the core of the problem of poverty. It shows that the chronically poor households in rural Bangladesh are more heavily female headed, have a higher dependency ratio of children in demographic composition, and are dominated by lower levels of assets, shorter years of schooling and limited employment opportunity. This book also deals with shocks, vulnerability and coping strategies. Income erosion due to covariate shocks is estimated and strategies adopted to cope with shocks are discussed as is an analytical description of the main paradigms used to define and measure vulnerability. The cause and consequences of vulnerability are identified and discussed.

Facing the Unexpected: Disaster Preparedness and Response in the United States by Tierney, et al.(2001)studied social systems theory, also known as functionalism, has had a major influence on disaster research in the United States. Many of the studies done on disasters in the United States continue to implicitly reflect this perspective. The social science perspective conceptualizes disasters

systematically. It holds the assumption that "societies and communities are systems organized around necessary social functions that from time to time are disrupted by natural and technological agents". After a disruption, or crisis period, the social system must readjust and recover. In addition, the demands placed on organizations or communities are influenced by the size and time line of a disaster. The demands of a slow onset, small-scale disaster may enable social units to respond autonomously. On the other hand, rapid onset, large-scale disasters are likely to require co-ordinated and timely efforts by many public and private sectors to minimize destruction and restore the community to routine functioning.

Minority Citizens in Disasters by Perry and Mushkatel (1986) studies economics as another motivating factor for preparedness. According to the study "non minorities and people of higher socioeconomic status are better prepared for disaster and serious accidents than others". Limited finances and resources make evacuation difficult if not impossible without government assistance. Socio-demographics such as income, education and ethnicity impact the awareness of a threat and the ability to prepare for a threat. In addition, they reveal that communities become more vulnerable to natural hazards and disaster management is more limited, as they become less socially and economically sound.

Community Based Disaster Management during the 1997 Red River Flood in Canada, (Buckland and Rahman, 1999) studies a mixed methods analysis based on research conducted immediately following the 1997 Red River Flood, wherein they examined the relationship between community preparedness and response to a natural disaster and the level and the pattern of community development. They found evidence that the level and pattern of community development, measured by community social capital, does affect the community's capacity to respond. There was a positive correlation between communities with higher levels and more community oriented patterns of development, and effective response to the flood. In their study, they found that the community with the most unique historic,

cultural, and religious background had the most social capital, and was able to respond to the flood most vigorously.

*Understanding Citizen Response to Disasters with Implications for Terrorism by Perry, et al. (2003)*reports that disasters are event-based; they are extreme events that exert pressure on a vulnerable community adversely impacting public health, safety, and property. The more vulnerable the system, the less demand necessary to increase stress, and the less able the system is to recover and adapt to the situation. In addition, this study reveals that the magnitude and unexpected nature of disaster demands may compromise the organization's or community's ability to coordinate responses. It is in the face of such demands that previous training and practice are of great importance. Preparedness actions taken on by the community, organizational, and household levels, facilitate effectiveness and efficiency of routine and improvised response activities. In order for the preparedness and response activities to be assessed accurately, an understanding of the complex demands the social units' face, the tasks they perform, and how they mobilize resources is necessary.

2.17. Disaster Policy, Recovery and Management

With regard to disaster management in terms of its structure, function, and significance of network-centric operation, *Journal of Homeland Security and Emergency Management*, (Lubitz, Beakley, and Patricelli, 2008) describes and recommends establishment of operations that will redesign the essential criteria of the methods of distribution of information during a disaster. One emphasis of the article is that disasters have certain attributes in "common", and the author's remark upon the need to understand the statement and to create from the premise a standard that will permit information to be conveyed in an effective manner. According to the authors, in military and combat environs, such a system to strengthen communication and operations does exist. Of relevance to the current research is the passage that remarks upon the "interdisciplinary" requirements requisite in emergency preparedness. The fascinating discussion, however, would well serve one whose focus is a technological pursuit, and although it prompts one to reconsider the breadth of knowledge necessary

to make decisions for hurricane emergency preparedness at institutions of higher learning, the details in the article are somewhat beyond the realm of the dissertation's tropic.

Disaster Policy and Politics: Emergency Management and Homeland Security (Sylves's, 2008) is an excellent resource for anyone with an interest in disaster studies. The author articulates succinctly the various phases of emergency management in the United States of America. He provides terminology relevant to the contemporary student and to the practitioner of the field. In addition, Sylves discusses theories and models that have contributed to the evolution of the study of dissertations. From both the scientific and administrative disciplines, the objective of the author is to acquaint the reader with the past, present and future of the complex field of emergency management. His discussion of the various levels of governments' roles in preparedness is also relevant to the current research because of the emphasis on the complexities of intercommunication amongst numerous entities. Furthermore, the inclusion of a plethora of historical context of United States legislation provides a framework for anyone who has an interest and inclination to digest all of the information. Sylves indicates that he wishes to encourage interest in the field of study. He achieves the objective with remarkable alacrity.

Natural Disaster Analysis after Hurricane Katrina (Risk Assessment, Economic Impacts and Social Implication) by Harry, W.R., Peter, G., James, E.M. (2008)explores some of issues arising from the Hurricane Katrina disaster. Scholars from many fields such as decision analysis, risk management, economics, engineering, transportation, urban planning and sociology explore some of the more important policy issues resulting from Katrina such as insurance, flood control and rebuilding the levees, housing, tourism, evacuation and relocation, utility lifelines recovery and resilience, the racial implications of the disruption of life in New Orleans, and the inter-regional economic impacts of the disaster. The focus is less on what happened in the past than on how to deal with future risk, not only in New Orleans but also in other locations threatened by disaster. However, they do not fully answer the question of how to manage the tradeoff between high construction costs and category 5 hurricane

protections. Nevertheless, this book also examines the role that insurance can play as a policy tool for reducing losses from future natural disasters while at the same time providing funds for recovery.

2.18. Summary of Literature Review

Parker and Tunstall (1991) mention that natural hazard studies provide a novel and imaginative vehicle for teaching aspects of physical and human geography because they deal with the dynamic relationship between humans and their environment, providing an opportunity to introduce the concept of perception and enhance general environmental awareness; an important element of environmental education. Gregory (2000), categories hazards research as a part of the 'third stand' of research in physical geography from asocioeconomic point of view. Accordingly, as studies of the magnitude of human impact encouraged physical geographers to move towards applied problems, they saw the need to change attitudes toward the physical environment. One of these changes is the growing awareness of the difference between the real world and they way in which it is perceived, because such perception often influenced decision-making and, therefore, management. This chapter reviews selected studies and research related to hazards in particular. It focuses on the development of hazard research in the 1940s under the initiatives of Gilbert White and discusses how research on hazards has taken different directions in response to the changing times.

Based on the analyses of major hazard events, the significant conclusions are: hazards may be conceived as composed of a series of linked stages beginning with human needs and ending in adverse consequences; ideally, hazard management should consist of a sequence of four major activities assessment: control analysis, selection of management strategy, implementation, and evaluation.

An increasing number of people have become vulnerable to hazards because of changes in socio-demographic conditions as well as their cultural and political circumstances. This condition is more prevalent in developing countries where economic pressures have forced many of the poor people to live in cyclone-prone areas.

People of higher socioeconomic status are better prepared for disaster than other people. People with limited finances and resources are not able to relocate to less vulnerable areas without government assistance. Socio-demographics such as income, education and occupation impact the awareness of a threat and the ability to prepare for a threat. Better educated people are more likely to have a positive attitude toward damage prevention adjustments. Cyclone and storm surge perception research in Galachipa in Bangladesh reveals that socioeconomic factors such as occupation and education do not cause any variation in perception. More importantly, economic pressures and social preferences are the prevailing reasons for residents to remain in their homes after experiencing a cyclone rather than moving to a less vulnerable area.

People's opinions regarding a cyclone's magnitude and frequency differed. Despite the disadvantages of living in the cyclone-prone areas, very few expressed intent to move somewhere outside their present community. The major factors involved in cyclone risk perceptions include previous experience; knowledge of cyclones and cyclone risks; and socioeconomic variables. Location, among other factors was the most important factor affecting cyclone risk perception. Experience of a cyclone generally outweighs general knowledge of the hazard.

The more cyclone experience the people had, the less likely they were to see the need to evacuate during the next cyclone. In addition, those who had lived for longer periods on the coast were less likely to be concerned about evacuation. However, as in the case of two coastal communities in Bangladesh, reasons for not evacuating were the fear of looting and losing their belongings, and the lack of local shelters. This reflects the need for an integrated disaster mitigation strategy to encourage people to migrate to less vulnerable regions.

In addition, people resist moving to the cyclone shelters during a cyclone. The reasons are thought to be disbelief in warnings among coastal dwellers, the distance of cyclone shelters from settlements,

poor conditions and overcrowding of shelters, mismanagement of weather forecasts and a lack of proper management of the cyclone shelters as well as a fatalistic attitude that the cyclone is the will of *Allah* and that they cannot do anything to counter the event.

In many areas of the coastal belt in Bangladesh, there is no embankment. Therefore, mangroves that offered shelter have been removed to make way for shrimp and salt farming enterprises. Such levels of direct exposure to cyclone hazards mean that the shelters are all the more crucial as an intervention, as one of a few ways in which people can gain protection.

Female deaths attributed to cyclones (relative to male mortalities) are primarily due to gender specific roles and on restrictions of women's spatial mobility imposed by the norm of *purdah* or veil. *Purdah* not only correlates with female's lack of social power and autonomy as well as basic rights, but also hinders spatial mobility in times of cyclones, which is the primary reason for the disparity in cyclone mortality rates between males and females in Bangladesh. Because of gendered division of space, women have less access to information and knowledge regarding any disaster compared to males. Therefore, the combination of impeded mobility and lack of information created by the cultural and religious practice of *purdah* in Bangladesh places women at a higher risk of mortality in all situations.

The communities become more vulnerable to natural hazards, if disaster management is limited, as they become less socially and economically sound. The level and pattern of community development, measured by community social capital, does affect the community's capacity to respond. There was a positive correlation between communities with higher levels and more community oriented patterns of development, and effective response to disaster. The community with the most unique historic, cultural, and religious background had the most social capital, and was able to respond to the disaster most vigorously.

The magnitude and unexpected nature of disaster demands may compromise the organization's or community's ability to coordinate responses. It is in the face of such demands that previous training

and practice are of great importance. Preparedness actions taken on by the community, organizational, and household levels, facilitate effectiveness and efficiency of routine and improvised response activities.

Existing literature shows that several disastrous cyclones hit Bangladesh in 1822, 1876, 1961, 1965, 1970, 1991, 2007 and 2009 (Blaikie, et al., 1994; Dube, et al., 1997; GOB, 2008; Paul, 2009a). During the cyclone 1970, 1991 and 2007 about 500,000; 138,000; and 3,406 people were killed respectively (Ali, 1980; Haider, et al., 1991; GOB, 2008; Paul, 2009a). In fact, more than 50% of total deaths in the world due to cyclones and induced surges occurred in Bangladesh (Ali, 1999; GOB, 2008). The geographic location, unusual characteristics of the tropical monsoon climate, a shallow continental shelf with the confluence of three mighty river systems and funnel shaped estuary exacerbate cyclone and surge impacts in Bangladesh (Haque, 1995; Madsen and Jakobsen, 2004; Paul and Rahman, 2006; Paul, 2009a).

The review of existing literature finds that, although a number of studies have been carried out in Bangladesh looking at different issues of coastal flooding, cyclones and storm surges, the systematic documentation of indigenous knowledge and practices and the identification of how different underlying factors influence coping behavior is still lacking. Therefore, the review of literature on reducing vulnerabilities to natural hazards study intends to explore different pre-disaster, during disaster and post-disaster coping measures, and their effectiveness to mitigate the impacts of cyclones and induced surges on coastal Bangladesh. An attempt has been made to explain how different variables such as age, gender, income, education, occupation, and other exogenous factors influence the adoption of coping measures.

2.19. Vulnerability Redefined

The characteristics of a person or group and their situation influence their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard (an extreme natural event or process).

Decreasing the sensitivity/fragility (very young, elderly persons, female headed household, poor housing, recurring disaster, outside of embankment, inadequate cyclone shelter, lack of preparedness and training, warning system, etc.) and increasing the adaptability (social network & support, savings, insurance, livelihood related coping, etc.) reduce the vulnerability. It involves a combination of factors that determine the degree to which someone's life; livelihood, property and other assets are put at risk by a disaster and identifiable event (series or cascade of such event) in nature or society. Vulnerability varies across geographical space and social groups. The local level may not be the same as vulnerability at regional or national level. In this dissertation, to measure vulnerability as the degree of risk a particular household/community/country faces. Thus, risk was seen as a function of hazard and vulnerability. However, the frequency of experiencing hazards and hazard adjustments reduce vulnerability.

CHAPTER : 3

METHODOLOGY

3.0. CHAPTER THREE: METHODOLOGY

3.1. Methodology

To achieve the objective of the present study, intensive fieldwork was conducted to collect the data directly from primary sources; i.e. the study areas, as there were no other sources to collect relevant data. Secondary data was also used in this research study. The following procedures were followed in collecting different information from the study areas:

3.2. Methodological Basis

This study utilizes the concept of hazards-of-place vulnerability (Cutter, 1993; Cutter, et al., 2003), to examine the components of social vulnerability. In this conceptualization, risk (an object measure of the livelihood of a hazard event) interacts with mitigation (measures to lessen risks to reduce their impact) to produce the hazard potential. The hazard potential is either moderated or enhanced by a geographic filter (site and situation of the place, proximity) as well as the social fabric of the place. The social fabric includes community experience with hazards, and community ability to respond to, cope with, recover from, and adapt to hazards, which in turn are influenced by economic, demographic, and housing characteristics. The social and biophysical vulnerabilities interact to produce the overall place vulnerability. Two models were examined.

Pressure and Release model (PAR) (see Figure 1). In this model two opposing forces are described; on one side is the vulnerability progression and on the others is the natural hazard. The interaction of these two components will produce a disaster risk to a specific hazard. This model presents risk as the result of the occurrence of some conditions of vulnerability and some of possible threats (Cardona, 2004, Wisner, et al., 2006). It is a simple model to show how disaster occurs when natural hazards affect vulnerable people. Birkmann (2006) also highlighted that the PAR model is an important approach and one of the best known conceptual frameworks worldwide that focuses on vulnerability and its underlying driving forces. However, in the PAR model the contribution of adaptation and

capacity of vulnerable people to absorb the impact of the hazard are not discussed.

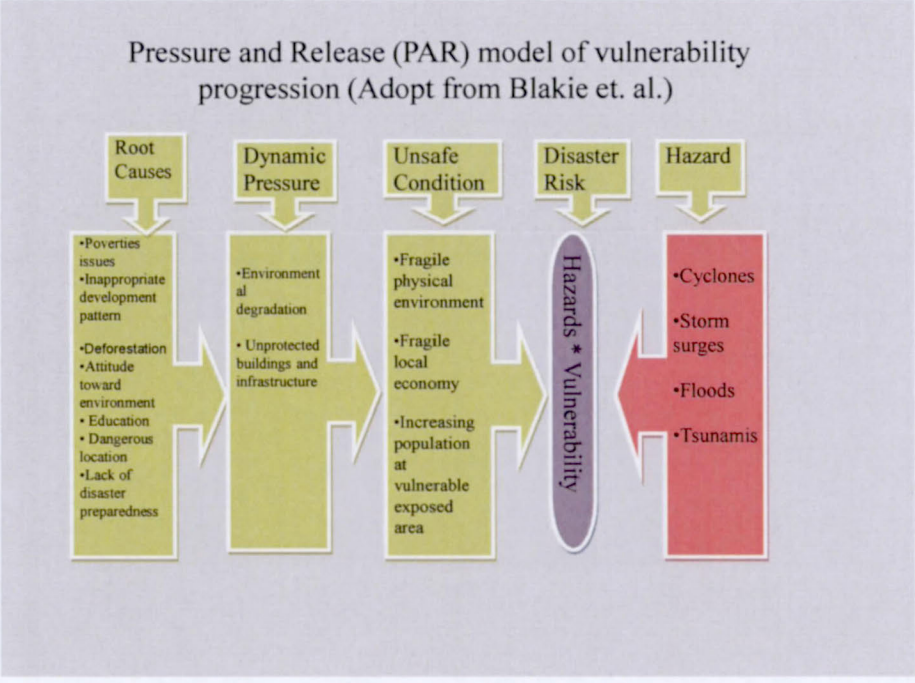


Figure: 3. 1). Pressure and Release (PAR) model of vulnerability progression (Adopted from Blakie, et. al.)

Another conceptual framework on vulnerability promoted by Birkmann, Bogardi (2004) and Cardona (1999) combines different elements of the previous frameworks, which include the people's and community's ability to cope with the impact of a hazardous event, the potential to resist the negative impact of disaster, and the potential intervention tools to reduce vulnerability (Figure 2). For example this encompasses the identification and assessment of the vulnerability of the population exposed (different social groups), basic infrastructure services and physical structures within coastal communities.

The Bogardi, Birkmann, and Cordona (BBC) framework distinguishes between the response before risk and disasters are manifested ($t=0$) and the response needed when risk and disaster occur ($t=1$). Due to its theoretical definition of vulnerability, the approach that is used in this study is based on the BBC (Bogardi, Birkmann and Cardona) conceptual framework, which stresses the fact that

vulnerability is defined through exposed and susceptible elements, on one hand, and the coping capacities of affected entities (e.g. social groups) on the other. Additionally, the BBC-framework shows that it is also important to address the potential intervention tools that could help to reduce vulnerability in the social, economic and environmental sphere (Brikman, 2006), such as early warning.

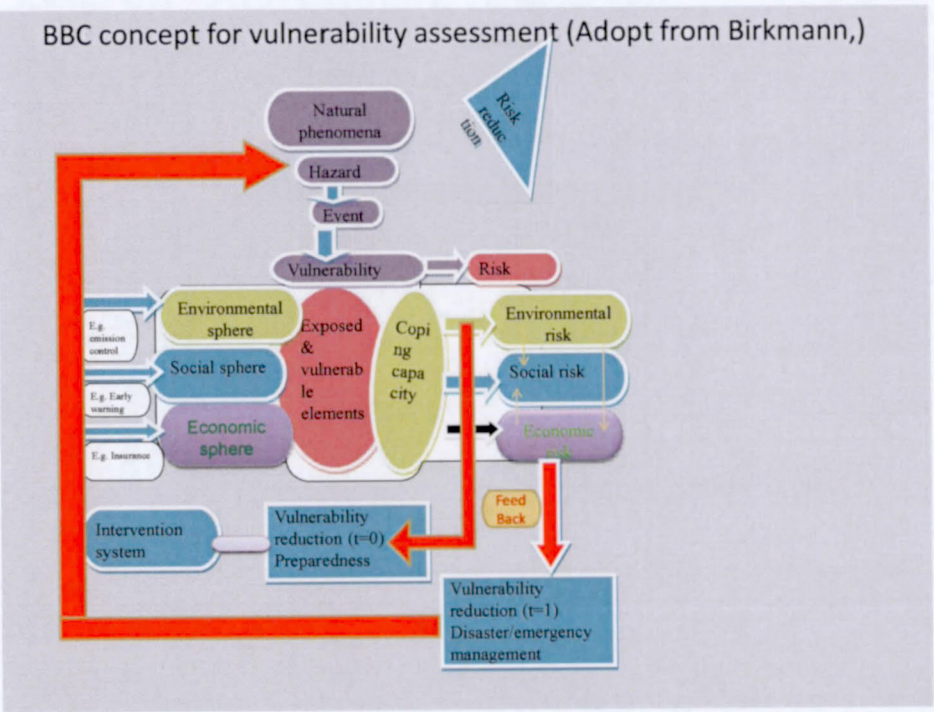


Figure: 3. 2). BBC concept for vulnerability assessment (Adopt from Birkmann, 2006)

3.3. Criteria for Study Area Selection

The main criterion in choosing the coastal districts of Coxes Bazar, Noakhali, Bhola, and Barguna as the study area was the degree of their vulnerability to coastal hazards, especially to cyclones and tidal surges. Therefore, the influence of seasonal cyclones, tidal surges, and the extent and depth of flooding were considered as important variables in determining the vulnerability of this area.

First, the National, International and NGOs information was correlated with local statistical data, to determine which districts & *upazilas* were more vulnerable to cyclone and tidal surges. Then, two unions which were affected by cyclones and tidal surges were selected in each *Upazila*.

Table: 3. 1). Selection procedure of study area

Unit	Bangladesh	Coastal Area	Selected Area
Division	7	3	2
District	64	19	4
Upazila	507	147	4
Union	4,562	1,382	8
Household	32.17 Million	7.84 Million	385

Source: BBS, 2011; PDO-ICZMP, 2004b.

3.4. Determination of Sample Size

The universe is unknown. So, considering constrains of cost, manpower and time limitation to determine the optimum size of the sample, the following formula was used. The sample survey, if p is such a proportion that has a given attribute, and q is the proportion not having the attribute, such that $p + q = 1$, then for a sufficiently large population, the formula is:

$$n_0 = \frac{z^2 pq}{d^2}$$

Where, *no* = desired sample size

z = standard normal deviate usually set at 1.96, which corresponds to the 95% confidence level

p = assumed proportion in the target population estimated to have a particular characteristic.

d = degree of accuracy desired in the estimated proportion.

If p is difficult to assume, take it to be 0.50. In that event, estimating the sample size is:

$$n_0 = \frac{(1.96^2)(.5)(.5)}{(.05)^2} = 385$$

According to formula, the sample size in the present study was 385.

3.5. Sampling Design of the Baseline Survey

A multi-stage sampling design was followed for selecting the final sampling unit (FSU). Once the primary sampling units were selected at the first stage, the subsequent stages were a process of sub-sampling from the units chosen at the immediate previous stages. Thus the second stage sample of units was chosen from the first stage sample of units, the third stage sample of units was chosen from the second stage sample of units and so on.

Table: 3. 2). Systematic sampling design

Stage	Sampling units	Referred here as	Number	Name
1	District	Primary sampling unit (PSU)	4	Bhola, Cox's Bazar, Noakhali, Barguna.
2	*Upazila*	Secondary sampling unit (SSU)	4	Manpura, Kutubdia, Hatiya, Pathargata
3	Union	Penultimate sampling unit (PUSU)	8	Hajirhat, Manpura,Ali Akbor Deil, Kaiyarbil, Nijimdip, Char Isshor, Pathargata, Char Duani.
4	Household	Ultimate sampling unit (USU)	385	

In the survey, the whole coastal area was divided into 19 ecological administrative zones (ICZMP, 2006). Initially, districts (each an administrative unit) were selected as primary sampling units (PSU). From each selected district, four sub-districts were selected as the secondary sampling units (SSU). This is the second stage. From the selected sub-district, eight unions were selected as the penultimate sampling units (PUSU). This is the third stage. At the fourth and final stage, households were selected from eight unions, and all members of the selected households were subjected to a detailed interview. The first and the second stages adopted a purposive sampling method while at the third and fourth stages, systematic sampling methods were employed.

3.6. Data Gathering Techniques

The study utilized both primary and secondary data collection. Secondary data were gained from desk research (publications, journals and reports). Primary data were collected using a combination of approaches that included households' questionnaires, key informant interviews, and community level Focus Group Discussion (FGDs). These methods related to the collection of data directly from the household heads or individual respondents and community people. The field investigators personally contacted the respondents and obtained the desired information by explaining the objectives of the study. Some data, especially those relating to housing conditions, toilet facilities and other housing characteristics were collected by observation as far as possible. The first two approaches (household's questionnaires, key informant interviews) gathered quantitative data while the last (FGDs) captured qualitative responses from a sample of the target population as participants.

3.7. Primary Survey Tools/ Instruments Used

A structured questionnaire was used to gather primary data from randomly sampled households. The questionnaires focused on determining the source of risks and vulnerabilities of the target population by studying their social, economic, environmental and physical conditions [Appendices, 3]. Their behavior towards risk, mitigation and coping mechanisms against calamities and natural disasters was likewise inquired into.

To triangulate the data gathered from secondary information and primary data, commonly social knowledge, people's experience, and coping strategies, a focus group discussion guide was designed to get qualitative data [Appendices, 4]. One FGD was conducted for each union level (community level) and participants were union chairmen, members, school teachers, health employees, NGO workers, farmers and union prominent people.

3.8. Physical Investigation and Studies (Direct Observation)

To study existing physical conditions and components of the study areas, and their housing patterns, reconnaissance to every individual community's facilities was done. The 'rule of thumb' method

(Walking a distance of 44 steps equal to 100 feet) was applied to measure the areas of various community functions and different infrastructures. At the same time, information regarding patterns was extracted through the discussions with the local union *porishod* employees, U.P. members, NGO workers, revenue officers, local elders and literate persons and other concerned people.

3.9. Collection of Data from Secondary Sources

All efforts have been made to collect data from secondary sources. These data have been collected from the Ministry of Disaster Management and Relief (MoDMR), Ministry of Food and Disaster Management (MoFDM), Ministry of Water Resources (MoWR), Disaster Management Bureau (DMB), Directorate of Relief and Rehabilitation (DRR), Cyclone Preparedness Programme (CPP), Bangladesh Red Crescent Society, Bangladesh Bureau of Statistics (BBS), Water Resource Planning Organization (WARPO), Integrated Coastal Zone Management (ICZM), Ministry of Environment and Forest (MoEF), Housing and Settlement Directorate (HSD), Civil Aviation of Bangladesh, Roads and Highways, Bangladesh University of Engineering and Technology (BUET), and some related NGOs like, Bangladesh Disaster Preparedness Center (BDPC), Cooperative for Assistance and Relief Everywhere (CARE), Christian Association for Development in Bangladesh (CCDB), Bangladesh Rural Advancement Committee (BRAC), Comprehensive Disaster Management Programme (CDMP),CARITAS, World Vision, etc.

3.10. Analytical Framework

The model below (Figure: 1.4) was used to analyze the results of the survey. It looks into a number of factors in determining the causes of the risks and vulnerabilities of the households:

- Socioeconomic, cultural and behavioral indicators: age, sex, number of children and their age distribution, household size; occupation; household income per month; productive assets; savings; insurance; attitudes towards calamities etc.

- Environmental indicators: natural hazards like cyclones and storm surges are due to geographical locations which determine the number of cyclones visiting the areas and their frequency and intensity etc.
- Physical vulnerability indicators: the types of housing; school buildings and health centers; the critical lifelines like water supply, electricity, roads, bridges and other transport facilities and telecommunication systems which are vital for post-disaster rehabilitation and reconstruction. Of special concern is a look at land and resource use practices in the survey areas.

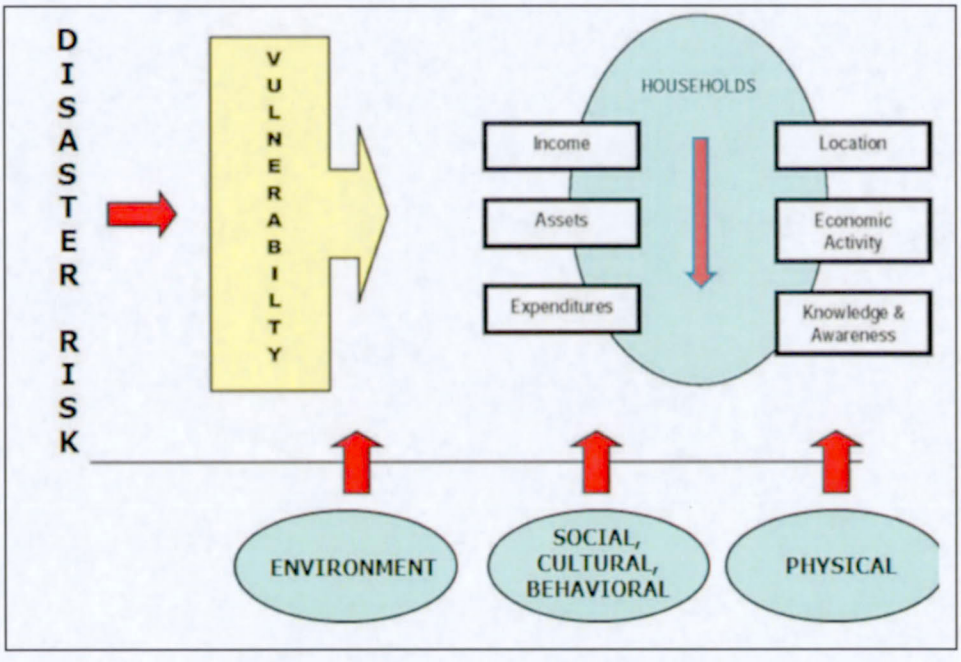


Figure: 3. 3). Analytical framework

- Capacity indicators-preparedness and mitigation measures as indicated by:
  - The existence of standard operating procedures during emergencies (like designation of evacuation centers and other contingency measures) and availability of search and rescue capabilities.
  - Warning systems available to the people
  - Awareness of the people and perceptions of the community on natural disaster and Disaster Risk Reduction (DRR).

- Programs and projects implemented by the government and NGOs in the area, including the effect and impact of these programs and projects in terms of damages and the cost involved per program/ project.
- Community-initiated preparedness and mitigation activities, their effectiveness and costs.

3.11. Limitation of the Research

Like many other studies, the present study has its limitations. Efforts have been made to complete the present research as precisely as possible in order to present it as a PhD dissertation. The researcher thinks that time limitation is one of the main barriers to complete the vast present research. Due to time shortage the sample size (385 in number) was also kept small.

The analysis of people's vulnerability from natural disasters is complex and extensive. Detailed data were unavailable for complete research in this field. For the development of the present socioeconomic condition of Bangladesh, it is very important to reflect on and analyze the existing housing structures & their vulnerability. In the regional perspective, had there been such research conducted in the entire country, more effective roles could have been played in making accurate research plans for the development of the coastal area.

One of the key sources of vulnerability was the quality of housing. This issue was covered in the survey, but only perceptions of the strength of such buildings. Evaluating such buildings can be a future activity of the local government and the community as part of Disaster Risk Reduction (DRR).

The choice of the study areas was based on available secondary data from the different offices at national and regional levels, and from the expert opinion of the key stakeholders on disaster risk management in the region. The experts were chosen based on their experience and relative familiarity with the Disaster Risk Management (DRM) on the ground.

It should be noted that the survey focused on macro-level disasters and therefore did not cover particular vulnerabilities such as disabilities of individuals or the pattern of food sharing within the household. Therefore, the survey results do not provide detailed information about the specific vulnerabilities of individuals in a given household. The survey revealed that on average two members of the family were children, one was elderly, and one person in each household was able to work. All of these factors add not only to the vulnerability of those individuals but to that of the household as a whole.

In spite of limited opportunity and time, the present study shows considerable depth. It is assumed that the vulnerable people of the coastal areas will be able to mitigate their vulnerabilities caused by cyclones and tidal surges through the present research heading into the future.

CHAPTER : 4

HISTORICAL BACKGROUND HAZARD IN BANGLADESH

4.0. HISTORICAL BACKGROUND OF HAZARD IN BANGLADESH

4. 1. Introduction

Bangladesh is a low lying deltaic country in South Asia formed by the Ganges, the Brahmaputra and the Meghna rivers. It is a land of about 152.51 million people within its 147,570 sq. km (BBS, 2011). One fifth of the population lives within 19 coastal districts that are prone to multiple vulnerabilities (PDO-ICZMP, 2004a). These areas have fragile ecosystems and potential for enormous development. The geographic location, land characteristics, monsoon climate, and constant flow of more than 230 rivers and tributaries, which carry a great deal of sediments, have made the country a land of natural hazards (MoFDM, 2010). It is one of the most disaster-prone countries and is affected mainly by droughts, cyclones, floods, earthquakes, and tidal surges. The natural disasters Bangladesh is regularly subjected to include flooding and cyclonic weather that wash away crops and damage property (Chowdhury, et al., 2011).

Disasters have two historical trajectories, one 'natural' and the other societal. They are both 'historical' in the sense that both forces change over time. The fact that the nature of hazards varies over the years is perhaps less immediately apparent than that societies do. As Paul Edwards (2002) notes, this is largely due to differences between human, historical and geo-physical scales of time. Human time scales are set by our natural characteristics (days, years, decades) in which the nature of the hazards often changes too slowly for most of us to notice.

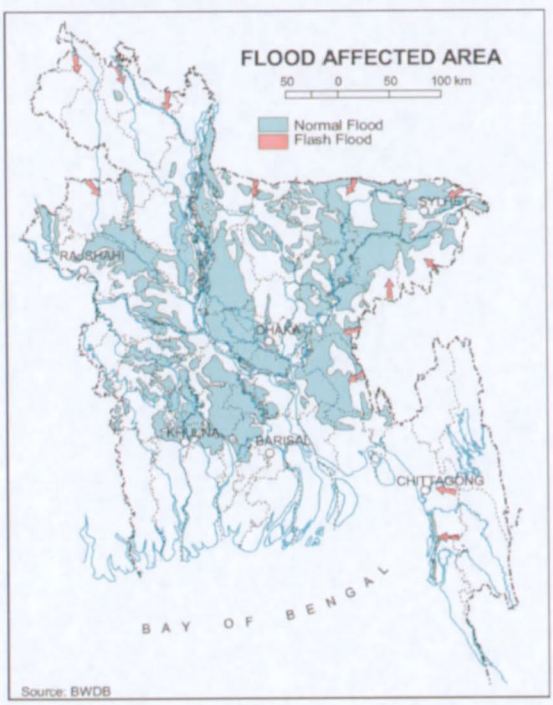
4.2. Hazard in Bangladesh

Bangladesh is exposed to natural hazards, such as, floods, river bank erosion, cyclones, droughts, tornadoes, cold waves, earthquakes, drainage congestion/ water loggings, arsenic contamination, salinity intrusion etc. But the nature of such occurrences, the seasons and extent of effects of the hazards are not the same in all places.

4.2.1. Flood

The major portion of Bangladesh is low land, one of the largest flood plains in the world. The total catchment area of the major rivers in Bangladesh is more than 12 times the size of Bangladesh (Choudhury and Sarker, 2011). Floods are annual phenomena, with the most severe occurring during the months of July and August. Regular river floods affect 20% of the country, increasing up to 68% in extreme years. Some parts of India and Bangladesh experience floods almost every year with considerable damage. Severe floods occur periodically and Bangladesh experienced floods in 1954, 1955, 1974, 1987, 1988, 1998, 2004 and 2007. Post-independence floods of 1974 and 1987 inundated about 40 to 45 percent of the land area of Bangladesh and over 75 percent of the land area in 1988 (MoFDM, 2010; BBS, 2011). During the middle of 1998, Bangladesh experienced the most devastating and prolonged flood in its history, which caused a serious disruption to the economy of the country. The extent of the damage caused by the flood is estimated to be around 3.0 billion US dollars (Alam, 2003).

Map: 4. 1). Flood affected area in Bangladesh



Source: Bangladesh Water Development Board

Approximately 37%, 43%, 52% and 68% of the country is inundated with floods of return periods of 10, 20, 50 and 100 years respectively (MPO, 1986). Four types of flooding occur in Bangladesh.

- Flash floods caused by the overflowing of hilly rivers in eastern and northern Bangladesh (in April-May and September-November).
- Rain floods caused by drainage congestion and heavy rains.
- Monsoon floods caused by major rivers usually in the monsoon (during June- September).
- Coastal floods caused by storm surges (MoFDM, 2010).

In the year 2000, Bangladesh faced an unusual flood over its usually flood-free south-western plain, which also caused loss of life and massive damage to property (Choudhury and Sarker, 2011).

4.2.2. Cyclones and Storm Surges

Tropical cyclones from the Bay of Bengal accompanied by storm surges are one of the major disasters in Bangladesh. The funnel shaped northern portion of the Bay of Bengal causes tidal bores when cyclones make landfalls, and thousands of people living in the coastal areas are affected (Choudhury and Sarker, 2011). The country is one of the worst sufferers of all cyclonic casualties in the world.

The number of casualties is due to the fact that cyclones are always associated with storm surges. Storm surge heights in excess of 9 meters are not uncommon in this region. For example, the 1876 cyclone had a surge height of 13.6 meters and in 1970 the height was 9.11 meters (WARPO, 2005).

Table: 4. 1. Chronology of major cyclonic storms from 1904 to 2010

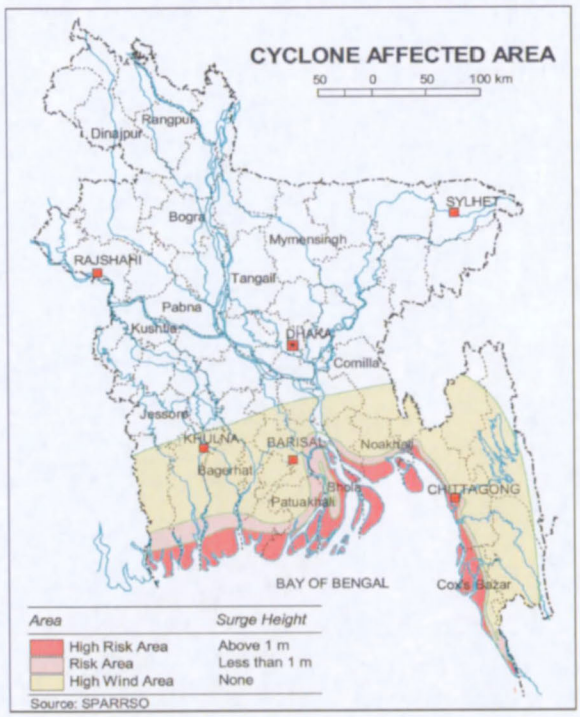
Date of occurrence	Landfall Area	Max. wind speed in Km/hr	Storm surge ht. (in ft)	Deaths
11.11.1904		-	-	143
16.10.1909		-	-	698
12.10.1913		-	-	500
24.09.1917		-	-	432
18.05.1941		-	-	-

19.05.1948		-	-	1,200
19.05.1958		-	-	870
11.10.1960	Chittagong	160	15	3,000
31.10.1960	Chittagong	193	15-20	5,149
09.05.1961	Chittagong	160	8-10	11,468
30.05.1961	Chittagong	160	6-15	-
28.05.1963	Chittagong, Cox's Bazar	209	8-12	11,520
28.05.1963		203	14-17	11,520
11.04.1964		-	-	196
11.05.1965	Chittagong, Barisal	160	12	17,279
05.11.1965	Chittagong	160	8-12	873
15.12.1965	Cox's Bazar	210	8-10	1,000
01.11.1966	Chittagong	120	20-22	850
11.10.1967		-	6-28	-
24.10.1967		-	5-25	-
10.05.1968		-	9-15	-
17.04.1969		-	-	75
10.10.1969		-	8-24	-
23.10.1970	Khulna, Barisal	163	10-16	-
12.11.1970	Chittagong	224	10-33	500,000
08.05.1971		-	8-14	-
30.09.1971		-	8-14	-
06.11.1971		-	8-18	-
18.11.1973		-	8-13	-
09.12.1973		122	5-15	183
15.08.1974		97	5-22	-
28.11.1974	Cox's Bazar	163	9-17	350
21.10.1976		105	8-16	-
13.05.1977		122	-	-
10.12.1981	Khulna	120	7-15	72
15.10.1983	Chittagong	93	-	143
09.11.1983	Cox's Bazar	136	5	300
03.06.1984		89	-	-

24.05.1985	Chittagong	154	10-15	11,069
29.11.1988	Khulna	160	2-15	12,133
18.12.1990	Cox's Bazar	115	5-7	-
29.04.1991	Chittagong	225	12-22	138,000
02.05.1994	Cox's Bazar Coast	278	5-6	188
25.11.1995	Cox's Bazar	140	10	6
19.05.1997	Sitakundu	232	15	155
27.09.1997	Sitakundu	150	10-15	78
20.05.1998	Chittagong Coast	173	314	
17.10.1999	Orissa Coast	-	-	-
25.10.1999	Orissa Coast	-	-	-
28.10.2000	Sundarban Coast, Mongla	50-60	2-4	3
16.10.2001	Andhra Coast	65-85	-	-
12.11.2002	Sundarban Coast	65-85	5-7	2
20.05.2003	Myanmar Coast	65-85	3-5	-
19.05.2004	Cox's Bazar	65-90	2-4	26
15.11.2007	Khulna, Barisal Coast	223	15	3,363
25.05.2009	West Bengal, Khulna Coast	70-90	4-6	330

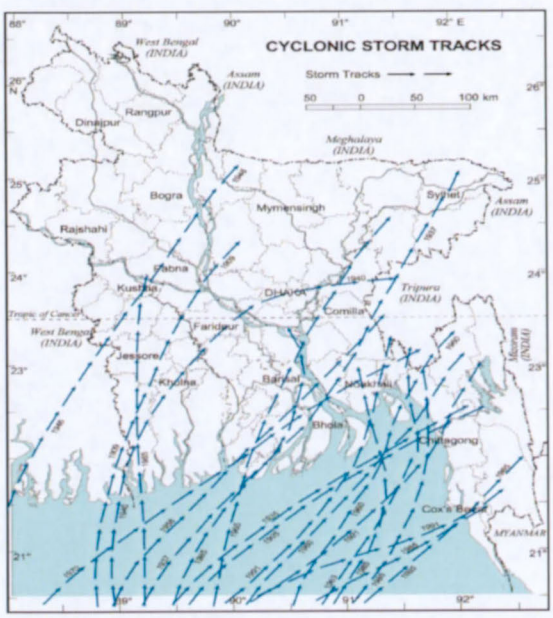
Source: Banglapedia, 2011; Bangladesh Meteorological Department, 2011; CPP, 2011; B.B.S., 2011.

Map: 4. 2). Cyclone affected area in Bangladesh



Source: Space Research and Remote Sensing Organization

Map: 4. 3). Cyclonic storm tracks in Bangladesh



Source: Banglapedia

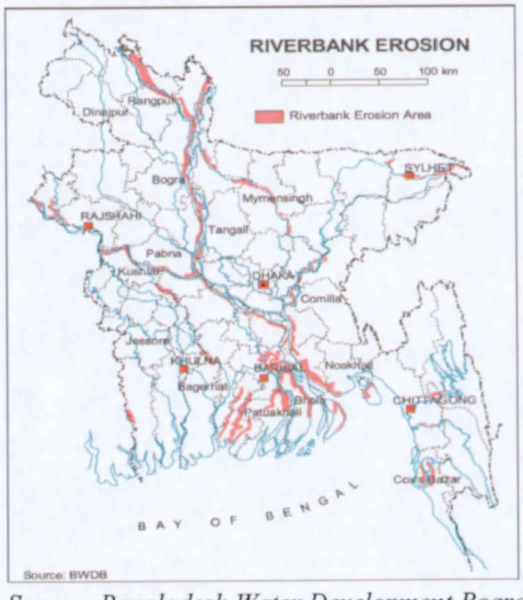
4.2.3. Tornado

The two transitional periods between southwest and northeast monsoons over the Indian sub-continent are characterized by local severe storms. The transitional periods are usually referred to as pre-monsoon (March-May), and post-monsoon (October-November). It is the pre-monsoon period when most of the abnormal rainfall or drought conditions frequently occur in different parts of Bangladesh. Tornadoes are embedded within a mother thundercloud, and move along the directions of the squall of the mother storm. Tornadoes are more frequent in the afternoon.

4.2.4. River Bank Erosion

This is an ongoing disaster and there is no specific indicator to measure the extent of damage. So the extent of damage caused by the river erosion in most cases is based on various reports/ information. Needless to say, whatever the difference in ascertaining the extent of damage river bank erosion is, it causes huge loss of property throughout the year. According to "World Disaster Report 2006" published by IFRCS, every year about 1,000,000 people are affected by river erosion and 9,000 hectares of cultivable lands are banished to rivers. Among these few affected people are able to find new shelters while others become homeless for uncertain periods.

Map: 4. 4). Riverbank erosion in Bangladesh



Source: Bangladesh Water Development Board

Photograph: 4. 1). Riverbank erosion in Bangladesh

4.2.5. Earthquake

Bangladesh and the northeastern Indian states have been some of the most seismically active regions, and have experienced several large earthquakes during the past 200 years. Many seismic tectonic studies have been undertaken on the area comprising the Indo-Burma ranges and their western extension and in Northern India. Major active fault zones of the country have been delineated through geological trenching and dating methods. A seismic zoning map of Bangladesh was proposed in 1979 by the Geological Survey of Bangladesh (GSB), dividing the country into three seismic zones which was accompanied by an outline of a code for earthquake resistant design. A list of reference on this is provided in Haque, (1990), using data from various sources. Later, a new updated seismic zoning map and detailed seismic design provisions were incorporated in the Bangladesh National Building Code (BNBC, 1993). Bangladesh has been classified into three seismic zones with zone-3 the most and zone-1 the least vulnerable to seismic risks.

Map: 4. 5). Earthquake zones in Bangladesh

Source: Geological Survey of Bangladesh

4.2.6. Drought

Drought is an abnormal condition where there is a lack of sufficient water to meet the normal needs of agriculture, livestock, industry, or human use. Bangladesh faces unpredictable drought hazard in the dry monsoon due to inadequate and uneven rainfall. It varies from place to place, however, and the northwestern region suffers most from the drought. Basically, in Bangladesh, there are three types of droughts: permanent, seasonal and unpredictable.

- Permanent drought characterizes regions with the driest climate, having sparse vegetation that is adapted to aridity. Agriculture cannot be practiced without irrigation.
- Seasonal drought occurs due to abnormal rainfall shortage in places where there are well defined annual rainy and dry seasons.
- Unpredictable drought involves an abnormal rainfall failure, mostly in localized areas of humid and sub-humid climates.

Bangladesh is at a high risk from droughts. Drought conditions due to deficiency in rainfall affect different parts of Bangladesh mostly during the pre-monsoon and post-monsoon periods (Brammer, 1981). Between 1949 and 1991, droughts occurred in Bangladesh 24 times. Very severe droughts hit the country in 1951, 1957, 1958, 1961, 1972, 1975, 1979, 1981, 1982, 1984 and 1989. Past droughts have typically affected about 47% of the country's area and 53% of it's the population (WARPO, 2005).

4.2.7. Landslide

In Bangladesh, landslides are mostly triggered by heavy rainfall. However, underlying causes of landslides include deforestation, hill cutting, unregulated development work, etc. Moreover, poverty and landlessness force poor people to live on the risky hill slopes. In the past, landslides were not considered a major hazard in Bangladesh.

4.2.8. Arsenic Contamination

Groundwater in 61 out of the 64 districts in Bangladesh is contaminated with arsenic. According to the study conducted by the British Geological Survey and DPHE, Bangladesh, arsenic concentrations in the country range from less than 0.25mg/L to more than 1600mg/L. The waters in the southwest and southeast parts of Bangladesh are highly contaminated with arsenic.

At present, arsenic contamination is considered to be a dangerous environmental threat and a serious health risk. It is identified as a public health emergency in Bangladesh. There is no specific treatment for chronic arsenic other than ceasing further intake of arsenic contaminated water and raising awareness in the population about the problem.

4.2.9. Salinity Intrusion

Saline water intrusion is mostly seasonal in Bangladesh; in winter months the saline front begins to penetrate inland, and the affected areas rise sharply from 10 percent in the monsoon to over 40 percent in the dry season. Coastal districts such as Satkhira, Khulna, Bagerhat, Barguna, Patuakhali, and Barisal are the victims of salinity in the dry season. It is observed that dry flow trend has declined, as a result of which sea flow (saline water) is traveling far inside the country resulting in contamination both in surface and ground water (WARPO, 2005).

4.2.10. Tsunami

Strong underwater earthquakes, volcanic eruption or other submarine landslide usually cause tsunamis. When earthquakes occur offshore at seduction zones (places where a tectonic plate that carries an ocean is gradually slipping under a continental plate), some tsunamis can be very large. In coastal areas their height can be as great as 30 feet or more (100 feet in extreme cases), and they can move inland several hundred feet.

Considering the state of tsunami vulnerability and potential seismic sources, Geological Survey of Bangladesh has divided the Bangladesh coastal belt into three zones:

- Tsunami vulnerable zone-1 (Chittagong- Teknaf coastline): Most vulnerable zone. The intra-deltaic coastline is very close to the tectonic interface of India's and Burma's plates. The active Andaman-Nicobar fault system is often capable of generating tsunami waves.
- Tsunami vulnerable zone-2 (Sundarban-Barisal coastline): Moderately vulnerable zone. This old deltaic belt is extremely vulnerable to local tsunamis due to the presence of Swatch of No Ground.
- Tsunami vulnerable zone-3 (Barisal-Sandwip estuarine coastline): Least vulnerable zone. The estuarine coastal belt considered to be less vulnerable due to the presence of numerous islands and shoals in the upper regime of the continental shelf.

Bangladesh needs detailed study to scientifically asses the tsunami vulnerability. Bangladesh also needs to develop a tsunami early warning system and mass awareness of the tsunami threat along the coastal areas.

4.3. Overview of Climatology of Landfalling Tropical Cyclones in Bangladesh (1877-2010)

A total of 121 tropical cyclones hit the coast of Bangladesh from 1877 to 2010 of which 39 are tropical depressions (TD), 52 are tropical storms (TS), and 30 reach hurricane intensity. In the past century (1901-2000), the rate of tropical storms striking the coast is 10 storms/decade, or one storm per year. Since 1950, the rate of land falling tropical storms in this area has increased, 1.18 per years for 1950-2000 (Islam & Peterson, 2009; CPP, 2011).

By landfall locations, Khulna coast located in the south-west corner of Bangladesh faced the highest number (36) of tropical cyclones in 1877-2003. The next subdivision is Barisal, where 31 storms hit during 1877-2003. Chittagong and Cox's Bazar are very close to each other by the number of hits, 21 and 20, respectively. The lowest number (9) of tropical cyclones hit the Noakhali coastal segment (Islam &Peterson, 2009).

Barisal and Chittagong subdivisions experienced a large number of deaths compared to the other coastal segments mainly due to the 1970 and 1991 super cyclones. The former hit the Barisal coast

and killed 300,000 people; the latter made landfall at Chittagong coast and caused 138,866 deaths. Ironically, Khulna coast experienced fewer deaths compared to its number of cyclone hits. The key mitigating factor is the location of the Mangrove forest (Sundarbans) in this segment, which works as a shield against the wind and storm surges during tropical cyclones. Effective land use is, therefore, very important to the reduction of cyclone damage. Cox's Bazar experienced the lowest number of deaths. Low population density in this segment might be one of the reasons for fewer casualties (Alam, et al., 2003; CRED, 2006).

In the pre and post-monsoon seasons, the average sea surface temperature in the Bay of Bengal region and associated weather conditions is ideal for the formation of tropical cyclones. Most tropical cyclones (70%) hit Bangladesh in the months of May-June and October-November from 1877-2003. These periods are also favorable for tropical cyclones with hurricane winds. During 1877-2003, 19 out of 26 hurricanes (73%) made landfall in these months (Islam & Peterson, 2009).

A reliable and comprehensive land falling tropical cyclone database and subsequent climatology have been established for the Bangladesh coast. The trend of tropical cyclones hitting the Bangladesh coast is not steady. It has vacillated in the past century. Presently, there is an increasing trend. Among the coastal segments, Khulna is the most vulnerable in terms of cyclone landfall. Barisal and Chittagong coasts are highly vulnerable in terms of cyclone casualties. In Bangladesh, cyclone disturbances are absent in January, February, and March. Most of the tropical cyclones including the ones in the hurricane category strike the coast of Bangladesh in the pre and post-monsoon seasons, thus, confirming two annual tropical cyclone seasons for Bangladesh (Alam, et al., 2003; Islam & Peterson, 2009).

4.4. Conclusion

The relief and recovery approach of disaster management in Bangladesh has been improved. The early warning system was implemented in Bangladesh after the 1970 cyclone which resulted in 300,000

deaths; nonetheless, 138,000 people perished in the subsequent 1991 cyclone when most failed to respond to warnings, as well as the problem of lack of shelters (Shultz, et al., 2005). Now it is widely believed that the Bangladesh Government's attempt to improve the early warning system has contributed to fewer deaths (Paul, 2009a). In 2004, a cyclone made landfall on Cox's Bazar, causing over 24 deaths; In 2007, cyclone *Sidr* made landfall on southern Bangladesh, causing over 2,388 deaths and inflicting severe damage; in 2009, cyclone *Aila* caused 330 deaths (Shaw, et al., 2009).

CHAPTER : 5

HISTORY OF DISASTER MANAGEMENT AND CAPACITY BUILDING IN BANGLADESH

5.0. HISTORY OF DISASTER MANAGEMENT AND CAPACITY BUILDING IN BANGLADESH

5. 1. Introduction

With its densely populated low-lying river zone, high poverty rates and extreme exposure to cyclones, storms and floods, multiple hazards and risks culminate in Bangladesh. It is one of the most disaster-prone countries in the world (IFRC, 2012). With limited resources, its real development is not possible without the integration of disaster mitigation programs. The country is striving hard to establish an elaborate and experienced disaster management system from the national down to the community level to mitigate the effects of disasters.

5.2. Background of Disaster Management

Disaster management involves complete preparation for disasters before they occur, and after they occur, the rebuilding of society and rehabilitation of the people. It requires a concerted effort between the government and the private sector (Newsjockey, 2008). It is a continuous process of individuals, groups, and communities managing hazards to avoid or ameliorate the impact of disasters where action taken depends partially on the perceptions of risk of those exposed (Wisner, et al., 2004). In 1989, the United Nations General Assembly declared the 1990s the International Decade for Natural Disaster Reduction to address issues associated with disaster prevention.

In 1994, as a corollary of the International Decade for Natural Disaster Reduction, the Yokohama Strategy for a safe world and its plan of actions were adopted at the World Conference on Natural Disaster Reduction held in Yokohama, Japan. This strategy detailed the guidelines for prevention, preparedness, and mitigation of disaster risks. The principles embodied in the strategy acknowledge the necessity of a better prevention mechanism against disasters for the global population. The most significant aspect is the principle of sharing technology among international communities to prevent and mitigate disasters. The World Conference on Disaster Reduction in the year 2005 was another milestone event conducted to increase the consensus for incorporating disaster risk reduction into

development agendas. The conference defined and determined challenges, critical needs, and opportunities in disaster risk reduction initiatives worldwide. It also identified the good practices followed since the adoption of the Yokohama Strategy in 1994 and adopted the Millennium Development Goals (Newsjockey, 2008).

5.3. Comparative Perspective Disaster Capacity Building of Bangladesh, Cuba and the Philippines

Comparing one society with another across time is a significant historical methodology; looking to see what other cultures or communities did or do to tackle similar problems is educational to both. A country's response to natural hazard may depend more on its social and organizational practices than on its wealth or resources, a realization that until recently was sorely lacking in most discussions of disaster management. International recognition that all communities are resilient and that their capacities have relevance to Disaster Risk Reduction (DRR) was finally accorded by member states of the United Nations (UN) when they adopted the Hyogo Framework for Action in January 2005. The plan's emphasis on ensuring that DRR was both a national and local priority that utilized knowledge, innovation and education to build 'a culture of safety and resilience at all levels' was indicative of the need to think comparatively through time and across cultures (UNISDR, 2005b). Just as the past has its own 'lesson' to disclose to the present, so communities and societies can learn from each other's experiences.

A contemporary case is Cuba. Through public education, national training exercises, a comprehensive early warning system, an integrated civil defense structure and firm government leadership, Cuba is better able to protect its citizens and resources than most other states in the world. In particular, authorities are able to carry out large scale evacuations in an orderly and timely manner without extensive loss of life, as when 750,000 and 1.5 million people were respectively removed from low lying areas in the paths of Hurricane Michelle in 2001 and Hurricane Dennis in 2005 (Aguirre, 2005; Sims and Vogelmann, 2002). Hurricane Jeanne, which cut a swath of destruction through the

Caribbean in 2004 leaving over 3,000 dead in neighboring Haiti, passed without loss of life over Cuba (Bermejo, 2006: 14). Cuba now serves as a model for the UN, and its government has even organized special medical brigades to provide assistance overseas in the case of disasters (Sims and Vogelmann, 2002). The Cuban model, however, has had no lack of critics who, while grudgingly acknowledging its effectiveness in certain areas of disaster preparedness and management, maintain that it depends upon an extensive system of social controls unrealizable in more 'democratic' societies (Aguirre, 2005).

In the Philippines, for instance, one of the most hazard-prone land masses in the world, there is a long history of a variety of formal and informal associations and networks committed to individual and community welfare that stretch back to 1556, when written records began (Bankoff, 2007b). It is manifested these days in a strong commitment to community-based development oriented disaster management that has become an international model for communities to emulate around the world. The comparative approach used by historians emphasizes the need to consider alternatives, that no one culture or state has a monopoly on 'best practice', and underscores the importance of dialogue between peoples and across cultures.

5.4. Disaster Management in Bangladesh: Institutional Structure and Capacity Building

5.4.1. Between 1972 to 1990

Given the extreme hazard and risk exposure found in Bangladesh, Disaster Risk Management (DRM) has been the cornerstone of Bangladesh Red Crescent Society (BDRCS) since its very inception in 1971. BDRCS launched a cyclone preparedness programme (CPP) in 1972 to reduce the vulnerability of cyclone-exposed communities along the country's coastline (IFRC, 2012).

The cyclone preparedness program was developed after the devastating effects of the 1970 cyclone. The government has a standing order for natural disasters, especially designed to deal with the issues of floods and cyclones, which must be followed by all the ministries, divisions or departments, and

government agencies before, during, and after the disaster period. In addition, the draft National Water Management Plan emphasizes the effective implementation of nonstructural measures to reduce the effects of floods and river bank erosion, which enunciates the importance of participatory planning or incorporation of the informal sector for effective disaster management.

5.4.2. Between 1990 to 2010

Bangladesh has a well developed institutional mechanism at the national and field levels to manage the consequences of natural disasters. Earlier, disasters were considered natural occurrences and rehabilitation efforts were confined to the relief and recovery process. In the 1990s, a significant change occurred when disasters began to be thought of as integral parts of the development continuum. After a cyclone in 1991, an aspiring change to develop an ideal disaster management regime occurred in the mindset of the policymakers.

The main focus of Disaster Risk Management (DRM) activities in its first two decades had concerned cyclone preparedness along the coast. In 1996, the Bangladesh Red Crescent Society (BDRCS) began to transfer the knowledge to inland areas. In 1997, it established a Disaster Management (DM) division at its headquarters in Dhaka to raise management capacity for the several preparedness programmes and response operations (IFRC, 2012).

Through the Community-Based Disaster Preparedness (CBDP) programme, BDRCS reached out to 179 communities in 39 flood-prone districts. The CBDP programme included capacity-building, awareness-raising and small-scale mitigation measures. An external evaluation in 2004 recommended extending this programme and addressors underlying risk factors more comprehensively. In particular, the livelihoods of community members needed to be strengthened and made more flood resilient (IFRC, 2012).

The Disaster Management Bureau was established in 1993 to enhance disaster preparedness and management. It is entrusted with the responsibility of supplying information to the concerned authorities for the preparation of rehabilitation plans and the adaptation of steps for minimizing future disaster risk. The Disaster Management Bureau and the Directorate of Relief and Rehabilitation work under the direction of the Ministry of Food and Disaster Management. The Disaster Management Bureau is a professional unit and works under the guidance of the IMDMC to perform specialized functions in association with the district and the sub-district level authorities and the concerned ministries. It designs plans, arranges public education campaigns, and organizes training for government officers and other personnel from the national level down to the community level.

In 2002, the Ministry of Disaster Management & Relief was renamed the Ministry of Food and Disaster Management. The Ministry of Food and Disaster Management is the principal actor for the inter-ministerial coordination, planning, and response to disaster management.

The Directorate of Relief and Rehabilitation is charged with managing the post-disaster provision of relief and rehabilitation works. The Ministry of Water Resources is involved in planning for water resources and water-related natural disasters, such as cyclone protection, flood proofing, river bank erosion control, and drought management. The flood forecasting and warning Center of the Ministry of Water Resources provides early warnings to the agencies involved.

5.5. Strategies of Risk Reduction

Mainstreaming risk reduction efforts within government, NGOs and the private sector is viewed as being the key to achieving sustainable hazards risk reduction interventions across the whole country. In Bangladesh, mainstreaming of disaster risk reduction is the outcome of many top-down and bottom-up interventions. These are summarized below and articulated briefly (figure 4.1).

5.5.1. Advocacy

Awareness-raising among politicians, government department officials, media and academic institutions is a priority strategy for building knowledge and understanding on the benefits of risk reduction and the roles these organizations play in implementing risk reduction programmes.

Mainstreaming strategies

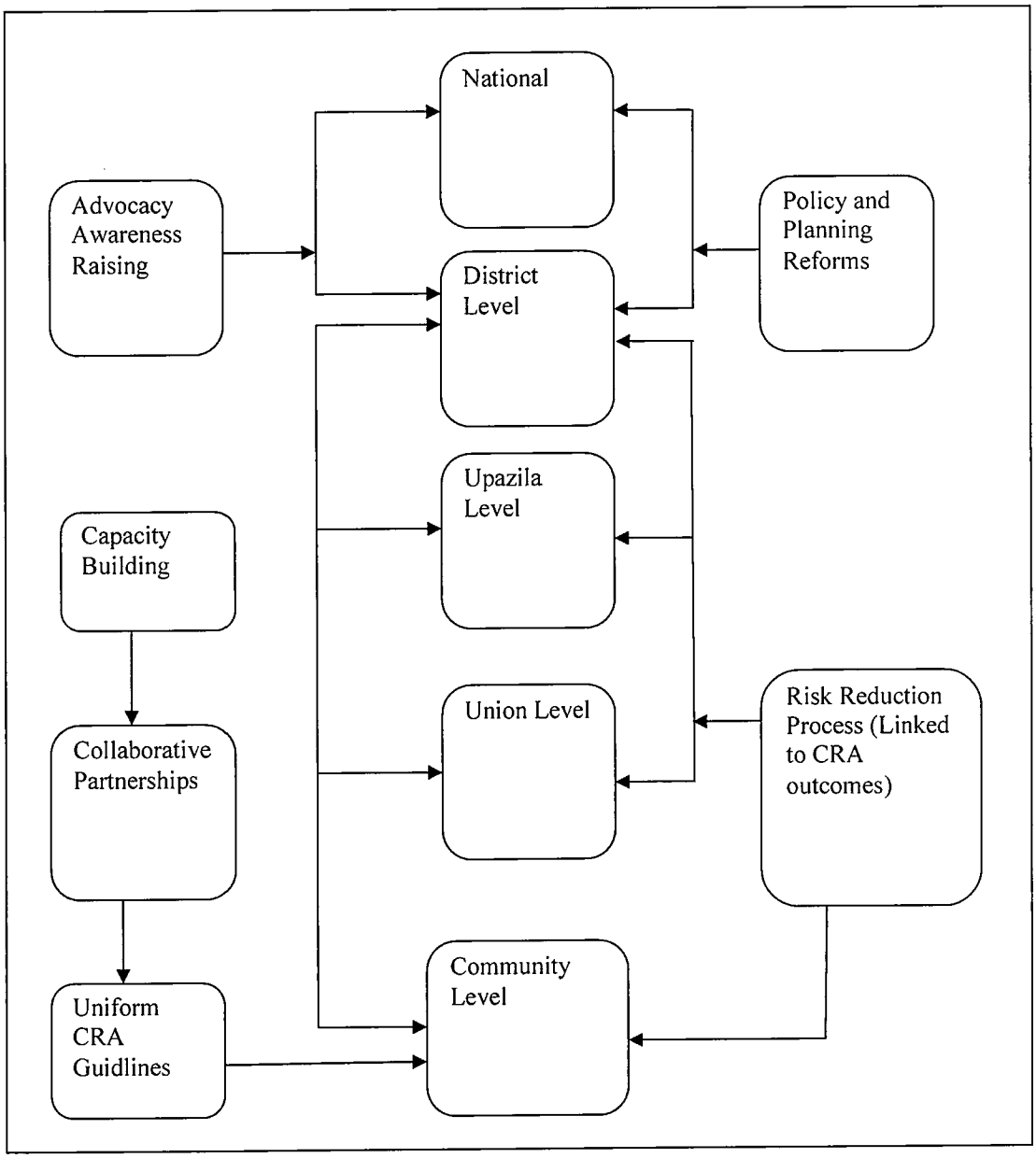


Figure: 5.1. Disaster risk reduction mainstreaming strategies

Source: Government of Bangladesh, 2010.

5.5.2. Policy and Planning Reform

A significant review of disaster management and development planning policy is being undertaken to ensure that they facilitate mainstreaming and promote a comprehensive risk reduction culture.

5.5.3. Capacity Building

The strategies have targeted a complete review of the roles and responsibilities of disaster management committees (DMCs) at all levels to ensure they reflect risk reduction as well as emergency response functions. A national training curriculum is being developed to ensure that committees receive capacity building training and fulfill their functions effectively.

5.5.4. Planning Framework

Disaster management planning at all levels is being significantly overhauled to ensure that DMC plans accommodate risk reduction mainstreaming at all levels.

5.5.5. Uniform CRA Guidelines

Uniform CRA processes are being established to ensure consistency in the conduct of community risk identification and compatibility with the risk reduction planning processes of the respective DMCs. The guidelines have also steps to ensure strong linkage with scientific analysis information.

5.6. Role of NGOs

NGOs in Bangladesh are a vibrant sector that plays a leading role in the social and economic advancement of the people.. After 1971, donor supported NGOs could provide more effective and efficient service delivery in war-ravaged Bangladesh. In 1970, there were only 40 NGOs in the country, 19 of which were foreign organizations. Currently, there are estimated 22,000 NGOs, of which approximately 1,400 are registered with the NGO Affairs Bureau, including 150 foreign NGOs (Ahamed, 2004). Their contributions have been found to be efficient in coping with recurring natural

disasters, creating a base for community participation and developing the capacities of vulnerable people.

The Disaster Management Bureau coordinates the NGOs' activities. Organizations such as BRAC, CARE Bangladesh, OXFAM-Bangladesh, Action Aid, Bangladesh Disaster Preparedness Centre, Bangladesh Disaster Forum, Eminence, Concern Worldwide, Concern Universal, and Dhaka Ahsania Mission etc. are involved in activities before, during, and after disasters. NGOs' activities include public education campaigns and training programs for people involved in disaster management in the pre-disaster period, undertaking emergency evacuation and sheltering of the victims during the disaster, and organizing rehabilitation programs for the affected people in the post-disaster period.

The Association of Development Agencies of Bangladesh, the association of NGOs, operates a preparedness and mitigation program. Regular meetings of the Disaster Forum, an NGO umbrella group, occur during flood recovery periods, and all organizations exchange information to avoid duplication of efforts and to ensure effective coverage (Beck, 2005). The Association of Development Agencies of Bangladesh has included risk reduction measures in its project planning.

5.7. Role of Donor Agencies

Donors are important stakeholders in disaster management. International assistance from inter-governmental and bilateral development partners for relief, reconstruction, and rehabilitation activities in Bangladesh following each disaster are provided by United Nation agencies. The Flood Action Plan was launched with the support of the development agencies to reduce the risk of severe flooding and to enhance the technical capacity of the storm warning centre of the Bangladesh Meteorological Department. Support of the Disaster Management Project was initiated in 1992 with support from donors. The Disaster Management Bureau was created under this project and, since its inception in 1992; it has contributed to enhancing the national capacity to plan and prepare for and cope with the consequence of disasters.

5.8. Comprehensive Disaster Management Program (CDMP)

The Government of Bangladesh has been trying to bring a paradigm shift in disaster management from conventional response and relief to a more comprehensive risk reduction culture (Alam, 2003) through the adaptation of a CDMP to reduce risks and expedite developmental interventions. The CDMP is a collaborative mechanism developed with the assistance of the Government of the People's Republic of Bangladesh, the United Nation Development Program, and the Department for International Development, and was formed in 2003 under the supervision of the Ministry of Food and Disaster Management. In 2006, the European Commission joined as the third major donor to the project. The program is designed to improve the performance capabilities of the country for disaster management.

The CDMP is working to improve disaster management nationwide. The Ministry of Food and Disaster Management (MoFDM) has adopted a more holistic approach through the CDMP that embraces the process of hazard identification and mitigation, community preparedness, and integrated response efforts. The relief and recovery activities are planned within an all-risk management framework that seeks to raise the capacities of communities at risk while lowering their vulnerability to specific hazards (Annual Progress Report, 2007).

The core purpose of the CDMP is to bring about a transformation from post-disaster relief and rehabilitation strategies to a comprehensive risk minimization culture by developing disaster resilience initiatives with a primary emphasis on community empowerment and partnership development. Implementation of the program warrants a series of interconnected strategic means and includes capacity building, partnership development, community empowerment, research and information management, and response management (Khan and Rahman, 2007).

The CDMP has created a strong ownership within the Disaster Management Bureau of MoFDM and has successfully laid the groundwork for the required paradigm shift. In addition, it has compiled a

fairly complete range of hazard information at the national level. The holistic approach of CDMP has an appropriate emphasis on disaster risk reduction (Annual Progress Report, 2007).

5.9. Disaster Management System in Bangladesh

The Disaster Management and Relief Division (DM&RD), MoFDM of the Government of Bangladesh has the responsibility for coordinating national disaster management efforts across all agencies. The National Disaster Management Council (NDMC) and Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) ensures coordination of disaster related activities at national level. Coordination at district, thana and union levels are done by the respective District, Thana and Union Disaster Management Committees. The Disaster Management Bureau renders all assistance to them by facilitating the process.

A series of inter-related institutions, at both national and sub-national levels have been created to ensure effective planning and coordination of disaster risk reduction and emergency response management (Figure: 5.2).

Disaster Management Institutions in Bangladesh

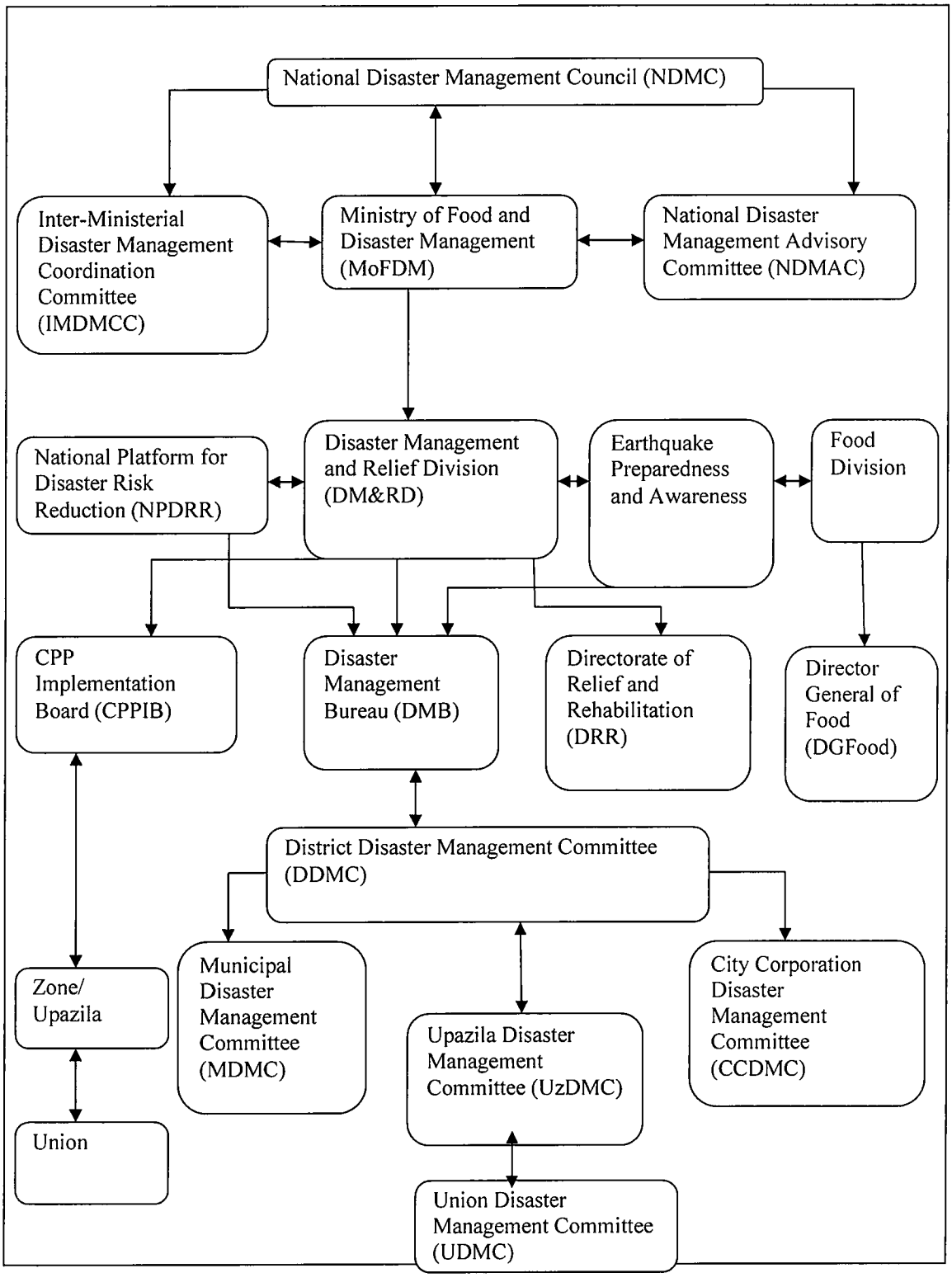


Figure: 5. 2. Disaster management institute chart
Source: Government of Bangladesh, 2010.

5.9.1. At National Level

1. The National Disaster Management Council (NDMC) headed by the Prime Minister to formulate and review the disaster management policies and issue directives to all concerns.

2. Inter-Ministerial Disaster Management Co-ordination Committee (IMDMCC) headed by the Minister in charge of the Disaster Management and Relief Division (DM&RD) to implement disaster management policies and decisions of NDMC /Government.

3. National Disaster Management Advisory Committee (NDMAC) headed by an experienced person having been nominated by the Prime Minister.

4. National Platform for Disaster Risk Reduction (NPDRR) headed by the Secretary, DM&RD and DG,DMB functions as a member secretary. This platform coordinates and provides necessary facilitation to the relevant stakeholders.

5. Earthquake Preparedness and Awareness Committee (EPAC) headed by the Minister for MoFDM and DG,DMB acts as a member secretary.

6. Cyclone Preparedness Program Implementation Board (CPPIB) headed by the Secretary, DM&RD, to review the preparedness activities in the face of initial stage of an impending cyclone.

7. Cyclone Preparedness Programme (CPP) Policy Committee headed by the minister, MoFDM and the Secretary, DM&RD act as a member secretary. Disaster Management Training and Public Awareness Building Task Force (DMTATF) headed by the Director General of Disaster Management Bureau (DMB) to coordinate the disaster related training and public awareness activities of the Government, NGOs and other organizations.

8. Focal Point Operation Coordination Group of Disaster Management (FPOCG) headed by the Director General of DMB to review and coordinate the activities of various departments/agencies related to disaster management and also to review the Contingency Plan prepared by concerned departments.

9. NGO Coordination Committee on Disaster Management (NGOCC) headed by the Director General of DMB to review and coordinate the activities of concerned NGOs in the country.

10. Committee for Speedy Dissemination of Disaster Related Warning/ Signals (CSDDWS) headed by the Director General of DMB to examine, ensure and find out the ways and means for the speedy dissemination of warning/ signals among the people.

5.9.2. At Sub-national Levels

1. District Disaster Management Committee (DDMC) headed by the Deputy Commissioner (DC) to coordinate and review the disaster management activities at the district level.

2. *Upazila* Disaster Management Committee (UZDMC) headed by the *Upazila Nirbahi* Officer (UNO) to coordinate and review the disaster management activities at the *upazila* level.

3. Union Disaster Management Committee (UDMC) headed by the Chairman of the Union *Parishad* to coordinate, review and implement the disaster management activities of the concerned union.

4. *Pourashava* Disaster Management Committee (PDMC) headed by the Chairman of *Pourashava* (municipality) to coordinate, review and implements the disaster management activities within its area of jurisdiction.

5. City Corporation Disaster Management Committee (CCDMC) headed by the Mayor of City Corporations to coordinate, review and implement the disaster management activities within its area of jurisdiction.

5.10. Disaster Management Plans

5.10.1. National Plan for Disaster Management

The National Plan for Disaster Management is prepared by DM&RD. The plan includes the following as minimum:

I. Introduction

ii. GOB vision for disaster management

iii. Hazards profile of Bangladesh

iv. Disaster development linkages: national and international drivers for change

v. Aim of the plan

vi. Strategic goals of the Plan

vii. Conceptualizing disaster management in Bangladesh

viii. Disaster management system in Bangladesh

ix. The roles and responsibilities of entities involved in emergency operations and risk reduction

x. Disaster management regulative framework

xi. Action matrix for disaster risk reduction and emergency management in Bangladesh describing the priorities and the strategies

xii. Review and evaluation

xiii. Implementation and follow-up

xiv. Financing of the Plan

xv. Other matters relating to disaster management as deemed necessary by appropriate authority for inclusion in the Plan.

The Plan is to be used to:

I. Articulate the long-term strategic focus of disaster management in Bangladesh.

ii. Demonstrate a commitment to address key issues: risk reduction, capacity building, information management, climate change adaptation, livelihood security, issues of gender and the socially disadvantaged, etc.

iii. Show the relationship between the government visions, key result areas, goals and strategies, and to align priorities and strategies with international and national drivers for change.

iv. Detail a road map for the development of disaster management plans by various entities.

v. Guide to the DM&RD in the development and delivery of guidelines and programmes.

vi. Illustrate to other ministries, NGOs, civil society and the private sector how their work can contribute to the achievements of the strategic goals and government vision on disaster management.

vii. Provide a framework within which to report performance and success in achieving goals and strategies.

5.10.2. District Disaster Management Plan (DDMP)

There is a District Disaster Management Committee (DDMC) at district level. DDMC consists of the Deputy Commissioner of the District as the chairperson and members comprising all district level department heads, NGO leaders and civil society members. The District Relief and Rehabilitation Officer (DRRO) acts as member secretary of the committee. Members of Parliament act as advisors to the committees. The Committee is required to meet bi-monthly during normal period and as and when necessary during emergency situations.

There will be a plan for each district titled "District Disaster Management Plan (DDMP)" comprising both disaster risk reduction and emergency response to be prepared by the District Disaster Management Committee. This is a plan to be prepared by compilation of the *Upazila* and *Pourashava* Disaster Management Plans of the District being received from the respective *Upazila* and *Pourashava*/City Corporation DMCs. The DDMP should highlight and articulate, among others, the following:

a. The areas in the district vulnerable to different forms of hazards and risks.

b. Total resource requirements and the planned actions for the district.

i. Measures to be taken for prevention and mitigation of disasters by government agencies, NGOs, CBOs and the private sector within the district.

ii. Capacity building and preparedness measures to be taken by government agencies, NGOs, CBOs and the private sector.

iii. The strengthening of emergency response management system plans and procedures in the event of a disaster.

c. The response plans and procedures in the event of a disaster, providing for:

i. Allocation of responsibilities to the departments of the government at district level and other DMC members

ii. Procedure for mobilization of resources

iii. Prompt response to disaster and relief

iv. Procurement of emergency supplies

v. Operation of disaster shelters

vi. Restoration of emergency services, such as water supply, gas supply, power, telecommunications, and road links

vii. Provision of emergency medical services

viii. Burial of dead bodies

ix. Trauma counseling

x. Dissemination of information

d. Recovery plans and procedures delineating damage assessment procedure, restoration of damaged public infrastructure, resumption of educational institutions, restoration of livelihood, rehabilitation of affected people, especially the disabled, and elderly women and children.

e. The DDMP shall be reviewed and updated annually.

f. Copies of the DDMP shall be made available to all district level stakeholders, Divisional Commissioners, etc.

g. A copy of the DDMP will be sent to DMB and all relevant ministries and divisions.

h. DMB/NDMTI will provide technical advice and capacity building services to all DMCs.

5.10.3. *Upazila* Disaster Management Plan (UzDMP)

Upazila is an important and vital administrative unit of Bangladesh. There is an *Upazila* Disaster Management Committee (UZDMC) at *upazila* level. The UzDMC consists of the *Upazila Nirbahi* Officer as the chairperson and members comprising all *upazila* level department heads, NGO leaders and civil society members. The PIO acts as the member secretary of the committee. Members of Parliament act as advisors of the committees. The committee is required to meet bi-monthly during normal periods and as and when necessary during emergency situations. There will be a plan for each *Upazila* titled "*Upazila* Disaster Management Plan" comprising both disaster risk reduction and emergency response to be prepared by the *Upazila* Disaster Management Committee by compiling all the Union Disaster Management Plans of the *Upazila* being received from the respective Union DMCs of the *upazila*. The UzDMP should highlight and articulate, among others, the following:

a. The areas in the *upazila* vulnerable to different forms of hazards and risks.

b. Total resource requirements and the planned actions for the upazila.

i. Measures to be taken for prevention and mitigation of disasters by government agencies, NGOs, CBOs and the private sector within the District.

ii. Capacity building and preparedness measures to be taken by government agencies, NGOs, CBOs and the private sector.

iii. The strengthening of emergency response management system plans and procedures in the event of a disaster.

c. The response plans and procedures in the event of a disaster, providing for:

i. Allocation of responsibilities to the departments of the government at upazila level and other DMC members

ii. Procedure for mobilization of resources

iii. Prompt response to disaster and relief

iv. Procurement of emergency supplies

v. Operation of disaster shelters

vi. Restoration of emergency services, such as water supply, gas supply, power, telecommunications, and road links

vii. Provision of emergency medical services

viii. Burial of dead bodies

ix. Trauma counseling

x. Dissemination of information

d. Recovery plans and procedures delineating damage assessment procedure, restoration of damaged public infrastructure, resumption of educational institutions, restoration of livelihood, rehabilitation of affected people, especially the disabled, elderly women and children.

e. The UzDMP shall be reviewed and updated annually.

f. Copies of the UzDMP shall be made available to all *Upazila* level stakeholders and members of DDMCs.

g. A copy of the UzDMP will be sent to the District Disaster Management Committee and DMB.

h. DMB/BIDMTR provides technical advice and capacity building services to all UzDMCss.

5.10.4. Union Disaster Management Plan (UDMP)

Union *Parishad* is the lowest administrative unit of Bangladesh. There is a Disaster Management Committee at the union level. The UDMC is chaired by the elected chairman of the respective union *Parishad.* The Union Disaster Management Committee consists of the union *Parishad* chairman as the chairperson and members comprising all the government department heads at union level, members of union *Parishad,* NGO leaders working in respective unions and civil society members. Secretary of the respective union *Parishad* acts as the member secretary of the committee. The committee is required to meet bimonthly during normal periods and as and when necessary during emergency situation.

There is a plan for each union titled "Union Disaster Management Plan" comprising both disaster risk reduction and emergency response to be prepared by the Union Disaster Management Committee following a proper community risk assessment procedure to be provided by DM&RD with the participation of vulnerable groups and the communities. The UDMP should highlight and articulate, among others, the following:

a. Definition and redefinition of community risks to hazards utilizing both traditional and scientific knowledge.

b. Total resource requirements and the planned action for the union.

i. Measures to be taken for prevention and mitigation of disasters by government agencies, NGOs, CBOs and the private sector within the union.

ii. Capacity building and preparedness measures to be taken by government agencies, NGOs, CBOs and the private sector.

iii. The strengthening of emergency response management system plans and procedures in the event of a disaster.

c. The response plans and procedures in the event of a disaster, providing for:

i. Allocation of responsibilities to the departments of the government at union level and other UDMC members

ii. Procedure for mobilization of resources

iii. Prompt response to disaster and relief

iv. Procurement of emergency supplies

v. Operation of disaster shelters

vi. Restoration of emergency services, such as water supply, gas supply, power, telecommunications, and road links

vii. Provision of emergency medical services

viii. Burial of dead bodies

ix. Trauma counseling

x. Dissemination of information

d. Recovery plans and procedures delineating damage assessment procedure, restoration of damaged public infrastructure, resumption of educational institutions, restoration of livelihood, rehabilitation of affected people, especially the disabled, and elderly women and children.

e. The UDMP shall be reviewed and updated annually.

f. Copies of the UDMP shall be made available to all union level stakeholders, UNOs and DCs.

g. A copy of the UDMP will be sent to the *Upazila* Disaster Management Committee.

h. DMB/BIDMTR provides technical advice and capacity building services to all UDMCs.

5.11. Conclusion

The historical approach to disasters can make apparent a community's vulnerability and resilience not just after a disaster but before it. It can be predictive. It reveals the inherent vulnerability, the background social vulnerability that has built up sequentially over time. With vulnerability, the emphasis is always one of degree, as all people are vulnerable in one way or another to some extent. However, some communities 'share' a common cultural and historical exposure to higher background

levels of risk than others that requires special consideration before any engagement with more specific factors of vulnerability.

Historically, the coastal communities of Bangladesh have faced the furies of nature and have inherited an intuitive and holistic knowledge of the way it behaves and the impact on animals, plants and human lives and livelihood. Accordingly, communities have learnt to develop indigenous coping mechanisms for survival, which were internalized as lifestyle activities were transmitted from one generation to another. Many isolated communities on the coasts have survived through this process. Unfortunately, the processes of so-called modernization and globalization are resulting in changes in the life-style of the coastal communities and much of the traditional wisdoms and practices are quickly dying out (Shaw, et al., 2009)

CHAPTER : 6

COASTAL AREA DESCRIPTION OF BANGLADESH

6.0. COASTAL AREA DESCRIPTION OF BANGLADESH

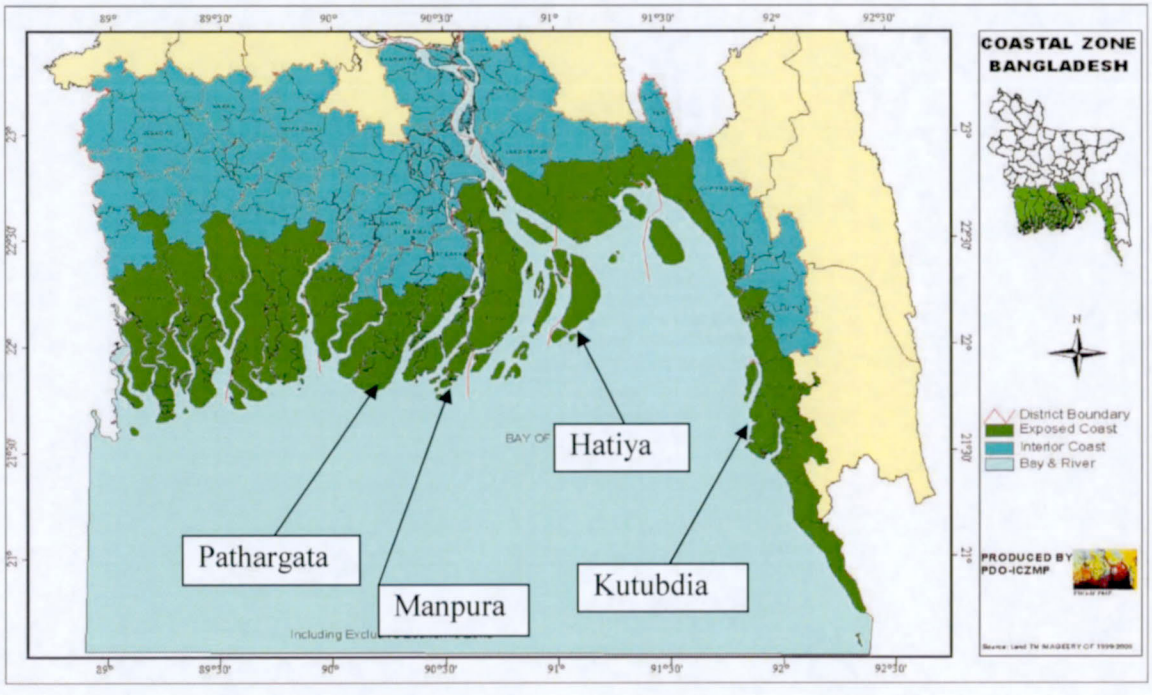
6. 1. THE COASTAL ZONE

6. 1. 1. Location

The coastal zone of Bangladesh is a mixture of very old settlements and new land developments. It was part of different kingdoms and ruled by different dynasties for many centuries, which consequently shaped the cultural trait and the social fabric of respective populations.

Along the coast in easterly direction, the physical features change, as well as the social makeup. The western part is a moribund delta (in this part the largest mangrove forest, *Sundarban*, is located); the middle part (the *Meghna* estuary area) is an active delta; and the eastern part (Chittagong coast) is a stable landmass. These parts have also some cultural differentiations rooted in the political history. The western part (Khulna) belonged to the territory of *Rarh*; the Barisal area (formerly called Bakerganj) was known as *Chandradwip*; the Comilla-Noakhali area was part of *Samatat* and the eastern part (Chittagong coast) belonged to *Horikel*.

Coastal Zone of Bangladesh



Map: 6. 1). Coastal zone of Bangladesh

Nineteen southern districts facing the Bay of Bengal or having proximity to the Bay and the Exclusive Economic Zone (EEZ) in the Bay are grouped into the coastal zone in terms of three geo-physical characteristics that distinguish them from the rest of the country; interplay of tidal regime, salinity in soil and waters and cyclones and storm surges. These districts are Bagerhat, Barguna, Barisal, Bhola, Chadpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jessore, Jhalkati, Khulna, Lakshmipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira, and Shariatpur (PDO-ICZMP, 2004a).

There are 48 *upazilas*/thanas with cyclone risks, salinity and tidal movement above threshold level facing the sea or the lower estuary in 12 districts, which comprise the 'exposed coast'. This includes among others all *chars* and more than 50 islands. The rest of the area which mainly consists of old and stable lands is considered as the 'interior coast'.

Table: 6. 1). Exposed and Interior Coastal areas of Bangladesh

District	Area sq. km	Exposed Coast	Interior Coast
Bagerhat	3,959	Mongla, Saran Khola, Morrelganj	Bagerhat Sadar, Chitalmari, Fakirhat, Kachua, Mollahat, Rampal
Barguna	1,831	Amtali, Barguna Sadar, Patharghata, Bamna	Betagi
Barisal	2,785		Agailjhara, Babuganj, Bakerganj, *Gaurnadi*, Hizla, Mehendiganj, Muladi, Wazirpur, Banari Para, Barisal Sadar
Bhola	3,403	Bhola Sadar, Burhanuddin, Char Fasson, Daulatkhan, Lalmohan, Manpura, Tazumuddin	
Chandpur	1,704		Chandpur Sadar, Faridganj, Haimchar, Hajiganj, Kachua, Matlab, Shahrasti
Chittagong	5,283	Anowara, Banshkhali, Chittagong port, Double Mooring, Mirsharai, Pahartali, Panchlaish, Sandwip, Sitakunda, Patenga, Halisahar, Kotwali, Boijid Bostami,	Boalkhali, Chandanaish, Lohagara, Rangunia, Chandgaon, Fatikchhari, Hathazari, Patiya, Raozan, Satkania, Bakalia, Karanaphuli, Kulshi
Cox'sBazar	2,492	Chakaria, Cox's Bazar Sadar, Kutubdia, Ukhia, Maheshkhali, Ramu, Teknaf	

District	Area sq. km	Exposed Coast	Interior Coast
Feni	928	Sonagazi	Chhagalnaiya, Feni Sadar, Parshuram, Daganbhuiyan.
Gopalganj	1,490		Gopalganj sadar, Kshiani, Kotali Para, Muksudpur, Tungipara
Jessore	2,567		Bagher Para, Chaugachha, Jhikargachha, Manirampur, Abhaynagar, Keshabpur, Jessore Sadar, Sharsha
Jhalokati	749		Jhalokati Sadar, Kanthalia, Nalchity, Rajapur
Khulna	4,394	Dacope, Koyra	Batiaghata, Daulatpur, Dumuria, Dighalia, Khalishpur, Khan Jahan Ali, Khulna Sadar, Paikgachha, Phultala, Rupsha, Sonadanga, Terokhada.
Lakshmipur	1,456	Ramgati	Lakshmipur Sadar, Raipur, Ramganj.
Narail	990		
Noakhali	3,601	Companiganj, Hatiya, Noakhali Sadar	Chatkhil, Senbagh, Begumganj.
Patuakhali	3,221	Dashmina, Rangabali, Galachipa, Kala Para	Bauphal, Mirzaganj, Patuakhali Sadar.
Pirojpur	1,308	Mathbaria	Bhandaria, Kawkhali, Nazirpur, Pirojpur Sadar, Nesarabad (Swraupkati).
Satkhira	3,858	Assasuni, Shyamnagar	Debhata, Kalaroa, Kaliganj, Satkhira Sadar, Tala
Shariatpur	1,182		Bhederganj, Damudya, Goshairhat, Naria, Palong, Zanjira
Total	47,201		

Source: PDO-ICZMP, 2004a, b; ICZMP, 2006.

6.1. 2. Natural Setting

The natural setting of the coastal zone is similar to the rest of the country in some respects and again it is also different to a considerable extent. The coastal zone covers both land and sea; in fact, it is the zone of interface between the land and the sea. The land area of the coastal zone has mud flats, sandy beaches & sand dunes, flatlands and undulating terrain that houses different ecosystems with a diverse and wide range of habitats. The coastal zone of Bangladesh has saline water, brackish water and fresh water arenas and includes ecosystems like mangroves, marines, estuaries, islands, coral, sea grass

beds, and sand dunes. At least, 10 different agro-ecological zones have been identified in the coastal zone and again contain various bio-ecological zones. These large numbers of ecosystems support a wide range of flora and fauna including genetically rich varieties. Thus all levels of biodiversity (genetic, species and ecosystem diversity) are very high in the coastal zone. The coastal zone contains one of the most hydro-morphologically active estuaries; diurnal tide, dynamic changes in land form due to erosion and accretion, more than 250 coastal islands, 'world heritage sites' and 'ecologically critical areas'; the world's largest single tract of mangrove forest, *Sundarban*; and the world's longest single stretch of sandy beach in Cox's Bazar. Several soil types occur in the coastal stretches of Bangladesh. South-west and north-east monsoons influence Bangladesh climate. The position of the coastal zone with respect to the country's situation is given:

6.1. 3. Natural Hazards

As has repeatedly been said in this paper, the coast of Bangladesh is prone to severe natural disasters, such as cyclones, storm surges, and floods. There are other natural and man-made hazards, such as river bank erosion, high arsenic contents of ground water, water logging, water and soil salinity, tectonic process and deteriorating coastal ecosystems and various forms of pollution. These hazards occur as shocks (sudden changes such as natural disasters, conflict or Living in the Coast Measuring Quality of Life collapsing market prices), seasonality (low demand for farm labor between plantation and harvesting periods) and trends (gradual environmental degradation, oppressive political systems or deteriorating terms of trade) (PDO-ICZMP, 2004b). The intensities and magnitudes of these hazards vary over space and time. In addition the coastal zone faces the extreme (possible) impact of climate change; and is the ultimate recipient of the pollution load. Like elsewhere in the world, the coastal zone of Bangladesh has the highest concentration of natural hazards.

6.1. 4. Opportunities

The coastal zone contains distinctive development opportunities like fisheries, forestry, livestock, port and related activities, industrial development, ship breaking, transport, gas and oil, other minerals, salt production, tourism, land accretion and coastal agriculture (ICZMP, 2006).

6. 2. Coastal People and Livelihood

6.2. 1. People

According to the 2011 population census, the coastal zone of Bangladesh has a population of 38.8 million. They are 26 percent of the total population. Average size of household is 4.49. The density of population is 943 per km^2. Women make up 49 percent, while 23 percent are urban-dwellers. The size of the labor force (population of 15-59 year age group) is 18.6 million. The population increased at an exponential rate of 1.36 percent annually during the inter census period of 1991-2001. This is lower than the national rate (1.48%) and is indicative of net out-migration from the coastal zone to other areas. More than a quarter of the population of the country lives in a coastal environment with multiple vulnerabilities and opportunities. Their despair and dreams, their plight and struggle, their vulnerability and resilience, are uniquely situated in an intricate ecological and social setting that makes their livelihoods distinctive from other parts of the country to a considerable extent (PDO-ICZMP, 2004b).

Table: 6. 2). Position of the coastal zone with respect to country situation

No	Indicator	Unit	Coastal zone	Bangladesh	Year & date source
1.	Area	Km^2	47,201	147,570	2001(B.B.S, 2003)
2.	Sex Ratio	Males/100 females	105	107	2001(B.B.S, 2003)
3.	Literacy rate (15 year +)	% Of total population	57	47	2001(B.B.S, 2003)
4.	Average size of Household.	Number	4.49	4.44	B.B.S. (2011)
5.	Total number of household	Million	7.84	32.17	2001(B.B.S, 2003); B. B. S. (2011)
6.	Total number of Division	Number	3	7	B.B.S. (2011)
7.	Total number of districts	Number	19	64	B.B.S., 2011
8.	Total number of *Upazilas*	Number	147	507	2001(B.B.S, 2003)
9.	Total number of Union	Number	1,382	4,562	B.B.S. (2011)
10.	Severe child	%	6	5	2000(B.B.S & UNICEF

No	Indicator	Unit	Coastal zone	Bangladesh	Year & date source
	malnutrition.				2001)
11.	Infant mortality rate	Per 1000	51-68	43	2001(B.B.S, 2003)
12.	Household with sanitary latrine	%	45.60	36.87	2001(B.B.S, 2003)

Sources: B. B .S, 2001; 2011, & UNICEF 2001.

6.2. 2. Livelihood

Livelihood conditions of the people largely depend on what resources are available at the household level in terms of ownership and access. Access to these resources often influences livelihoods of the people to a significant extent (PDO-ICZMP, 2004a). Livelihood activities in the coastal zone were clustered into some broad categories: These are: (a). Natural resource based activities, such as: agriculture, salt making, fishing, aquaculture, shrimp fry collection, fuel collection, extraction of forest products, etc; and (b). Human resource based activities, such as: livestock and poultry keeping, boat building (carpentry), net making, fish processing, trading, etc.

These two categories broadly correspond to farm and non-farm activities. Both categories of activities were based on self-employment and wage employment. It is also true that one engaged in self-employment is also available for wage employment and vice versa. However, livelihood activities at the household level are diversified. Farmers along with agriculture are also involved in fishing, animal husbandry and trading (selling crops or dairy products to buy other essentials). The driving force behind opting for multiple occupations is to maximize household income and to minimize risk. Certain activities are common everywhere and some are typical of the coastal zone. Coastal zone-specific activities include: salt production; fishing; fish processing (drying); net making; fry collection; shrimp farming; crab/shell collection; extraction of forest products (wood, honey, *golpata* and wax collection from *Sundarban*); and boat building (boat carpentry) (PDO-ICZMP, 2004a). Coastal people and their livelihoods are given:

Table: 6. 3). Coastal people and livelihoods

No	Indicator	Unit	Coastal zone	Bangladesh	Year & date source
1.	Population	Million	38.8	152.51	B.B.S., 2011
2.	Population density	Km^2	943	1015	B.B.S., 2011
3.	Gross Domestic Product	Crore	67,880	2,37,074	2001(B.B.S, 2003)
4.	Per capita GDP	US$	770	775	B.B.S.,2011
5.	Active labor force (15 year +)	Thousand	17,418	53,514	1999/2000(B.B.S, 2002)
6.	Proportion of females working for cash or kind	% (15-49)	26	28	2001(NIPORT 2003)
7.	Fishing household	% Of total HH	14	8	1996(B.B.S, 1999)
8.	Extreme poor HH Absolute poor HH	% Of HH % of HH	24 52	23 49	1998(B.B.S, 2002)
9.	Households with electricity connection.	% Of total HH	31	31	2001(B.B.S, 2003)
10.	Households with access to tap & tube well.	% Of total HH	72.5	85.7	2001(B.B.S, 2003)
11.	Household coverage by major micro credit NGOs.	% Of total HH	19	21	2001(B.B.S, 2003)
12.	Land erosion	(Ha/Yr)	3199		1973-2000(MES)
13.	Susceptibility to severe cyclone and storm surge.	No. Of Occurrence (1948-1998).	51	-	1948-98(PDO-ICZMP)
14.	Average area per growth center.	Km^2 /number	80	70	2001(B.B.S, 2003)

Sources: B. B .S, 2001; 2011; UNICEF, 2001, ICZMP, 2004a.

6.2. 3. Vulnerability

For poor people, vulnerability is both a condition and a determinant of poverty, and refers to the ability of people to avoid, withstand or recover from the harmful impacts of factors that disrupt their

lives and that are beyond their immediate control. In the coastal zone of Bangladesh, a wide range of vulnerabilities are identified. These are:

. Threat of cyclones and storm surges that cause death and destruction

. Threat of land erosion that causes untold suffering and dislocation

. Deterioration and declining viability of many distinctive and threatened coastal ecosystems

. Widespread poverty, limited livelihoods opportunities (especially outside agriculture) and poorly developed economic linkages

. Poor levels of service provision that make the isolation of many coastal areas worse

. Highly unequal social structures, with small powerful elite dominating the mass of people, allied to high levels of conflict and poor law and order

. Changing patterns of land use (including the growth of shrimp and salt production) that are affecting the coast's morphology and water resources characteristics

. Resource degradation

. Poor access to many forms of infrastructure and technologies

. Surface and sub-surface salinity and saline water intrusion into the freshwater aquifers (PDO-ICZMP, 2004b)

These vulnerabilities affect the livelihoods of coastal communities. Their significance, however, varies greatly between localities, occupational groups and sexes. Also important are the ways in which vulnerabilities interact with each other, with most coastal households, and especially the poor, facing multiple vulnerabilities that compound each other in terms of both the impact of specific events and the capability to recover from these events when they do strike. For example, the poor infrastructure and remoteness of many coastal localities mean that the immediate impact of a major cyclone is likely to be more severe and relief efforts hampered. Subsequently, when the survivors are rebuilding their livelihoods after the disaster, poor access to market, credit and other services, institutional weaknesses and the deterioration of the coastal resource base delay and hamper the recovery process. These vulnerabilities affect different households differently. In general, the more affluent a household is, and

in particular the more assets it possesses, the more resilient it is to disruption in its livelihood base from these shocks, seasonality and trends. People, of course, are not passive in the face of these risks, but the poorer the asset base of a household the more they have to forego potentially profitable but risky opportunities. The experience of one person on two different occasions is presented here, which narrates how people can or cannot cope with particular situations.

6.3. Social Cohesive and Conflict Char Land Areas

Chars are low-lying temporary sand islands formed and reformed yearly through silt deposition and erosion. It is estimated that char households migrate up to five times a generation, with poorer households moving more times due to the relative vulnerability of their homestead land (Conroy, et al., 2020). Most char land areas in migration can be termed short-distance circular migration, driven by landscape changes due to erosion and accretion of new land. When char land is lost to the river, displaced landowners resettle on other parts of the char, or on a neighboring char, or on the mainland; when their land area re-emerges, they will return and re-establish their homestead. However, the pejorative stereotyping of a separate and non-mainstream, particularly violent and rude *choura* culture may have implications for migration patterns.

Char dwellers are some of the poorest and most vulnerable people in Bangladesh, with 80 percent estimated to be amongst the 'extreme poor' (DFID, 2002). People living within this region suffer from multiple and very particular forms of vulnerability rooted in the threat of seasonal flooding and erosion. In this respect, in terms of impact on people's lives, a critical distinction must be drawn between the impact of erosion and the impact of flooding in the chars. Erosion can create catastrophic livelihood shocks through which households lose their land, their shelter, and other assets. In contrast, flooding is part an annual cyclone of monsoon and drought is regarded by char's dwellers as a 'way of life' to which they adopt a range of strategies to cope with seasonal variation.

Despite the extreme environment and obvious vulnerability, all char's dwellers have well established livelihood strategies that help them to survive in the chars. However for the extreme poor, these strategies merely permit survival and do not enable them to accumulate sufficient assets to overcome their poverty. This is compounded by the fact that communities are largely excluded from mainland services and infrastructure and do not represent a priority for the government.

A key dimension of the physical environment is the isolation of char dwellers from government services, from markets, from NGO support, and even from one another due to poor transport and communications links. The combination of extreme environmental conditions and large numbers of functionally-landless households means that char's dwellers are more heavily dependent on daily labor for part or all of the year than their mainland counterparts. The multiple vulnerabilities (physical, social, economic and political) experienced by the char dwellers are the underlying cause of chronic, persistent, and extreme poverty on the chars.

The isolated char communities are severely deprived and face multiple livelihood challenges. The poverty that characterizes char households is not just a lack of income or assets; they also experience limited access to healthcare, education services, markets and other government institutions, and inadequate infrastructure. Labor markets are also constricted, with limited diversification in the rural Bangladeshi economy resulting in few off –farm employment options. Most char households are reliant on daily wage employment for survival. Moreover, the limited and fluctuating opportunities and wages for agricultural activities rarely allow for human capital investments or asset accumulation. Although local government exists in the chars, due to the remote location and difficult environment, many services are limited. Power is invested in local elites through stable lines of patronage and deeply entrenched social and cultural norms.

Household coping strategies employed are often trade-off between short-term survival and longer-term economic goals and can include the distress sale of assets, reduction in consumption and

high interest usury. Subsequently, the impact at the household level can be severe with sustained losses in income, assets, consumption and future household growth.

Ownership of and control over land has been a dominant theme in most studies of char areas, and violent conflicts, often involving many deaths, are regularly reported in Bangladeshi newspapers (Baqee, 1998). In a set of publication based on the REIS project, the anthropologist M.Q.Zaman (1989; 1991a; 1991b) attributed this environment to a continuation of the *lathyial* system, a socio-political practice among frontier communities in Bangladesh whereby powerful local leaders or 'strongmen' (*mattabars*) gain control over newly emerging land through outright occupation, secured by deploying poor farmers dependent upon them for employment and access to land.

On the other hand, chars are remarkably law-abiding and peaceful and that most conflicts, including land disputes, trend to be resolved locally through the *samaj* (village community) and *shalish* (mediation).

It is widely held in Bangladesh that char dwellers have their own distinct (*choura*) subculture (Zaman, 1989). Moving from a mainland village to a char and being labeled a '*choura*' might be regarded as such a loss of social status that even for the landless poor it is more preferable to become an urban squatter (*busthee*). Yet, obviously some people do opt to settle andcultivate char land, either through buying land or share cropping. Mainlanders consider char dwellers in general to be poor, rude and dangerous people. Schmuck-Widmann (1996) sees the per-occupation with violence and violent conflict over land in much of the writings and reportage on char settlements as a reinforcement of this generally prejudicial view. However, from the FGD and in interviews conducted, it was clear that social coherence and solidarity (social capital) is perceived as one of the key strengths of char society. Several informants agreed that 'the char is a good place to live because people take care of each other' (Field Survey, 2011).

The study reveals that society in the chars seems to be particularly cohesive and supportive (Field Survey, 2011). In many ways the strength of social capital is responsible for maintaining the social fabric in the absence of a strong presence by the state and confers significant advantages to individual households above those which they would otherwise gain.

Despite poor living conditions, households continue to live in the chars because they simply have no alternative. Moving the char dwellers to safer areas is not feasible because land is so scarce in Bangladesh and is becoming increasingly so with the rising population (Field Survey, 2011).

6.4. Background and Description of the Study Areas

6.4.1. Hatiya Island (Noakhali)

Hatiya Island is located in the Meghna estuary, in the southern part of Noakhali District. Within an area of 1,507.35 square km, a total of 452,463 people live on this Island, bringing population density per sq. km to 300. Population growth rate is 2.82, and average household size is 4.98. Out of this total population, 87% are Muslim and 12% are Hindu (BBS, 2011). The literacy rate is 34.2%. This rate is significantly lower than the national average rate of 65% above 7 years old (BBS, 2011). Around 62% of the people are in the agriculture sector, and 6% of the population belongs to the fishery sector, and the rest of the people are mostly day laborers and employees at water-related transportation systems businesses. Among the peasant population, 52% of them are landless. Importantly, both in respect of income and calorie intake, about 88% of the people of Hatiya live below the poverty line (Banglapedia 2006; *Upazila* Administration 2011).

Not only the economic condition of people but also the geographical location of Hatiya has imposed the highest level of vulnerability and climate disaster risk to its population. Due to location conditions, tropical cyclones, tidal surges and river bank erosion have become a normal part of life for Hatiya Island people. Hatiya is well known for being severely affected by the devastating cyclones of 1970, 1985, and 1991. It is estimated that about 130,000 people in Hatiya alone have died due to cyclones

and related storm surges (*Upazila* Administration 2011). In addition, the northern part of Hatiya is continuously affected by river bank erosion. Approximately 108 square kilometers of land north and east of Hatiya Island has been eroded from 1960 to 1984; at the same time, 30 square kilometers of land has been accreted south of Hatiya (Huq, et al., 1999).

Map: 6. 2). Hatiya Upazila of Bangladesh

Source: Compiled from Banglapedia

To prevent continual river bank erosion as well as to alleviate energy of cyclones and storm surges from the Bay of Bengal, a mangrove afforestation program was started in the 1960s by the government in order to protect Hatiya Island. In addition, in order to lessen the damage caused by storm surges and saline water intrusion to the inner land, embankments were built to enclose the entire Island, except in the northern part. Since the 1960s, community shelters serving as cyclone shelters for

the purpose of evacuation during a cyclone have been constructed on this Island by various organizations. To date, the number of cyclone shelters has risen to 117 on Hatiya Island (*Upazila* Administration, 2011). In addition to these factors, regrettably, there is only one hospital with 50 beds in Hatiya to serve more than 452,463 people (BBS, 2011). Being a linear-shaped island, the location of the hospital is far both for the northern and southern residents.

The *Upazila* consists of 11 unions, and 62 villages (BBS, 2011). Ali Nijumdip Union and Char Issar Union are most vulnerable & affected by cyclones and tidal surges.

6.4.2. Kutubdia Upazila (Cox's Bazar)

Kutubdia, the offshore island of Cox's Bazar district, became a police station in 1917 and was upgraded to an *upazila* in 1983. It is the smallest *upazila* of Cox's Bazar District in respect of both area and population. During the British regime a Light House was established at Kutubdia for the incoming ships to the Chittagong Port. This light house is not in existence today because 50% of the land of Kutubdia has been eroded into the Bay of Bengal (BBS, 2011).

According to the 2011 Population Census Kutubdia *Upazila's* total population is 125,279 and the population's annual growth rate is 1.54, but district population growth rate is 2.55, and population density per sq. km is 581. Kutubdia *Upazila's* total number of households is 22,587 and household average size is 5.54. Here the literacy rate is 34%, though the country literacy rate is 51.8% (BBS, 2011).

Not only the economic condition of people but also the geographical location of Kudubdia has imposed the highest level of vulnerability and climate disaster risk to its population. Due to location conditions, tropical cyclones, tidal surges and river bank & sea erosion have become a normal part of life for Kutubdia people. Kudubdia is well known for being severely affected by the devastating cyclones of 1970, 1985, and 1991. It is estimated that about 120,000 people in Kutubdia alone have died due to cyclones and related storm surges (*Upazila* Administration 2011). In addition, the

northern, western and eastern parts of Kutubdia are continuously affected by river bank erosion (Field observation, 2011).

To prevent continual river bank erosion as well as to alleviate energy of cyclones and storm surges from the Bay of Bengal, a mangrove afforestation program was started in the 1970 by the government in order to protect Kutubdia Island. In addition, in order to lessen the damage caused by storm surges and saline water intrusion to the inner land, embankments were built to enclose the entire Kutubdia *Upazila*. Since 1992, community shelters serving as cyclone shelters for the purpose of evacuation during a cyclone have been constructed on this *Upazila* by various organizations. To date, the number of cyclone shelters has risen to 101 on Kutubdia *Upazila* (*Upazila* Administration, 2011).

Map: 6. 3). Kutubdia Upazila of Bangladesh

Source: Compiled from Banglapedia

Area and Location

The *Upazila* occupies an area of 215.80 square kilometers including 4.46 square kilometers of forest. The Upazila is bounded on the north by Banshkhali Upazila of Chittagong District, on the east by

Banshkhali, Chakaria and Moheshkhali *Upazilas*, on the south and on the west by the Bay of Bengal. The *Upazila* consists of 6 unions, and 55 villages (BBS, 2011). Ali Akbor Deil Union and Kaiyarbil Union are most vulnerable & affected by cyclones and tidal surges.

6.4.3. Manpura *Upazila* (Bhola)

Manpura was upgraded to an *upazila* in 1983. Manpura *Upazila's* total population is 76,582 and annual growth rate is 1.28%, though district's population growth rate is 0.42%. Manpura *Upazila's* total number of households is 17,080 and average household size is 4.48. In the *Upazila,* population density per sq. km is 205, whereas country population density per sq. km is 1,015 (BBS, 2011).

Map: 6. 4). Manpura Upazila of Bangladesh

Source: Compiled from Banglapedia

The economic condition of people and the geographical location of Manpura Island have imposed the highest level of vulnerability and climate disaster risk to its population. Due to location conditions, tropical cyclones, tidal surges and river bank erosion have become a normal part of life for manpura

people. Manpura Island is well known for being severely affected by the devastating cyclones of 1970, 1985, 1991, and 2007. It is estimated that about 70,000 people in Manpura Island alone have died due to cyclones and related storm surges (*Upazila* Administration 2011). In addition, the northern, western and eastern parts of Manpura Island are continuously affected by river bank erosion (Field observation, 2011).

To prevent continual river bank erosion as well as to alleviate energy of cyclones and storm surges from the Bay of Bengal, a mangrove afforestation program was started in the 1970 by the government in order to protect Manpura Island. In addition, in order to lessen the damage caused by storm surges and saline water intrusion to the inner land, embankments were built to enclose the entire Manpura *Upazila*. Since the 1970s, community shelters serving as cyclone shelters for the purpose of evacuation during a cyclone have been constructed on this *Upazila* by various organizations. To date, the number of cyclone shelters has risen to 70 on Manpura *Upazila* (*Upazila* Administration, 2011).

Area and Location

The *Upazila* occupies an area of 373.19 square kilometers with 55.40 square kilometers of forest. The *Upazila* is bounded on the north by Tazumuddin *Upazila* and Hatiya *Upazila*, on the east by Hatiya *Upazila*, on the south by the Bay of Bengal and on the west by Charfashion and Lalmohan *Upazila*. The *Upazila* consists of 4 unions, and 30 villages (BBS, 2011). But Hajirhat Union and Manpura Union are most vulnerable & affected by cyclones and tidal surges.

6.4.4. Patharghata *Upazila* (Barguna)

Patharghata as a thana came into existence in 1925 and upgraded into an *upazila* in 1983. Within an area of 387.36 square km, 37.29 sq. km is forest and a total of 163,927 people live in this *Upazila*. Out of this total population, 87% are Muslim and 12% are Hindu (BBS, 2011). The literacy rate is 60.5%. This rate is lower than the national average rate of 65% above 7 years old (BBS, 2011). Around 62% of the people are in the agriculture sector, and 20% of the population belongs to the fishery sector, and the rest of the people are mostly day laborers and employees at water-related transportation systems

businesses. Among the peasant population, 52% of them are landless. Importantly, both in respect of income and calorie intake, about 68% of the people of Pathargatha live below the poverty line (Banglapedia 2006; *Upazila* Administration 2011).

Map: 6. 5). Patharghata Upazila of Bangladesh

Source: Compiled from Banglapedia

Not only the economic condition of people but also the geographical location of Pathargatha has imposed the highest level of vulnerability and climate disaster risk to its population. Due to location conditions, tropical cyclones, tidal surges and river erosion have become a normal part of life for these people. Patharghata is well known for being severely affected by the devastating cyclones of 1970, 1985, 1991, 2007 and 2009. To alleviate energy of cyclones and storm surges from the Bay of Bengal, a mangrove afforestation program was started in the 1960s by the government in order to protect Patharghata. In addition, in order to lessen the damage caused by storm surges and saline water intrusion to the inner land, embankments were built to enclose the entire Patharghata. Since the 1970s,

community shelters serving as cyclone shelters for the purpose of evacuation during a cyclone have been constructed on this *Upazila* by various organizations. To date, the number of cyclone shelters has risen to 100 on Patharghata alone (*Upazila* Administration, 2011).

The *Upazila* consists of 7 unions, and 66 villages (BBS, 2011). But Patharghata Union and Char Duani Union are most vulnerable & affected by cyclones and tidal surges.

CHAPTER : 7

ANALYSIS OF DATA COLLECTION AT HOUSEHOLD LEVEL & COMMUNITY LEVEL

7.0. ANALYSIS OF DATA COLLECTION AT HOUSEHOLD LEVEL & COMMUNITY LEVEL AND CASE STUDIES

7.1. Household Size and Other Characteristics

The respondents from the survey areas had large-sized households. On average there were about six members per household with an average of two children, one of which was below 5 years of age, though household members over 6o years old were very few. This shows that every household has about two members who may have special needs during and after disasters, especially during evacuation periods.

Table: 7. 1). Household size

	Number of family member
N	385
Mean	5.63
Median	6.00

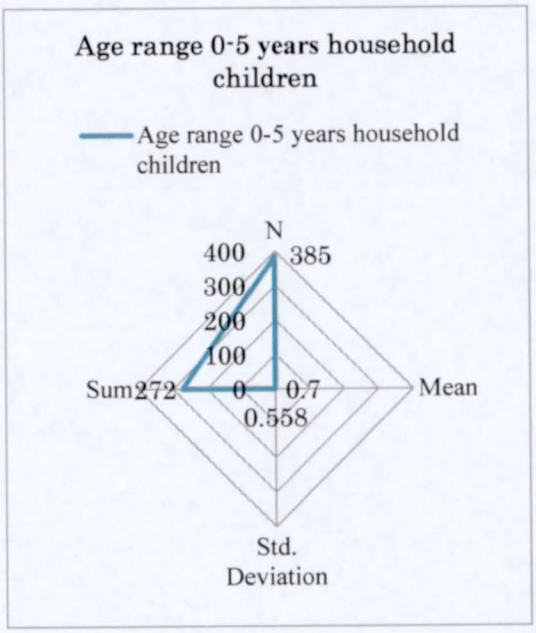


Figure: 7. 1). Age range 0-5 years household children

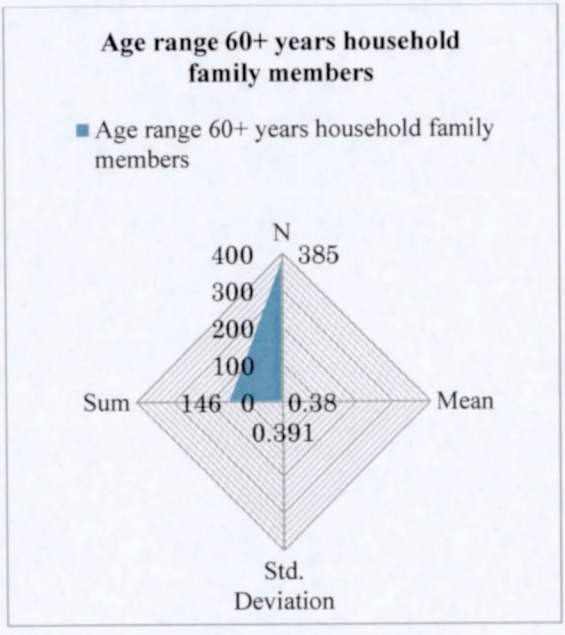


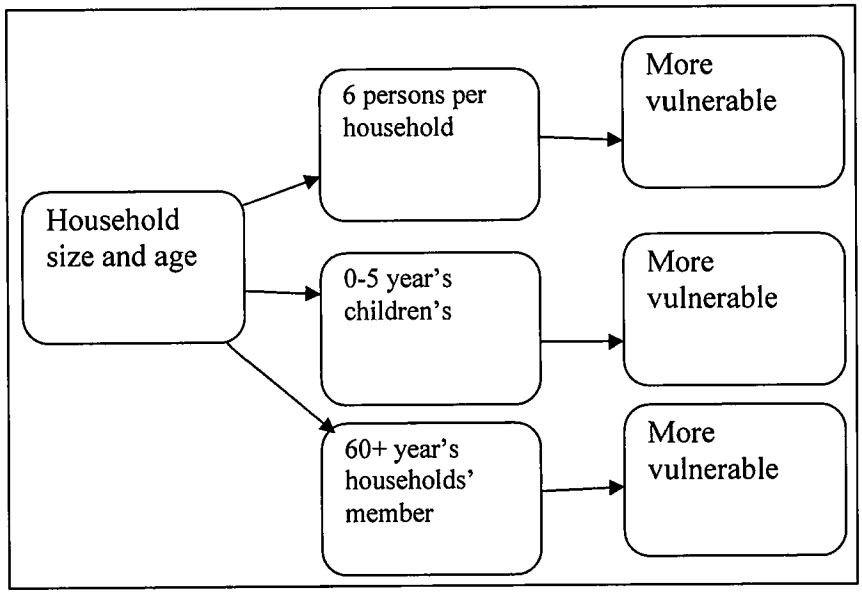
Figure: 7. 2). Age range 60+ years household family member

The average household size in Bangladesh is 4.4 (BBS, 2011). However, the study found that coastal areas' average household size was 6; which means, it is higher than the country's average household

size. Large sized households are vulnerable to any natural disasters, especially cyclones and storm surges. This finding was consistent with Paul, (2009).

7.2. Measuring Vulnerability based on Household's Size and Age

The household composition and size were contributory factors to a family's vulnerability. Households with many family members and a higher number of dependents are faced with a big challenge when recovering after a disaster. Household with more children (below 5 years), more elderly members (60+ years) or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster. The most striking feature of the study is that the average household size is large at 6 which are considered as more vulnerable. It is also noticeable that there are high numbers of children below 5 years and elderly 60+ years hence adding to the vulnerability of households.



7.3. Household Occupations and Income

In terms of occupation, 26 % of the respondents in the surveyed areas were fishermen, 24.4% of the respondents farmers, 19% of the respondents owned small businesses, and 18.2% of the respondents were day laborers, while rickshaw drivers and those with government jobs accounted for 3.1% and

1.8% respectively. The majority of the respondents' (44%) income per month was 5,000 to 8,000 Taka. Only 13.2 % of the respondents' monthly income was more than 10,000 taka. However, the monthly average household income was 7,393 taka.

Table: 7. 2). Household occupation

Occupation	Frequency	Percent (%)
Fisherman	100	26.0
Farmer	94	24.4
Small business	73	19.0
Day labor	70	18.2
Rickshaw driver	12	3.1
Govt. employee	7	1.8
Private sector employee	4	1.0
Teacher	4	1.0
Car driver	2	0.5
Others	19	4.9
Total	385	100.0

Table: 7. 3). Household monthly income (Taka)

Taka	Frequency	Percent (%)
1000-2000	6	1.6
2001-3000	23	6.0
3001-4000	33	8.6
4001-5000	52	13.5
5001-6000	66	17.1
6001-7000	59	15.3
7001-8000	39	10.1
8001-9000	27	7.0
9001-10000	29	7.5
10001-highest	51	13.2
Total	385	100.0

On the other hand, household expenditures, which were largely used for food averaged at 5,215 taka. In addition, children's education cost an average of 903 taka, and the cost of medical treatment averaged 781 taka. As average monthly household expenses were 7,014 taka, this did not leave much for households to generate savings.

Table: 7. 4). Monthly expenditure of household (taka)

	Food expense	Education expense	Medical expense	Total expense
N	385	385	385	385
Mean	5,215.84	903.69	781.04	7,014.59
Median	5,000.00	500.00	500.00	6,500.00

Table: 7. 5). Household average of income

		Income
N	Valid	385
Mean		7,393.90
Median		6,500.00

- Taka is Bangladeshi currency

Table: 7.6). Occupation with total income correlations

		Occupation	Total Income
Occupation	Pearson Correlation	1	.231(**)
	Sig. (2-tailed)	.	.000
	N	385	385
Total Income	Pearson Correlation	.231(**)	1
	Sig. (2-tailed)	.000	.
	N	385	385

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation of the Result: The value of correlation coefficient, r=0.231, which means that there exists a very weak degree of positive linear relationship between the variables, occupation and total income.

Table: 7.7). Total income with total expenses correlations

		Total Income	Total expense
Total Income	Pearson Correlation	1	.528(**)
	Sig. (2-tailed)	.	.000
	N	385	385
Total expense	Pearson Correlation	.528(**)	1
	Sig. (2-tailed)	.000	.
	N	385	385

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation of the Result: The value of correlation coefficient, r=0.528, which means that there exists a very strong degree of positive linear relationship between the variables, total income and total expenses.

Table: 7.8). Total expenses with household size correlations

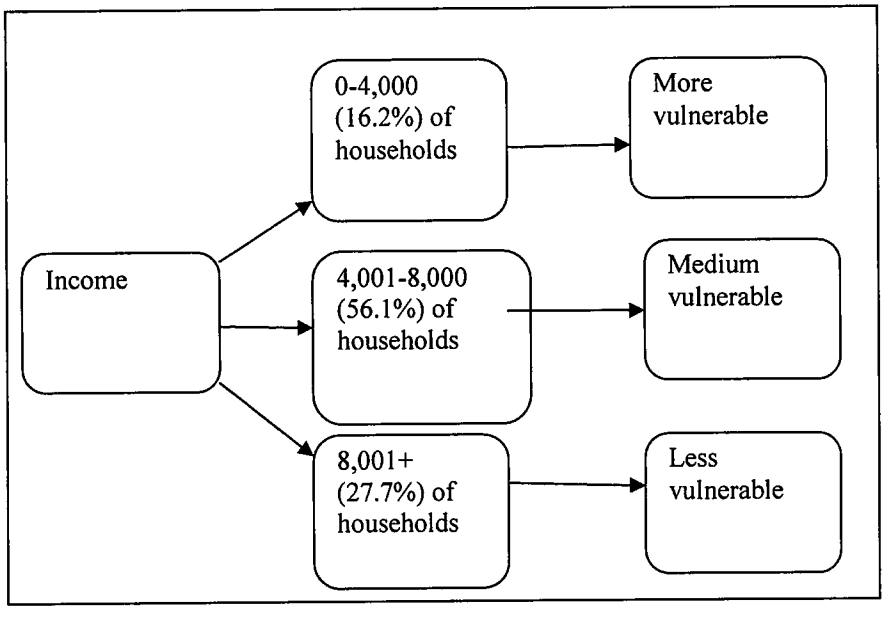
		Total expense	Household size
Total expense	Pearson Correlation	1	.278(**)
	Sig. (2-tailed)	.	.000
	N	385	385
Household size	Pearson Correlation	.278(**)	1
	Sig. (2-tailed)	.000	.
	N	385	385

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation of the Result: The value of correlation coefficient, r=0.278, which means that there exists a very weak degree of positive linear relationship between the variables, total expenses and household size.

7.4. Measuring Vulnerability based on Income Levels

The amount of income can indicate the capacity of the people to afford physical mitigation and recover from disasters. Large income means that people can build better houses, build savings or purchase insurance that cushion the impacts of disasters. Income has significant influence on the adaptation of coping measures. For example, lower income groups have a very small and risky portfolio of assets. The most striking feature is that 16.2% of households had a monthly income less than 4,000 taka. This portion is considered as more vulnerable because less than 4,000 taka is not sufficient money for a household. 56.1% of households had a monthly income of 4,001-8,000 taka and considered to be of medium vulnerability.

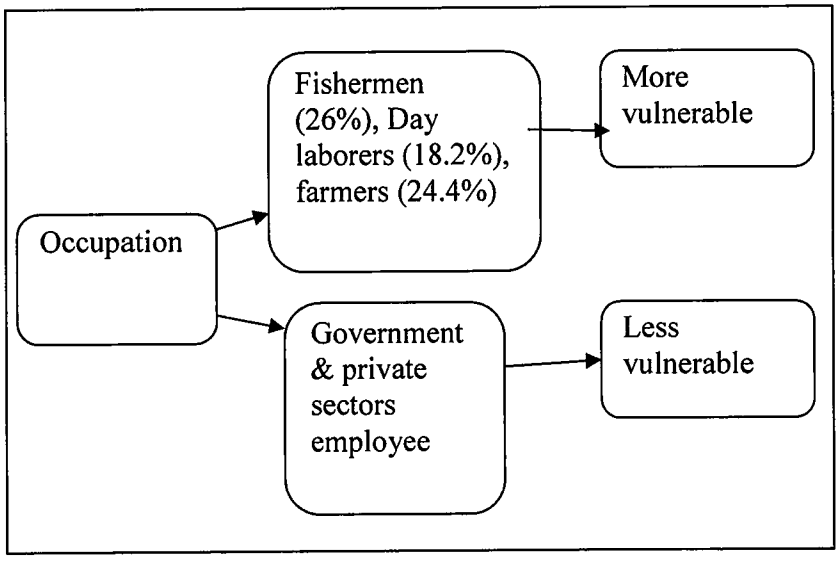


27.7% of the households, whose monthly income was more than 8,000 taka, are considered as less vulnerable. A noticeable point is that scant financial recourses hinder the fast recovery of the households from external shocks and crises like calamities and disasters. (Population living on less than $1.5 ($1= 80 taka) a day at 2005 international prices is considered below poverty line, World

Bank, 2012). Poverty remains the overarching problem, as, according to the latest available statistics, 81.3% live below $2 a day at 2005 international prices (adjusted for PPP). According to the national poverty line, 41.2% of the population lives in poverty, of which 31.9% are in poverty and 9.3% in extreme poverty (Bangladesh country report, 2012).

7.5. Measuring Vulnerability based on Occupation Patterns

The foremost cause of vulnerability was the source of income of the household. Those dependent on self employment, wage labor, and fishing were the most vulnerable groups. The income derived from such activities was marginal and often uncertain. Some sources of income were very vulnerable to disasters such as cyclones. For instance, open sea fishing was dependent on the size of waves in the sea, which normally grow bigger during the cyclone and monsoon season. So, fishermen (26%), day laborers (18.2%), and farmers (24.4%) considered as having more vulnerable households due to their occupations. In contrast, government employees, private-sector employees and teachers are considered as having less vulnerable households.



7.6. Household Education

Education is considered as one of the crucial determinants of coping and adaptation for both supporting survival and enhancing quality of life (D'Oley, et al., 1994). Moreover, it is important to

create awareness regarding disaster forecasting to reduce tangible and intangible damage to victims (Parker and Tunstall, 1991).

In terms of education, 39.2% of the households never went to school. Rates of completion for primary school, high school and college education were 37.9%, 16.1% and 6.5% respectively. The university graduation rate was very low.

Table: 7. 9). Education qualification

Qualification	Frequency	Percent (%)
No schooling	151	39.2
Primary	146	37.9
High School	62	16.1
College	25	6.5
University	1	.3
Total	385	100.0

Table: 7.10). Education qualifications with occupation correlations

		Education qualification	Occupation
Education qualification	Pearson Correlation	1	.214(**)
	Sig. (2-tailed)	.	.000
	Covariance	1.346	.706
	N	385	385
Occupation	Pearson Correlation	.214(**)	1
	Sig. (2-tailed)	.000	.
	Covariance	.706	8.100
	N	385	385

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation of the Result: The value of correlation coefficient, r=0.214, which means that there exists a very weak degree of positive linear relationship between the variables, education qualifications and occupation.

Table: 7.11). Education qualifications with total income correlations

		Education qualification	Total Income
Education qualification	Pearson Correlation	1	.356(**)

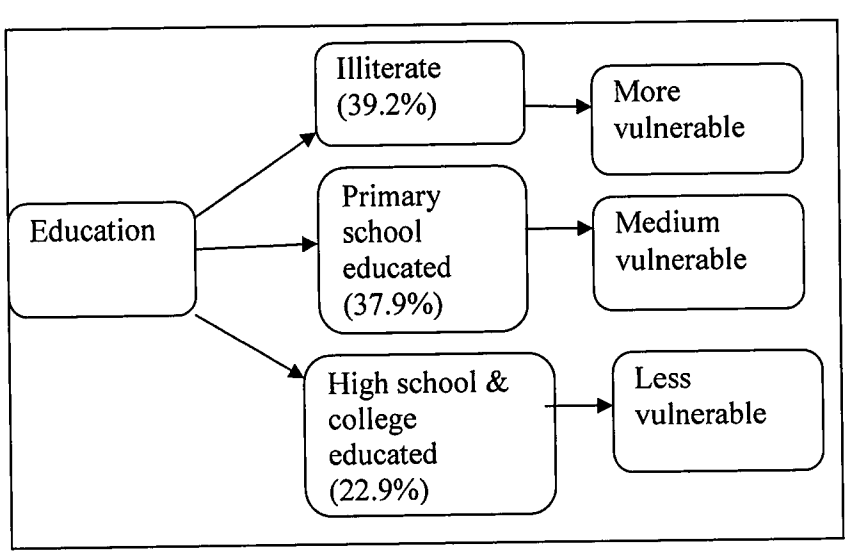
	Sig. (2-tailed)	.	.000
	N	385	385
Total Income	Pearson Correlation	.356(**)	1
	Sig. (2-tailed)	.000	.
	N	385	385

** Correlation is significant at the 0.01 level (2-tailed).

Interpretation of the Result: The value of correlation coefficient, r=0.356, which means that there exists a positive linear relationship between the variables, education qualifications and total income.

7.7. Measuring Vulnerability based on Education Levels

Level of education of the household head was a factor in their increased susceptibility to crises and shocks. The study reveals 39.2% of the respondents as illiterate. This portion of the households is more vulnerable because illiterate persons seldom gain good employment. As a result, their income is low and their households are always more vulnerable. The households with primary school education, 37.9% of the total, are considered to exhibit medium vulnerability as they have a higher awareness of disasters. However, incomes and occupations of such households are still vulnerable.



22.9% of the respondents with high school and college education are considered as less vulnerable portions, because these portions of households have good income and occupations. Moreover, these portions of household are more conscious about disaster.

7.4. Housing and Other Facilities

Housing in all the survey areas was commonly made of mixed materials. Most of the houses had roofs made of tin (62.9%), thatch (20.5%), tin & thatch mixed (14.3 %) and politians (2.1%). Walls were made of tin (31.7%), bamboo (22.9%), wood & tin (16.4 %), mud (19.2%) and wood (4.4%). However, a larger portion of those who were poorer had dwellings that were made of light materials. This type of housing, with walls made of wood, bamboo and thatch roofs are very vulnerable to strong winds. The poorer segments of the respondents who had this type of housing were the fishermen, tenant farmers and wage earners.

The study also found that most of the respondents (66.5%) had lived in their current residence more than 10 years. 17.4% of the respondents had lived in their current residence 1 to 5 years. Only 2.9% of the households had lived in their current resident for less than one year.

Table: 7. 12). Number of years living in current residence

Years	Frequency	Percent (%)
Less than one year	11	2.9
1-5 years	67	17.4
6-10 years	51	13.2
More than 10 years	256	66.5
Total	385	100.0

Table: 7.13). Housing structure of roof

Types of roof	Frequency	Percent (%)
Thatch	79	20.5
Tin	242	62.9
Mixed	55	14.3
Politian	8	2.1
Others	1	.3
Total	385	100.0

Table: 7. 14). Housing structure Walls

Wall types	Frequency	Percent (%)
Wood	17	4.4
Tin	122	31.7
Cement	13	3.4
Mud	7	1.8
Mixed	64	16.7
Bamboo	88	22.9
Soil	74	19.2
Total	385	100.0

Table: 7. 15). Housing structure Floor

Floor types	Frequency	Percent (%)
Soil	380	98.7
Wood	1	.3
Concrete	4	1.0
Total	385	100.0

7.5. Household Farmland & Livestock Assets

51.7% of the respondents have no farmland assets. The survey reveals that 8.6% of the respondents have a 1-50,000 taka equivalent of farmland assets, 6.7% of the respondents have 50,001-100,000 taka equivalent of farmland assets, 7.8% of the respondents have 100,001- 200,000 taka equivalent of farmland assets, and 6.5% of the households have 200,001-300,000 taka equivalent of farmland assets. 18.7% of the respondents have more than 300,001 taka equivalent of farmland assets.

Table: 7. 16). Household assets of livestock (in taka)

Amount of Taka	Frequency	Percent (%)
0	95	24.7
1-10,000	137	35.6
10,001-20,000	42	10.9
20,001-30,000	39	10.1
30,001-40,000	21	5.5
40,001 +	51	13.2
Total	385	100

Table: 7. 17). Household assets of farmland (in taka)

Amount of Taka	Frequency	Percent (%)
0	199	51.7
1-50,000	33	8.6
50,001-100,000	26	6.7
100,001-200,000	30	7.8
200,001-300,000	25	6.5
300,001 +	72	18.7
Total	385	100

The study reveals that 35.6% of the respondents have 1-10,000 taka equivalent of livestock assets, 10.9% of the respondents have 10,001-20,000 taka equivalent of livestock assets, 10.1% of the households have 20,001-30,000 taka equivalent of livestock assets, and 13.2% of the respondents have more than 40,000 taka equivalent of livestock assets. 24.7% of the respondents have no livestock assets at all.

7.6. Household Assets of Agricultural Equipment and Fishing Boats

The study found that 9.9% of the respondents have 1-10,000 taka equivalent of assets in boats, 5.2% of the respondents have 10,001 taka equivalent assets in boats, 3.1% of the respondents have 50,001-100,000 taka equivalent of assets in boats, and 3.9% of the respondents have more than

100,001 taka equivalent of assets in boats. 77.9% of the respondents do not have the assets to buy a boat.

Table: 7. 18). Household assets of boat (in taka)

Amount of Taka	Frequency	Percent (%)
0	300	77.9
1-10,000	37	9.9
10,001-50,000	20	5.2
50,001-100,000	12	3.1
100,001 +	16	3.9
Total	385	100

Table: 7. 19). Household vehicles use of agriculture (in taka)

Amount of Taka	Frequency	Percent (%)
0	362	94.0
1-1,000	12	3.1
1,001 +	11	2.9
Total	385	100

The study also found that 94% of the respondents have no agricultural equipment. Only 3.1% & 2.9% of the respondents have 1-1,000 taka and more than 1,000 taka equivalent of agricultural equipment of assets respectively.

7.7. Household Location Vulnerability

The study reveals that 83.9% of the respondents said that their house location was nearby the sea/ or river.

Table: 7. 20). Is your house near (location)?

Location	Frequency	Percent (%)
Sea/River	323	83.9
Upper land	8	2.1
Low land	49	12.7
Char	5	1.3
Total	385	100.0

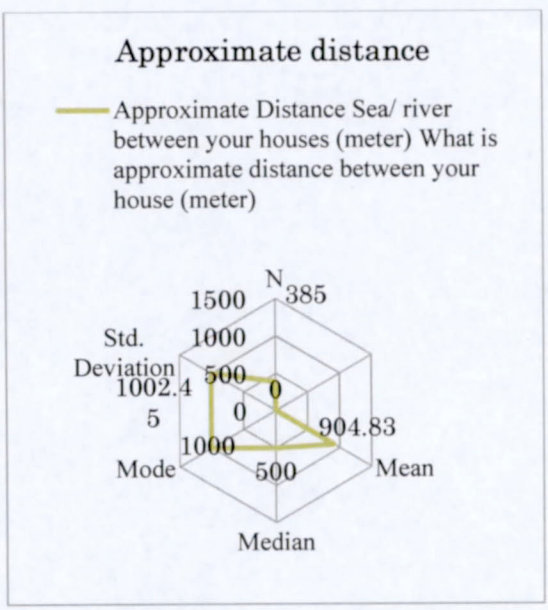


Figure: 7. 3). Approximate distance from sea to house

The mean distance was 904.83 meters to sea or river. 12.7% of the respondents said that their house location was on low land and only 2.1% of the respondents said their house location was upper land.

7.8. Household Saving and Insurance Characteristics

The study reveals that 62.6% of the respondents said that there was no surplus of savings in the last year. Only 37.4% of the respondents replied that they had savings.

Table: 7. 21). Savings in last one yea

Savings	Frequency	Percent (%)
Yes	143	37.1
No	241	62.6
Total	385	100.0

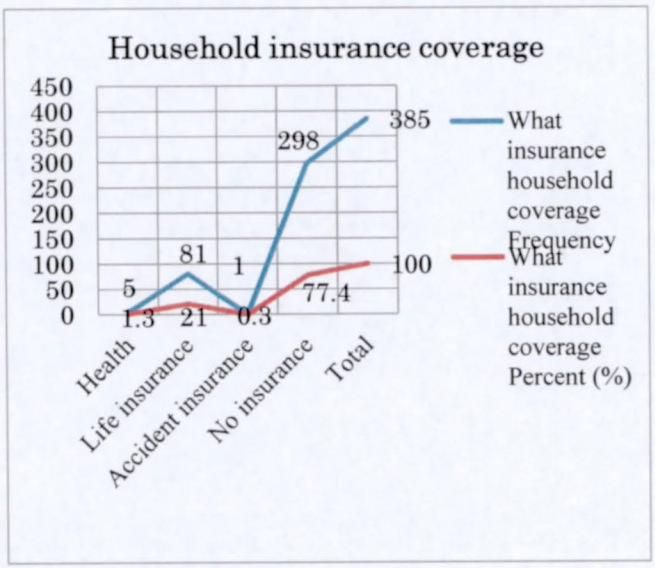


Figure: 7. 4). Household insurance coverage

77.4% of the respondents replied that they did not have any insurance coverage. Only 22.6% of the respondents replied that they had insurance coverage. Of the respondents who had insurance coverage, most of them (21%) had life insurance coverage. Only 1.3 % of the respondents had health insurance coverage.

Household savings were used by 10.6% of the respondents to buy assets, 9.1% for business, 9.1% for education, and 8.3% replied to cope with an emergency. Though, 62.6% of the respondents did not have any savings.

Table: 7. 22). Reason for saving

Why household save	Frequency	Percent (%)
Education	35	9.1
Buy assets	41	10.6
To cope with emergency	32	8.3
For business	35	9.1
Others	1	.3
No save	241	62.6
Total	385	100.0

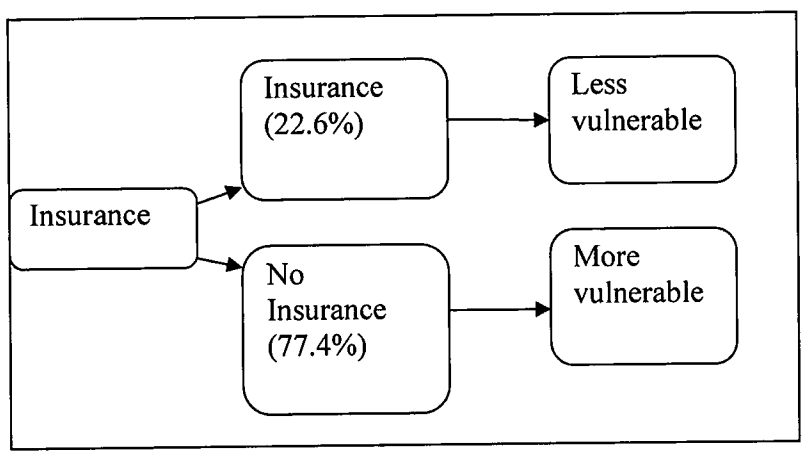
Table: 7. 23). Place of saving

Where save	Frequency	Percent (%)
Bank	53	13.8
NGO	38	9.9
Cooperative	48	12.5
House	6	1.6
No save	241	62.6
Total	385	100.0

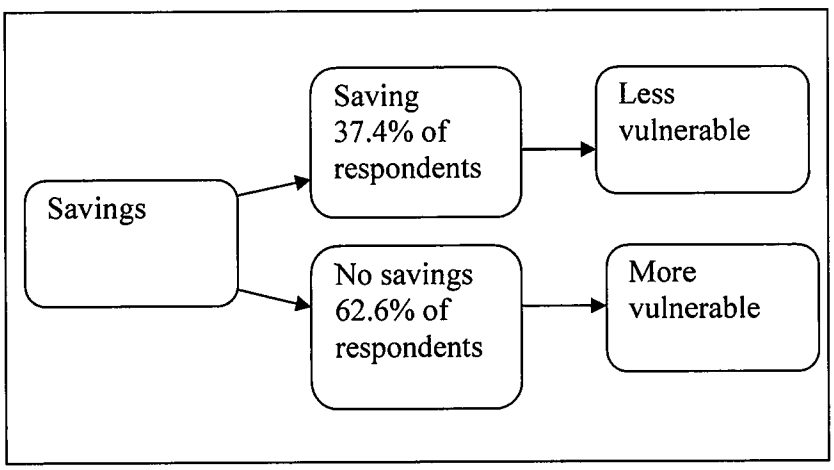
13.8% of the respondents said that they kept money at the bank, 9.9% of the respondents replied they kept money with an NGO, 12.5% of the respondents replied that they kept their money within a cooperative society, and only 1.6% of the respondents replied that they kept money in their own house. 62.6% of the respondents did not have any savings.

7.13. Measuring Vulnerability based on Insurance

Insurance is absolutely essential for disaster risk reduction. The study reveals that 77.4% of the respondents have no insurance coverage. This portion of the respondents is considered as more vulnerable, with 22.6% of the respondents who have insurance considered as less vulnerable. However, most respondents have only life insurance coverage.



7.14. Measuring Vulnerability based on Savings The study reveals that 62.6% of the respondents have no savings. This portion of respondents is considered as more vulnerable because in an emergency period they have no savings to recover from the situation. 37.4% of the respondents who have savings are regarded as less vulnerable, as they are more able to cope with an emergency period.



7.15. Household Health Facilities and Accessibility

The study found that 20.8% of the respondents replied that the nearest health facilities were within 1 kilometer, 24.7% of the respondents replied that the nearest health facilities were within 1 to 2 kilometers, and 54.5% of the respondents replied that the nearest health facilities were more than 2 kilometers away. The study also found that, 71.4% of the respondents replied that during a disaster period health facilities were available. 28.6% of the respondents replied that during a disaster period health facilities were not available.

Table: 7. 24). Distance of household from the nearest public health facility

How far	Frequency	Percent (%)
<500 meter	17	4.4
0.6 km-1 km	63	16.4
1km-2km	95	24.7
>2 km	210	54.5
Total	385	100.0

Table: 7. 25). Is the health facility accessible and operational during disaster?

Accessible	Frequency	Percent (%)
yes	275	71.4
no	110	28.6
Total	385	100.0

7.10. Household Transportation Mode for Health Facilities

The study found that the modes of transportation of households to the health facilities were not good. Most of the respondents (62.1%) replied that they went to the hospital on foot, 31.2% of the respondents replied that they went to the hospital by bicycle, and 5.5% of the respondents replied that they went to the hospital by jeep or bus. Only 1% of the respondents replied that they went to the hospital by rickshaw.

Table: 7. 26). Mode of transportation of household to the health facilities

Transportation mode	Frequency	Percent (%)
By foot	239	62.1
By bicycle	120	31.2
By jeep or bus	21	5.5
By animal-driven car	1	.3
By rickshaw	4	1.0
Total	385	100.0

7.11. Household Accessibility to Roads

Government infrastructure in the survey areas met some basic needs. Public school buildings were rated by most respondents as good or average by the respondents. The access road conditions were not good. The respondents' survey lists road access as *Kacha* (61%), semi-*pacca* (16%), gravel (3%) and *pacca* (20%) respectively (See glossary for Bengali word). However, access roads to the more remote areas of the country were still muddy during the rainy season.

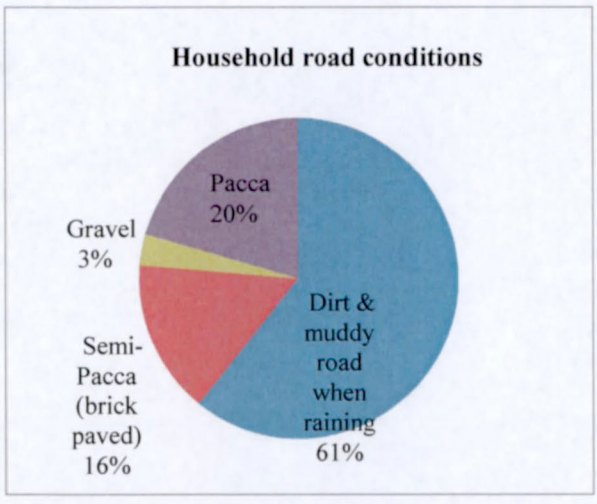


Figure: 7. 5). Household road conditions

7.12. Household Toilet Facilities

Household toilet facilities were not good. The study found that 43.4% of the respondents replied that their toilet was a pit, 33.2% of the respondents replied that their toilet was Jupri (open flow), and only 23.4% of the respondents replied that their toilets flushed (sanitary latrines).

Table: 7. 27). Household toilet facilities

Toilet types	Frequency	Percent (%)
With flush (sanitary latrines)	90	23.4
Pit	167	43.4
Jupri (open flow)	128	33.2
Total	385	100.0

7.13. Household Water Sources and Accessibility

Similar to other infrastructures, cyclones normally cause serious damage to the water supply and sanitation system. The tube-wells were broken, partially damaged and became unusable due to being submerged. Ponds have been contaminated by the onrush of saline water and sludge. Therefore, after the cyclone there was a serious crisis of drinking water and the outbreak of water-borne diseases was very common. As a result, they have become vulnerable to diarrhea and other water-borne diseases.

Therefore, post cyclone diarrhea and other common water-borne diseases were the major causes of death casualties associated with the cyclone.

Table: 7. 28). Access to potable water (Individual tube-well & Community tube-well) during natural disasters

	Frequency	Percent (%)
Yes	180	46.8
No	205	53.2
Total	385	100.0

Access to potable water in surveyed areas was mostly from community tube-wells (76%), own tube-wells (17%), and ponds/ reservoirs (6%) respectively. However, 46.8% of respondents said that during the disaster period drinking water facilities were accessible and available.

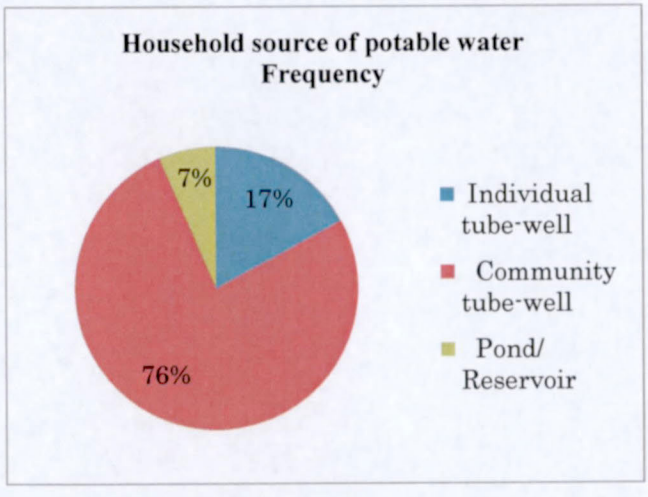


Figure: 7. 6). Household source of potable water

7.14. Presence of Hazards

The study found that the people in all survey areas were vulnerable to natural disasters. Due to the geographic location and the topographic composition of the areas in which they live, almost all respondents in the survey areas were exposed to cyclones, strong winds, and storm surges that

accompanied or resulted from the cyclones. Tidal surges had the greatest impact on homes, farms, fishing activities and small business resulting in damages to property, assets, and loss of income.

Table: 7. 29). Household affected by cyclone

	Frequency	Percent (%)
Yes	374	97.1
No	11	2.9
Total	385	100.0

Table: 7. 30). Household affected by storm surges

	Frequency	Percent (%)
Yes	295	76.7
No	90	23.4
Total	385	100.0

Table: 7. 31). Household affected by flood

	Frequency	Percent (%)
Yes	7	2.6
No	375	97.4
Total	385	100.0

In the survey areas 97.1% of the households had experienced cyclones and 76.4 % of the households had experienced tidal surges. Within the last 10 years an average of 2.21 tidal/ storm surges and 2.41 cyclones affected these areas. Fortunately, in all of the survey areas, injury or death due to natural disasters had been negligible even though most of the respondents lived close to bodies of water like rivers and the sea.

Table: 7. 32). Frequency cyclone and storm surge in last 10 years

	No. of time cyclone happened	No. of time storm surges happened
N	385	385
Mean	2.42	2.21
Median	3.00	2.00
Mode	3	2
Std. Deviation	.910	1.773

It is widely accepted that children and the elderly are highly vulnerable to disasters. The study found that children and elderly people were more affected by natural disasters at around 67.8% and 31.2% respectively. The study also found that pregnant women were more vulnerable pre-, during and post-disaster; though their portion was very small.

Additionally, the study found that most of the older people could not run fast enough to escape the waves or swim to safety.

Table: 7. 33). Who were most affected by disasters in household family?

Affected by disasters	Frequency	Percent (%)
Children	261	67.8
Elderly	120	31.2
Pregnant women	4	1.1
Total	385	100.0

7.15. Household Perception about Natural Disasters

96.9% of the respondents feel that the frequency and intensity of natural hazards has been increasing recently; and 96.6% of the respondents consider that they are vulnerable to natural hazards and their perception of such vulnerability is increasing.

Table: 7. 34). Household perception, recently (last 3 years) about frequency and intensity of natural hazards

Natural disasters	Frequency	Percent (%)
Increasing	373	96.9
Decreasing	12	3.1
Total	385	100.0

Table: 7. 35). Household perception, recently (last 3 years) about your vulnerability to natural hazards

Vulnerability	Frequency	Percent (%)
Increasing	372	96.6
Decreasing	13	3.4
Total	385	100.0

7.16. Evacuation Centre and Characteristics

To prevent or mitigate the loss of human lives and probably livestock and poultry, the cyclone shelters can probably play a more vital role than any other means. After the cyclone of 1971 a number of

cyclone shelters were constructed in the coastal areas. These were not sufficient in number and were not properly designed and located.

The study reveals that the majority of the respondents (94.4%) replied that there was an evacuation centre to use during emergency periods. In the last 5 years, 74.8% of the respondents had evacuated to shelters during cyclones. While in the same period, 25.2% of the respondents had never evacuated to a cyclone shelter.

Table: 7. 36). Availability of evacuation centre during emergency

	Frequency	Percent (%)
yes	365	94.8
no	20	5.2
Total	385	100.0

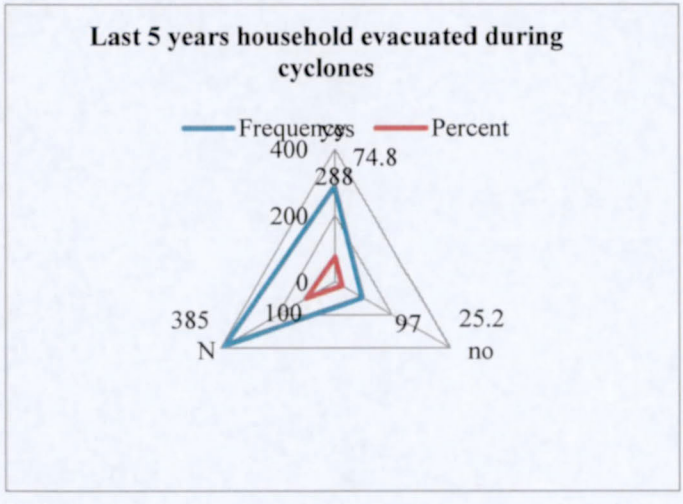


Figure: 7. 7). Household evacuated last 5 years

The study reveals that 64.4% & 35.1% of the respondents replied that toilet facilities and potable water were available in evacuation shelters. Though, in the cyclone shelters there were no kitchen facilities. The majority of the respondents (54.8%) replied that potable water should be improved in cyclone shelters. Also, 33.8% of the respondents said that toilet facilities should be improved in cyclone shelters.

Table: 7. 37). Needed facilities to improve evacuation centre?

	Frequency	Percent (%)
Toilet	130	33.8
Kitchen	10	2.6
Potable water	211	54.8
Medicine	33	8.6
Others	1	.3
Total	385	100.0

Table: 7. 38). Facilities available at evacuation centre

	Frequency	Percent (%)
Toilet	248	64.4
Kitchen	2	.5
Potable water	135	35.1
Total	385	100.0

The study found that a majority of 74.5% of the respondents went to cyclone shelters during cyclones. The respondents took shelter along embankments/ roads, neighbors' houses, and in public schools (8.6%, 4.9% and 3.9% respectively) during cyclones. 65.2% of the respondents said that most cyclone shelters were within 1 kilometer of their house. Additionally, the study reveals that when a cyclone shelter was far from their house, they took shelter at their neighbors' houses, or by the embankment/ road/levee etc.

Table: 7. 39). What do you consider as your evacuation area?

Evacuation area	Frequency	Percent (%)
Cyclone shelter	287	74.5
Embankment/ Road	33	8.6
Neighbors house	19	4.9
Own house	22	5.7
Public school buildings	15	3.9
Public buildings (gymnasiums, municipal halls, etc)	5	1.3
Relative house	4	1.0
Total	385	100.0

Table: 7. 40). How far is your nearest evacuation area?

Distance	Frequency	Percent (%)
<1km	251	65.2
1km-2km	104	27.0
2km-3km	18	4.7
>3km	12	3.1
Total	385	100.0

7.23. Measuring Vulnerability based on Evacuation Distance

The potential loss of their only means of livelihood means that household heads do not choose to move to cyclone shelters easily. However, if the severity of the cyclone increases and warning signals mount, the family then decides to go to a cyclone shelter. The study found that 65.2% of the households had an evacuation shelter within 1 kilometer of their place of residence. This portion of

households is considered as less vulnerable. On the other hand, for 34.8% of the households' evacuation shelters were more than 1 kilometer away. These households are considered as more vulnerable. However, those who did not have any alternatives took shelter on the embankments, raised roads or other elevated places.

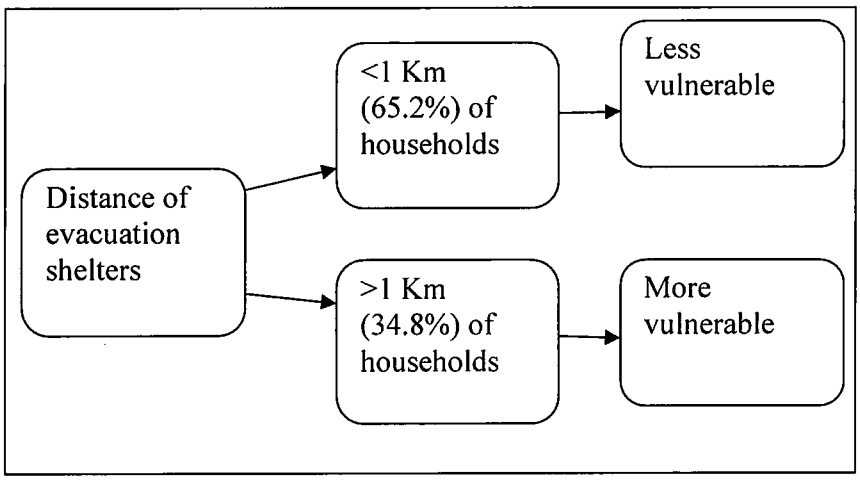


Table: 7.41). Education qualification with Cross tabulation evacuation area

Education qualification			evacuation area						
			Public school building	Public (gymnasiums, hall)	Neighbor's house	Relative's house	Cyclone shelter	Embankment/ Road	Others
	No schooling	Count	1	0	4	0	121	20	5
		% of Total	.3%	.0%	1.0%	.0%	31.4%	5.2%	1.3%
	Primary	Count	8	3	10	3	105	9	8
		% of Total	2.1%	.8%	2.6%	.8%	27.3%	2.3%	2.1%
	High School	Count	6	1	5	1	41	4	4
		% of Total	1.6%	.3%	1.3%	.3%	10.7%	1.1%	1.0%
	College	Count	0	1	0	0	20	0	4
		% of Total	.0%	.3%	.0%	.0%	5.2%	.0%	1.0%
	University	Count	0	0	0	0	0	0	1
		% of Total	.0%	.0%	.0%	.0%	.0%	.0%	.3%
Total		Count	15	5	19	4	287	33	22
		% of Total	3.9%	1.3%	4.9%	1.0%	74.5%	8.6%	5.7%

The study found that 31.4% of the respondents, who were illiterate, took shelter at cyclone shelters, 5.2% took shelter at embankment/ road, and only 1% took shelter at relatives' houses. 27.3% of the respondents, who had completed primary school, took shelter at cyclone shelters, 2.3% of respondents took shelter at embankments, 2.6% of respondents took shelter at neighbors' houses, and 2.1% of respondents took shelter at public school buildings. 10.7% of the respondents, who had completed high school, took shelter at cyclone shelters, 1.1% of respondents took shelter at embankments, 1.3% of respondents took shelter at neighbors' houses, and 1.6% of respondents took shelter at public school buildings. 5.2% of the respondents, who had completed college, took shelter at cyclone shelters.

The study also found that 74.5% of respondents took shelter at cyclone shelters, 8.6% of respondents took shelter at embankments, 4.9% of respondents took shelter at neighbors' houses, and 3.9% of respondents took shelter at public school buildings.

From the data it can be seen that 95% of the respondents with college education, 70% of the respondents with high school education, 76% of the respondents with primary school education, and 82% of the respondents who are illiterate took shelter at cyclone shelters.

So, the most remarkable point is that, although college respondents were the most likely to take this form of shelter, there was not much variation between illiterate respondents and educated respondents when seeking cyclone shelter usage during disasters. Thus, the fact worth noticing is that education qualifications do not influence evacuation patterns.

Table: 7.42). Occupation with cross tabulation evacuation area

			Evacuation area						
Occupation			Public school building	Public (gymnasiums, municipal halls,)	Neighbor's house	Relative's house	Cyclone shelter	Embankment/Road	Others
	govt. employee	Count	0	0	0	0	7	0	0
		% of Total	.0%	.0%	.0%	.0%	1.8%	.0%	.0%
	private	Count	0	0	0	0	4	0	0

	sector employee								
		% of Total	.0%	.0%	.0%	.0%	1.0%	.0%	.0%
	fisherman	Count	5	1	9	0	73	11	1
		% of Total	1.3%	.3%	2.3%	.0%	19.0%	2.9%	.3%
	farmer	Count	3	1	6	1	71	6	6
		% of Total	.8%	.3%	1.6%	.3%	18.4%	1.6%	1.6%
	day labor	Count	1	1	2	1	52	9	4
		% of Total	.3%	.3%	.5%	.3%	13.5%	2.3%	1.0%
	rickshaw	Count	0	0	0	0	11	0	1
		% of Total	.0%	.0%	.0%	.0%	2.9%	.0%	.3%
	car driver	Count	0	0	0	0	1	1	0
		% of Total	.0%	.0%	.0%	.0%	.3%	.3%	.0%
	teacher	Count	0	1	0	0	2	0	1
		% of Total	.0%	.3%	.0%	.0%	.5%	.0%	.3%
	business	Count	5	1	2	1	50	6	8
		% of Total	1.3%	.3%	.5%	.3%	13.0%	1.6%	2.1%
	others	Count	1	0	0	1	16	0	1
		% of Total	.3%	.0%	.0%	.3%	4.2%	.0%	.3%
Total	385	Count	15	5	19	4	287	33	22
	100%	% of Total	3.9%	1.3%	4.9%	1.0%	74.5%	8.6%	5.7%

The study found that 19.0% of the respondents, who were fishermen, took shelter at cyclone shelters, 2.9% took shelter at embankments/ roads, 2.3% took shelter at neighbors' houses, and 1.35% of the respondents took shelter at public school buildings. 13.5% of the respondents, who were day laborers, took shelter at cyclone shelters, 2.3% took shelter at embankments/ roads. 13.0% of the respondents, who ran small business, took shelter at cyclone shelters, 1.6% took shelter at embankments/ roads, and 1.3% of the respondents took shelter at public school buildings. On the other hand 1%, who were government employees, 1%, who were private-sector employees and 1%, who were rickshaw drivers, took shelter at cyclone shelters.

The data found that 100% of government employees, 100% of private-sector employees, 99% of fishermen, 94% of farmers, 94% of day laborers, 92% of rickshaw drivers and 89% of businessmen took a shelter at cyclone shelters.

The most striking feature is that occupations had no influence on evacuation patterns.

7.17. Recovery after a Disaster and Emergency Response

The study found that recovery after a disaster takes time. 30.4% of the respondents said that they needed 4 to 7 days to recover after a disaster, while 31.4% of the respondents said that recovery after a disaster took more than 1 month.

The present study found that external assistance creates relief dependency among the cyclone victims in all study locations. Most of the respondents (81.6%) said they got emergency relief from local government authorities 2 days later. 14.3% of the respondents said that they got relief from local government I day later. Only a few respondents said that they got relief from local government authorities within 24 hours.

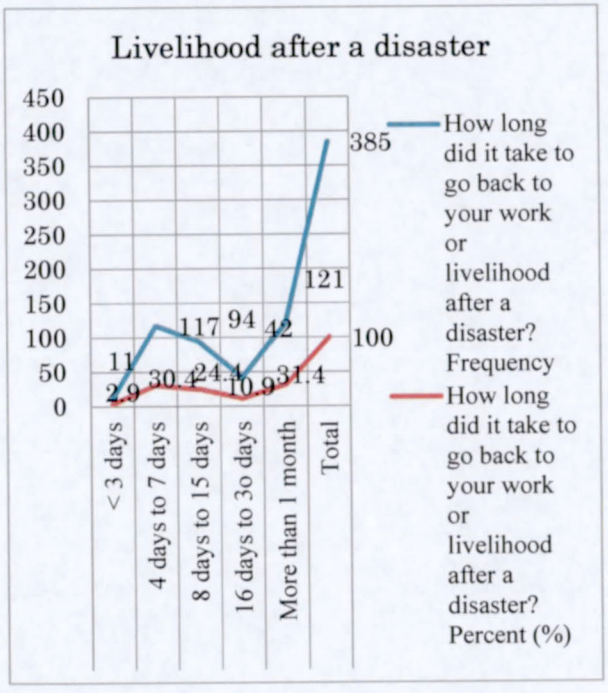


Figure: 7. 8). Household livelihood after a disaster response

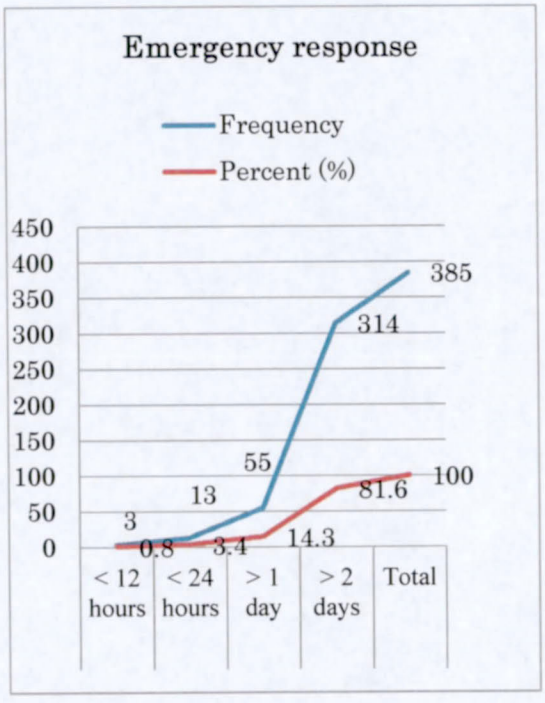


Figure: 7. 9). Household emergency

7.18. Adaptation of Coping Strategies

This study has considered the sequence of coping measures well in advance of the hazard event, immediately before the hazard event, and post event. The following section provides a brief

description of coping strategies adopted by different households in response to cyclones and induced surges in the study areas.

7.18.1. Coping Strategies Immediately before the Cyclone and Induced Surge Event

In disaster prone localities coping measures immediately before the hazard event start with the saving of human lives (Rasid and Paul, 1987; Thompson and Tod, 1998). The present study found that in the worst cases, those who did not have any alternatives took shelter on the embankments, raised roads or other elevated places after a cyclone. Besides saving their own lives, people also try to save poultry and livestock as these are the most valuable assets for rural communities.

Moreover, a few of the respondents did not take any protective measures, with the belief that a cyclone is God's will and God will save them; it is beyond the control of people.

7.18.2. Post-cyclone and Induced Surge Event Coping Strategies

Post-cyclone coping measures include risk management and risk coping strategies. Risk management strategies try to reduce the risk to the income process by activities such as income smoothing including income diversification, and income skewing by accepting low risk activities with low return (Dercon, 2002). It was found that, a majority of the respondents were involved in government or NGO sponsored 'food for work' or 'cash for work' programs. A few were also involved in rickshaw-van pulling, fuel wood collection, repairing houses, boats and nets etc.

In every disaster-prone locality people have some habitual coping strategies, but the type of response and effectiveness of such strategies may vary over time and the coping ability might be overwhelmed by the scale of the disaster itself (Few, 2003; Paul and Routary, 2010).

Respondents in the survey had varying ways of coping with disasters. Most of the households (41%) coped with the effects of disasters by using personal savings; others borrowed money from relatives (32.7%), received relief from the government (18.4%), borrowed money from NGOs (17.7%), received relief from NGOs (15.3%), asked children to work (6%), borrowed money from the bank

(3.1%) and sold or mortgaged assets (2.9%). A small proportion stopped the schooling of children and temporarily migrated to other areas, or reduced expenditure on food and other types of household consumption.

Disposal of assets is also a common coping strategy for rural households exposed to shock in order to meet consumption requirements or acquire the means to purchase food (Del Ninon, et al., 2003). The study reveals that the main disposable items were big trees, jewelry, household utensils, paddies, chickens, cattle, fish, fishing and agricultural equipment, the leasing out or mortgaging of farmland, etc. However, the selling of cattle and chickens was most common in all study areas. Similarly, few people had sold out field crops in advance to the *mahajans* against borrowing money for emergencies. However, such strategies were common in the lower income groups who borrowed conditional money from *mahajan* or *arotdar* against future crops, fish or labor. Similarly, the disabled or women headed households could not find any alternative income sources for survival.

Table: 7. 43). Household coping mechanism from cyclone & storm surges

Coping mechanisms	Frequency	Percent (%)
By own savings	158	41.0
By borrowing money from relatives	126	32.7
By relief from the Government	71	18.4
By borrowing money from NGO	68	17.7
By relief from the NGO	59	15.3
By asking children to work	23	6.0
By borrowing money from Bank	12	3.1
By sold or mortgage assets	11	2.9
By stopping schooling of children	6	1.6
By reducing expenses on food and other household consumption	6	1.6
By migrating temporarily to other area	1	0.3
Total	385	100

The study also found that the borrowing of money was a common coping measure. The majority of the respondents (63.5%) borrowed money after a cyclone to rebuild their livelihoods, and meet consumption needs and emergencies. It was also observed that people had borrowed money

simultaneously from multiple sources and used one source to repay another and thus were trapped in the 'vicious circle of borrowing'.

Table: 7.44). Education qualification with cross tabulation coping mechanisms by personal savings

			Coping mechanisms by personal savings	
			yes	no
Education qualification	No schooling	Count	66	85
		% of Total	17.1%	22.1%
	Primary	Count	48	98
		% of Total	12.5%	25.5%
	Junior High School	Count	13	28
		% of Total	3.4%	7.3%
	High School	Count	11	10
		% of Total	2.9%	2.6%
	College	Count	19	6
		% of Total	4.9%	1.6%
	University	Count	1	0
		% of Total	.3%	.0%
Total	385	Count	158	227
	100%	% of Total	41.0%	59.0%

The study found that 17.1% of the respondents that were illiterate, 12.5%, who completed primary education, 3.4%, who completed junior high school 2.9%, who completed high school, and 4.9%, that were college graduates had a coping mechanism which used personal savings.

The study found that 41% of the respondents used personal savings as a coping mechanism. The most striking feature is that the respondents with college or university education used personal savings as a coping mechanism at 100% and 76% respectively. On the other hand, 52% of the respondents with high school education, 31% of the respondents with junior high school education, and 32% of the respondents with primary school education used personal savings as a coping mechanism.

So we found that persons with higher education were more likely to use personal savings as a coping mechanism.

Table: 7.45). Education qualification with cross tabulation coping mechanisms by relief assistance from the government

			Coping mechanisms by relief from the govt.	
			yes	no
Education qualification	No schooling	Count	9	142
		% of Total	2.3%	36.9%
	Primary	Count	39	107
		% of Total	10.1%	27.8%
	Junior High School	Count	10	31
		% of Total	2.6%	8.1%
	High School	Count	9	12
		% of Total	2.3%	3.1%
	College	Count	4	21
		% of Total	1.0%	5.5%
	University	Count	0	1
		% of Total	.0%	.3%
Total	385	Count	71	314
	100%	% of Total	18.4%	81.6%

The study found that 2.3% of the respondents that were illiterate, 10.1% who completed primary school, 2.6% who completed junior high school, 2.3% who completed high school, and 1.0% who were college graduates had a coping mechanism which received relief from the government.

The table shows that 18.4% of the respondents used relief assistance from the government as a coping mechanism. It is noticeable that only 6% of the illiterate respondents and 16% of the college educated respondents used relief assistance from the government as a coping mechanism. However, 26.71% of the respondents with primary school education, 24% of the respondents with junior high school education and 42.85% of the respondents with high school education used relief assistance from the government as a coping mechanism.

So, the study found that the illiterate respondents and the respondents with higher education have low tendency to receive relief assistance from the government as a coping mechanism, while the respondents with middle education have higher reliance on relief assistance from the government.

Table: 7.46). Education qualification with cross tabulation coping mechanisms by borrowing money from NGOs

			Coping mechanisms by borrowing money from NGOs	
			yes	no
education qualification	No schooling	Count	32	119
		% of Total	8.3%	30.9%
	Primary	Count	28	118
		% of Total	7.3%	30.6%
	Junior High School	Count	7	34
		% of Total	1.8%	8.8%
	High School	Count	1	20
		% of Total	.3%	5.2%
	College	Count	0	25
		% of Total	.0%	6.5%
	University	Count	0	1
		% of Total	.0%	.3%
Total	385	Count	68	317
	100%	% of Total	17.7%	82.3%

The study found that 8.3% of the respondents that were illiterate, 7.3% of the respondents who completed primary school, 1.8% who completed junior high school , and 2.3% who completed high school had a coping mechanism which used borrowing money from NGOs. Though, the respondents who completed college or university had a coping mechanism which did not use borrowing money from NGOs.

The study found that 17.7% of the respondents used borrowing money from NGOs for coping mechanism. The most striking features of the table is that 21% of the illiterate respondents, primary educated 19% of the respondents with primary education, 17% of the respondents with junior high school education and 5% of the respondents with high school education used borrowing money from NGOs for coping mechanism. However, the respondents with college or university education did not use borrowing money from NGOs for coping mechanism.

So, the noticeable finding of the study is that the illiterate respondents had more tendencies to borrow money from NGOs for coping mechanism, in contrast to the respondents with higher education who showed lower tendency to borrow money from NGOs for coping mechanism.

Table: 7.47). Occupation with cross tabulation coping mechanisms by borrowing money from relatives

			Coping mechanisms by borrowing money from relatives	
			yes	No
Occupation	Govt. employee	Count	1	6
		% of Total	.3%	1.6%
	Private sector employee	Count	1	3
		% of Total	.3%	.8%
	Fishermen	Count	38	62
		% of Total	9.9%	16.1%
	Farmer	Count	31	63
		% of Total	8.1%	16.4%
	Day labor	Count	23	47
		% of Total	6.0%	12.2%
	Rickshaw	Count	4	8
		% of Total	1.0%	2.1%
	Car driver	Count	0	2
		% of Total	.0%	.5%
	Teacher	Count	1	3
		% of Total	.3%	.8%
	Small business	Count	21	52
		% of Total	5.4%	13.5%
	Others	Count	6	13
		% of Total	1.6%	3.4%
Total	385	Count	126	259
	100%	% of Total	32.7%	67.3%

The study found that 9.9% of the respondents that were fishermen, 8.1% that were farmers, 6.0% that were day laborers, and 5.4% that were small business owners had a coping mechanism which used borrowing money from relatives.

The study data found that 32.7% of the respondents used borrowing money from relatives as a coping mechanism. The fact worth noticing from the data is that 61% of fishermen, 32% of farmers, 32% of

day laborers, 33% of rickshaw drivers and 29% of small businessmen used borrowing money from relatives as a coping mechanism.

So, the study data found that fishermen had a much higher tendency to borrow money from relatives as a coping mechanism than government or private-sector employees.

Table: 7.48). Occupation with cross tabulation coping mechanisms by relief on assistance from the NGO

			Coping mechanisms of relief on assistance from the NGO	
			yes	no
Occupation	Govt. employee	Count	0	7
		% of Total	.0%	1.8%
	Private sector employee	Count	0	4
		% of Total	.0%	1.0%
	Fisherman	Count	17	83
		% of Total	4.4%	21.6%
	Farmer	Count	18	76
		% of Total	4.7%	19.7%
	Day labor	Count	9	61
		% of Total	2.3%	15.8%
	Rickshaw	Count	4	8
		% of Total	1.0%	2.1%
	Car driver	Count	1	1
		% of Total	.3%	.3%
	Teacher	Count	1	3
		% of Total	.3%	.8%
	Small business	Count	21	52
		% of Total	5.4%	13.5%
	Others	Count	0	19
		% of Total	.0%	4.9%
Total	385	Count	59	326
	100%	% of Total	15.3%	84.7%

The study found that 4.4% of the respondents that were fishermen, 4.7% that were farmers, 2.3% that were day laborers, and 5.4% that were small business owners had a coping mechanism that included receiving relief from NGOs.

The study data found that 15.3% of the respondents used relief assistance from NGOs. 33% of rickshaw drivers, 29% of small businessmen, 19% of farmers, 17% of fishermen and 13% of day

laborers used assistance from NGOs as a coping mechanism, while government employees and private-sector employees did not use relief assistance from NGOs as a coping mechanism.

It is noticeable that rickshaw drivers and small businessmen had a tendency to rely on assistance from NGOs, whereas fishermen and day laborers were less reliant on this form of assistance. Government and private-sector employees, however, did not use relief assistance from NGOs as a coping mechanism.

Table: 7.49). Occupation with cross tabulation coping mechanisms by borrowing money from NGO

			Coping mechanisms of borrow money from NGO	
			yes	no
Occupation	Govt. employee	Count	0	7
		% of Total	.0%	1.8%
	Private sector employee	Count	1	3
		% of Total	.3%	.8%
	Fisherman	Count	25	75
		% of Total	6.5%	19.5%
	Farmer	Count	16	78
		% of Total	4.2%	20.3%
	Day labor	Count	17	53
		% of Total	4.4%	13.8%
	Rickshaw	Count	1	11
		% of Total	.3%	2.9%
	Car driver	Count	1	1
		% of Total	.3%	.3%
	Teacher	Count	0	4
		% of Total	.0%	1.0%
	Small business	Count	21	52
		% of Total	5.4%	13.5%
	Others	Count	0	19
		% of Total	.0%	4.9%
Total	385	Count	68	317
	100%	% of Total	17.7%	82.3%

The study found that 6.5% of the respondents that were fishermen, 4.2% that were farmers, 4.4% that were day laborers, and 5.4% that were small business owners had a coping mechanism which used borrowing money from NGOs.

The study data found that 17.7% of the respondents used borrowing money from NGOs for coping mechanism. While 25% of fishermen, 29% of small businessmen, 24% of day laborers, 17% of farmers and 8% of rickshaw drivers used borrowing money from NGOs, government employees and teachers did not do so.

So, the study's noticeable point is that small businessmen, fishermen and day laborers had a higher tendency to borrow money from NGOs as a coping mechanism, whereas rickshaw drivers tended not to. In contrast, no government employees or teachers borrowed money from NGOs as a coping mechanism.

Table: 7.50). Occupation with cross tabulation coping mechanisms by personal savings

			Coping mechanisms of personal savings	
			yes	no
Occupation	Govt. employee	Count	5	2
		% of Total	1.3%	.5%
	Private sector employee	Count	2	2
		% of Total	.5%	.5%
	Fishermen	Count	31	69
		% of Total	8.1%	17.9%
	Farmer	Count	36	58
		% of Total	9.4%	15.1%
	Day labor	Count	30	40
		% of Total	7.8%	10.4%
	Rickshaw	Count	5	7
		% of Total	1.3%	1.8%
	Car driver	Count	1	1
		% of Total	.3%	.3%
	Teacher	Count	3	1
		% of Total	.8%	.3%
	Small business	Count	21	52
		% of Total	5.4%	13.5%
	Others	Count	11	8
		% of Total	2.9%	2.1%
Total	385	Count	158	227
	100%	% of Total	41.0%	59.0%

The study found that 8.1% of the respondents that were fishermen, 9.4% that were farmers, 7.8% that were day laborers, and 5.4% that were small business owners had a coping mechanism which used personal savings.

The study data found that 41% of the respondents used personal savings as a coping mechanism. 75% of teachers, 71% of government employees, 50% of private-sector employees, and 50% of car drivers used personal savings as a coping mechanism, while 43% of day laborers, 41% of rickshaw drivers, 38% of farmers, and 31% of fishermen used personal savings as a coping mechanism.

So, the study's noticeable point is that government employees, teachers and private-sector employees tended to use personal savings as a coping mechanism. In contrast, fishermen, farmers, day laborers and small businessmen were not likely to do so.

Table: 7.51). Correlation of education with coping mechanism

Education qualification		Coping mechanism during last disaster		
		By personal savings	By relief from government	By borrowing money from NGOs
No schooling	39.2%	43.70%	6%	21%
primary	37.9%	32.87%	26.71%	19%
Junior high school	10.6%	31%	24%	17%
High school	5.5%	52%	42.85%	5%
College	6.5%	76%	16%	-
University	0.3%	100%	-	-

Most striking features are that 100% and 76% of the respondents with college or university education used personal savings as a coping mechanism respectively. On the other hand, 52% of the respondents with high school education, 31% of the respondents with junior high school education, and 32.87% of the respondents with primary school education used personal savings as a coping mechanism.

So we found that those with higher education tended to use personal savings as a coping mechanism.

A noticeable finding is that 6% and 16% of the illiterate respondents and college-educated respondents used relief assistance from the government as a coping mechanism respectively, compared to 26.71% of the primary school educated, 24% of the junior high school educated, and 42.85% of the high school educated.

So, the study found that illiterate respondents and the respondents with higher education tended not to use relief assistance from the government as a coping mechanism, while the respondents with middle education have a much higher tendency to rely on such relief assistance.

The most striking feature of the table is that 21% of the illiterate respondents, 19% of the respondents with primary school education, 17% of the respondents with junior high school education and 5% of the respondents with high school education used borrowing money from NGOs as a coping mechanism, whereas none of the respondents with college or university education used NGOs in this way.

So, the study found that illiterate respondents had a much higher tendency to borrow money from NGOs than the respondents with higher education when coping with disasters.

Table: 7.52). Correlation of occupation with coping mechanism

Occupation		Coping mechanism during last disaster			
		By personal savings	By relief from NGOs	By borrowing money from NGOs	By borrowing money from relatives
Govt. employee	1.8%	71%	-	-	14%
Private sector employee	1.0%	50%	25%	-	25%
Teacher	1.0%	75%	-	25%	25%
Small business	19.0%	29%	29%	29%	29%
Fishermen	26.0%	31%	25%	17%	61%
Farmer	24.4%	38%	17%	19%	32%
Day laborers	18.2%	43%	24%	13%	32%
Rickshaw driver	3.1%	41%	8%	33%	33%
Car driver		50%	50%	50%	-

We can see that 75% of teachers, 71% of government employees, 50% of private-sector employees, and 50% of car drivers used personal savings as a coping mechanism. On the other hand 43% of day laborers, 41% of rickshaw drivers, 38% of farmers, and 31% of fishermen used personal savings as a coping mechanism.

So, the study's noticeable point is that government employees, teachers and private-sector employees were more likely to use personal savings as a coping mechanism than fishermen, farmers, day laborers and small businessmen.

It can be seen from the data that 25% of fishermen, 29% of small businessmen, 24% of day laborers, 17% of farmers and 8% of rickshaw drivers used borrowing money from NGOs as a coping mechanism, while none of government employees and teachers surveyed did so.

It is remarkable that small businessmen, fishermen and day laborers had a higher tendency than rickshaw drivers to borrow money from NGOs as a coping mechanism, whereas government employees and teachers did not use this avenue of assistance.

When looking at the data on relief assistance from NGOs, we see that 33% of rickshaw drivers, small 29% of businessmen, 19% of farmers, 17% of fishermen and 13% of day laborers used this assistance, whereas government employees and private-sector employees did not take advantage of this service at all.

So, the study's noticeable point is that a higher proportion of rickshaw drivers and small businessmen used this kind of relief assistance compared to fishermen and day laborers. In contrast, government employees and private-sector employees did not do so.

Another fact worth noticing from the data is that 61% of fishermen, 32% of farmers, 32% of day labors, 33% of rickshaw drivers and 29% of small businessmen used borrowing money from relatives as a coping mechanism.

So, the study data found that fishermen had a higher tendency to borrow money from relatives as a coping mechanism, while government employees and private-sector employees had a lower tendency to borrow money from relatives as a coping mechanism.

7.18.3. Indigenous Coping Strategies for Cyclones and Induced Surge Mitigation

Coping responses reveal an individual's perceptions and efforts to manage resources for mitigating the adverse consequences of hazards (Haque, 1997; Wisner, et al., 2004). It usually begins when the

household is required to mobilize its assets to respond to a crisis; such as the consumption of savings, asset disbursement, borrowing from kin and patrons etc. (Adams, et al., 1998). Coping strategies may be successful if a household is able to allocate resources to overcome a crisis without compromising the long term objective of livelihood security (Corbet, 1988). In contrast, coping may fail when all efforts to overcome a crisis are abortive, such as selling productive assets and labor, consumption smoothing and the collection of wild foods; and in the worst case result in destitution (Devereux, 1992). This study found that people in four study areas have developed their own coping strategies which are distinct in character as compared to other regions of the country. Based on a specific situation, the adoption of a particular set of strategies depends on people's cultural and socioeconomic background, physical location, the characteristics of the cyclone and induced surge, and the level of the individual's vulnerability and ability to absorb shock. Moreover, people did not adopt coping strategies arbitrarily, but rather followed a sequence of coping measures.

7.19. Early Warning, Forecasting, Awareness, and Training

One of the most effective countermeasures for the reduction of cyclone related losses is the establishment of an early warning system. By predicting the possible occurrence of cyclones, their destructiveness may be minimized. In Bangladesh the cyclone forecast is generally the responsibility of the Meteorological Department. The forecast is transmitted via radio and television stations and the warning is spread through a comprehensive Cyclone Preparedness Programme (CPP). This program is jointly operated by the Bangladesh Red Crescent Society and the Ministry of Relief and Rehabilitation.

The technology of warnings systems has been a major dimension of research on natural hazards mitigation. Typically, tropical cyclones are detected multiple days to weeks prior to landfall, providing time for serial public warnings. News media are able to carefully, repetitively provide updated guidance regarding preparation, protection, evacuation, and sheltering (Shultz, et al., 2005).

It is important to create awareness regarding disaster forecasting & warnings to reduce the tangible and intangible damage of victims (Parker and Tunstall, 1991). The study reveals that the response to

cyclone warnings varies among the coastal people. Most of the respondents in the surveyed areas received disaster warning information from their radios, neighbors, kin, and the Disaster Management Committee (DMC). The main sources of warning for disasters came from the Disaster Management Committee (60.8%), radio (22.3%), neighbors (13.2%), and television (2.9%) respectively. A small proportion received early warnings from mobile phones. It is important to note that, in the study area, most of the households did not own a television, radio or mobile phone.

Additionally, about half of the respondents did not understand the forecast, and some understood only superficially or got some signals. Similarly, the majority of fishermen did not have a radio in their fishing boats, and rarely listened to weather forecasts.

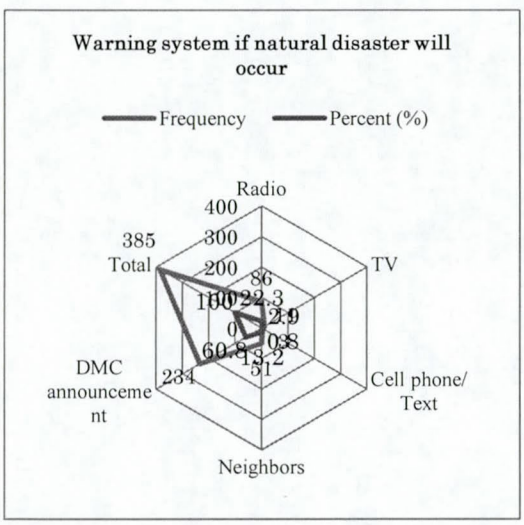


Figure: 7. 10). Household warning system

Table: 7. 53). Household received any training on disaster risk management

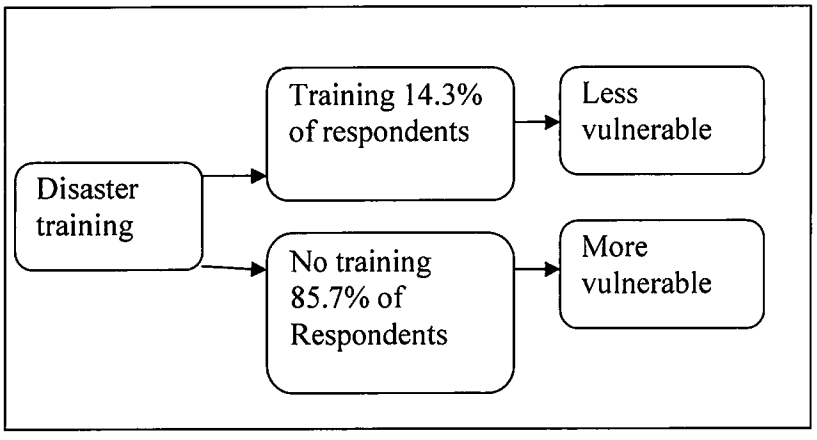
Training activities	Frequency	Percent (%)
Yes	55	14.3
No	330	85.7
Total	385	100.0

The study also found that 85.7% of the respondents did not receive any training on disaster risks. Only 14.3% of the respondents received training on disaster risk management.

7.27. Measuring Vulnerability based on Disaster Training

Training is particularly necessary for cutting-edge functionaries within and outside the government at various levels in different sectors. A remarkable point of the study is that 87.7% of the respondents have had no disaster risk training. This makes them more vulnerable as cyclone risk reduction is

impossible without training /drills. Such training may include maroon search and rescue, first aid, evacuation, temporary shelter management, arrangement of drinking water and sanitation, provision of cooked food and so on. In contrast, 14.3% of the respondents who have received disaster training are considered as less vulnerable.



7.20. Preparedness and Mitigation

Preparedness behavior for disasters has been conceptualized into the categories of provisions, protection, planning, and skill. Specific to tropical cyclones, preparedness includes stocking ample hurricane lamp supplies, developing family disaster plans, training with community disaster response teams, and seeking information for action when a storm is approaching (shultaz, et al., 2005).

Along with impact-minimizing strategies, pre-cyclone preparedness measured at the individual or small group level involves measures such as avoiding a disaster event, a dangerous period, exposed locations for housing and other relevant efforts that might help to avoid disaster (Wisner, et al., 2004).

In terms of preparedness and mitigation, the respondents had several practices. In the surveyed areas most of the respondents had seemingly standard practices as far as preparedness was concerned. They tied rope to secure their houses when a cyclone was coming (16%); moved to a safer place (19%), moved assets to safer place (36%), prepared emergency kits (20%), and stockpiled food (9%). No one went to repair the embankments or levees.

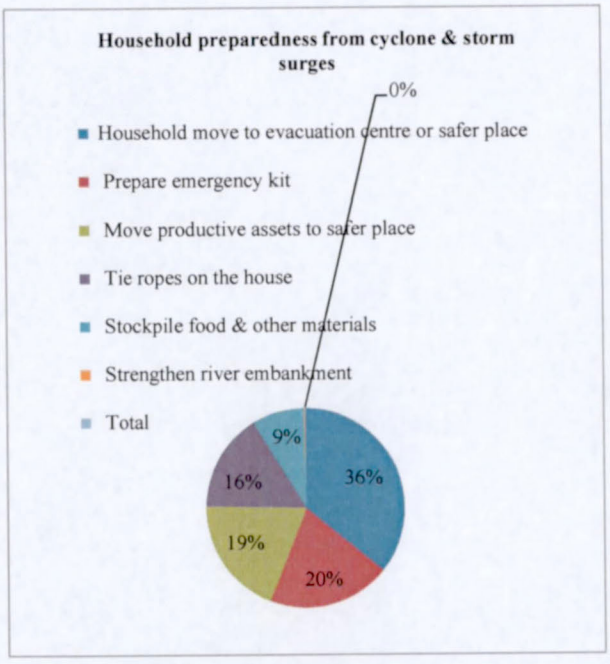


Figure: 7. 11). Household preparedness from cyclones and storm surges

Across survey areas, although the respondents were aware of and prepared for disasters, it must be noted that they were not involved in more community level activities such as improving river embankments or levees. They considered such activities to be the responsibility of the local government units.

7.20.1. Indigenous Knowledge or Perception about Predicting Cyclone and Cyclone Preparedness

This study explored non-structural cyclone preparedness from Focus Group Discussion (FGD) questionnaires. People experienced this indigenous preparedness from generation to generation.

① Symptoms in animal behaviors and symptom period

The respondents said that they have been able predict the approach of cyclones from animal behaviors. When a cyclone is imminent, wild and domestic animals seem to predict that something wrong is going to happen earlier than people, and they flee for safety. Their symptoms (during) that time, which are dependent on the degree of imminence of the cyclone and different types of animals, are believed

to be early cyclone warnings. According to the experiences of participants, events of animal behavior and their symptom period during cyclones are stated below:

Table: 7. 54). Symptoms and symptom period of animal behavior

Symptoms of animal behavior	Symptom period
Fish jump in the river and ponds	0-12 hours before
Frogs call continuously	Up to 1 day before
Grasshoppers fly united (in swarms)	Up to 1 day before
Termites show enormously in the sky	Up to 1 day before
Bees move around in clusters	Up to 2 days before
Red ants climb trees with eggs on their backs	Up to 2 days before
Black ants climb trees straightly and house in great numbers	Up to 2 days before
Dogs wail continuously	2-5 days before
Cattle become restless and stop eating grass	2-5 days before

Source: Field survey, November, 2011

The present study confirms the findings of Hossain, et al., (2008) & Motaleb, et al., (2011) that ants' behavior was more effective than that of frogs' because both rainy season and cyclonic storm frogs croak continuously. Termite and fish behaviors were moderately effective for cyclone warning.

② Symptoms and symptom period of weather patterns

Weather pattern was considered very important to predict cyclone direction, movement and occurrences. But the symptom period of weather patterns manifests only a few hours beforehand. The wind directions were associated with other attributes such as red colored clouds, gloomy skies etc.

Table: 7. 55). Symptoms and symptom period of weather patterns

Symptom of weather patterns	Symptom period
Weather usually hot and humid spells after rain	0-3 hours before
Sky turns gloomy	0-7 hours before
Red colored clouds and appearance of rainbow in the sky	0-10 hours before
Strong wind blows from the south-western side	0-12 hours before

Source: field survey, November, 2011

The present study confirms the earlier findings of Motaleb, et al., (2011) that wind direction was contradictory, but when strong wind blows from the south-western side it can be an effective predictor for a cyclone within 12 hours. When there are red colored clouds in the sky and a rainbow appears

during day time, it may serve as a moderate cyclone predictor which indicates a cyclone may show up in the next 10 hours.

③ Symptoms and symptom period of river and canal patterns

Villagers often found it was useful to use river and cannel patterns to predict cyclones. Symptoms and symptom periods of river and canal patterns were in the table below:

Table: 7. 56). Symptom and symptom period of river and canal patterns

Symptom of river and canal pattern	Symptom period
Big waves in the river	0-4 hours
'Groom-groom' sounds in the river	0-6 hours before
River water becomes hot	Up to 1 day before
Water hyacinth in the canal	1-2 days before

Source: field survey, November, 2011

The present study confirms the earlier findings of Hasan, M.T. (2010) and Edris & Collins (2008) that river and canal behaviors were considered effective symptoms of an early warning. Hot water and water hyacinth are good indicators. Nonetheless, big waves and '*groom-groom*' sounds were regarded as moderately effective, which appear when the cyclone is near.

7.20.2. Seasonality of Cyclone Preparedness

From the analyses of the Focus Group Discussion (FGD), we found that local people developed aseasonality calendar based on the occurrence of cyclone events. The calendar prepared by local people, shows the months with the occurrence of cyclones and times for preparedness.

March to July was the riskiest time for cyclones in the study areas. Preparedness and other activities should be enacted before and during cyclone periods. Mock drills were preparedness efforts to keep villagers alert though, they have been prepared for cyclones since the month of March.

7.21. Informal Risk Sharing within the Community

Despite the adoption of different strategies to cope with the disasters, vulnerability remains high in Bangladesh (Dercon, 2002). The study reveals that 68.6% of households trust their neighbors very

much. 24.2% of households trust their neighbors somewhat, and 6.2% only a little. On the other hand, households helped each other during cyclones and post-cyclone periods somewhat (40.5%), a little (29.9%), and very much (24.2%) respectively.

Table: 7. 57). Level of trust toward neighborhood/ relatives

Household Trust	Frequency	Percent (%)
Not trustful	4	1.0
A little	24	6.2
Somewhat	93	24.2
Very much	264	68.6
Total	385	100.0

Table: 7. 58).Level of help from neighborhood during natural disasters or in case of your illness

Household help	Frequency	Percent (%)
Somewhat	156	40.5
A little	115	29.9
Very much	93	24.2
Very unlikely	21	5.5
Total	385	100.0

7.30. Social Processes and Vulnerability

The social structures that form the basis of community and family life play a key role in determining the individual and collective vulnerability in communities. 'Closer Knit' communities tend to be more resilient (Perry, 1979; Twigg, 2000). Residents within communities (mainland) that grow and evolve over a period of time form relationships based on common interests and experiences. These relationships strengthen and bind individuals into meaningful groupings where they experience a true sense of belonging. This community feels that they belong together or form a cohesive group. Here people 'take care of each other'. The study reveals that 68.6% of respondents trust their neighbors very much (see table, 7:55). As a result social bonding and bridging of these communities' people are so strong.

In areas (char land) that have grown rapidly, strong social bonds will not have had time to develop. Individual households may then be isolated within their neighborhoods. Char dwellers are different in the sense that they are perceived as rude, dangerous and perpetually involved in violent conflicts over land. As a consequence in char land areas social bonding is not so strong.

However, from the FGD and in interviews conducted, it was clear that social coherence and solidarity (social capital) is perceived as one of the key strengths of char society. Several informants agreed that 'the char is a good place to live because people take care of each other'.

The warning period is a time when people could share information and offer and receive support, actions that would effectively reduce individual and household vulnerability. Therefore, in addition to being isolated within their neighborhoods, many residents are also likely to be separated from their extended families, the unit that would usually be expected to provide advice and support, particularly in times of need. Family and community cohesions have been shown to increase effective responses in times of disaster.

7.23. Community Perception and Vulnerability Reduction

Community vulnerability is not a static state but rather it is a dynamic process that is generated by the complex relationships and inter-relationship arising from the unique actions and interactions of the social and community attributes and characteristics of a particular population. This includes:

- Social structures, infrastructure and institutions- and includes the integrity of physical structures
- Community process and structures such as community organization, mobility of the household population, and community cohesiveness and the social support this affords, and
- Demographic characteristics of individuals within the community such as age, ethnicity, education and wealth (Fothergill, 1996; Buckle, 1999; Cannon, 2000)

In combination, these contribute to forming the basis of community, family and individual knowledge, understanding and life processes that give rise to the individual and community perception of risk. The

perception of risk, once formed, is then further shaped by the individual's personal experience of a particular hazard.

With regard to household perception of natural hazards 96.9% of the respondents feel that the frequency and intensity of natural hazards has been increasing recently and 96.6% of the respondents consider that they are vulnerable to natural hazards (see table, 7:34; 7:35). So the point here is that community's people are more vulnerable to natural hazards and their perception of such vulnerability is increasing.

For disaster reduction, peace-time efforts are important for building disaster-resilient communities and societies and preventing disasters. In order to build disaster-resilient communities and societies, it is necessary to reduce disaster risks in the relevant community /society. In order to reduce disaster risks, it is necessary to deepen understanding of disasters and to improve coping capacity.

Disasters cannot be fully controlled even if preventive measures are taken. Thus, efforts to save lives quickly and effectively after the occurrence of a disaster are necessary. In order to prevent secondary disasters, it is essential to establish emergency response systems, to conduct rescue operations, and to urgently provide assistance to disaster victims.

In order to help disaster victims leave chaotic conditions behind and return to their normal lives, it is necessary to recover social and lifeline infrastructures, such as housing, electricity, road, medical and educational facilities and to provide support that contributes to the reconstruction of livelihood so that disaster victims can lead independent lives. Furthermore, since serious emotional and mental health issues are commonly faced by disaster victims, measures for mental care would be necessary on medium and long term bases.

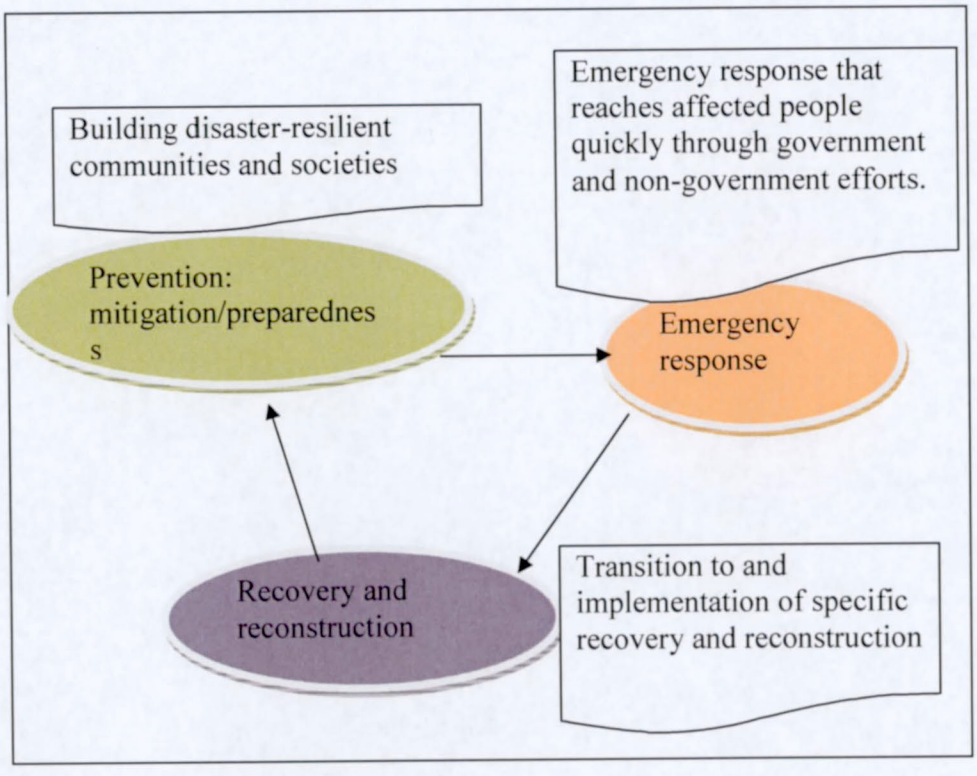


Figure: 7:12. Disaster management cycle for reducing vulnerability

Based primarily on these perceptions, people within communities individually and collectively decide what precautionary measures will be undertaken and how warnings will be complied with so as to ensure that loss resulting from a hazard event is limited to an acceptable level-based primarily on these perceptions. If perceived risk is a true reflection of the actual risk associated with a particular hazard, then mitigation strategies, warning compliance and response preparedness are likely to be appropriate and vulnerability can be minimized. If risk perception is biased, the reverse is true and vulnerability may be increased.

CHAPTER : 8

CASE STUDY IN BANGLADESH AND IN JAPAN

8.0. CASE STUDIES: HATIYA UPAZILA OF BANGLADESH AND ISHINOMAKI CITY IN JAPAN

Through two case studies, Hatiya upazila of Bangladesh and Ishinomaki city in Japan, the author tried to disclose people's perceptions about coastal hazards and their vulnerabilities to these hazards. Hatiya upazila of Bangladesh is to investigate the coastal community's risk, vulnerabilities and coping methods from different hazards. On the other hand, Ishinomaki city of Japan is to describe people's perception about tsunami, warning system, relief, response and recovery.

8.1. Case study: In Hatiya Upazila of Bangladesh

8.1.1. Introduction

Hatiya Island is surrounded by the South Hatiya Channel, West Hatiya Channel and East Shahbazpur Channel. East Shahbazpur is a flood channel and the south-west Hatiya is an ebb channel. Hatiya is the famous "pathway" of cyclones in Bangladesh. The ground level in Hatiya is 10 m above the mean sea level; therefore the coastal community has been hampered by seasonal tidal inundation and subsequent salinity intrusions, especially in the dry season when the flow of river water diminishes (Islam, 2008). The residents are extremely vulnerable to future sea level rise. Available data on Hatiya Island from 1952 to 1988 indicate that considerable erosion of the Island took place in the north, with simultaneous accretion in the south (Banglapedia, 2011).

8.1.2. Area and Administration

Hatiya Upazila (NOAKHAL District) with an area of 1508 sq km is bounded by Noakhali Sador and Ramgati *Upazila* in the north, Bay of Bengal in the south and the east, and Manpura *Upazila* in the west. Hatiya *Upazila* consists of many large and small offshore Islands (BBS, 2011).

Hatiya Thana was turned into an upazila in 1983. The Upazila consists of 11 unions, 44 mouzas and 62 villages. Hatiya (Town) consists of three mouzas (BBS, 2011).

8.1.3. Socioeconomic Characteristics

Population: Hatiya *Upazila's* total population is 452,463; male 223,853; female 228,610; Muslim 87.16%, Hindu 12.31%, Buddhist 0.16% and others 0.37%; population density per sq km 300; total household number is 91,013, and average household size is 4.98 (BBS, 2011).

Educational institutions: government college 1, non-government college 2, government high school 2, non-government high school 23, madrasa 16, government primary school 105, non-government informal primary school 117 (Banglapedia, 2011).

Main occupations: agriculture 38.65%, agricultural laborer 24.23%, wage laborer 3.77%, commerce 8.69%, services 3.58%, fishing 5.37% and others 15.71% (Banglapedia, 2011).

Land use and main crops: total cultivable land 28,396.2 hectares; fallow land 2,815.46 hectares; single land 38%, double crop 46% and treble crop land 16%; cultivable land under irrigation 75% (Banglapedia, 2011). Main crops are paddy, jute, wheat, potato, sugarcane, chilli, and varieties of pulses, oil seed, betel leaf and betel nut (Upazila Administration Office, 2011).

Roads: *pucca* 380 km, semi-*pucca* 220 km and mud road 800 km (Banglapedia, 2011).

NGO activities: operationally important NGOs are BRAC, PROSHIKA, CARE, and CARITAS (Upazila Administration Office, 2011).

8.1.4. Background of the Study

The Fourth Assessment Report of the IPCC (2007), the National Adaptation Program of Action (NAPA) (MoEF, 2005) and (Parvin, et al., 2008) have recognized the coastal island of Hatiya as one of the most vulnerable areas of the country due to the recurrent coastal hazards and the threats of climate change-induced impacts. The nature and types of coastal hazards and vulnerabilities have been well documented by the IPCC, NAPA, the World Bank and various researchers.

This study's prime concern is to investigate the coastal community's risk, vulnerability and coping methods from different hazards. Community's risk from hazards depends on the frequency and severity of hazards and their vulnerability (ISDR, 2004). In this study, community's perception about the types of coastal hazards, trends, and the vulnerability of people is briefly presented.

8.1.5. Risk and Vulnerabilities in Hatiya Island

The people of Hatiya Island are vulnerable because they live in an extremely dynamic estuarine environment facing threats such as: cyclones, tidal surges, riverbank erosion, floods, salinity

intrusion, and deteriorating coastal ecosystems. These threats affect almost every aspect of life and livelihood choices of the people. These vulnerabilities create a context of insecurity, which in turn, discourages investments, limits economic activities and squeezes employment opportunities.

As elsewhere in the coastal zone of Bangladesh, The Hatiya Island has the highest concentration of natural hazards. Some of these are dreadful and devastating. Major vulnerabilities are summarized as follows:

Table: 8.1). Overview of Vulnerabilities

Vulnerabilities	Vulnerable area	Present status	Risk of aggravation
Cyclones	Entire Hatiya Island	Devastating but seasonal.	Increasing
Storm surges	Islands, exposed areas.	Devastating but seasonal.	Increasing
Riverbank erosion	Northern parts of Hatiya Island.	Serious, localized, seasonal.	Increasing
Floods	Entire Hatiya Island	Serious, seasonal	Increasing
Salinity intrusion	Northern, eastern and southern parts of Hatiya Island.	Localized, seasonal	Increasing

Source: Field Survey, 2011.

Five key vulnerabilities have been identified in Hatiya Island. These are cyclones, storm surges, riverbank erosion, floods and salinity intrusion. It is forecasted that these vulnerabilities would become more acute due to the combined effects of climate changes, sea level rise, subsidence, change of upstream river drainage, and coastal embankments.

Table: 8. 2). Disaster, Risk, Vulnerabilities and Coping Capacity

Disasters	Risk and vulnerabilities	People's coping capacity
Cyclones	a.) Causes infrastructural damage b.) Damages houses & crops c.) Roads and communication are also hampered d.) Tree and animals are	a.) There is a cyclone shelter present. b.) Cyclone warning disseminated by Cyclone Preparedness Program (CPP)

	hampered	
Tidal surges	a.) Damages roads and structure. b.) This makes the agricultural land unfertile and creates inundation ponds.	a.) Construction of embankment by Government.
Salinity intrusion	a.) This makes the agricultural land unfertile and creates inundation ponds.	a.) Construction of embankment by Government.
Flood	a.) Damages agricultural crops and housing	a.) Construction of embankment by local government.
Riverbank erosion	a.) Agricultural lands are disappearing. b.) Roads and homes get engulfed and disappear.	

Source: Field Survey, 2011.

8.1.6. Community Perception to Coastal Hazards and Vulnerabilities

The coastal areas of Bangladesh are divided into different geo-morphological regions, so their climate, geology, soil, and hydrology are different in different parts of the country (Islam, 2004). The people of Hatiya were asked about their most prevalent coastal hazards, and according to the people's perceptions, the most prevalent coastal hazards in Hatiya are cyclones, tidal surges (storm surges and tidal floods), and river bank erosion (Field survey, 2011). As noted, Hatiya is located on the southern coast, which is relatively more vulnerable to cyclones and associated storm surges. In addition to this, being located at the estuary of Mehgna River, the northern part of Hatiya is facing severe riverbank erosion. Fortunately, arsenic contamination and salinity, which are catastrophic problems in many other parts of coastal areas, are not remarkable hazards in Hatiya (Parvin, et al., 2008).

Regarding the trend of coastal hazards in Hatiya, 97% of people perceived that both the intensity of the hazards and vulnerabilities of the people have increased over the last three years, (Field survey, 2011) though they have no perception about climate change (Parvin, et al., 2008). Especially the intensity of cyclones, tidal surges, and riverbank erosion has increased in Hatiya. Moreover, decreases

in incomes along with a rapid increase of the price of food and daily necessities have enhanced the vulnerabilities of most of the coastal population.

8.1.7. Response to Warnings Delay

The Hatiya Island people's particular process of response to cyclones can make them vulnerable to disaster. As they are used to facing multiple hazards each year, their responses to warnings depend on the intensity of wind speed, experience of hazards, local belief in the probability of dangerous cyclone events, or the presence of a cyclone signal hoisted by the Bangladesh Meteorological Department (BMD). If the symptoms of previous hazards coincide with a Bangladesh Meteorological Department (BMD) warning of about six to seven on average, they start to prepare to save belongings or decide to leave their homes for a cyclone shelter or stronger buildings nearby. Before that, they adopt a 'wait-and see' approach, observing whether the cyclone intensity is rising. These study findings were consistent with Haque and Blair, 1992; Edris and Collins, 2008; Paul, 2009a.

8.1.8. Traditional Disaster Forecasting

The indicators of traditional forecasting of disasters by the communities of Hatiya Island were broadly divided into two categories: hydro-metrological and biological. Some forecasting signs were quite straight forward. For example, high temperatures and humid conditions were indicating heavy rainfall; heavy rainfall was resulting in flood. Some forecasting indicators observed by Hatiya communities were similar to those in other areas, like birds flying to and fro restlessly and dogs barking abnormally before cyclones. Some signs were very specific and exact, like the movement of ants. In the case of hailstorms ants only climb up houses, in the case of cyclones or *kalboishakhi*, they only cross roads, but in the case of heavy rainfall they do both. The present study findings were consistent with Khan, et al., (2000); Howell, (2003); Motaleb, et al., (2011).

Table: 8.3). Traditional Disaster Forecasting by the Hatiya Island Communities

Hazards	Traditional forecasting of disasters	
	Hydro-meteorological	Biological
Heavy rainfall	a.) High temperature and humidity b.) Wind moves from south to north in April to May	a.) Ants climbing houses and crossing roads in lines 1-2 days before heavy rainfall.
Floods	a.) Heavy rainfall b.) Irregular rainfall c.) Very strong wind for 3-4 days	
Cyclones	a.) High temperature b.) Fast moving clouds in the sky c.) No wind for 5-6 days, thus no movement of leaves on the tree d.) Clouds roaring like the sea	a.) Dogs barking abnormally b.) Birds flying to and fro unusually c.) Ants crossing roads in lines
Hailstorm	a.) Black stripes in the sky before rainfall b.) Very hot and humid conditions for 3-4 days c.) Clouds rumbling heavily	a.) Ants climbing houses in lines

Source: Field Survey, 2011

8.1.9. Women's Vulnerability in a Disaster

Discussions with family groups indicated that the decision to save belongings and to leave home in most cases depended on the arrival of the male head of the household. Therefore, other family members wait for the arrival of the family head from outside. Due to conservative religious beliefs, many of the male heads of households prefer not to move to cyclone shelters, thinking that the female members of household might lose their *purdha* (a scarf worn by Muslim women on their heads) while travelling to or staying at cyclone shelters. The household also considers the problems that can arise at cyclone shelters, such as space issues, lack of light and poor sanitation. This finding was consistent with Ikeda, 2005; Edris & Collins, 2008.

8.1.10. Cyclone Shelters

Hatiya has more than 100 cyclone shelters that have been constructed with financial support from the Red Crescent Society, the Saudi Government, and the Japanese Government. Nonetheless, from the

people's perception, it was observed that most of the communities have need of more cyclone shelters in their villages. Also, according to Islam (2008a, b), in coastal areas, the capacity of the cyclone shelters was insufficient for the quantity of those who need shelter from the cyclones.

It may be noted that, there are more than 2,000 cyclone shelters along the coast of Bangladesh, but these can only accommodate one-fourth of the population in high-risk areas (Hasan, 2004). A similar situation also exists in Hatiya. According to union disaster management plans of two of the most cyclone-prone unions in Hatiya, namely the Jajajmara Union and Nijhum Dwip Union, the total capacity of cyclone shelters was about 10,000 and 5,000 persons, respectively, whereas the total population of both of the unions was more than 90,000 (Field survey, 2011). This means that if strong cyclones like the ones that occurred in 1970 and 1991 were to strike Hatiya again, there would be no space to accommodate all the population who would be evacuating to their nearest shelters, regardless of the perfect dissemination of warnings worked out in advance.

Not only the lack of capacity but also the distance to the nearest cyclone shelters was a concern with the proper functioning of a cyclone shelter. In some parts of Hatiya, especially the southern part, unpaved, undulated and discontinued (due to rivers and canals) rural roads have made the communication system very difficult and time consuming (Parvin, et al., 2008). This caused people to perceive that the emergency shelter was too far away. Besides this, the southern part of Hatiya, namely Nijhum Dwip, is a small Island, exposed to the Bay of Bengal, and was not protected by any embankments. In total, about 50,000 people of this area are highly vulnerable to cyclone and tidal surges (Field survey, 2011).

8.1.11. Livelihood-related Coping Methods for Different Hazards

It is said that rather by being specialized, and therefore, vulnerable to hazards, people in coastal communities are well suited to adapt to changing situations (Pomeroy, et al., 2006). This statement is also true for the people of Hatiya. Among the different coping methods related to livelihood or income

sources, people primarily try to use whatever savings they have. Those who have no savings or no property like poultry or livestock to sell must then take a loan from relatives, neighbors, moneylenders, or from local NGOs. However, during these events, most of these relatives and neighbors also have to face similar socioeconomic crises.

On the other hand, in order to get a loan from an NGO, one must meet some terms and conditions, such as, membership, full payment of a previous loan and submission of an application, etc., so some people turn to the moneylender as an easy and prime source of loans during an emergency. People have claimed that though moneylenders charge high interest rates, they can negotiate with them and can change their repayment dates (Field Survey, 2008).

Another common method of livelihood-related coping is that each household tries to raise poultry between August and November, which is the peak season for tidal surges and cyclones. They will then sell the poultry at this time to raise needed capital, even though they get relatively lower prices at this time. Since the majority of Hatiya's people are landless or have only a small amount of land, selling land or mortgaging their property is a very rare method of coping with crisis circumstances (Field survey, 2011). At this time, leaving one's village for a job is also very common. Chittagong, which is the second largest city and serves as the largest sea port of Bangladesh, is relatively close to Hatiya. After any coastal hazards or disasters, many people go to Chittagong city for opportunities. Finally, those with no access to any of these alternatives usually are forced to resort to starvation (sometimes only one meal a day or nothing at all). These findings were consistent with Parvin, et al., (2008).

8.1.12. Conclusion

It is advised that understanding a community's unique perceptions and assessments of their adaptive and proactive capacities is important in creating successful coastal hazard management programs. The development of effective hazard-reduction programs requires cooperation and exchange of experiences between the affected communities and the local governments (Marfai, et al. 2007).

Therefore, this case study has tried to disclose people's perceptions about coastal hazards, their vulnerabilities to these hazards, and the methods they employ to cope with a variety of hazards.

The complete investigation reveals that both the intensity of coastal hazards and people's vulnerabilities are increasing over time. A number of socioeconomic and location factors are enhancing their vulnerabilities though they are relentlessly struggling to minimize their vulnerabilities by undertaking various coping methods. It is necessary to build a bridge between the efforts taken at the community level and development organizations. The efforts of development organizations need to ensure adequate accommodation in cyclone shelters, which should be connected by a better transportation system, and the location of the center, should be selected with community's participation.

8.2. CASE STUDY: ISHINOMAKi CITY IN JAPAN

8.2.1. Introduction

Japan is an island arc that sits in the monsoon region, and is under the influence of warm and moist air masses in summer and cool air masses in winter. The moisture that is taken in the lower level of the air masses over the sea is poured on the country by typhoons in summer, by snowfall in winter, particularly by the "Bai-u Front" (rainy season) in June and July, and by depressions and fronts in all seasons. This precipitation is predominantly in the form of locally specific torrential downpours. In winter, the northern part of the country usually receives heavy rainfall that causes prolonged floods in spring from the melting of snow (Takeuchi & Shaw, 2010).

Owing to these meteorological characteristics, flood disasters caused by heavy rains occur frequently in Japan. Seventy percent of the land is mountainous. Consequently, the rivers are generally short with steep gradients. Erosion and devastation in the mountain areas are very rapid. Rivers have flash flooding with high concentrated peak discharges soon after an intense rainfall. The remaining 30% of

the land is mostly alluvial plains where housing, farming, and industries are densely concentrated, consequently increasing the vulnerability to flood disasters (Shaw, Takeuchi & Badaoui, 2008).

In Japan, artificial changes in natural environments are rapid and large, accompanying the great increase in economic activity and exploitation that the country has seen (Nakano, Kadomura, Mizutani, Okuda, & Sekiguchi, 1974). Although, 10% of Japan's land area is flood prone, about 50% of the population lives in floodplains and almost 75% of the property is concentrated in the floodplains (JWF, 2006).

8.2.2. Disasters in Japan

Every year there is a great loss of people's lives and property in Japan due to natural disasters. Up until the 1950s, numerous large-scale typhoons and earthquakes caused extensive damage and thousands of causalities (Japan Meteorological Agency, 2009). However, with the progress of society's capabilities to address disasters and the mitigation of vulnerabilities to disasters by developing disaster management systems, promoting national land conservation, improving weather forecasting technologies, and upgrading disaster information communications systems, disaster damage has shown a declining tendency.

In spite of such efforts, every year, natural disasters affect people's lives and damage properties. In 1995, more than 6,400 people became casualties of the Great Hanshin-Awaji Earthquake and in 2004, 10 typhoons- the largest number in a single year on record- crossed over Japan, causing damage throughout the nation. Recently, in 2011, The Tohoku Earthquake and huge consequent tsunami resulted in 15,867 deaths, 6,109 injuries and 2,909 people missing, in addition, 129,225 buildings totally collapsed, with a further 254,204 buildings 'half collapsed', and another 691,766 buildings partially damaged (GoJ, 2006; NPA, 2012). There is also a high probability of the occurrence of large-scale earthquakes in the coming decades.

8.2.3. Disaster Risk Reduction Approach in Japan

In 1961, the Disaster Countermeasures Basic Act was passed; the immense damage Typhoon Isewan caused in 1995 was also a turning point for disaster management that led to the planning and preparation of a comprehensive disaster management system. Therefore, the disaster management system has been improved and strengthened following the occurrence of large natural disasters. The Disaster Countermeasures Basic Act is the basis for disaster management in Japan, and the expectation for effective disaster management is that the government, the local government, and designated public corporations are expected to work out disaster management plans and carry them out appropriately. The main contents of the act are as follows:

① Definition of jurisdictions and responsibilities for disaster management

② Disaster management system

③ Disaster management plan

④ Disaster prevention and preparedness

⑤ Disaster emergency response

⑥ Disaster recovery and rehabilitation

⑦ Financial measures

⑧ State of disaster emergency

The Central Disaster Management Council was established for the purpose of promoting comprehensive countermeasures in which the prime minister takes the chair and other ministers of state are members. The duties of the Central Disaster Management Council are as follows:

① Prepare and promote implementation of the basic disaster management plan and draft the earthquake disaster management plan.

② Prepare and promote implementation of the urgent measures plan for major disasters.

③ Consider important matters pertinent on disaster management according to requests from the prime minister and/ or ministers of state

④ Offer opinions regarding important matters on disaster management to the prime minister and

minister of state for disaster management

The Central Disaster Management Council's members include the prime minister, all cabinet ministers, chief of the designated public corporations (Governor of the Bank of Japan, President of Japan Red Cross Society, President of Japan Broadcasting Corporation, and President of Nippon Telegraph and Telephone Corporation), and four people of experience or academic standing (GoJ, 2006).

8.2.4. Disaster Management Planning System in Japan

(a.) Basic Disaster Management Plan

This plan is a basis for disaster reduction activities and is prepared by the Central Disaster Management Council based on the Disaster Countermeasures Basic Act. The Basic Disaster Management Plan states comprehensive and long term disaster reduction issues, such as disaster management related systems, disaster reduction projects, early and appropriate disaster recovery and rehabilitation, as well as scientific and technical research.

This plan was revised entirely in 1995, as mentioned above, based on the experiences of the Great Hanshin-Awaji Earthquake. It now consists of various plans for each type of disaster, where tangible countermeasures to be taken by each stakeholder such as the national and local governments, public corporations and other entities are described for easy reference according to the disaster phases of prevention and preparedness, emergency response, as well as recovery and rehabilitation (Goj, 2006).

(b.) Disaster Management Operation Plan

This is a plan made by each designated government organization and designated public corporation based on the Basic Disaster Management Plan.

(c.) Local Disaster Management Plan

This is a plan made by each prefectural and municipal disaster management council, subject to local circumstances and based on the Basic Disaster Management Plan.

Table: 8. 4). History of Basic Disaster Management Plan in Japan

Year	Contents
1963	Initial plan drawn up
1971	Revision of Earthquake Disaster Countermeasures and Petroleum Industrial Complexes Disaster Countermeasures
1995	Overall Revision of Natural Disaster Countermeasures
1997	Addition of Accident Disaster Countermeasures
2000	Overall Revision of Nuclear Disaster Countermeasures
2002	Revision of Storm and Flood Countermeasures and Nuclear Disaster Countermeasures
2004	Revision of Earthquake Disaster Countermeasures
2005	Revision of Natural Disaster Countermeasures

Source: white Paper on Disaster Management, 2006.

8.2.5. Disaster Prevention and Preparedness

(A). Observing, Forecasting and Warning of Disaster Risks

Observing systems that can accurately detect disaster risks in real-time have been progressively improved for establishing early warning systems, supporting the early evacuation of residents and response activities of disaster management organizations, and thereby reducing disaster damage. Organizations involved in disaster reduction, especially the Japan Meteorological Agency (JMA), use 24-hour systems to carefully monitor various natural phenomena and weather conditions. In addition to announcing observed information related to natural phenomena, JMA issues a wide range of forecasts, warnings and advisories regarding earthquake generated tsunamis and severe weather events such as heavy rain (JMA, 2009).

(B). Information and Communication System

The development of a quick and accurate communications system is essential for the effective use of early warning information. JMA has therefore built an online system linking disaster management organizations of the national and local governments and media organizations. Disaster management organizations have also been developing radio communication networks exclusively for disasters: the Central Disaster Management Radio Communication System which connects firefighting

organizations across the country; and prefectural and municipal disaster management radio communications systems which connect local disaster management organizations and residents. The Cabinet Office has developed the Central Disaster Management Radio Communication System so that designated government organizations and designated public corporations can use telephones or facsimiles via a hotline, and has prepared an image transmission circuit so that pictures of disaster situations can be transmitted from helicopters in real time. Furthermore, as a backup for terrestrial communication, a satellite communications system has also been constructed.

Simultaneous wireless communications systems using outdoor loudspeakers and indoor radio receivers are used to disseminate disaster information to residents. Tsunami and severe weather warnings are widely and continuously provided to citizens via TV and radio broadcasts (GoJ, 2006).

(C). Integrated Disaster Management Information System

Based on the experiences of the Great Hanshin-Awaji Earthquake, the Cabinet Office has developed an integrated disaster management information system that helps to grasp the situation of the disaster early on and promotes information sharing among relevant organizations; thereby enabling quick and appropriate decision-making for emergency response operations.

a.) DIS (Earthquake Disaster Information System)

DIS is automatically activated upon the receipt of earthquake (intensity level of 4 or greater) information from JMA to estimate the approximate distribution of seismic intensity and scale of damage (human suffering and building damage) within 30 minutes.

b.) RAS (Real Damage Analysis System by Artificial Satellite)

RAS uses satellite images to assess actual disaster damage when it is otherwise difficult to determine the disaster situation due to the disruption of transportation and communications networks.

c.) PF (Disaster Information Sharing Platform)

PF is a common information sharing system with a standardized information format, where a variety of disaster information provided by ministries and agencies, local governments, relevant organizations and residents, can be posted and freely accessed by all.

(D). Development of Disaster Management Bases

In order to secure wide-area collaboration for quick and smooth response, recovery and rehabilitation activities at the time of a large scale disaster, disaster management bases with such functions as information management, operations coordination and logistics have been developed.

The Cabinet Office is constructing main wide-area disaster management bases in cooperation with relevant ministries in Ariake-no-Oka (Tokyo) and Higashi-Ogishima (Kanagawa) in the Tokyo Bay area: these will function as core bases for responding to a large-scale disaster in the Tokyo metropolitan area (GoJ, 2006).

(E). Issuing of Evacuation Order and Instruction

When a disaster occurs or is imminent, residents may start evacuating on their own, and the mayor of the municipality may also issue an evacuation order or instruction. It is effective for municipalities to prepare a manual explaining the criteria regarding disaster situations that require the issuance of evacuation orders or instructions, thereby helping the mayor's quick decision. The Cabinet Office, in cooperation with relevant ministries, published the "Guidelines for Producing a Decision and Dissemination Manual for Evacuation Orders and Instructions" in 2005, and has promoted its implementation (GoJ, 2006).

(F). Measures for People Requiring Assistance during Disaster

In view of the aging society and the increasing number of the elderly being killed or injured by disasters, measures to provide necessary assistance to the elderly and physically impaired at the time of a disaster need to be reinforced. Therefore, tangible countermeasures are included such as the issuance of evacuation preparation information which calls for the early evacuation of people requiring assistance, and the sharing of information on people requiring assistance among disaster management and social welfare-related organizations (GoJ, 2006).

(G). Disaster Reduction Drills and Exercises

Disaster reduction drills and exercises are good opportunities to review the effectiveness of the disaster management system in view of quick and appropriate emergency operations and to enhance public awareness through wide participation. The Disaster Countermeasures Basic Act stipulates the obligations of disaster drills. In order to promote various drills and exercises nationwide, the central Disaster Management Council sets forth an annual Comprehensive Disaster Reduction Drills Plan (UNEP, 2005), which is implemented in earnest by all organizations.

8.2.6. Disaster Emergency Response

The national and local governments need to quickly collect and disseminate disaster and damage information and secure communications so that they can carry out effective disaster emergency activities such as search and rescue and medical operations. Based on such information, local governments set up a disaster response headquarters and related organizations establish their own operations mechanism.

In the case of large scale disasters that exceed the response capabilities of the affected local government, various wide area support mechanisms are mobilized by the National Policy Agency (Inter-prefectural Emergency Rescue Unit), Fire and Disaster Management Agency (Emergency Fire , and Disaster Rescue Team), and Japan Coast Guard. Furthermore, the Self Defense Forces can be dispatched for emergency response activities upon request from the governor of the affected prefectural government.

A wide area medical transportation system for dispatching disaster medical assistance teams (DMAT) and ambulance parties for transporting seriously injured people to disaster management base hospitals outside of the disaster stricken area is being developed (GoJ, 2006).

8.2.7. Disaster Recovery and Rehabilitation

The recovery and rehabilitation of disaster stricken areas focus on providing support to help rebuild the normal livelihoods of the affected population as quickly and smoothly as possible, as well as on

restoring public facilities, giving consideration to mitigating future disasters so that affected communities can be made more resilient and meet fundamental conditions for sustainable development (GoJ, 2011).

8.2.8. Case Study Ishinomaki City

8.2.8.1. 2011 Earthquake, Tsunami, and Subsidence

The Ishinomaki City was among the most seriously affected by the 2011 Tōhoku Earthquake and tsunami. Several tsunamis, up to about 10 meters high traveled inland up to 3 miles from the coast. The tsunamis destroyed around 80% of the 700 houses in the coastal whaling port of Ayukawa, and the Kadonowaki neighborhood was largely leveled. Approximately 46% of the city was inundated by the tsunami (JMA, 2012).

As of 17 June 2011, a total of 3,097 deaths had been confirmed in Ishinomaki alone due to the tsunami, with 2,770 unaccounted for. Approximately 29,000 city residents lost their homes (NPA, 2012).

8.2.8.2. Warning System and people's perception

One of the most effective countermeasures for the reduction of earthquake and tsunami related losses are the establishment of an early warning system. The study reveals that the response to tsunami warnings varies among the affected areas. Most of the respondents in the surveyed areas received tsunami warning information from their televisions, radios, neighbors, kin, and the Disaster Management Committee (DMC).

The case study also found that many of the respondents did not believe that a tsunami was coming. They never imagined that a tsunami would be so devastating. However, some people believed that a tsunami was coming and they evacuated to high land or a safer place.

8.2.8.3. Emergency Relief and Response

The present study found that most of the respondents said they got emergency relief from local government authorities 1 day later. Only a few respondents said that they got relief from local government authorities within 24 hours.

8.2.8.4. Disaster Recovery

The study found that recovery after a disaster takes time. The recovery of damaged public infrastructure facilities, educational facilities, welfare facilities, agricultural, forestry and fishery facilities is either conducted directly by the national government or put into practice by the local governments with subsidies from the national government.

Persons engaged in the agriculture, forestry or fishery industries, small and medium enterprises and low-income people who incurred damage were eligible for a variety of low-interest loans with generous conditions as compared to normal ones.

Affected persons engaged in the agriculture, forestry or fishery business can obtain compensation for disaster losses. An earthquake insurance system has been established by the national government. Most of the respondents benefit from earthquake insurance coverage. For affected persons measures have been taken for the reduction, exemption and postponed collection of income and residential taxes.

8.2.8.5. Designation of Extremely Severe Disaster

When a disaster causes extremely severe damage, it is designated an "extremely severe disaster". Various special measures are to be taken for disaster recovery projects.

8.2.8.6. Support for the Livelihood Recovery of Disaster Victims

The study found that livelihood recovery after a tsunami took time. The people who were farmers took around 7 months to return to their previous livelihood, though fishermen took around 2 months.

mutual-help efforts of various community-based organization and public-help efforts national and local governments.

8.2.9. Conclusion

In order to reduce disaster damage, Ishinomaki city had a close combination of "self-help efforts" rooted in the awareness of people, "mutual-help efforts" of various community-based organizations, and "public-help efforts" national and local governments. In Japan, community based disaster reduction organizations, local firefighting teams and flood fighting teams play valuable roles in disaster reduction activities. Following the Great Hanshin-Awaji Earthquake, and the 2011 Tōhoku Earthquake and tsunami this activity has expanded in all aspects of disaster prevention, emergency response, recovery and rehabilitation.

8.3. Conclusion of these two case studies

Through these case studies, the author concluded that in Hatiya upazila of Bangladesh, the majority of the people perceived that the intensity of the hazards and vulnerability of the people have increased over the last three years. In addition, decreases in incomes along with a rapid increase of the price of food and daily necessities have enhanced the vulnerabilities of the majority of the coastal population. On the other hand, in order to reduce disaster damage, Ishinomaki city had a close combination of "self-help efforts" rooted in the awareness of people, "mutual-help efforts" of various community-based organizations, and "public-help efforts" national and local governments. From these case studies, information on the vulnerability to earthquake, tsunami & cyclonic hazards on a local level may help decision makers, stakeholders, and others to make better decision regarding an effective disaster management.

CHAPTER : 9

FINDINGS, HYPOTHESIS JUSTFY, RECOMMENDATIONS AND CONCULUSION

9.0. SUMMARY OF FINDINGS, HYPOTHESIS JUSTIFY, RECOMMENDATIONS, AND CONCLUSION

9. 1. Summary of Findings

Aside from the presence of natural hazards due to both climatic conditions and topography, several other factors, as mentioned above, were considered when determining the vulnerability of the areas. This study showed that several factors increase the vulnerability and risk of the target population. Findings of the study area's qualitative and quantitative information are summarized as follows:

9. 1. 1. Household Size, Age and Sex

Firstly, the household composition and size was a contributory factor to a family's vulnerability. Households with large family sizes and a higher number of dependents, i.e., children and the elderly, pose a big challenge to their recovery after a disaster. In the survey, families of farmers, wage laborers, the self employed and fishermen were found to have a high dependency ratio and bigger family size.

Secondly, the age and sex of household members were other factors in determining vulnerability. Households with more children, more elderly members or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster. The study also found that the very young, the elderly, women-headed households, persons in poverty, and persons with special medical needs were more vulnerable throughout all phases of the disaster response process.

Thirdly, increasing age gradually erodes the physical capabilities of the poor and puts them in an increasingly more disadvantaged situation than their younger cohorts (Hutton and Haque, 2004). Vulnerability to disaster usually increases with age (Paton, 1996; Kaniasty and Norris, 1999). The present study found that old age increases the likelihood of vulnerability to disaster; but experience may help them as well. Additionally, increasing age erodes their physical capability and makes them unfit for government and NGO sponsored 'food for work' or 'cash for work' programs or to work as

wage laborers. Hence, it is evident in this study that increasing age might lessen the physical ability of household heads to some extent, but increased experience might help them to better understand the disaster risk and discourage them from adopting passive coping measures. In general, however, younger and aged household heads are comparatively less capable to adapt to disaster shocks and thus become more vulnerable.

Fourthly, earlier studies reveal that the impacts of a disaster are much higher on women than on men; and women are always considered the worst victims and consequently become the most vulnerable groups in the society (Agarwal, 1990; Begum, 1993; walker, 1994; Fordham, 1998; Cannon, 2002; Hutton and Haque, 2004; Ray-Bennett, 2009). Therefore, it is evident in this study that female headed households mostly adopt passive coping measures that increase their vulnerability to disasters compared to their male counterparts.

9. 1. 2. Household Sources of Income

Firstly, the foremost cause of vulnerability was the source of income of the household. Those dependent on farming, self employment, wage labor, and fishing were the most vulnerable groups. The income derived from such activities was marginal and often uncertain. Therefore, the amount of income and sources of income can indicate the capacity of the people to afford physical mitigation and their capability to, recover from disasters. Large incomes mean that people can build better houses, build savings or purchase insurance that cushion the impacts of disasters. On the other hand, some sources of income were very vulnerable to disasters such as cyclones. For instance, open sea fishing is dependent on the size of waves in the sea, which normally grow bigger during the cyclone and monsoon season.

Secondly, scant financial resources hinder the fast recovery of the households from external shocks and crises like calamities and disasters. These households were unable to invest in preventive mechanisms like repair and improvement of houses, healthcare services, sanitation, children's

education, and had a weakened ability to accumulate financial assets through savings. As a consequence, children's welfare and development were affected and sometimes sacrificed in order for the whole family to survive and get through the crisis. Children of vulnerable groups were more prone to stop going to school.

Thirdly, household income is the composite indicator that reflects assets, education and occupation; hence it is assumed to have influence on an individual's coping response (Haque, 1997). The study found that family members from higher and middle income groups usually migrate to take temporary shelter in nearby Thana and friends/relatives' houses, while the lower income groups mostly migrate for income earning. Therefore, the present study confirms the findings of Green, et al., (1994), that higher income households are readily able to help themselves and are less vulnerable to any disaster than lower or middle income households.

Landownership, income and occupational status also have significant influence on the adaptation of coping measures. For example, landless and lower income groups have a very small and risky portfolio of assets. Service and business households have a more stable income than daily laborers, fishermen or fry-collectors. Therefore, they have a higher capacity to procure food as well as a higher ability to capture forecast information for reducing disaster vulnerability. The study confirms the findings of Agarwal (1990), Winchester (1992), as well as Kesavan and Swaminathan (2007) that prevailing social, gender and economic inequities greatly weaken the coping capacity of the under-privileged sections of society.

9. 1. 3. Household Education

Firstly, education is considered as one of the crucial determinants of coping and adaptation for both supporting survival and enhancing the quality of life (D'Oley, et al., 1994). The study found that, households with higher education had sent family members to nearby Thana headquarters to take temporary shelter, while households with lower education sent family members out to work. It is

evident in this study that the higher the education level, the greater the scope is to understand weather forecasts and the higher the ability is to store precautionary food and save money which reduces the level of vulnerability to disaster.

Secondly, level of education of the household head was another factor in their increased susceptibility to crises and shocks. A majority of the target population have reached a basic education level of usually up to primary school. Many of the vulnerable groups were found to be within this educational level, and hence increased their risks. Improving the level of skills and knowledge will go a long way to enable vulnerable families to cope with disasters since they will have better work opportunities. People's perception about the quality and reliability of disaster forecasts also plays a pivotal role for future preparedness and the adoption of coping measures.

9. 1. 4. Household Housing Condition

Firstly, the quality of houses can approximate the risks that people face from certain natural disasters such as cyclones and tidal surges. Wooden and bamboo houses with thatched roofs can be easily destroyed (blown) by strong winds. The people are aware of this; however, a strong correlation was found between the type of housing families live in and their income levels.

Secondly, the present study found that unique design and construction method of houses, building *Machan* and *Pataton*, and other measures to save household items, food and goods are some common strategies that households adopt to minimize impact of a disaster. In this regard, an initial attempt to protect a shelter starts with erecting the dwelling unit or courtyard on a raised earth platform to protect it from normal tides, and avoiding the use of housing materials susceptible to surge water. Additionally, temple shaped houses are found in the study areas. This has more than one roof with less space in the upper floor and is usually square in shape. This is where people keep their valuables and take shelter during cyclones.

Thirdly, this study also found that plantations of coconut, betel nut and banana trees around the house are also very common. The plantations have often grown so densely that they provide protection for the houses while also contributing towards a regular income and privacy, especially for women who follow the '*purdah*' system. In low surge locations, people support four sides of the house with guy ropes tied to bamboo poles or trees with the hope that such extra support will prevent houses from getting blown or washed away during a cyclone and surge. The gentle sloping of the house roof towards the south-east is also common as strong winds from that direction usually occur with cyclones. This construction technique helps the wind to flow over the house and thus the house is more likely to withstand less severe wind forces. This finding was consistent with Vasta (2004), Islam (1981), Parvin, et al. (2008), which states that housing structure has a significant influence on the household's survival rate against disaster.

Fourthly, usually cyclone storms come from the southeast. Ancestrally, the household has developed indigenous settings for housing. There were houses that were oriented towards the west, but they were set in a clustered way to receive the advantage of protection from cyclones. Finding the reason for such settings, it was sorted out from the field survey that villagers were mostly affected by cyclones coming from the north-west.

9. 1. 5. Household Exposed to Risk by Physical Location

Firstly, physical location of the households adds to their risks and vulnerability. Risk exposure from cyclones was high in many areas. Poor families who did not own a home or their lot often resided in dangerous areas such as by the river side, along the beach areas or coast-line, and other low-lying marginal areas. This is further compounded by the fact that with their meager income, they will not be able to build strong houses or fortify them to reduce the risk of being damaged by cyclones, strong winds or tidal surges. Relocation is usually a long-term solution for families in these areas but it needs significant investment. Usually, this risk was managed by strengthening their social capital.

Secondly, the present study reveals that people on offshore islands and adjacent to the coast are more vulnerable to cyclones and induced surges than inland settlers. High wind velocity accompanied by surge waters with strong currents and more height during a cyclone hits the island and shoreline settlements first causing severe damage. Even within island or shoreline locations, those who are closest to the sea are more vulnerable to cyclone and surge impacts.

Moreover, it is found that, high velocity cyclones with surge waters create devastating phenomena. If surge water remains stagnant for an extended period, it pollutes both surface and drinking water. The spreading of water borne diseases reduces people's coping ability and increases the state of vulnerability.

Moreover, this study found that the most exposed locations, such as islands and shoreline areas with a high frequency of cyclonic events, have negative influences on the inhabitants' coping ability. About 5% of the respondents did not take any protective measures, with the belief that a cyclone is God's will and God will save them; it is beyond the control of people. This study also confirms that indigenous coping strategies can significantly minimize cyclone vulnerability.

9. 1. 6. Shelter-related Coping

Firstly, due to the affection for domestic animals in these communities, concern about belongings in general, and the loss of their only means of livelihood, household heads did not choose to move to cyclone shelters easily. However, if the severity of the cyclone increases and warning signals mount, the family then decides to go. By then, though, they may not be able to move because the wind and rainfall have increased. Besides these elements, trees uprooted by the wind may block access roads to cyclone shelters. A combination of rain and wind may damage or destroy earthen roads. Fear of injury by flying debris was another factor which made people hesitates from moving to cyclone shelters once winds gathered pace.

In the worst cases, those who did not have any alternatives took shelter on the embankments, raised roads or other elevated places after the cyclone. Besides saving their own lives, people also tried to save livestock and poultry as these were the most valuable assets for rural communities.

Secondly, many households were living in coastal areas in the major cyclone areas where improvised evacuation arrangements existed, but households were often sheltering in the homes of family members and friends.

9. 1. 7. Warning System

It is widely believed that the Bangladesh government's attempt to improve the early cyclone warning system since the 1991 cyclone contributed to fewer deaths occurring in 2007. It should be noted that there are 11 warning signal numbers. These signals were introduced by the British when Bangladesh was a part of British India. Signal numbers 1-4 are considered precautionary warning signals; 5-7 are considered danger signals; and signal numbers 8-10 indicate great danger. Signal number 11 means communications with the meteorological warning centre have broken down and the local officer considers weather conditions to be extremely dangerous. But most of the coastal rural people were illiterate. They could not understand this signal system, and sometimes they were confused.

9. 1. 8. Indigenous Knowledge

Apart from the country's existing weather forecasting mechanism, people can predict impending cyclones through indigenous knowledge. Examples of such indigenous cyclone prediction methods include observations of the abnormal south-easterly wind circulation, along with a dark and cloudy sky; the tendency of ants to climb walls carrying grain and moving purposefully towards higher ground or roofs of the houses; sea birds coming inland in groups; an abnormal increase of water temperature in the sea and rivers; and flies attaching themselves to cattle for protection against the surge water and wind. A majority of the respondents mentioned that they have learned these methods through experience, or from elderly people and neighbors. Nonetheless, a majority of the respondents

can make predictions and perceive these indigenous predictions as effective. Despite indigenous cyclone prediction techniques, a majority of the fishermen did not avoid the cyclone period and were in exposed fishing locations. The main reasons were to increase household earnings, the non-availability of alternative employment, pressure from the *arotdar* and employers, and loan commitments.

9. 1. 9. Coping Mechanisms

Cyclones and induced surges have overwhelming impacts on infrastructure, the environment, as well as on people's livelihoods. These impacts depend not only on the location exposure and magnitude of disasters, but are also linked with several demographic, socioeconomic, cultural and other exogenous variables. Hence, the study findings were consistent with the earlier propositions made by Haque and Zaman (1993), Haque (1997), Kunii, et al. (2002), and Hutton and Haque (2004). The study also found that, in response to cyclones and induced surges, people habitually come up with various indigenous coping strategies following different sequences. Adaptation of such strategies varies with socioeconomic and cultural factors. It was also observed that indigenous coping strategies were effective as long as the cyclone and induced surge do not exceed the tolerable limit of the community. When surge disasters cross the critical limit and suppress the people's ability to cope, they usually take shelter in cyclone shelters or other alternative safer places, and adopt several other coping mechanisms, such as consumption smoothing, borrowing, distress selling and migration etc.

9. 1. 10. Bonding and Bridging Network

The coastal and offshore inhabitants of areas near the Bay of Bengal often become isolated during cyclones, yet they cope with these events due to knowledge passed down by previous generations. Although people passively react to cyclone hazards before the event, during, and after the cyclone and associated sea surges, they demonstrate strong coping mechanisms, including ensuring the survival of daily necessities through individual initiatives, kinship ties and obligations, and social networking.

These instinctive survival strategies during and after a cyclone have existed for generations and play significant roles in people's ability to survive disasters along the coastal areas of Bangladesh.

It remains unquestionable among 'mainlanders' in Bangladesh that char dwellers are different in the sense that they are perceived as rude, dangerous and perpetually involved in violent conflicts over land. However, living on char Nijhum Deep emphasized their felt sense of strong cohesion and of it being a good society to live in because people 'take care of each other'. While this contradicts the centrality of poverty, and endemic conflict and violence described in much of the academic literature and media reportage, the findings here are confirmed by other studies.

9. 1. 11. Household Internal & External Assistance

The present study found that external assistance creates relief dependency among the cyclone victims in all the study locations. Mostly, cyclone victims had received relief materials from different government, non-government and donor agencies within a period of 3 months; most frequently varying from one to five times in the form of cash, rice, pulses, cooking oil, household utensils and clothes. It was also found that, relief providers had never provided any support services, money or material assistance for rebuilding the local economy (agriculture and fishery) or reviving the livelihoods of individuals.

An increasing number of NGOs are addressing development needs in some chars, but they too are not reaching many needy households. For example, only 19% of char households were members of NGO microcredit or savings groups, compared with 32% in rural Bangladesh (Nutritional Surveillance Project, 2003). Interventions should therefore aim to support the livelihoods of char people so that they can make best use of their available resources and cope better with the hazardous environment.

9. 1. 12. Household Other Facilities

The study found that for drinking purposes, households collected rain water, which is not very difficult to obtain as cyclones are always accompanied by rain for several hours. Due to the non-availability of drinking water, they also drank coconut water.

The study also found that households stated that herbs and other local substances were used to treat minor injuries, fever and diarrhea. However, major injuries remained unattended until medical services were received from government and non-government health service providers.

9.2. Justification of Hypotheses

The household composition of age, sex, and size was a contributory factor to a family's vulnerability. Households with large family sizes and a higher number of dependents, i.e., children and the elderly, pose a big challenge to their recovery after a disaster. Households with more children, more elderly members or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster. The study also found that the very young, the elderly, women-headed households, persons in poverty, and persons with special medical needs were more vulnerable throughout all phases of the disaster response process. Therefore, the statement of hypothesis, which stated that the age and sex of household members and households with more children, more elderly members or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster is proved.

People of higher socioeconomic status are better prepared for disaster than other people. People with limited finances and resources are not able to relocate to less vulnerable areas without government assistance. Socio-demographics such as income, education and occupation impact the awareness of a threat and the ability to prepare for the threat. Better educated people are more likely to have a positive attitude toward damage prevention adjustments. The studies reveal that socioeconomic factors such as occupation and education do create variations in perception. So, the statement is proved that a higher income, better occupations, education and qualifications can indicate the capacity of the people to afford physical mitigation and their capacity to recover from disaster.

People's opinions regarding a cyclone's magnitude and frequency differed. Despite the disadvantages of living in the cyclone-prone areas, very few expressed intent to move somewhere outside their

present community. The major factors involved in cyclone risk perceptions include previous experience; knowledge of cyclones and cyclone risks; and socioeconomic variables. Location, among other factors was the most important factor affecting cyclone risk perception. Experience of a cyclone generally outweighs general knowledge of the hazard. Moreover, economic pressures and social preferences are the prevailing reasons for residents to remain in their homes after experiencing a cyclone rather than moving to less vulnerable areas. So, the hypothesis of statement is proved that the frequency of experiencing hazards may lead to a *taken-for-granted attitude* toward hazards.

The more cyclone experience the respondents had the less likely they were to see the need to evacuate during the next cyclone. In addition, those who had lived for longer periods on the coast were less likely to be concerned about evacuation. However, as in the case of coastal communities in Bangladesh, reasons for not evacuating were the fear of looting and losing their belongings, and the lack of local shelters. This reflects the need for an integrated disaster mitigation strategy to encourage people to migrate to less vulnerable regions. In addition, people resist moving to the cyclone shelters during a cyclone. The reasons are thought to be disbelief in warnings & mismanagement of weather forecasts, the distance of cyclone shelters from settlements, poor conditions and overcrowding of shelters, as well as a fatalistic attitude that the cyclone was the will of *Allah* and that they cannot do anything to counter the event. Referring back to the hypothesis statement, the government early warning system is efficacy is unproved.

People can predict impending cyclones by indigenous knowledge. Examples of such indigenous cyclone prediction methods include observations of the abnormal south-easterly wind circulation, along with a dark and cloudy sky; the tendency of ants to climb walls carrying grain and moving purposefully towards higher ground or roofs of the houses; sea birds coming inland in groups; an abnormal increase in water temperature in the sea and rivers; and flies attaching themselves to cattle for protection against the surge water and wind. A majority of the respondents mentioned that they

have learned these methods through experience, or from elderly people and neighbors. So, the hypothesis statement that predictions and indigenous knowledge are effective is proved.

In the rural coastal areas of Bangladesh social capital (bonding network) is strong. The study found that most of the respondents (68.6%) trust their neighbors during a disaster. Though, social capital (bridging network) is not so strong. The main reason was the information gap between local governments and the central government, the central government and donor agencies, the central government and NGOs, and local governments and NGOs etc. The hypothesis that social capital bonding network is effective is proved. On the other hand, social capital bridging network is not effective.

9. 3. RECOMMENDATIONS

Based on the study analyzed in the preceding chapters especially data analysis and findings the general and specific recommendations made are below:

(A). General recommendations:

9. 3. 1. Building Design and Construction

Upgrading and enforcing building codes decrease the risk of cyclones. Designing and constructing new structures and retrofitting existing structures to withstand natural disasters are important preventive measures. [See, section: 7, page: 135; section: 9, page: 195]

9. 3. 2. Storm Resistant Houses

The most common indigenous shape is rectangular for wind resistance. The traditional houses in the coastal areas were mostly rectangular with a length to width ratio within 2:1. It may be mentioned here that length to width ratio of up to 3:1 is suggested for cyclone resistant houses. In addition to the roof structure, the thatch roof cladding must be able to transfer the wind loads to purlins. Study and research have shown that the eaves and ridges of the roof are particularly susceptible to wind load during cyclones. [Section: 9, page: 194, 195]

The main cause of wind damage to houses, particularly houses built with bamboo, is insufficient weight of these houses when they are subjected to external pressure and suction on the walls during a cyclone. This can be improved or even avoided by improving the anchoring of the vertical support firmly to the foundation. The roof support system is fabricated with wood of standard quality and size. The vertical wooden post makes the house very strong and cyclone resistant. Implementation of disaster resistant housing techniques in the study area will minimize the cost for repairing and maintenance of houses to a great extent. [See, section: 7, page: 133; section: 194]

9. 3. 3. Tree Plantation and Orchard

A well thought-out plan of planting of trees helps reduce the impact of both cyclones and tidal surges. Tree plantation should be undertaken by involving local people in order to select species of trees and locate plants. [See, section: 9, page: 195]

9. 3. 4. Adaptation Strategy

Cyclones and storm surges are natural disasters. We cannot stop them, even if we stop greenhouse gas emissions. Since we cannot stop them, we should learn how to better live with them.

There are several adaptive measures, such as:

A) Creation of a coastal green belt

B) Construction of embankments and polders. [See, section: 7, page: 150]

9. 3. 5. Structural Mitigation Measures

Structural preventive measures are especially important in the coastal areas of Bangladesh. These are listed below:

1) **Seawall and embankments**

Among all the structural mitigation measures, seawalls and embankments are probably the most effective and capital intensive investment to mitigate the risks of cyclones. The height of seawalls is determined according to the maximum observed height of storm surges which may be as high as 10 meters. Embankments/levees are recommended to protect rural settlements and to prevent saline water ingress into agriculture and horticultural land. Such embankments are usually a ridge built with earth or rock to prevent the storm surges. [See, section: 6, page: 120, 122, 123]

2) **Cyclone shelters**

Construction of cyclone shelters is an option to mitigate disaster risk in coastal areas. An adequate number of cyclone shelters should be constructed in these areas immediately to save lives from impending cyclones. A large number of poor people in the coastal areas live in thatched houses which cannot withstand the high wind velocity and storm surges and hence suffer extensively. So, community cyclone shelters should be constructed at appropriate places where they can provide easy access for the vulnerable communities. These shelters should be built on pillars above the danger level of storm surges/inundation, be spacious enough to accommodate a thousand people of the neighboring hamlets and provide provisions of drinking water, sanitation, a kitchen and so on. During normal

seasons, such shelters can be utilized as a school, a dispensary or for other community purposes. Transport networks between settlements and cyclone shelters could also be improved to facilitate the movement of people and goods during disaster events. [See, section: 6, page: 118, 120, 122, 124; section: 7, page: 144, 145; section: 9, page: 196]

9. 3. 6. Non-structural Mitigation Measures

1.) Early warnings and communications

Early warnings of cyclones and their dissemination to the coastal habitations are important preparatory measures for the reduction of the losses of life and property during cyclones. With the advances of early warning technology, the predictions would be more and more accurate leading to better responses in emergency situations. It is also recommended that increasing the coverage of radio and television, more extensive use of ham radios and the innovative use of mobile communication systems would facilitate better dissemination of early warnings to the isolated coastal communities; particularly in the remote islands. [See, section: 7, page: 162, 163; section: 9, page: 197]

2.) Community based disaster preparedness

If the communities are mobilized and trained to assess their own risk through participatory risk assessment process, develop their own contingency plans and set up their own teams for evacuation, search and rescue, emergency shelter and first aid, the risks of cyclones can be managed with significant reduction in number of deaths and injuries. [See, section: 7, page: 170, 171]

3.) Risk transfer and risk financing

It has been a win-win situation for the private and individual sector in transferring its risks to the insurance companies, for the insurance companies in generating business and for the government in reducing its expenditure on relief and reconstruction, while at the same time encouraging private investments for better safety standards for buildings and infrastructure.

The experiences gained in this regard need to be further adapted according to the conditions of Bangladesh. Various innovative services and products like micro-insurance and micro-credit have been developed in Bangladesh for increasing the resilience of local communities. Micro-credit will be playing a particularly importance role in retrofitting the vulnerabilities of the poorer sections of a community, especially women, in Bangladesh. [See, section: 5, page: 92, 93; section: 7, page: 136, 137; section: 9, page: 199]

4.) Capacity development and training

Capacity development is the most cost effective method for reducing the vulnerabilities of the people living in the coastal areas. Therefore, the local capacities have to be continuously upgraded and further developed according to the changing needs and developments in science and technology and other improved practices in various sectors. Such capacities can be developed through meetings, interactions, discussions, exposure visits and training.

Training is particularly necessary for cutting-edge functionaries within and outside the government at various levels in different sectors to impart them with necessary skill for cyclone risk reduction and management. Training programmes have to be practical, scenario-based; exercise and problem solving-oriented so that the functionaries are aware of their specific responsibilities and are able to discharge those responsibilities efficiently before, during and after the cyclonic disasters. Training is also required for those community members who would be part of the community response teams for the initial critical period. Such training may include maroon search and rescue, first aid, evacuation, temporary shelter management, arrangement of drinking water and sanitation, provision of cooked food and so on. [See, section: 7, page: 163, 164]

5.) Awareness and education

It is important to generate awareness about the risks, vulnerabilities, mitigation and preparedness measures that can be taken at the government, community, household and individual levels. Electronic, print and folk media can play important roles in awareness generation on a large scale. The coastal

and island people generally increase their religious activities prior to a cyclone to satisfy their God. In this regard, future and alternative awareness can be generated among coastal communities of the nature of cyclones, such as by revealing at the local level the satellite imagery that detects cyclones.

A curriculum at various levels of general and professional courses would help to develop necessary professional expertise to support the disaster risk mitigation and preparedness programmes of the government and other agencies at different levels. [See, section: 7, page: 131, 132; section: 9, page: 193, 194]

6.) Improved relief and response

It is extremely important to promote disaster management planning with focus on the poor as a priority group for relief and rehabilitation. Based on the field survey and assessment, it was observed that it is necessary and more sensible to provide assistance to produce food that might enhance the coping ability of disaster victims. The traditional form of relief operations (food, blankets etc.) seems less effective in the study locations; rather it should acknowledge the real needs raised by the victims such as agricultural inputs, fishing equipment and employment generation etc. Providing food relief and first aid are immediate needs to rescue the victims after a cyclone. Assistance should be given in a way that helps them to rebuild their livelihood and regain their pre-disaster status. Therefore, it is important to provide relief to those who experience greater losses and those at the bottom of society who are unlikely to recover without external help. Moreover, if relief is made available immediately after a cyclone based on the victim's priority, it may help them survive. [See, section: 7, page: 149, 164]

7.) Contingency plan

A cyclone risk management contingency plan, which would clearly delineate the roles and responsibilities of various agencies within and outside the government, define the exact functions, the tools and equipments to be kept in readiness, procurements to be made, evacuation drills to be followed, and the emergency medical plan should be put in place. Such contingency plans should be

prepared vertically at the national, district, sub-district and community levels and horizontally for the different sectors: police, civil defenses, health services, fire services, food and civil supplies, agriculture, fisheries, water supply, roads and bridges and so on. There are various agencies involved in the response, relief, rehabilitation and reconstruction programmes after disasters. [See, section: 7, page: 162, 163, 164]

9.3.7. Tasks of Various Stakeholders and Their Partnership (Self-help, Mutual Help, and Public Help):

The occurrence of a disaster imposes a great impact on the nation at large. In addition to individuals and communities, various stakeholders of society are involved, such as administrative bodies (central and local governments) and NGOs In order to reduce damage caused by disasters, each of the following elements is important: "self help" (each individual protects him/herself), "mutual help" (individuals in the community help each others), and "public help" (provided by the government). For example, at the time of the Tohoku Earthquake in March, 2011, it is known that many victims were rescued by their family members or people in the community. [See, section: 8, page: 190]

9.3.8. Socioeconomic and Cultural Development

Disaster management should not be viewed as an estranged component from the overall development process. Vulnerability of the people in the study areas is intertwined with their livelihood and socio-cultural aspects. There should be adequate emphasis on the overall socioeconomic development of the people of these areas beside disaster management. Illiterate children will continue to be vulnerable in the future even if any training program for disaster resistant housing is taken there right now. So, it is strongly recommended here that more focus should be given on these issues of socioeconomic and cultural development in the study areas beside disaster management. [See, section: 7, page: 168, 169]

9.3.9. Indigenous knowledge

Incorporate indigenous knowledge into technological systems and mix knowledge dissemination regarding traditional and modern, technological early warning system. This is especially true when information cannot be accessed by local fishermen due to climate conditions, especially during monsoon seasons. Further, if scientific information is not available, traditional knowledge must be used. Therefore, there must be a seamless movement between the two types of knowledge. [See, section: 7, page: 165, 166, 167; section: 8, page: 176, 177]

(B). Specific recommendations: Several specific policy recommendations to the Government, stakeholders, NGOs and community level organizations are below:

9.3.10. Recommendations for the Central Government

(1).The existing embankments are not sufficient for storm surge protection, because they were designed for protection against salinity intrusion due to normal tides. So, storm surge prevention embankments should be constructed along the coastal areas. [See, section: 6, page: 120, 122, 123]

(2). Construction of cyclone shelters is an option to mitigate disaster risk in coastal areas. So, an adequate number of cyclone shelters should be constructed in these areas immediately to save lives from impending cyclones. [See, section: 6, page: 118, 120, 122, 124; section: 7, page: 144, 145; section: 9, page: 196]

(3). Establishing an advanced early warning system would lead to far more accuracy in these areas and therefore better responses in emergency situations. [See, section: 7, page: 162, 163; section: 9, page: 197]

(4). Awareness about the risk, vulnerabilities, mitigation and preparedness that can reduce disaster vulnerability needs to be raised on a large scale. [See, section: 7, page: 164, 165]

(5). Relief and response efforts during a disaster period should be promoted and elaborated. [See, section: 7, page: 149]

(6).A cyclone risk management contingency plan should be established, which clearly delineates the roles and responsibilities of various agencies within and outside the government. [See, section: 7, page: 162, 163, 164]

(7). An umbrella program approach should be adopted, that encompasses all aspects of risk management, and in doing so a move should be facilitated from a single agency response and relief strategy to a holistic strategy of the entire government that addresses the issue of community vulnerability. [See, section: 5, page: 91, 96]

(8). Long-term strategies focusing on disaster management in Bangladesh should be provided. [See, section: 5, page: 95]

(9). Incorporate indigenous communication systems (sound, flags, etc.) into early warning dissemination. [See, section: 7, page: 165, 166, 167; section: 8, page: 176, 177]

9.3.11. Recommendations for Local Governments

(1). Tree plantation should be undertaken with the involvement of local people in order to select species of trees to reduce the impact of both cyclones and tidal surges. [See, section: 9, page: 195]

(2). Community-based disaster preparedness should be promoted. [See, section: 7, page: 169, 171]

(3). Dissemination of early warnings to the isolated coastal communities, particularly in the remote islands, should be promoted. [See, section: 7, page: 162, 163]

(4). Capacity development and training should be promoted. Training programmes have to be practical, scenario-based; exercise and problem-solving oriented so that the functionaries are aware of their specific responsibilities and are able to discharge those responsibilities efficiently before, during and after the cyclone disasters. [See, section: 7, page: 163, 164, 170]

(5). Recovery plans and procedures should be promoted, delineating damage assessment procedure, restoration of damaged public infrastructure, resumption of educational institutions, restoration of livelihood, and rehabilitation of affected people - especially the disabled, elderly women and children. [See, section: 7, page: 142, 143, 149]

9.3.12. Recommendations for NGOs

(1). School cum cyclone shelters can be constructed at appropriate places where they can provide easy access for the vulnerable communities. [See, section: 6, page: 118, 120, 122, 124; section: 7, page: 144, 145]

(2). Capacity development and training for reducing vulnerability of the people living in the coastal areas should be promoted. [See, section: 7, page: 163, 164]

(3).Various innovative services and products like micro-insurance and micro-credit should be promoted in coastal remote areas to increase the resilience of local communities. [See, section: 9, page: 199]

(4). Food relief and first aid to cater for the immediate needs of rescued victims after a cyclone should be promoted. [See, section: 7, page: 149]

(5). Disaster risk training for community people and dissemination awareness along the coastal areas should be promoted. [See, section: 7, page: 162, 163]

9. 4. CONCLUSION

Bangladesh is one of the most disaster prone-countries in the world, with extremely limited resources; its real development is not possible without the integration of disaster mitigation programs. The country is striving hard to establish an elaborate and experienced disaster management system from the national down to the community level to mitigate the effects of disasters.

The household composition of age, sex, and size were contributory factors to a family's vulnerability. Households with large family sizes and a higher number of dependents, i.e., children and the elderly, pose a big challenge to their recovery after a disaster. Households with more children, more elderly members or more women can experience more difficulties during evacuation and will require greater resources like food and water after a disaster. The study also found that the very young, the elderly, women-headed households, persons in poverty, and persons with special medical needs were more vulnerable throughout all phases of the disaster response process.

People of higher socioeconomic status are better prepared for disaster than other people. People with limited finances and resources are not able to relocate to less vulnerable areas without government assistance. Socio-demographics such as income, education and occupation impact the awareness of a threat and the ability to prepare for the threat. Better educated people are more likely to have a positive attitude toward damage prevention adjustments.

People's opinions regarding a cyclone's magnitude and frequency differed. Despite the disadvantages of living in the cyclone-prone areas, very few expressed intent to move somewhere outside their present community. The major factors involved in cyclone risk perceptions include previous experience; knowledge of cyclones and cyclone risks; and socioeconomic variables. Location, among other factors was the most important factor affecting cyclone risk perception. Experience of a cyclone generally outweighs general knowledge of the hazard.

The more cyclone experience the respondents had the less likely they were to see the need to evacuate during the next cyclone. In addition, those who had lived for longer periods on the coast were less likely to be concerned about evacuation. However, as in the case of coastal communities in Bangladesh, reasons for not evacuating were the fear of looting and losing their belongings, and the lack of local shelters. This reflects the need for an integrated disaster mitigation strategy to encourage people to migrate to less vulnerable regions. In addition, people resist moving to the cyclone shelters during a cyclone. The reasons are thought to be disbelief in warnings & mismanagement of weather forecasts, the distance of cyclone shelters from settlements, poor conditions and overcrowding of shelters, as well as a fatalistic attitude that the cyclone was the will of *Allah* and that they cannot do anything to counter the event.

People can predict impending cyclones by indigenous knowledge. Examples of such indigenous cyclone prediction methods include observations of the abnormal south-easterly wind circulation, along with a dark and cloudy sky; the tendency of ants to climb walls carrying grain and moving purposefully towards higher ground or roofs of the houses; sea birds coming inland in groups; an abnormal increase in water temperature in the sea and rivers; and flies attaching themselves to cattle for protection against the surge water and wind. A majority of the respondents mentioned that they have learned these methods through experience, or from elderly people and neighbors.

In many areas of coastal belt in Bangladesh, there were no embankments. Therefore, mangroves that offered shelter have been removed to make way for shrimp and salt farming enterprises. Such levels of direct exposure to cyclone hazards mean that the shelters are all the more crucial as an intervention, as one of a few ways in which people can gain protection.

Female deaths attributed to cyclones (relative to male mortalities) are primarily due to gender specific roles and on restrictions of women's spatial mobility imposed by the norm of *purdah* or veil. *Purdah* not only correlates with female lack of social power and autonomy as well as basic rights, but also hinders spatial mobility in times of cyclones, which is the primary reason for the disparity in cyclone

mortality rates between males and females in Bangladesh. Because of gendered division of space, women have less access to information and knowledge regarding any disaster compared to males. Therefore, the combination of impeded mobility and lack of information created by the cultural and religious practice of *purdah* in Bangladesh places women at a higher risk of mortality in all situations.

The level and pattern of community development, measured by community social capital, do affect the community's capacity to respond. There was a positive correlation between communities with higher levels and more community-oriented patterns of development, and effective response to the disaster. The community with the unique historic, cultural, and religious backgrounds had the most social capital, and was able to respond to the disaster most vigorously.

Social capital (bonding & bridging) in particular plays an interesting and complex role in Community Based Disaster Management. Like development management, effective disaster management requires participation of social organizations that promote cooperation and problem solving. However, even more than development, effective disaster management requires efficiency in decision making and implementation matters. Where communities are socially and economically marginalized, vulnerability is greater and an effective community based disaster management is limited (Wisner, et al., 2006). Conversely, where a community is characterized by social and economic development, it is expected that vulnerability is minimized and the community's capacity to manage the event is greater.

In the rural coastal areas of Bangladesh social capital (bonding network) is strong. The study found that most of the respondents (68.6%) trust their neighbors during a disaster. However, social capital (bridging network) is not so strong. The main reason is the information gap between local governments and the central government, the central government and donor agencies, the central government and NGOs, and local governments and NGOs etc.

Focusing disaster mitigation programs on an increasing adaptive capacity and lowering human sensitivity to natural hazards can also be a useful strategy in the context of other types of hazard events elsewhere. Reducing social vulnerability to hazards should always be the center of any disaster mitigation policy because it is the most important factor that shapes the human experience with natural events. The lack of proper knowledge is a fundamental hurdle towards mitigating damage by cyclones and tidal surges in the coastal areas. Moreover, the study emphasizes that these are strong implications for adaptation for future climate change and also through an active government policy to promote climate change adaptation. In this case, this study will hopefully help the policy makers take immediate measures through the integrated planning and the building of awareness among the people of the coastal areas of Bangladesh.

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APPENDICES I

Measurement of variables at household level

Variables		Measurements	
Respondent's characteristics	Gender	Male/ Female	
	Age	Age in years	
	Education	Final education attainment	
	Household size	No. of household members	
	Occupation	Household occupation	
	Income	Monthly Income from various sources	
	Expenditure	Monthly Expenditure	
	Years	Years living in the community	
Housing structure	Housing roof, walls, floor and overall condition		
Age below 5 and over 60	Child and elderly household members		
Female head household			
Early warning system	Effectiveness or not		
Risk perception	Perception about frequency and intensity of hazards		Increasing/ Decreasing
	Perception about vulnerability to hazards		Increasing/ Decreasing
Socio-economic factors(Responsible for vulnerability increase)			
	Increasing cost of living		
	Population density		
	Frequency of disasters		
	Scarcity of job opportunity		
Location / Physical factors(Responsible for vulnerabilities increase)	Distance from cyclone shelter		
	Accommodation in cyclone shelter		
	Distance to river or sea		
	Site of riverbank erosion		
	Outside of embankment and distance to river or sea		
	Communication system		
	Distance from medical facilities		
Coping mechanism	Preparedness & Training		
	Saving, Insurance		
	Networking (Human capital)		
	Livelihood related coping		
	Shelter related coping		

APPENDICES 2

Measurement of variables at community level

Variable		Measurement	
Communities vulnerabilities	Level of exposure	Perceived level of risk(People at risk) Perceived level of risk(Property at risk) Perceived level of utility facilities(facilities at risk) Perceived level at transportation facilities (facilities at risk)	Level of agreement 1). Strongly disbelieve 2). Somewhat likely 3). Strongly believe
	Hazard adjustment level	Belief in residential hazard adjustment Belief in business hazard adjustments	
	Community capacity	Perceived problem in internal resource Perceived problem in access to outer sources	
Hazard reduction(Program effectiveness)	Identify local mitigation needs		
	Providing program diversity		
	Coordinating local hazard adjustment projects		
	Prioritizing hazard mitigation project		
	Mobilizing local resources		
Obligation(level of commitment)	Protecting family member and relatives		
	Participating in decision making process		
	Building community safer		
	Helping people and business at risk		

APPENDICES 3

Questionnaire for Survey
To be interviewed directly
(Note: This is the translated version from questionnaire in Bengali)

Rikkyo University (Japan) Ph.D. (second year) student field Survey at Disaster Prone Coastal Areas (Bhola, Nohakhali, Borguna & Coxesbazar) in Bangladesh.
Purpose: To procure information on socio-economic conditions and resilience toward disasters.
Period of survey: 24th November to 26th February

Instruction to Enumerator
The respondent will be a household head of family or his/her spouse who live in a disaster prone coastal area in Bangladesh.
Introduce the survey and its objective, which is to elicit and generate data and information from the respondents on the presence of hazards and their perception on the vulnerabilities that are faced by them. The information from this survey will use for writing a dissertation.

Respondent code number:
Date of interview:
Name of interviewer:
Start time: End time:

I. Respondent`s personal information

1. Name of respondent:

2. Name of locating: Village: Union: Upazila:
District:

3. Age of respondent:

4. Sex: 1.Male 2. Female

5. Occupation:

☐ Government employee ☐ Private sector employee ☐ Fishermen
☐ Farmer
☐ Day labor ☐ Rickshaw/ Van driver ☐ Car driver ☐ teacher
☐ Business ☐ Other (specific)

6. Highest education attainment:
☐No schooling ☐ Some elementary ☐ Junior high school
☐Some high school ☐ High school (SSC) ☐Some college (HSC)
☐ Vocational ☐ University graduate ☐ Post graduate

7. Number of member (total number of members living in the family:)

8. How many of your children & household member (living with you) are in the following age range

Age range years	Male	Female
❶ 0-5		
❷ 60 +		

9. Is your house near?

☐ Upper land ☐ Low land ☐ Sea/ River
☐ Char ☐ Marshy land (Bill) ☐Others (please specify)

10. What is the approximate distance (in meters) between your house and the objects in previous question?

11. Number of years living in current residence:

☐ Less than one year ☐ 1-5 years
☐ 6-10 years ☐ More than 10 years

12. House structure:

16a. Roof: ☐ Thatch ☐ Tin ☐Mixed ☐ Politian ☐ Others (please specify)

16b. Walls: ☐ Wood ☐ Tin ☐ Concrete ☐ Mixed ☐ Bamboo ☐ Mud

16c. Floor: ☐ Earthen ☐ Wood ☐ Concrete ☐ Mixed

16d. Overall condition: ☐ Good ☐ Average ☐ Poor / need repairs

II. Household Economic Information

13. What are the top 3 income sources of your household?
(Monthly income is estimated to be the total income in a year divide by 12 months)

Sources (Please check)	Classification (selected code: 1. Regular 2. seasonal	Summer season	Rainy season	Winter season		Estimated monthly income in Taka
1. Farming a. Own land b. Tenant/ c. Agricultural Worker						
2. Fishing						
3. Wage labor						
4. Formal employment a. Government						

b. Private						
5. Pension						
6. Remittance (Domestic/Int`l)						
7. Micro enterprise/Self employed a. Sari-longi store b. Transport (Rickshaw or Bus) c. Trading (Buy & sell) d. Handicrafts e. Food processing f. Carpentry/Mechanic g. Others						
8. Others (please specify)						

14. Estimated household monthly expenses
(Monthly expenses can be estimated)

Type of expenses	Estimated amount (Taka)
1. Food	
2. Education	
3. Utilities a. Electricity b. Telephone/Mobile c. Others	
4. Transportation	
5. Others (please specify)	
Totals	

15. What other assets do you own? (Can be multiple answers)
Estimated value of assets can be aggregated

Asset(Please check)	Number	Estimated value (Taka)
Farmland a. How many hectares? b. Crops grown in a year? 1. Rice 2. Vegetable & others		
Mechanized farm equipment		
Livestock and Poultry a. Cow b. Buffalo c. Goat d. Chicken e. Others (please specify)		
Vehicles a. Truck or Bus for hire		

b. rickshaw c. Motorcycle foe personal use d. Bicycle e. Others (please specify)		
Appliances a. Radio b. TV c. Furniture d. Others (please specify)		
Boat a. Own use for fishing b. Transport c. Others (please specify)		
Jewelry		
Others (please specify)		

16. In the last one year, do you have savings? ☐ Yes ☐ No

17. If yes, where do you keep your savings?
☐ Bank ☐ Cooperative ☐ MFI (NGO; Association)
☐ House

18. Why do you save?
☐ Education ☐ Buy assets ☐ For business
☐ To cope with emergency (During or after natural disaster) ☐ Others

19. Are you, or any members of your household, covered by any form of insurance?
☐ Yes ☐ No

20. If yes, what insurance coverage?
☐ Health ☐ Accident ☐ Life insurance ☐ Others

III. Access to Services

21. How far from your house is the nearest public health facility?
☐ <500 Meter ☐ 0.6 Km to 1 Km ☐ >1 Km

22. What is the mode of transportation to the health facilities?
☐ By foot ☐ By bicycle/ motorcycle ☐ By jeep or bus
☐ By animal–driven car ☐ By motorboat ☐ Row-boat

23. Is the health facility accessible and in operation during disaster?
☐ Yes ☐ No

24. What is your toilet?

☐ With flush (sanitary latrines) ☐ Pit ☐ Jupri (open flow) ☐Nil

25. What is the general road condition?

☐ Dirt & muddy road when raining ☐ Semi-Pacca (brick paved) ☐ Gravel ☐ Pacca

26. What is the source of potable water?

☐ Individual tube-well ☐ Community tube-well

☐ Pond/ Reservoir ☐ River/ Cannel

27. Is the drinking water facility accessible and available (Individual tube-well & Community tube-well) during natural disasters?

☐ Yes ☐ No

IV. Impacts, Preparedness, Mitigation and Response

28. Whether you, or any of your family members, have been affected or victims of any of the following disasters or calamities in the past 10 years?

Disasters or calamities	Yes	No	No. of times they happened	No. of Injuries	No. of people missing
1. Cyclone					
2. Storm surges					
3. Flood					
4. Others					

29. Do you think or your perception, recently (last 3 years) about frequency and intensity of natural hazards

☐ Increasing ☐ Decreasing

30. Do you think or perception about your vulnerability to natural hazards

☐ Increasing ☐ Decreasing

31. Who were most affected by disasters in your family?

☐ Children ☐ Elderly ☐ Able people (all to move fast)

☐ Pregnant women ☐ Others

32. Is there any evacuation centre for you to use during emergency? ☐ Yes ☐ No

33. In last 5 years, have you and your family evacuated during Cyclones or other natural disasters?

☐ Yes ☐ No

34. What do you consider as your evacuation area?

☐ Public school building ☐ Public buildings (gymnasiums, municipal halls, etc)

☐ Mosque/Temple/ Church ☐ Neighbors house ☐ Relative house
☐ Embankment/ Road ☐Cyclone shelter ☐ Others (please specify)

35. How far is your nearest evacuation area?
☐ < 1 Km ☐ 1 Km to 2 Km ☐ > 2 Km

36. Is this evacuation centre in a safe area? ☐ Yes ☐ No

37. What are the facilities available in your evacuation area? (Can be multiple responses)
☐ Toilet ☐ Kitchen ☐ Potable water
☐ Medicine ☐ Sleeping quarters ☐ Other (specific)

38. Did you receive any training on disaster risk management? ☐ Yes ☐ No

39. If yes, what information did you receive during the training? (Can be multiple responses)
☐ On warning / alert signal ☐Evacuation route and sites
☐ Identification of hazard and risks in your community, etc ☐ Others (specify)

40. What coping mechanism did you do to mitigate the loss from of last disasters you experienced?
Coping mechanisms (Please check: Can be multiple answers)

Types of coping mechanism	Cost Incurred
1. Borrowed money from relatives/ friends	
2. Borrowed money from NGOs	
3. Borrowed money from banks	
4.Relief on assistance from the government	
5. Relief assistance from humanitarian organization	
6.Used savings	
7.Assisted financially by relatives/ Money transfers/ Remittances	
8.Sold or mortgaged assets	
9.Reduced expenses on food and other household consumption	
10.Stopped schooling of children	
11.Asked children to work	
12.Migrated temporarily to other areas	
13. Others (specific)	

41. How long did it take to go back to your work or livelihood after a disaster?
☐ < 3 days ☐ 4 days to 7 days ☐ 8 days to 15 days
☐ 16 days to 3o days ☐ More than 1 month

42. How do come to know in advance if natural disasters (cyclones, storm surge) will occur?
☐ Radio ☐ TV ☐ Cloud formation
☐ Cell phone/ Text
☐ Animal sounds & signs ☐ DMC announcement ☐ Relatives

☐ Other (specific)

43. How long did it take for local authorities to provide emergency or relief services after disaster?

☐ < 12 hours ☐ < 24 hours

☐ > 1 day ☐ > 2 days

44. What does your family do to prepare for and mitigate natural disasters? (Can be multiple responses)

Types of mitigation activities	Cost Incurred
1. Tie ropes on the house	
2. Stockpile food and other materials	
3. Prepare emergency kit	
4. Strengthen river embankments	
5. Clean sewers and cannel	
6. Move to evacuation centre or safer places of relatives and other friends/ neighbors	
7. Move productive assets to safer places	
8. Others	

45. How much do you trust your neighborhood/ Relatives?

☐ Not trustful ☐ Little ☐ Somewhat ☐ Very much

46. How much do your neighborhood to help in case of your illness and natural disasters

☐ Very unlikely ☐ Little ☐ Somewhat ☐ Very much

This ends the interview; please ask the respondent if he / she have any question/ comments.
Thank you very much the respondent.

End

APPENDICES 4

Questionnaire for Focus Group Discussion (FGD) Survey

To be interviewed in groups

(Note: This is the translated version from questionnaire in Bengali)

Rikkyo University (Japan) Ph.D. (second year) student field Survey at Disaster Prone Coastal Areas (Bhola, Nohakhali, Borguna & coxesbazar) in Bangladesh.

Purpose: To procure information on socio-economic conditions and resilience toward disasters.

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Instruction to Enumerator
The respondent will be a household head of family or his/her spouse who live in a disaster prone coastal area in Bangladesh.
Introduce the survey and its objective, which is to elicit and generate data and information from the respondents on the presence of hazards and their perception on the vulnerabilities that are faced by them. The information from this survey will use for writing a dissertation.

Date of interview: Union name: Upazila name:

Name of interviewer: Start time: End time:

1. How likely do you think, in the next ten years there will be natural disaster such as Cyclone and storm surge that will cause:

	Not at all likely	Somewhat likely	Almost certainly
Property loss to you, your relatives, or your neighbor	①	②	③
Injury to you, your relatives, or your neighbors	①	②	③
Business loss to you, your relatives, or your neighbors	①	②	③

2. How much do you believe that your community is vulnerable to natural hazards due to the following factors:

	Strongly disbelieve	Somewhat likely	Strongly believe
Many people live within hazard prone areas	①	②	③
Many buildings and structures are located within hazard prone areas	①	②	③

Many utility facilities are located within hazard prone areas	①	②	③
Many transportation facilities are located within hazard prone areas	①	②	③
Many small business lack resources to adopt hazard adjustments	①	②	③
Many housing and structures are not elevated	①	②	③
Community has limited number of resources for implementing mitigation plans	①	②	③
Community has limited amount of access to external resource source	①	②	③

3. How much do you believe that community vulnerabilities to natural disasters can be reduced by following actions:

	Strongly disbelieve	Somewhat likely	Strongly believe
Identifying local hazard mitigation needs and demands	①	②	③
Providing a variety of program activities for hazard reduction	①	②	③
Efficiently coordinating local hazard adjustment efforts	①	②	③
Prioritizing hazard mitigation projects based on local mitigation needs	①	②	③
Mobilizing resources needed to implement hazard mitigation measures	①	②	③

4. Indicate your level of agreement with each of the following statements

	Strongly disbelieve	Somewhat likely	Strongly believe
The activity of a single person can't reduce community vulnerabilities to hazard	①	②	③
Working together is more effective than working individually for hazard reduction	①	②	③
Each and every one make small contributions to build a safer community	①	②	③
You can influence the decisions that make your community safer	①	②	③

5. Indicate your level of agreement with each of the following statements that you feel obliged to:

	Strongly disbelieve	Somewhat likely	Strongly believe
Take preventive actions for protecting your family members or property from disaster	①	②	③

Participate in the decisions that make your community safer	①	②	③
Participate in hazard mitigation programs for building a safer community	①	②	③
Volunteer hazard mitigation program activities to help people or business at risk	①	②	③

6. Did the government and other humanitarian organizations do anything to prepare for or mitigate effects of natural disasters in your area?

☐ Yes ☐ No

7. If yes, what was done? (Please check the appropriate box, can be multiple responses)

Program / Project	check
1. Helped for family preparedness and mitigation	
2. River or dikes embankment or strengthening	
3. Emergency medical supply	
4. Search and rescue operation	
5. Community organizing for preparedness and mitigation	
6. Early warning	
7. Strengthening of bridges, water supply, electricity, etc.	
8. Others (Please specify)	

8. Who/which organization leads the disaster prevention activities in your community?

☐ Union Chairman ☐ Community member in charge of disaster prevention ☐ NGOs

☐ Fire brigade member ☐ Political leader ☐ No person in charge of leading disaster prevention activities

9. What are any visible environmental activities that contributed to increase the risk of disasters in your community?

☐ Logging (deforestation) ☐ Dam building

☐ Siltation of rivers ☐ others (please specific)

This ends the interview; please ask the respondent if he / she have any question/ comments.

Thank you very much the respondent.

End