ARTISAN FISHERS' PERCEPTIONS OF, AND ADAPTATION TO, CLIMATE CHANGE IN THE SOUTHEAST COAST OF BANGLADESH

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ABSTRACT

Climate change has been identified as one of the most defining challenges of the twenty first century to the wellbeing of humans and ecology systems. The new Climate Change Vulnerability Index, released by the Global risks advisory firm Maplecroft ranked Bangladesh as one of the most vulnerable countries in the world at 'extreme risk' of climate change (Maplecroft, 2014). Coastal Bangladesh is a potential hotspot in the world threatened by extreme floods, cyclones, rising sea levels and high temperatures (World Bank, 2013). Traditional small-scale marine fishing communities living in the coastal areas are at the forefront of disaster threats and are frequent victims of deadly events. Planned adaptation strategies are necessary in light of increased disasters and the limited adaptation capacity of the artisanal fishing communities.

This research focuses on the contextual determinants and dimensions of artisanal marine fishing community perceptions of, and adaptation to, climate change and recommends policies for adaptation. Seven fishing villages (jeleparas) in Chittagong and Chakaria were selected for this study. These fishing villages are located in the high-risk zones to disasters, noteably floods, cyclones and storm surges (GOB, 2010). A mixed method research approach was used here to investigate key dimensions and determinants of community perceptions of climate change and adaptation. Some of the key aspects of this research are climate change, environmental disasters, community culture and customs, local institutions and politics, socio-economy, and the demography of the traditional marine fishing communities in Bangladesh. This study documents how world views, disaster experiences, institutional factors, culture and customs play a central role in community risk perceptions and adaptation responses.

This study found that awareness of climate change impacts is high among the small-scale fishing community in Bangladesh, in which nine in ten respondents were worried but not panicked about climate change. Respondents had clear perceptions about changes in rainfall, seasonal patterns and increased temperatures. Fishers reported that rough waves and stronger winds have become a common phenomenon at sea and risks to fishers have increased significantly. However, the majority of respondents perceived that climate change is a natural process and some claimed that it was an *Act of God*. Tradition, faith, values, observations and disaster experiences are powerful indicators of fishers' understanding of climate change and environment change in the future. Results showed that there are clear differences in scientific and community conceptions of climate change. Respondents also believed that adaptation to climate change was possible

through proper planning and support, while they perceived that individual, community and government actions are necessary to minimise impacts related to climate change. Infrastructure development, financial support for the community, specially from the government, better construction of boats, improved housing, and the inclusion of community representatives in the local disaster management committee, were all ranked as some of the adaptation policy preferences for the community. The design and implementation of appropriate climate change adaptation policies are seen to be necessary to help the fishing community adapt gradually to the changing environment.

DECLARATION

This work does not contain any material that has been accepted for the award of any other degree or diploma in any university or tertiary institution by Zaheed Hasan. Furthermore, to my best knowledge and belief, this work contains no material previously published or written by another person, except where due reference has been made in the text. After the copy of my thesis is deposited in the university library, I give consent for the material to be made available for loan and photocopying, subject to provisions of the Copyright Act 1968. Unless permission has been granted by the university to restrict access for a period, my consent is given for a digital version of my thesis to be made available on the web, via the University's digital research repository, the library catalogue, the Australian Digital Thesis Program (ADTP) and web search engine.

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Zaheed Hasan

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ABBREVIATIONS

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plans
BDT	Bangladesh Taka (AUD 1 = 57 BDT: 2015 rate)
BWDB	Bangladesh Water Development Board
CC	Climate Change
DMB	Disaster Management Bureau
DoE	Department of Environment
DoF	Department of Fisheries
GoB	Government of Bangladesh
IPCC	Intergovernmental Panel on Climate Change
MoEF	Ministry of Environment and Forests
NAPA	National Adaptation Programme of Action
NGOs	Non-governmental Organizations
SLR	Sea Level Rise
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank

CHAPTER 1

INTRODUCTORY BACKGROUND AND STATEMENT OF THE PROBLEM

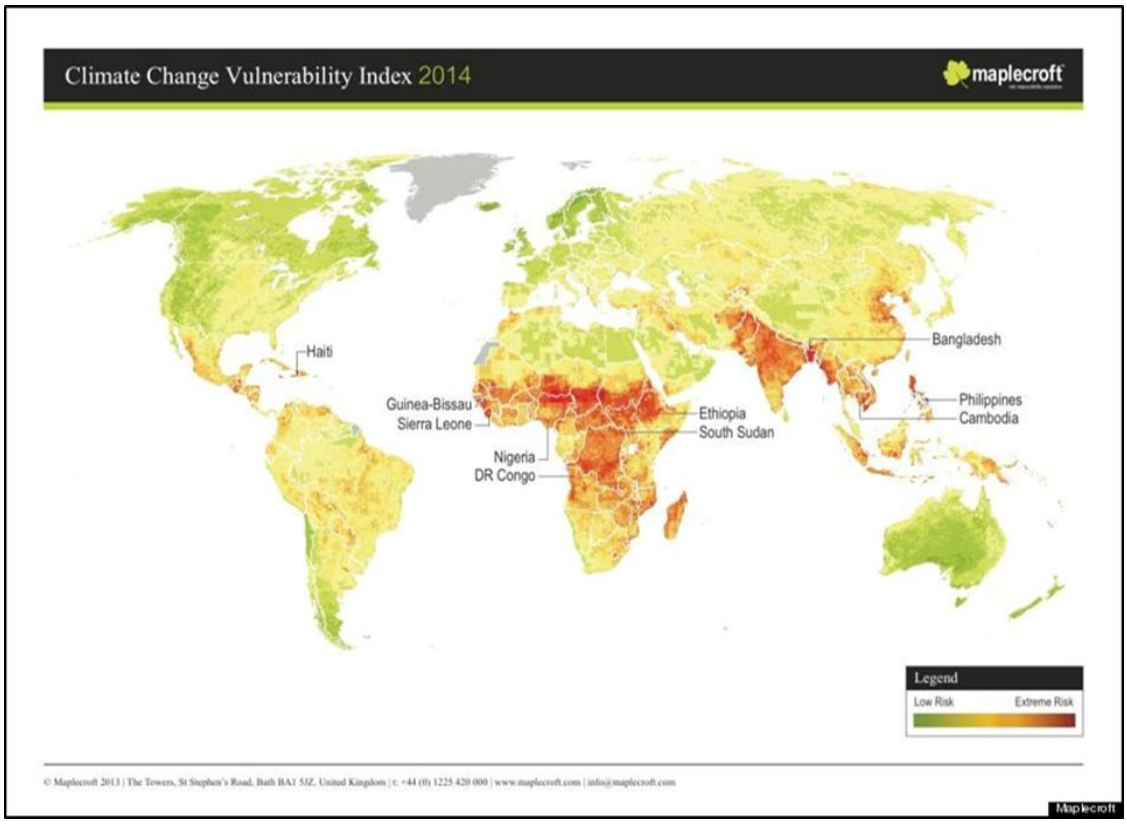
1. 1 Introduction

Climate change is one of the most defining challenges of this century to the wellbeing of human and ecology and demands a global response (Reser and Swim, 2011, Bellard et al., 2012). The effects of climate change pose significant environmental and socio-economic threats across a number of sectors, including food security, health, coastal communities and infrastructure. The most scientifically valid report to date on climate change by the Intergovernmental Panel and Climate Change (IPCC) states that the impacts of climate change will be "*severe, pervasive and irreversible*" (UNEP, 2014). The IPCC warns that time is running out swiftly to act against climate change if the world wants to avoid catastrophic impacts. Other leading scientific bodies, e.g. the National Aeronautics and Space Administration (NASA) have reported that some of these adverse effects of climate change are already observable throughout the world. The United States (U.S) President Barak Obama has termed the problem as urgent, growing and immediate. A "*once distant problem has come into the present*" (Obama, 2014). The UN special envoy on climate change Mary Robinson says, "*We are the last generation to be able to do something about climate, and the first generation to understand how serious it is*" (Lynch, 2015).

A certain degree of climate change impacts are already inevitable (UNEP, 2014). Mendelsohn et al. (2006) report that low-income countries are on the frontline of the devastating impacts of climate change. Poor countries in low latitudes and high temperatures are the most vulnerable to climate change. The Climate Change Vulnerability Index 2014, released by the Global risks advisory firm Maplecroft, ranked Bangladesh as one of the most vulnerable countries in the world and at 'extreme risk' of climate change (Figure 1.1). According to this study, Bangladesh is

at most risk due to extreme levels of poverty, high levels of dependency on agriculture and low government capacity to adapt (Maplecroft, 2011, Maplecroft, 2014). Experts indicate that because of climate change the frequency and intensity of disasters will increase in coastal Bangladesh (World Bank, 2013). Government, civil society, research institutes and development partners are well aware of the growing threats associated with climate change in Bangladesh and various response policies are in place to address the crisis (Walsham, 2010).

Figure 1.1: Climate Change Vulnerability Index 2014



Source: Maplecroft (2014)

Traditional fishing communities living in the coastal areas are at the forefront of disaster threats and frequent victims of deadly events. Islam et al. (2014) identify physical, technological, social and institutional barriers for adaptation of the coastal fishing community. Planned adaptation strategies are highly important in light of increased disasters and the limited adaptation capacity of the artisanal fishing community. Moreover, public support and opposition of adaptation policies depend

on local perceptions of climate change risks (Zahran et al., 2006). Therefore, for effective communication and implementation adaptation policies it is important for policy makers to understand how the local public conceptualise climate change risks and how that differs from expert thinking. This research fills a gap by investigating and exploring perceptions of risk, vulnerability and adaptation to climate change of the marine fishing communities from the southeast coast of Bangladesh.

This chapter describes the context of this research. It discusses in detail past and present environmental disasters and climate in coastal Bangladesh, and the way policy makers and coastal communities perceive and have responded to these disasters. It also outlines how climate change and adaptation have emerged as one of the major political and social agendas in Bangladesh, especially for the policy makers and the small-scale marine fishing communities. This chapter reviews important policies and strategies of the Government of Bangladesh that have been developed to address the impact of climate change, and highlights the importance and challenges for policy makers in engaging with the public for the development and implementation of adaptation. The importance of this project to address community perceptions and attitudes to climate change policy development is also discussed, together with the aims of the research.

1.2 Research aims and objectives

This research investigates the contextual determinants and dimensions of artisanal marine fishing community perceptions of, and adaptation to, climate change and recommends strategies for adaptation policy.

Both qualitative and quantitative techniques are used here in order to investigate key dimensions and factors that influence individual perceptions of environment and climate change. Some of the key focus of this research is on climate change, environmental disasters, community culture and customs, local institutions and politics, the socio-economy, and the demography of traditional marine fishing communities in Bangladesh. This study documents how world views, disasters

experiences, institutional factors, culture and customs play a central role in community risk perceptions and their adaptation response.

The study has focused on the artisanal marine fishing communities from the southeast coast of Bangladesh, specially fishing villages from Chittagong and Chakaria. In Chittagong, selected fishing villages for this study are situated on the outskirts of the city corporation and near the shoreline of the Bay of Bengal, while in Chakaria, the selected fishing villages are located in a sub-district and about 30 kilometre inside the shoreline. The fishing villages selected for this study fell under the classification of high-risk zones to disasters and likely to be severely impacted by climate change. These areas are particularly vulnerable to cyclones, floods, storm surges and salinity intrusion (GOB, 2014, GOB, 2009, GOB, 2005). The two study areas were selected to investigate if the level of vulnerability and perceptions of climate change differ with geographic location. The case study provides details of the dynamics and dimensions of risk perception in the context of climate change for these two artisanal marine fishing communities. The relevant research questions are:

1. How do marine fishing communities in Bangladesh understand and respond to various environmental disasters?

2. How do artisanal fishers relate experiences of environmental change and disasters to climate change?

3. What are the dimensions of community understanding of, and response to, climate change?

4. What are the policy implications of this community based risk perception research?

1.3 Study context

The fishers residing in the small-scale fishing communities in the southeast coast of Bangladesh tend to be poor, uneducated and mostly located on the islands and coast of the Bay of Bengal. The economic hardship of these fishers is likely to be aggravated by the impacts of climate change. With an increase in cyclonic activities at

the bay, anglers have to come back to shore abandoning their fishing trips. Poor anglers would end up with a lesser number of active days, a reduced catch per annum, and less income opportunities. Unfinished fishing trips would cause a significant income and investment loss (Ahmed and Neelormi, 2007). Therefore, the artisanal fishing community is one of the most vulnerable communities to climate change in Bangladesh.

The various characteristics of the case study areas allow a comparison to be made based on the hazards of place. The fishers perceptions of environment and climate change were collected in the survey to understand and compare intra and inter community risk perceptions. Several fishing villages from Chittagong and Chakaria selected for this study are located along the shoreline of the Bay of Bengal and its estuaries. This study examines how social, economic, institutional, cultural and demographic factors shape public perceptions to climate change risks and adaptation.

There are a limited number of studies available on community perception of climate change in coastal Bangladesh. A better understanding of community perception of climate change risk will facilitate the formulation of policies through an evidence based policymaking approach. This study intends to assist in the development of sectorial and regional risk identification for researchers and decision makers, and to provide knowledge regarding social trends and the impacts of climate change.

To understand the local perception of risk in Bangladesh and the complexity of the interrelationships between the biophysical and social components of risk, it is necessary to adopt a comprehensive, multi-disciplinary and multi-method approach. Therefore, by using primary and secondary qualitative and quantitative data, risk perceptions and the adaptive capacity of the fishing community can be examined.

1.4 Small-scale marine fisheries in Bangladesh

In Bangladesh, fisheries are the second most important agricultural sector (Ghose, 2014). The sector provides employment opportunities and food security for millions of people. In 2010-2011, fisheries (captured fisheries and aquaculture combined)

contributed 4.43 percent to national Gross Domestic Product (GDP) and 20 percent to the total agriculture production. Fish is the main animal protein source for 60 percent of the population in Bangladesh (GOB, 2015). The growth rate of the sector is steady and between 2000 and 2010, the average growth rate was 5.6 percent. More than 11 percent of the 150 million people in Bangladesh directly or indirectly engage with fishing (DoF, 2013). Table 1.1 shows that the fisheries sector in Bangladesh can be divided into three sub-sectors, 1) the inland open water capture contributes 28 percent, 2) the inland close water culture contributes 55 percent, and 3) the marine capture contributes 17 percent of the total production of 32.62 million tons in 2011-2012 (DoF, 2013).

Table 1.1: Sector-wise annual fish production of Bangladesh (2012-2013)

Sector of fisheries	Total production (Metric ton)	Percent
Inland open water (Capture)	961,458	28
Inland close water (Culture)	1,859,808	83
Marine fisheries	588,988	17
Total	3,410,254	100

Source: DoF (2013)

Bangladesh has a sea area of 118,813 square kilometres, 200 nautical miles of exclusive economic zone (Chowdhury, 2014), and 711 kilometres of coastline along the Bay of Bengal (Minar et al., 2013, p. 114). The geographical position and climatic conditions makes coastal Bangladesh one of the most resourceful areas in the world in terms of marine aquatic bio-diversity (Islam, 2003). One of the unique features of coastal Bangladesh is the mangrove forests that are rich in bio-diversity and an important habitat and breeding ground for various fish species, aquatic organisms and animals (Gopal and Chauhan, 2006).

Marine fisheries can be divided into two categories, i.e. artisanal fisheries and industrial fisheries. Marine fisheries are largely artisanal. Table 1.2 shows that in 2011-2012, 87 percent of the marine fish catch came from the artisanal sector and 13 percent from the industrial sector (Moma, 2007, DoF, 2009). Industrial fisheries comprised 162 trawlers that mainly engage in demersal and shrimp fishing activities.

About 45,600 boats are engaged in the artisanal marine fishing sector; with 21,700 mechanised and 24,000 non-mechanised boats (DoF, 2013). Artisanal fishers use different types of gear based on target species and seasons (Islam, 2013, p.50). Most of the artisanal fishers use gill nets, set bag nets, long line and trammel nets for fishing (DoF, 2013). Some of the artisanal fishers use small nets (pull-push nets) to fish near shore (Islam, 2013). Industrial fishers mainly operate at a 40 to 100 metre depth and artisanal fishers operate between the shoreline and 40 metre depth (Khan et al., 1997).

Table 1.2: Annual fish production (2011-2012)

Marine fisheries	Production (MT)	Percentage of total production
Industrial fisheries	73,386	13
Artisanal fisheries	505,234	87
Total	578,620	100

Source: Department of fisheries (DoF, 2013)

The artisanal marine capture fisheries sector is characterised by the use of local, traditional and labour intensive small-scale fishing activities organised at the household and community level (Islam et al., 2014c). Generally, small-scale marine fishers in Bangladesh are one of the poorest communities in the country. Despite the economic and cultural importance of artisanal fisheries in Bangladesh, traditionally at a social and government level, the sector does not receive the recognition it deserves (Moma, 2007, Bennett et al., 2001, Ahmed and Troell, 2010, Harper et al., 2013).

Research by Alam and Thomson (2001) research on the constraints and prospect of fisheries in Bangladesh found several constraining factors that explained the continuous decline in productivity of marine fisheries. These are a) lack of capital, b) too many fishing fleets, c) inadequate knowledge and information about fishing stock, d) lack of modern fishing equipment, e) inadequate landing facilities and f) thefts and piracy. The low demand for marine fish in local markets could be a reason that the marine fishing sector is not getting the required attention (Alam and Thomson, 2001, p. 305).

Islam (2003) briefly reviews the coastal and marine fisheries sector to identify management and policy gaps. The study reported poor management policies, unmonitored enforcement of laws and over population that together contribute to massive ecological destruction, pollution and overexploitation of resources in the coastal region. The study proposed the need for the engagement of experts in the community to develop a plan for sustainable use of natural resources (Islam, 2003).

The mangrove forest in Bangladesh is one of the most important coastal features from a socio-economic and ecological point of view. Mangrove forests support a wide variety of biodiversity (Biswas et al., 2007), and this forest is a nursery ground for many offshore and deep-sea species, including giant tiger shrimps which is one of the most important commercially valuable species for the country (Robertson and Duke, 1987, Ahamed et al., 2012). Mangrove forests are important for sustainable livelihoods, biodiversity and to minimise climate change vulnerability of coastal regions of Bangladesh (Smith and Mansur, 2012). A study by Rahman et al. (2010) found that negative natural and anthropogenic impacts and overexploitation of resources have caused severe damage to the mangrove ecosystem in Bangladesh. Growing population with limited livelihoods opportunities, illegal chopping of trees, encroachment of forest areas, illegal poaching of wild life and rapid expansion of shrimp farming, are some of the significant threats to the mangrove forests (Rahman et al., 2010, p. 80).

Hilsha is the most valuable fishing species for the artisanal fishers in Bangladesh. In this sector hilsha fish contributes over 41 percent of the total catch. A study by Moma (2007) documented that hilsha was overexploited at 32 percent higher than the sustainable level. Between 1987 and 2006, freshwater hilsa catches have decreased by about 15 percent and marine production has increased by about 26 percent. Such a robust increase of hilsa production from the marine sector is associated with increased fishing, expansion of fishing areas and decrease in abundance and fishing areas in the inland waters (Moma, 2007).

A study by Allison et al. (2009) investigated the vulnerability of 132 national economies to potential climate change impacts on capture fisheries. The study listed

the fisheries sector in Bangladesh as one of the most highly vulnerable to climate change. Currently, the sector is under considerable stress from overfishing, habitat loss, pollution, invasive species, water abstraction and damming. Large-scale climate-related changes are likely to degrade the ecology and increase the frequency and intensity of disasters, which will result in more economic hardship for the fishing community (Allison et al., 2009).

Fishing of prawn post-larvae is another one of the main livelihood activities for small-scale artisanal marine fishers. Unregulated, indiscriminate fishing of wild post-larvae at a high level by catch is destructive to biodiversity and to the coastal ecosystem. A threat to biodiversity instigates a government response to impose a seasonal ban/ restriction of post-larvae prawn fishing in certain ecologically sensitive areas and post-larvae migration routes. However, the authorities have failed to effectively implement the ban due to various policy issues. A study by Ahmed et al. (2010) found that fishers face a number of livelihood constraints. The lack of alternative employment opportunities is one of the major constraints for complying with the seasonal post larvae fishing ban (Ahmed et al., 2010).

A study by Ahmed et al. (2013) found that climate change posed a greater threat to the artisanal 400,000 fishers whose livelihoods directly depend on post-larvae fishing. A sharp decline in the post-larvae catches in Pasur river are directly related to various climatic variables like cyclones, salinity, sea level rise, water temperature, rainfall and drought. These climatic variables are also affecting the physical operation of the fishing practices of anglers (Ahmed et al., 2013).

Islam et al. (2013) also analysed the vulnerability of fishery-based livelihoods to climate variability and change using a combination of composite index and qualitative methods. They found that the most climates related exposure of coastal fishers was floods and cyclones. The adaptive capacity of the marine fishers depended on a combinations of various physical, natural and financial capital and was influenced by the diversity of various livelihoods opportunities (Islam et al., 2013).

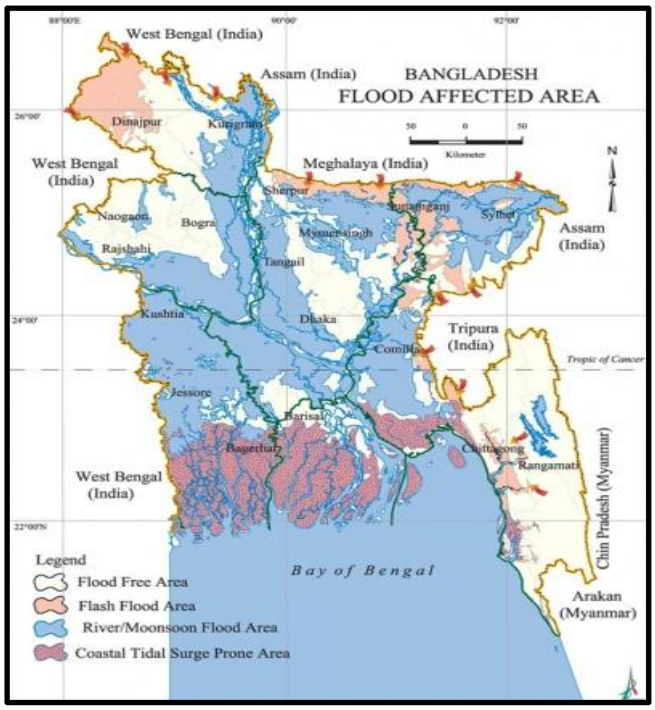
1.5 Disasters in Bangladesh

Historically Bangladesh is a disaster prone country. Almost every year the country faces disasters of one kind or another that cause serious damage to lives, properties and jeopardize development activities. Geographic location, the geomorphological setting and poor socio-economic status make Bangladesh vulnerable to various disasters (Paul and Routray, 2010). According to the policy paper National Plan for Disaster Management (2010-2015) by the Disaster Management Bureau, the major disasters in Bangladesh are floods, cyclones and storm surges, tornadoes, riverbank erosions, earthquakes, drought, arsenic contamination, salinity intrusion and landslides (GOB, 2010, p. 4).

Two-thirds of Bangladesh are less than five metres above the sea level and susceptible to various disasters like floods, cyclones, storm surges and erosions (Dasgupta et al., 2010). Once in every two to five years, two-thirds of Bangladesh is inundated by floods that cause substantial damage to agriculture, infrastructure, housing and livelihoods (World Bank, 2010). Figure 1.2 shows flood prone areas in Bangladesh.

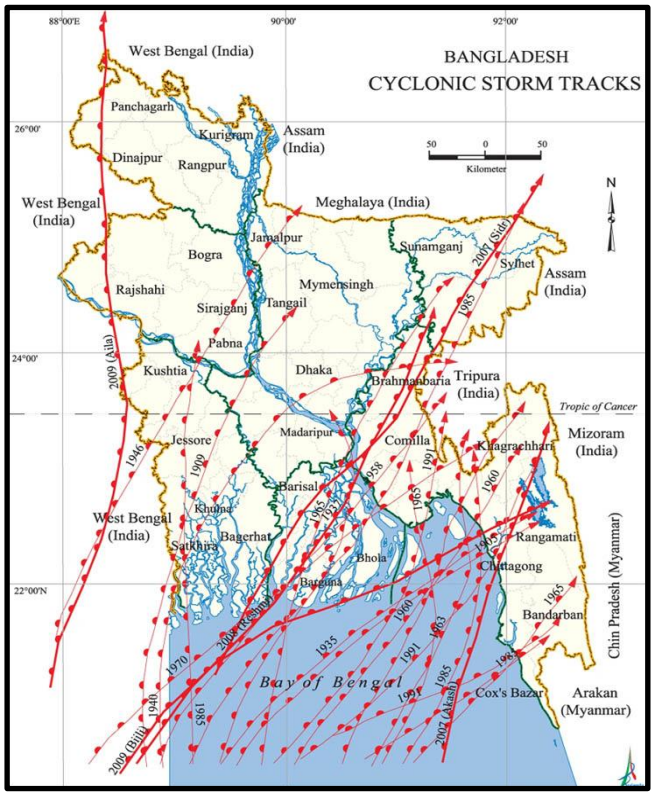
Tropical cyclones accompanied by storm surges have hit coastal Bangladesh in almost every year (Banglapedia, 2014). The funnel shaped coastline, with a low and flat topography and poor economic conditions make the coast of Bangladesh extremely vulnerable to disasters (Figure 1.3) (Shamsuddoha and Chowdhury, 2007). The Bay of Bengal that forms the Bangladesh coastline is one of the world's most active areas for the development of low-pressure systems. Alam et al. (2003) analysed 26 years (1974-1999) of storms and depressions that form in the Bay of Bengal and reported that on an average annually, 11 storms and depressions form in the sea. On average, seven storms and depressions, and three storms, that is 88 percent that formed in a year at the Bay of Bengal, cross the coast (Chowdhury, 2002, Alam et al., 2003). Figure 1.3 shows the tracks of cyclones that hit Bangladesh coast between 1909 and 2009 and it indicates that the pattern is not uniform.

Figure 1.2: Flood prone areas in Bangladesh



Source: Banglapedia (http://en.banglapedia.org/index.php?title=Natural_Hazard)

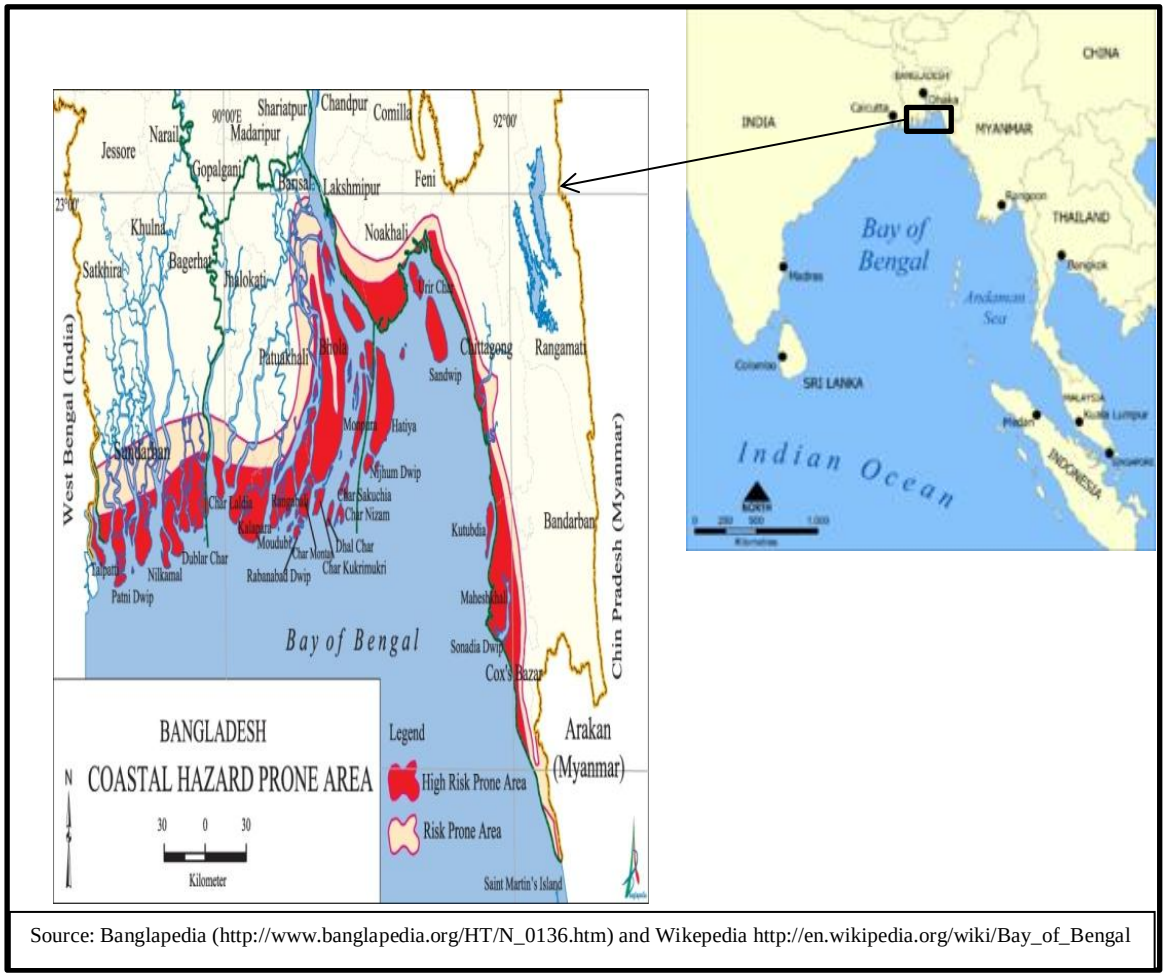
Figure 1.3: Cyclone track of Bangladesh (1909-2009)



Source: Banglapedia (http://www.banglapedia.org/HT/C_0469.htm)

Most of the death and destruction of property associated with cyclonic activity in Bangladesh is a result of abnormal storm surges. The great Bhola cyclone in 1970 is considered as one of the deadliest cyclones of all time, with the total death toll between 200,000 to 300,000 persons. Almost all of the coastal areas were flooded; a countless number of livestock died and most of the fishing fleets were destroyed. Beside loss of lives the cyclone caused enormous health, economic and infrastructural damage (Murty et al., 1986, Sommer and Mosley, 1972). The Bangladesh cyclone of 1991 is also one of the deadliest cyclones ever recorded. This severe cyclone was accompanied by a 30 feet high tidal surge that battered the south-eastern coast (Chittagong region) for 3-4 hours. According to government reports more than 130,000 people were killed and property worth USD 2.4 billion was damaged. Nearly 5 million people in eight coastal districts were affected. In both the 1970 and 1990 disasters the main cause of death was drowning (Chowdhury et al., 1993). A study by Bern et al. (1993) found that mortality was higher in children under 10 year old and women more than 40 years of age. This study suggests mortality associated with the cyclones can be prevented by more effective early warning systems, by increasing the number of cyclone shelters and providing better access to them and improved preparedness of the high-risk community (Bern et al., 1993). In November 2007 another super cyclone, Sidr, struck the southwestern coast. This time the death toll was far below that of the previous cyclones of this type. Around 3,500 people were killed and estimated damage was 1.67 billion. The relatively low number of deaths in this case is widely credited to the government's efforts to provide timely cyclone forecasting, early warnings and evacuation of coastal residents from the probable path of the cyclone. According to a study by Paul (2009) fewer casualties could also be attributed to the physical characteristics of the cyclone, for example the duration of the storm and storm surge, landfill time and site, the varied coastal ecology and coastal embankment (Paul, 2009). Figure 1.4 shows the hazard prone areas of coastal Bangladesh indicating the extent of disaster risks exposed to coastal areas.

Figure 1.4: Map of disaster prone coastal Bangladesh



Source: Banglapedia (http://www.banglapedia.org/HT/N_0136.htm) and Wikepedia http://en.wikipedia.org/wiki/Bay_of_Bengal

1.6 Climate change and Bangladesh

According to the IPCC fifth assessment report (2014) between 2000 and 2008, the Asian region sustained the most weather and climate related disasters in the world, which resulted in highest proportion (30 percent) of world economic losses. At the launch of this report experts indicated, "South Asia's climate is already changing and the impacts are already being felt" and further climatic changes are inevitable in the coming decades (IPCC, 2014, p. 5). Climate change is directly affecting human health, livelihoods and economic losses. Recent cholera epidemics and heat stress in Bangladesh are associated with climate change (Burkart et al., 2014).

The IPCC predicted that more frequent and extreme rainfall events during the Monsoon are most likely to increase which means that low lying, densely populated coastal areas

> of Bangladesh are at increased risk of storm surges and floods that will put millions of people at risk. Riverine and coastal floods linked to extreme rainfall events in addition to sea level rise and increased cyclonic events, could also cause widespread damage to livelihoods, settlements and infrastructure (IPCC, 2014, p. 6).

Figure 1.5 summarise the key messages of the fifth assessment report for Bangladesh. Dr. John Church, a lead author of the report noted at the press conference that 17 percent of the landmass of Bangladesh could be inundated with a one-metre rise in sea levels.

Figure 1.5: Key messages from the fifth assessment report for Bangladesh and South Asia

- South Asia including Bangladesh is already experiencing impacts related to climate change

- Further changes are inevitable in future

- Low lying and densely populated coastal Bangladesh is one of the most vulnerable areas to climate change related impacts

- Marine based sectors would be the worst affected

- Key climatic changes are increased temperature, extreme and erratic rainfall events, sea level rise, increased precipitation in Monsoon, extended monsoon, contrasting dry and wet season, increased intensity and magnitude of cyclones and associate storm surges, untimely occurrences of floods and droughts

- Changing patterns of climate is erratic and uncertain

- Climate change is affecting human health, contributing to socio-economic losses. Climate change poses a great challenge to growth and development of the region

- Adaptation can reduce the impacts of climate change

Source: (IPCC, 2014)

The IPCC 4 Assessment Report (2007) indicated that in the 21st century the most likely sea level rise will be 2 to 3 mm/year and that sea level rise in Asia will be geographically variable. Projected sea level rise could flood millions of people living in the low-lying coast of South, Southeast and East Asia. Under the most conservative scenario, sea levels will be 40 cm higher than today by the end of 21st century. The projected increase in the number of coastal populations affected by annual flood is 13 million to 94 million. Almost 60 percent of the population affected by increased floods will be coastal populations living in South Asian countries like Bangladesh, India, Pakistan, Burma and Sri Lanka. Coastal low lands below the 1000 year old

storm surge are widely distributed in Bangladesh. Parry (2007) argues that hundreds of thousands of people living in coastal Bangladesh will be affected by sea level rise by 2050.

Jakobsen et al. (2006) studied cyclone and storm surge levels from 1960 to 2000 for the Bangladesh coastline. The study reported that 17 severe cyclonic storms hit the coastline of Bangladesh during that period. The findings show that in the Northern Meghna Estuary a storm surge of 10.6 metres associated with a cyclone has a return period of 100 years and a surge level up 14 metres has a return period of 652 years (Jakobsen et al., 2006, p. 295).

Karim and Mimura (2008) investigated the impact of increased sea surface temperature (SST) and sea level rise (SLR) in the west coast of Bangladesh. Findings showed that storm surge under 2^0C SST and 0.3 m SLR flood risk area would be 15 percent greater than the present risk area and the depth of flooding area would increase by a little less than 23 percent within 20 km from the coast line (Karim and Mimura, 2008, p. 490).

In Bangladesh, coral reefs are found only around Saint Martin's Island in Cox's Bazar (Mollah, 1997). However, numerous studies have indicated that increased sea surface temperature and ocean acidification pose existential threats to coral reefs (Hoegh-Guldberg et al., 2007, Pandolfi et al., 2011, Glassom, 2014). A study by Rajasuriya et al. (2002) found that recovery of the coral reef of the Saint Martin's Island was very slow resulting from the damage caused by high water temperature associated with the 1998 El Nino event.

Agrawala et al. (2003) examined the implications of climate change in coastal Bangladesh by reviewing the results of the general circulation models (GCMs) published in the IPCC's special report and scientific literature. All the climate models indicated that there will be a steady increase in temperatures in coastal Bangladesh, and that more warming is estimated for winter than for summer. Most of the models estimated that precipitation would increase during the summer monsoon period because air over land will be warmer than the air over the ocean during summer.

Estimated increases in summer precipitation were found to be statistically significant. The authors predicted that a steady increase in rainfall during the monsoon is most likely to happen. Currently more than 80 percent of the annual 2,300 mm rainfall occurs in the monsoon season. Therefore, increased rainfall during the month of monsoon is critical for Bangladesh, given the country's extreme vulnerability to water related disasters. Most of the models predicted that strong cyclonic events might increase by 5 to 10 percent (Agrawala et al., 2003, p. 15).

1.7 Vulnerability and climate change adaptation in Bangladesh

In Bangladesh, the study of vulnerability and adaptation to climate change is an increasing area of interest that brings together experts from a wide range of fields, including climate science, development studies, geology, social science, policy development and economy.

Cannon (2002) in a review of literature identifies poverty as a major cause of climate change vulnerability. The study reported that in Bangladesh women are poorer than men and an increase in disasters and extreme climatic events linked with climate change, were more likely to affect women than men (Cannon, 2002).

Huq et al. (2004) discuss vulnerability and adaptation options for the least developing countries, focusing on Bangladesh and Mali and point out that health, infrastructure, food security and agriculture, water resources, forestry and biodiversity, coastal zone and fisheries, are the worst affected sectors by climate change. Though Bangladesh has made significant progress in disaster response and identifying adaptation options there remains much more to be done in terms of incorporating climate change adaptation into national policy (Huq et al., 2004).

Choudhury et al. (2005) presented and analysed the findings on water related vulnerabilities to climate change based on socio-economic and physical environmental perspectives. They concluded that the agriculture sector was severely hampered by floods. The poor quality of dwellings tended to exacerbate susceptibility to floods and cyclones. As the majority of the people are poor they could not afford

expensive coping options (Choudhury et al., 2005). Thomalla et al. (2005) explored the adaptation of coastal communities and found that it is constrained by limited efforts and exchange of information from the Government to civil society (Thomalla et al., 2005). In addition, Brouwer et al. (2007) focused on the relationship between environmental risk, poverty and vulnerability of flooding in Bangladesh, and investigated community vulnerability and coping mechanisms in response to coastal flooding. The study found somewhat that paradoxically the people faced the highest risk of flooding are the least prepared, both in terms of household-level preparedness and community-level post flood relief (Brouwer et al., 2007).

Another vulnerability study of a rural village in southwest part of coastal Bangladesh found that villagers face a number of environmental, political and economic stresses, particularly related to shrimp farming. These stresses have changed livelihood opportunities and increased the vulnerabilities of poor villagers to future environmental changes. Non-governmental organizations are working on planned adaptation strategies to improve the adaptation capacity of the poor villagers (Pouliotte et al., 2009).

1.8 Climate change and governance of coastal Bangladesh

1.8.1 Key policies and institutes for climate change

The government of Bangladesh and its development partners recognise climate change as a key development challenge (GOB, 2009). In response to this challenge, the Government of Bangladesh (GOB) introduced the National Adaptation Programme of Action (NAPA) in 2005 to address the most urgent and immediate adaptation needs. NAPA was developed by following the generic guidelines of the United Nations Framework Convention on Climate Change (UNFCCC) (GOB, 2005). Bangladesh was one of the first few countries in the world that introduced NAPA (Ayers, 2011). This was prepared along with the sustainable development goals and objectives of the country, which recognized the necessity of addressing environmental issues and natural resource management for all development policies and projects. Policy makers, local representatives of the government, civil society, independent

researchers and representatives from various professional and ethnic groups have contributed to the development of the NAPA in Bangladesh. NAPA 2005 identified that coastal areas and communities were the most vulnerable to climate change in Bangladesh (GOB, 2005). In 2008-2009 the government developed the Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009), which reviewed experiences and knowledge gained from the adaptation projects implemented through NAPA 2005. The BCCSAP describes the context, the likely impacts of climate change in Bangladesh, and provides an overview of potential adaptation strategies. This adaptation and mitigation programs have developed to address long-term challenges of climate change.

At present, the Department of Environment (DoE) under the Ministry of Environment and Forests (MoEF), is the key body in Bangladesh for environmental management and conservation. The ministry coordinates other government bodies, NGOs and other related institutes to implement various projects and policies related to climate change. Beside the government, non-state actors, i.e. NGOs and research institutes, have been working to develop and implement various policies on climate change and adaptation in Bangladesh.

In summary, the major actors in Bangladesh working on climate change are:

- National and local government,
- Development partners,
- Non-government organisations (NGOs),
- Civil society,
- Research institutes and
- Media.

1.8.2 Key regulations for the marine fisheries sector

Table 1.3 shows the key legislation and authorities responsible for law enforcement activities related to fisheries in Bangladesh. The enforcement of legislations related to coastal and marine resources is the joint responsibility of several government departments. Major departments to enforce regulations in marine sectors are the Department of Fisheries (DoF), Bangladesh Water Development Board (BWDB) and

Department of Environment (DoE). The Ministry of Fisheries and Livestock (MoFL), through its Department of Fisheries (DoF), has overall responsibility for development, management and conservation of fisheries in Bangladesh. The most fundamental act for regulating fisheries in Bangladesh is the Protection and Conservation of Fish Act (1950). The Marine Fisheries Ordinance (1983) and the Marine Fisheries Rules (1983) are the key regulations for management of marine fisheries. These acts provided detail descriptions of regulations for fishing vessels, authorities and responsibilities of the stakeholders and punitive rules for breaking the laws (GOB, 1983). The National Fisheries Policy was first introduced in 1998 with objectives to enhance fish production, to generate employment, to meet the increased demand for animal protein, to achieve an ecological balance and better conservation management. This policy was an effort to bring together all the related professionals, government and non-government agencies to gain better cooperation and management practices (GOB, 1998).

Following are some of the activities and management policies proposed and adopted by the government focusing on artisanal marine fishers.

1. Restrictions on fishing gear

The Fish Act (1950) banned jatka (hilsa fry less than 10 inch in length) catch, trade and marketing in Bangladesh. The government banned the use of monofilament gillnet (locally known as current jal) and gill nets of less than 100 mm mesh size in 1998.

2. Restrictions on fishing time and areas

Every year, the government ban catching of Hilsha fries in all the major spawning grounds for a certain period of time. In 2014 the government banned catching of Hilsha fish for eight months starting from November to June (The Daily Stat, 2014).

3. Zone restriction

The Marine Fisheries Ordinance, 1983 made provisions for the marine fisheries not to fish more than the depth of 50 metres. This rule is for to minimise conflicts between industrial vessels and artisanal fishers (GOB, 1983).

5. Regulation on fishing vessels

The Marine Fisheries Ordinance, 1983 introduce licencing system for all the mechanised boats. This regulation makes it compulsory for all the fishing vessels to be registered to get licence. The aim of licence is to keep track of the number of fishing vessels and to collect revenue. Licence is subject to certain conditions, such as

- To obey the government restrictions on fishing areas and periods,
- Declaration of type of species, size and quantities,
- Restrictions on type, size and amount of fishing gears and
- To carry identification on boat all the time (GOB, 1983, GOB, 1995).

In coastal Bangladesh, law enforcement, monitoring and surveillance activities suffer from a high degree of non-compliance for a number of reasons. Such as, 1) widespread corruption especially in the government agencies (Mallick and Vogt, 2009), 2) limited institutional capacity and lack of funds, 3) lack of inter-agency co-ordination for coastal zone development and management (Afroz and Alam, 2013) and 4) a geographically vast coastal jurisdiction (Ahmed, 2011).

Table 1.3: Key legislation and government agencies responsible for law enforcement in coastal Bangladesh

Legislation	Agency	Responsibility
Protection and Conservation of Fish Act (1950), amended in 1982	The Ministry of Fisheries and Livestock (MoFL) and the Department of Fisheries (D0F)	Basic act for regulating inland fisheries
Marine Fisheries Ordinance (1983)	The Ministry of Fisheries and Livestock (MoFL) and the Department of Fisheries (D0F)	Basic act for regulating marine fisheries
Shrimp Culture Users Tax Ordinance (1992)	The Ministry of Fisheries and Livestock (MoFL) and the Department of Fisheries (D0F)	To regulate tax for shrimp farmers
Bangladesh Fisheries Development Corporation Act (1973)	Bangladesh Fisheries Development Corporation	Development of fishing industry in areas of preservation, processing, distribution and marketing
National Fisheries Policy (1998)	The Ministry of Fisheries and Livestock (MoFL)	To develop and increase fish production
State Acquisition and Tenancy Act (1950)	Ministry of Land (MoL)	Administration and management of government-owned land and water bodies
Bangladesh Water and Power Development Boards Order (1972) and Water Development Board Act (2000)	Ministry of Water Resources (MoWR) and Bangladesh Water Development Board (BWDB)	To implement projects for flood control, drainage and irrigation
Water Resources Planning Act (1992)	Water Resources Planning Organization (WARPO)	Water resource planning and management at regional level
National Water Policy (1999)	Bangladesh Water Development Board (BWDB) and Water Resources Planning Organization (WARPO)	To plan and develop state owned water bodies
The Environmental Protection Act (1995)	Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF)	To protect environment and to control pollution
The Environment Conservation Rules (1997)	Department of Environment (DoE)	Provide Environmental Clearance Certificate to industries and projects
The Environment Court Act (2000)	Department of Environment (DoE)	Enforce powers and jurisdiction over environmental proceedings
The National Environmental Policy (1992)	Department of Environment (DoE)	To take measures to improve environmental conditions including fisheries
The Fish and Fish Product (Inspection and Quality Control) Ordinance (1983)	Department of fisheries (DoF)	To monitor fish processing and packing plant
The Coast Guard Act (1994)	Ministry of Home Affairs	To enforce maritime laws

Source: (GOB, 2015, GOB, 1983, GOB, 1995, GOB, 2012)

1.9 Research motivation

1.9.1 Climate change impacts and projections: the adaptation challenges

Climate change is likely to increase the frequency and magnitude of disasters in Bangladesh. It is widely recognised that the poorest and natural resource dependent communities will be the most vulnerable to climate change (Brouwer et al., 2007, Daw et al., 2009, Sultana and Thompson, 2007, Rawlani and Sovacool, 2011, Ayers,

2011, Coirolo and Rahman, 2014, Islam et al., 2014c). Adaptation measures prioritise the needs of the most vulnerable groups. Dolan and Walker (2006) suggested that community risk perception studies help policy makers to get information on adaptation priorities at the local level. In addition, for the policy makers it is important to know how risk is experienced at the local level and how the perceptions of climate change influence for the development and implementation of adaptation policies (Spence et al., 2011). Another challenge for the policy makers is to identify gaps in the on-going adaptation policies and to make appropriate changes to address those gaps (Reid and Huq, 2007). Risk perception studies at the local level are helpful to get direct opinions on adaptation policies from the stakeholders. Stringer et al. (2009) argue that stakeholders' perceptions are important for effective communication and development of adaptation policies that meet the local needs.

Bangladesh needs enormous funds to develop infrastructure and embankments to protect lives and livelihoods of the coastal population. According to UNEP (2014), currently Bangladesh is spending 1 billion USD a year for climate change adaptation that is 6-7 percent of the annual budget, and the Government pays the majority of these costs from local funds. According to a World Bank estimation Bangladesh will however need 5.7 billion USD per year by 2050 to adapt (UNEP, 2014). For Bangladesh, effective adaptation in the different time scales (immediate, middle and long-term) is a significant challenge in the context of limited resources, poor infrastructure and weak governance. Ayers, 2011, Ayers and Forsyth, 2009, Ayers et al., 2014 have all emphasised the need for addressing community/sectoral perceptions and knowledge sharing for the development and implementation of more effective adaptation policies in Bangladesh.

1.9.2 Limitations of policy

According to the key adaptation policy papers, NAPA 2005 and BCCSAP 2009, adaptation consultation workshops were conducted with the local level stakeholders (i.e. representative from the local government, local NGOs, vulnerable communities like farmers and women). Ayers (2011) notes that because of power dynamics within the communities the politically powerful stakeholders dominated the discussions. The

less powerful stakeholders were deterred or inhibited by the presence of socially rich and influential participants. Second, the study revealed that in the regional workshops, the participants were briefed on impacts of climate change and then they were asked to suggest adaptation options. This top-down approach limits the process to get comprehensive information regarding risks and response to climate change. Third, regional workshops were used primarily to verify expert opinions on climate change risk and adaptation. Participants were asked to prioritise from preselected adaptation options that were suggested in the NAPA which might not correlate with that suggested by coastal communities (Ayers, 2011).

1.9.3 Importance of local risk perceptions for adaptation policy development

There is a growing consensus among researchers to develop site-specific adaptation programs (Frank et al., 2010, Horlick-Jones et al., 2003, Huq, 2011). Dodman and Mitlin (2013) and Ayers and Forsyth (2009) claimed that though climate change is a global problem, impacts are experienced at the local level. Thus, adaptation programs should be developed and implemented considering local needs and dynamics. People's perception and response simply do not depend on impacts of climate change alone. Local perspectives on adaptation are based on multidimensional factors, ranging from risk experiences and knowledge, socio-economic and geographic factors, as well as associated institutional and cultural factors and interactions between various factors (Ayers, 2011). Frank et al. (2011) argue that local perceptions of environmental risk is an important factor of human response to climatic shocks and changes. As noted by Lebel (2013) local knowledge, experiences and perspectives can provide valuable information in relation to adaptation planning.

Numerous studies have identified that the success of adaptation policies depends on the willing cooperation and perceptions of the beneficiaries (Adger et al., 2009, Grothmann and Patt, 2005, Patt and Schröter, 2008). A study by Biswas and Choudhury (2007) identified that in Bangladesh some of the key reasons for policy failure in forest management are due to a lack of understanding of the local community by the government authority, and a lack of community participation and engagement. The study emphasised the need to understand community perceptions,

customs and culture, while developing participatory forestry and ecosystem management. Government policies, however well intentioned, will not benefit the members of the public unless they are properly developed and implemented.

The impacts of climate change vary among communities and ecosystems. Adaptation policies based on an impact based approach has important policy consequences. First it helps build an understanding of the key drivers of vulnerability, secondly resources for adaptation may be put to the most effective use, and finally, perhaps most importantly, this approach targets the key risk factors that exacerbate the vulnerability of the community (Ayers, 2011). In summary, understanding community perception should be one of the key steps in policy development for climate change adaptation.

It is imperative to examine in more detail the social elements of risk that influence the development of effective and acceptable adaptation policies for climate change in Bangladesh. Risk assessment and risk identification is crucial for risk communication, risk management and development of effective climate change adaptation policies. According to the IPCC, understanding the multi-faced nature of vulnerability and exposure is a prerequisite for determining how weather and climatic events contribute to the occurrence of disasters, and for designing and implementing effective adaptation and disaster risk management strategies (Cardona et al., 2012). Knowledge and factors that determine how people perceive and respond to specific risks or a set of multiple hazards risks, is key for risk management and climate change adaptation (Grothmann and Patt, 2005). Failure to understand peoples' perceptions could lead to unacceptable and ineffective adaptation policy (Patt and Schroter, 2008). Various studies report that community priorities are not adequately addressed in the process of adaptation policy development in Bangladesh (Agrawala et al., 2003, Pender, 2008, Ayers, 2011).

1.10 Thesis structure

This thesis consists of eight chapters. Chapter one outlines the research problem, background and context of the study, and research objectives. It briefly discusses past and present environmental disasters and climate in coastal Bangladesh and key

adaptation policies and programs for the fishing communities in particular. Chapter two reviews the relevant literature conducted on vulnerability, risk perception and adaptation to climate change, specially at individual and community levels. Relevant theories and empirical evidence are presented from various disciplines, such as, social sciences, environmental behaviour, psychology and sociology. This chapter describes how this project is based on findings from previous research. Chapter three describes the methodology and research techniques applied to obtain data used for this research. Chapter four describes disasters and climatic trends in coastal Bangladesh.

Chapter five, six and seven are major analytical chapters based largely on primary data. Chapter five describes [1]artisan fishers' concerns and understanding of climate change and identified important social, economic and demographic factors that influence their perceptions. Chapter six investigates and describes community perceptions and attitudes towards adaptation. Chapter seven is based on qualitative data and describes how tradition and culture shape community perceptions and adaptation to climate change. Chapter eight is the concluding chapter that assesses whether the objectives of the study have been addressed and summarises the key findings. This chapter also describes theoretical, methodological and policy implications of this study and future research recommendations.

1.11 Conclusion

This chapter provides the background and context of the study and has outlined the objectives of this research. The issues discussed in this chapter are climate change threats in coastal Bangladesh, vulnerability of small-scale marine fishing communities, the complex nature of coastal management and adaptation policies. This background to the study indicates a need for understanding the human dimensions of

[1] According to the Merriam-Webster dictionary, the term artisan means "one that produces something in limited quantities often using traditional methods". In this study artisan fishers' are used to describe small-scale commercial fishers who use traditional methods and skills for fishing as opposed to large-scale industrial fishers.

climate change. One way of acquiring an understanding of the human dimensions is through case studies that are community and place based.

CHAPTER 2

RISK PERCEPTIONS, VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE: LITERATURE REVIEW

2.1 Introduction

Climate change has emerged as one of the most defining challenges of this century to the wellbeing of human and ecology. Climate change is intrinsically a global issue. However, most of the impacts of climate change are local. Potential disaster scenarios underline the importance of adaptation research aimed at strengthening the local capacity to cope with climate change impacts (Few, 2003). The development and implementation of appropriate adaptation policies are particularly important for resource poor communities in developing countries. Policy makers face a number of challenges to communicate and to develop acceptable adaptation policies. A growing number of studies have indicated that resource constraints and psychological factors play an important role in determining individual perceptions, attitudes and response actions to climate change (Grothmann and Patt, 2005, Sundblad et al., 2007, Frank et al., 2011, Weber, 2010, Linden, 2014).

This chapter reviews the relevant literature conducted on vulnerability, risk perception and adaptation to climate change, especially at the individual and community levels. Relevant theories and empirical evidence are presented from various disciplines, e.g. social sciences, environmental behaviour, psychology and sociology. This chapter concludes by describing how this project builds on findings from previous research.

2.2 Climate change and vulnerability

Small-scale fisheries provide employment and food to millions of people around the world (Lunn and Dearden, 2006). Badjeck et al., (2010) raised concern over the consequences of climate change for the livelihoods of 36 million fishers and nearly

1.5 billion consumers who rely on fish for 20 percent of their animal protein supply. Daw et al., 2009 claimed that change in aquatic system and resulting impacts on fisheries livelihoods are likely to be significant, but remain a less explored area in climate change adaptation policy. Roessig et al., (2004) reported a relatively small change in temperature would have enormous impacts on the distribution and abundance of marine fishes. Changing in fish abundances will undoubtly affect livelihoods of fishing communities who depend on this natural resources.

Studies around the world have indicated that generally people are confused about the concept of climate change (Leiserowitz et al., 2010, Weber and Stern, 2011, Capstick et al., 2015). To study the perceptions of climate change of local people, it is useful to understand the scientific definition of the key concepts of climate change science, such as weather, climate and climate change. The IPCC Climate Change 2013: Physical science report defines weather, climate and climate change in the following way:

> "Weather describes the conditions of the atmosphere at a certain place and time with reference to temperature, pressure, humidity, wind, and other key parameters (meteorological elements); the presence of clouds, precipitation; and the occurrence of special phenomena, such as thunderstorms, dust storms, tornados and others."(Stocker et al., 2014, p. 123)

> "Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Classically the period for averaging these variables is 30 years, as defined by the World Meteorological Organization. Climate in a wider sense also includes not just the mean conditions, but also the associated statistics (frequency, magnitude, persistence, trends, etc.), often combining parameters to describe phenomena such as droughts." (Stocker et al., 2014, p. 126)

> "Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer." (Stocker et al., 2014, p. 126)

Experts' understanding of climate change risk are influenced by objective assessment and subjective value judgements (Lowe and Lorenzoni, 2007). There is a strong consensus among the scientific communities that anthropogenic activities are the key drivers of climate change. For centuries the burning of fossil fuel and coal have

increased atmospheric concentration of carbon dioxide (CO^2). Climatic models have concluded with more than 90 percent probability, that human activities over the past two and half centuries are the reason for climate change (IPCC, 2007). Most of the impacts of climate change are negative for ecosystems, human lives and properties. Experts have suggested various adaptation and mitigation measures to tackle climate change (IPCC, 2014a). In summary, various scientific models and findings from the systematic data analysis are the fundamentals of experts' understanding of climate change. Table 2.1 summarises the scientific conception of climate change.

Table 2.1: Scientific conception of climate change

- Climate change is a global problem but its impacts are regional and local (Wilbanks and Kates, 1999)
- Climate change is a physical process. Global average temperature is rising due to increasing greenhouse gas emissions. Human activities are largely responsible for climate change (Parry, 2007, Solomon et al., 2007, IPCC, 2014),
- Effects of climate change: loss of sea ice, sea level rise, increased frequency and intensity of disasters, abrupt seasonal transition (IPCC, 2014, NASA, 2015),
- Climate change risk in viewed in terms of probability of occurrence (Field, 2012, Palmer and Räisänen, 2002),
- Vulnerability assessments of people and resources are mostly quantitative and follow a systematic method (Smith et al., 2009, Kelly and Adger, 2000)
- Adverse impacts of climate change can be minimised by intervention and by changing human behaviour (IPCC, 2014)
- Institutional reforms are necessary to improve risk communication (IPCC, 2014).

Modern day concepts of vulnerability and adaptation have emerged from several decades of multidisciplinary research. Recently vulnerability and adaptation have received enormous attention in discussions linked to global climate change. Scientists and practitioners are continuously seeking better ways to understand vulnerability and adaptation concepts to develop effective intervention policies for creeping nature of climate change (Miller et al., 2010, Birkmann and Pardoe, 2014).

Vulnerability is a widely used concept in research areas that are particularly concerned with food security (Appendini and Liverman, 1994), livelihoods strategies, natural hazards and disaster management (Liverman, 1999, Blaikie et al., 2014), public health (Semenza et al., 2012), environment and climate change (Blaikie et al., 2014). According to Füssel and Klein (2006a), various research communities have used the term vulnerability in many ways. Despite differences in definition of the term, vulnerability is related to somewhat similar or related concepts, such as risk exposure, sensitivity, resilience, marginality, susceptibility, coping capacity and adaptability (Füssel, 2007, Liverman, 1990).

> Füssel and Klein (2006, p.305) pointed out some of the conceptual ambiguities of vulnerability, such as "whether vulnerability is the starting point …..or the outcome of an assessment; whether it should be defined in relation to an external stressor such as climate change, or in relation to an undesirable outcome such as famine; whether it is an inherent property of a system or contingent upon a specific scenario of external stresses and internal responses; and whether it is a static or a dynamic concept."

Despite these diversities, distinguished approaches have emerged for conceptualising and assessing vulnerability in climate change research. Füssel (2007) in a landmark article suggested a generally applicable conceptual framework of vulnerability for climate change research. They are: a) Risk- hazard framework is a widely used approach in risk and disaster management that conceptualise vulnerability as a function of exposure to exogenous hazards and sensitivity and resilience of a system (Turner et al., 2003, Dinh et al., 2012, Downing et al., 2003). Engineers and economists mostly apply this approach in technical literature. This approach is difficult to apply in research that tends to investigate how human behaviour and socio-economic conditions moderate exposure and vulnerability to hazards (Füssel, 2007). b) The political economy approach is based on an explanatory model of socioeconomic vulnerability to multiple stresses and exclusively focuses on vulnerability of people. c) The disaster pressure and release model approach takes its starting point from the risk-hazard framework and then presents an explanatory model of vulnerability that represents global causes, regional pressure and local vulnerability. d) Integrated approach combines the risk-hazard approach and political economy approach to develop a vulnerability framework. The integrated approach has its root in geography and a widely used approach in the context of environment and

climate change. e) The resilience approach is a tradition of vulnerability research that mainly focuses on the concept of resilience and has its root in ecology. Currently this approach is not so popular in environment and climate change research.

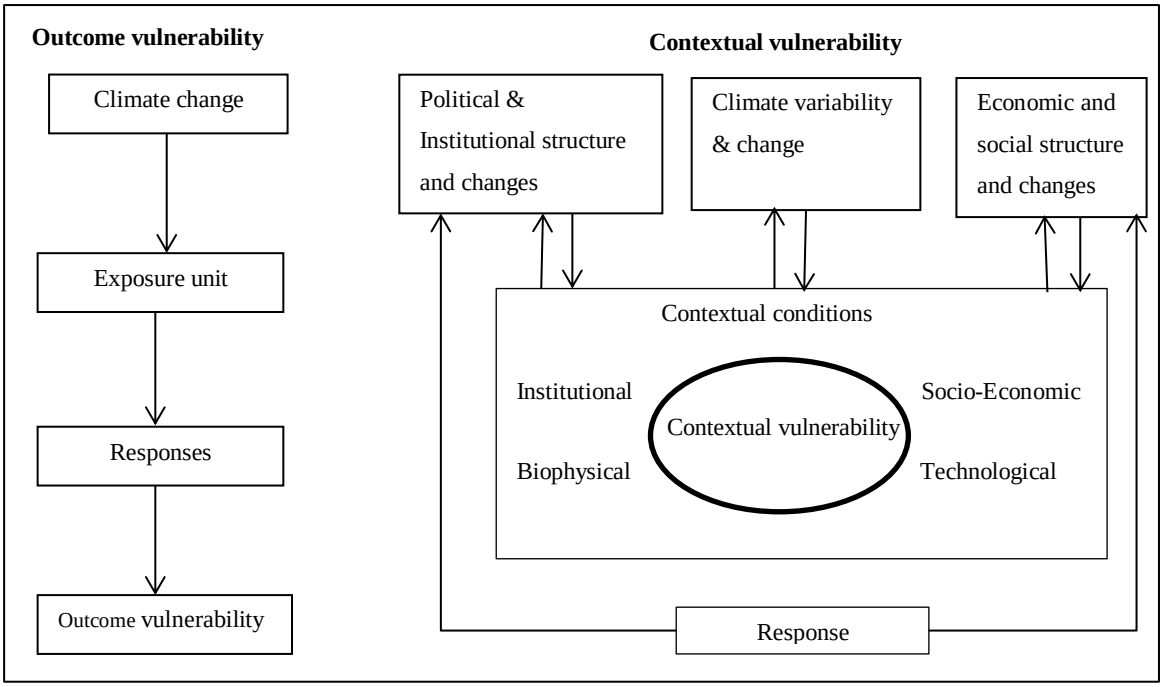
Thomalla et al. (2006) claim that vulnerability is an evolving concept in the area of climate change policy domains. To assess and manage climate change risks, it is essential to understand the pattern of vulnerability, how it builds up and increases. Adger (2006) reviewed literature on the challenges of vulnerability research on environmental change, and integrated vulnerability with the domains of resilience and adaptation. After reviewing divergent methods and epistemologies, the study argues that key challenges of emerging multidisciplinary vulnerability research are to develop a robust and credible measure that incorporates diverse methods of different research domains (vulnerability, adaptation and resilience). Turner et al. (2003) argue that a comprehensive theory of vulnerability to climate change needs to incorporate different views of risks and vulnerability by different stakeholders and institutions.

Füssel and Klein (2006) reviewed the historical development of the conceptual ideas for assessment of vulnerability to climate change. The study reported progressive inclusions of non-climatic determinants for vulnerability assessment in climate change literature (e.g. demographics, socio-political, technological and biophysical drivers), and a shift from estimating expected damage to attempting to reduce vulnerability from disasters. The authors found that there has been a growing interest of social scientists in vulnerability assessment with a multidisciplinary research approach, the increasing involvement of stakeholders and that they relied heavily on qualitative data for vulnerability assessment.

Over the past decades, researchers and practitioners from the social and natural sciences have defined the concept and theories of vulnerability. Current approaches in vulnerability research are driven by efforts to minimise the divide and gap between social and natural scientists (Fuchs et al., 2012). In the area of natural science, vulnerability and hazards are the outcome of various risks (Jones et al., 2007), while in the social science context, vulnerability is mostly or entirely socially constructed (Cutter et al., 2003, Bohle et al., 1994). Brooks (2003) indicates that by following

one of the two approaches (social science or natural science), there is a danger that climate change vulnerability is examined by ignoring the wider risk contexts (Brooks, 2003). Turner et al. (2003) recognised the importance of integration of the social science and natural science approaches to assess vulnerability and developed a framework for assessment that addresses both human and environmental systems. O'Brien et al. (2007) discusses the importance of the social and natural science interpretations of vulnerability in climate change research and the different policy implications of the one-dimensional approach. In their study, the two differing interpretations of vulnerability are termed as outcome vulnerability and contextual vulnerability, the former is linked to the scientific framing and the second to the human-security framing (Figure 2.1). The study highlights the practicality and usefulness of analysing vulnerability from different perspectives. The IPCC in the fifth assessment report (2014) adopts the vulnerability concepts of O'Brien et al. (2007), and recognised the importance of the two interpretations of vulnerability to understand climate change impacts. The IPCC in the Fifth Assessment Report (AR5) defines vulnerability as the *"propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt"* (John et al., 2014, p. 1775).

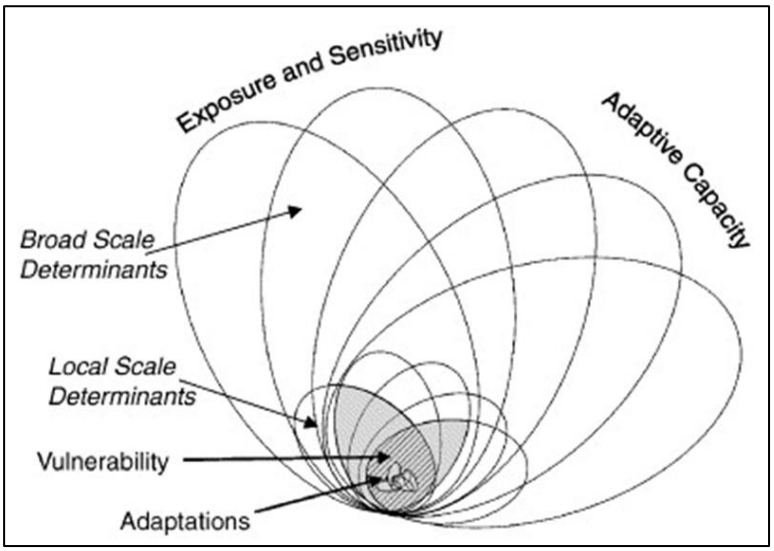
Figure 2.1: Framework depicting two interpretations of vulnerability to climate change: Outcome vulnerability and Contextual vulnerability



Source: O'Brien et al. (2007)

Smit and Wandel (2006) discuss the relationship of vulnerability with adaptation and adaptive capacity (Figure 2.2). Vulnerability is a function of stresses that expose the sensitivity of a system and configure adaptive capacity at a local level. The synergy of different environmental and social agents determines exposure and sensitivity of a system. Socio-economic, cultural and political factors shape the adaptive capacity, while the processes of exposure, sensitivity and adaptive capacity are frequently interdependent. A system (e.g. community) that is frequently exposed and sensitive to climatic hazards are often more vulnerable, and such vulnerability is reduced by enhancing adaptive capacity. Based on the discussion about the relations between vulnerability and adaptation, the authors argued for participatory vulnerability assessment for the development of feasible and practical adaptation strategies for a community. Several studies have argued for community participation for climate change risk assessment and adaptation policy development (Van Aalst et al., 2008, McEvoy et al., 2014, Haque et al., 2012).

Figure 2.2: Relationship between vulnerability, adaptation and adaptive capacity



Source: Smit and Wandel (2006)

Previous studies show that vulnerability assessment has been conducted with different approaches in a variety of contexts for diverse groups of stakeholders. In climate change research, vulnerability assessment is important for some critical decision contexts, such as to understand global, regional and local impacts of climate change (Watson et al., 1998, Assessment, 2007, Gardali et al., 2012, Chuvieco et al., 2014), to identify particularly vulnerable regions and groups (Haque et al., 2014, Islam et al., 2014), and to recommend adaptation and mitigation policies for a specific region and sectors (Islam et al., 2014, Shaw, 2015).

Social vulnerability in the context of disasters and climate change

Adger (1999) studied social vulnerability to climate change and its impacts in coastal Vietnam. The research showed that social vulnerability is enhanced by some institutional and economic factors, such as income inequality. Over time, this income inequality had increased and that was driven by the market liberalisation process. The resources were concentrated on an only small number of people in a society which constrains low-income groups to take necessary coping strategies at the time of stresses. The paper demonstrated the complex nature of social vulnerability and its relationships with the political economy.

Brouwer et al. (2007) investigated the complex relationship between environmental risk and vulnerability in one of the poorest and flood-prone areas of Bangladesh. The study found a positive relationship between environmental risk, poverty and vulnerability, and reported that average damage costs in absolute terms were higher for wealthier households compared to poor households. Natural resource dependent poor households were seen to suffer more in relative terms not in absolute terms. Moreover, poor communities, like farmers and fishers, and households living near rivers are more vulnerable to disasters.

Allison et al. (2009) compared the vulnerability of 132 national economies, including Bangladesh to the potential impacts of climate change on fisheries. In Asia the fisheries sectors in Bangladesh, Cambodia, Pakistan and Yemen as the most vulnerable, which was due to predicted warming, the relative importance of fisheries to national economies and food security, limited alternative income opportunities and the capacity of the fishing community to adapt.

Adger et al. (2005) pointed out that two-thirds of coastal disasters recorded each year are associated with extreme weather events, such as floods and cyclones and that they are likely to become more pervasive threats due to climate change. After they discussed the trends of human settlement, resource use and the impacts of climate change in coastal areas, the study highlighted the importance for building coastal resilience.

Klein and Nicholls (1999) in their article "*Assessment of coastal vulnerability to climate change*" describe how natural systems and socio-economic vulnerability were clearly related and interdependent. Vulnerability of a community was linked to geographic position, socio-economic conditions, demographic and political factors. Resource poor and nature resource dependent communities were exposed to climate change shocks and therefore were more vulnerable. Somewhat similar findings were also reported by Maraseni (2012) and Ahmed et al. (2013).

Bohle et al. (1994) in his article "Climate change and social vulnerability: toward a sociology and geography of food insecurity" describe in detail the nature of

vulnerable groups and point out that the most vulnerable were rural small-scale agriculturists with limited land and capital. Natural resource dependent communities like pastoralists who are sensitive to drought or climatic changes, wage labourers, urban poor, migrants, refugees, destitute groups, widowed, divorced and separated women, malnourished children and elderly groups were some of the most vulnerable groups to climate change. Denton (2002) studied the vulnerability of poor women involved in the agricultural sector in Africa and found that the consequences of climate change are leading marginalised communities into further deprivation and argued that sustainable climate change policy should address the interests of all stakeholders. Sugden et al. (2014) reported that at the time of disasters in Bangladesh women and girls were more vulnerable to mortality and security issues compared to men and boys. An empirical study by Paul (2010) reported a higher injury and fatality rate among women compared to men resulting from cyclone Sidr, 2007. Morrow (1999) argued that beyond geophysical vulnerability some unique social and political patterns can result in a heightened risk for some categories of people in a community. The study suggested the most vulnerable groups in a community could be elderly, particularly those who are frail, physically and mentally disabled, renters, women headed householders, poor householders, ethnic minorities, recent residences/immigrants/migrants, large householders and households with high number of children, homeless and tourists.

According to Bickerstaff (2004), the socio-cultural background of individuals influences the disaster response. Mercer et al. (2012) examined the influence of culture on adaptation and disaster risk reduction strategies and suggested that disaster risk reduction policies should be culturally sensitive. Phillips and Morrow (2007) investigated the vulnerability of specific populations to disasters and reported communities who lack political representation, traditionally those disadvantaged with poor socio-economic status were discriminated and/or excluded from main stream society and were less likely to receive, interpret and respond appropriately to disaster forecasts and warnings.

Bartlett (2008) investigated various aspects of climate change on poor urban children and reported potential impacts of climate change on health, learning and the

psychological wellbeing of children. Studies indicated older people, particularly in poor health were vulnerable to climatic disasters (Haq et al., 2008, Kovats, 2008). Oven et al. (2012) also reported that older people in the United Kingdom (UK) had become more vulnerable to climate change when they lived in disaster prone areas. Aged populations are also the most vulnerable to extreme weather events like heat waves and extreme cold.

A study by Agrawala et al. (2003) identified that the vulnerability of Bangladesh to climate induced disasters would increase due to over population and high population density. Karim and Mimura (2008) studied impacts of climate change on Sea Surface Temperature Rise (SST) and Sea Level Rise (SLR) in coastal Bangladesh and identified 22 percent of areas would fall under High Risk Zone (HRZ), which is 1.26 times higher than currently demarcated HRZ. In these areas, the depth of floods and frequency of cyclones would increase. The study reported 6.8 million people in coastal Bangladesh would be at a high risk of climate change by 2025, and they raised concerns about vulnerability of the coastal populations and the shortage of cyclone shelters.

Extreme climatic events irrevocably damage human lives, physical capital, and may cause a poverty trap for families for generations. Alderman et al. (2006) investigated the long- term consequence of shocks on individuals. The longitudinal study showed that young children in rural Zimbabwe who survived the famine of 1980s, were found to be stunted, and they had lost schooling and potential work experience, which resulted in a loss of lifetime earnings of around 14 percent.

Fothergill and Peek (2004) describe how people with different socio-economic status perceived, responded and recovered from disasters in the United States (US). The study reported that both psychologically and physically low-income populations are more vulnerable to disasters due to place and type of residence, poor construction of building materials and social exclusion. Studies have highlighted the importance of building infrastructure to reduce the vulnerability of disasters. Oven et al. (2012) argued that the health and social care system in England was likely to be influenced by climate change, particularly by the increase in the severity and frequency of

weather related disasters like floods, heat waves and cold waves. The study highlighted the importance of building infrastructure to protect the lives of people, especially for the most vulnerable. Weerakoon et al. (2012) highlighted the importance of road networks and associated services for preparing local and regional disaster management and response strategies.

Coastal districts in Bangladesh are considered to be one of the most vulnerable to natural disasters (GOB, 2010b). Multipurpose cyclone shelters have been highly effective in saving lives in the disasters prone coastal districts of Bangladesh (Paul, 2009). A recent study by Nateque Mahmood et al. (2014) on the state of disaster management Bangladesh, showed that cyclone shelters were not equally distributed across 16 coastal districts in Bangladesh to meet the needs of the highly vulnerable population, and 9 percent of the existing shelters are unusable in the event of cyclones.

It has been widely acknowledged that coastal Bangladesh is prone to cyclones, floods, erosions, salinity intrusion, tornadoes and droughts (Hossain et al., 2012). Alam and Collins (2010) reported people living in the coast and isolated settlements are particularly vulnerable as most of the fatalities are reported from these areas. The study argued vulnerability of people living near coast and in isolated areas increases because of the exclusion of pre-disaster information aimed at preparedness, high dependency on traditional social networks, and insufficient cyclone shelters.

Kartiki (2011) investigated the migration of rural people after cyclone Aila which occurred in Bangladesh in 2009. The study reported that climate shocks and stresses forced people to seek better and safer shelters. Loss of income and resources due to disasters are additional push factors for migration. Repeated environmental disasters at regular intervals limit peoples' capacity to adapt, and in such cases, migration becomes one of their survival strategies. People often move from rural areas to cities/towns in the hope to gain better income opportunities. Women migrants reported that their situation had become more vulnerable because of the lack of security and poor sanitation facilities.

Dolan and Walker (2006) studied the coastal vulnerability of the Canadian coastline and reported that due to differential physical exposure and vulnerability to hazards, climate change impacts are unevenly distributed among and within nations, regions, communities and individuals. Ribot (2010) noted vulnerability of poor, marginalised and underrepresented groups is widespread and highlights the importance of pro-poor adaptation policies to reduce human suffering and economic losses resulting from disasters related to climate change.

Table 2.2 summarises the key research findings on social vulnerability in the context of climate change discussed in detail in this section.

Table 2.2: Social vulnerability concepts and metrics in the context of disasters and climate change

Concept	Description	Social vulnerability Increase (+) / Decrease (-)
Socio-economic status National Level Community level	Least developed countries are more vulnerable due to combined impacts of climate change and limited social capacity to adapt. Source: Allison et al. (2009), Adger (1999) Resource poor communities, like small-scale fishing communities in Bangladesh, are more exposed to external shocks. Wealth enables communities to recover from losses relatively quickly. Sources: Bohle et al. (1994), Allison et al. (2009)	High income countries and communities (-) , Low income countries and communities (+)
Destitute groups	Extremely poor and depends on aid from various sources Sources: Bohle et al. (1994)	Population with special needs (+)
Gender	Women are more vulnerable compare to male due to insecurity, family responsibility, employment opportunity Source: Denton (2002), Masika (2002), Cannon (2002), (Sugden et al., 2014), Kartiki (2011)	Women (+)
Ethnicity	Racial and ethnic minorities tend to have lower socio-economic status Source: Phillips and Morrow (2007), Brouwer et al. (2007)	Ethnic group (+)
Age factor	Under develop immune system, lack of medical facility make children and elderly most vulnerable to impacts of disasters Source:Bartlett (2008), Haines et al. (2006), Kovats (2008), Alderman et al. (2006)	Children (+) Elderly (+)
Population density	Disaster vulnerability increases because of over population and high density Source: Karim and Mimura (2008), Agrawala et al. (2003)	Population density (+)
Location	Environmental problems are pushing people from rural to urban areas in Bangladesh Source: Kartiki (2011)	Low lying rural areas (+)
Infrastructure	Place and type of residence, housing materials, communication and utility, healthcare facilities, emergency management Source: Heltberg et al. (2009), Fothergill and Peek (2004), Paul (2009), Oven et al. (2012)	Lack of infrastructure (+) Loss of infrastructure (+)
Coastal communities	Communities living in the coast are exposed and more vulnerable to climate change compare to the communities living inner Bangladesh Source: Paul (2009)	Coastal communities (+)
Climate change impacts	Unevenly distributed among and within nations, regions, communities and individuals. Dolan and Walker (2006)	Exposure to hazards (+)
Occupation	Communities whose livelihoods depending on natural resources are more vulnerable to climate change Source: Ahmed et al. (2013)	Natural resource dependent communities (+)
Diseases	Change in climate will increase incidences of waterborne diseases. Source: Rahman (2008)	Diseases (+)
Coastal region	Social-ecological system more vulnerable to climate change Source: Adger et al. (2005)	Coastal areas (+)

2.3 Climate change adaptation

In the 1980s, adaptation was considered an important policy option designed to minimise the adverse impacts of climate change. In the late 1990s, adaptation action within national and international climate change negotiations was limited or even discouraged, after the former US vice president Al Gore argued that adaptation represented "*a kind of laziness, an arrogant faith in our ability to react in time to save our skins*" (Pielke et al., 2007, p. 597). This statement influenced a considerable number of economists and scientists at that time and the focus shifted more towards mitigation to manage climate change. Moreover, tensions between developed and developing countries during the 1990s contributed to the neglect of adaptation as a policy response. Developed countries feared that discussions on adaptation would lead to them taking responsibility for climate change and to finance developing countries for adaptation. This mind set steered many negotiators in developed nations away from adaptation (Ford et al., 2010, Ford et al., 2011). In the 1990s a good number of studies indicated that some of the impacts of climate change are unavoidable even after mitigation efforts and highlight the importance of adaptation (Pielke, 1998). Currently adaptation to climate change has gained a greater prominence in political and research agendas (Beck et al., 2013).

Pelling (2011) noted that the concept of adaptation can be broadly interpreted. Despite the diversity of definitions and interpretations, IPCC's impacts driven conceptualisation of vulnerability and adaptation dominated the literature (Ford et al., 2010, Füssel and Klein, 2006) until 2013. In the Fourth Assessment Report the IPCC (2007, p. 750) adaptation is defined as "*adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.*" The same report describes different forms of adaptation, e.g. anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC 2007, p. 869).

In the fifth Assessment report (AR5) the IPCC's adaptation focus moved further from biophysical vulnerability to wider drivers of social and economic vulnerability and an

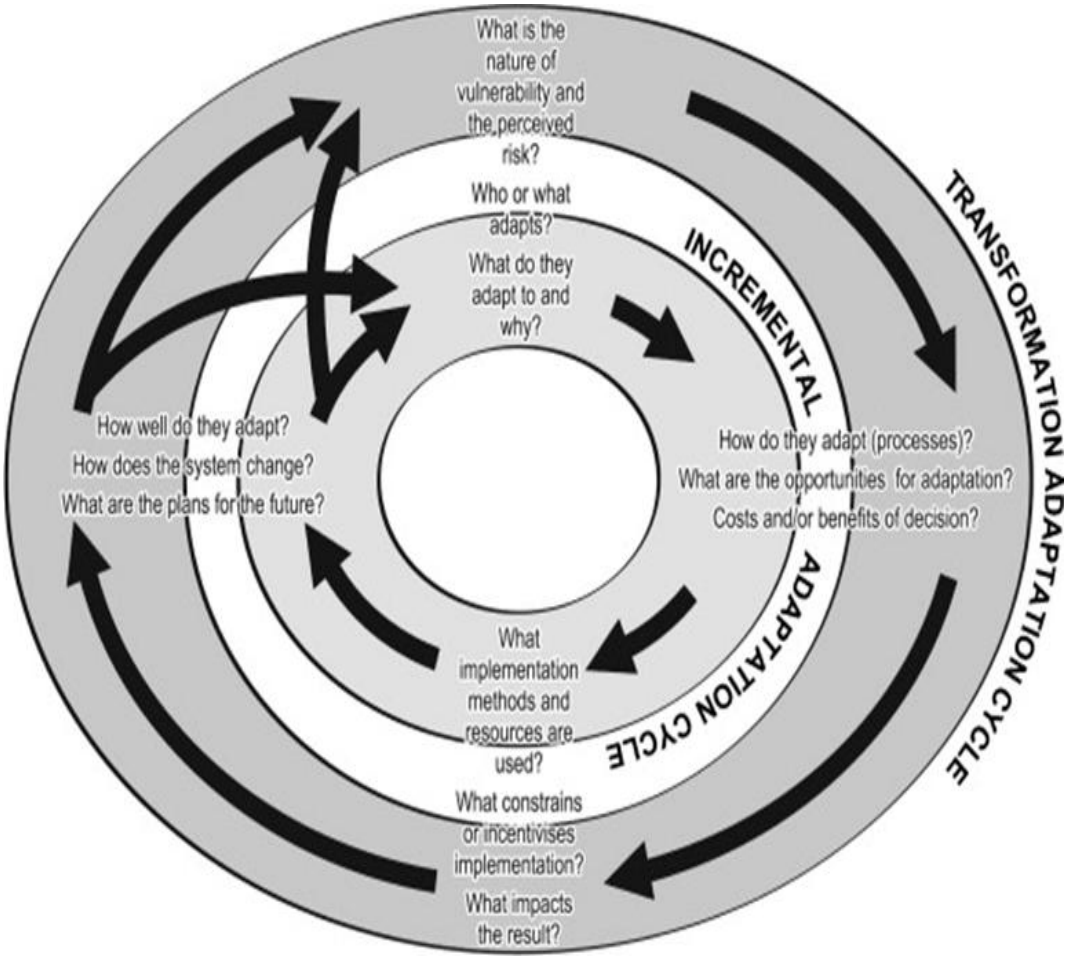
emphasis more on human adaptation capacity (IPCC, 2014, p. 836). In the Fifth Assessment Report (2014), the IPCC defines adaptation in the following way:

> Adaptation is "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC, 2014, p. 1758).

For the development of community adaptation policy, it is important to understand the perceptions, abilities, preferences of stakeholders and their resources to adapt (Grothmann and Patt, 2005). Park et al. (2012) in a landmark study developed a decision making model called the Adaptation Action Cycle that shows a link between incremental and transformational adaption processes. Each adaptation process represents four stages in the decision making process. Figure 2.3 shows that the incremental and transformative adaptation process cycles through the same four key questions cluster and the cycles operate through mutually exclusive processes. This applied and action oriented model is helpful for the contextual and actor-focused adaptation policy development. This model by Park et al. (2012) has been recognised by the IPCC in the fifth assessment report (2014).

Rawlani and Sovacool (2011) investigated drivers, benefits and challenges of community based coastal adaptation to climate change in Bangladesh. The community based coastal afforestation program is one of the key programs for adaptation in Bangladesh that is funded by the government, the United Nation (UN) and other donor agencies. The study argued that technological intervention is a partial component of successful adaptation efforts, and recommended integrated and multiple adaptation measures that incorporate social, institutional and infrastructure dimensions into adaptation programs.

Figure 2.3: Adaptation Action Cycle framework shows key questions for guiding systematic assessment of the decision-making processes and the link between Incremental Adaptation Cycle and Transformational Adaptation Cycle



Source: Park et al. (2012)

Black et al. (2011) pointed out that climate change will affect the already complex pattern of human mobility and argued that migration could be the most effective way for adaptation, as mobility brings opportunities to diversify income and build resilience for coping with environmental changes. The study reported that people are most likely to migrate to places that are less vulnerable to disasters and provide better income opportunities, for example, millions of vulnerable people from the floodplain and low-lying areas had moved to mega cities like Dhaka and Lagos in Asia and Africa in the hope of a better life and safer shelters.

Ahammad (2011) found that Chittagong is one of the most vulnerable and commercially important coastal cities in Bangladesh and yet was ill prepared at government and community levels for adaptation to climate change. The study reported that the national adaptation policies did not consider the adaptation priorities of poor urban communities and there was little communication between the government agencies and communities in terms of policy development for disaster management and adaptation.

Anik and Khan (2012) pointed out the importance of local knowledge for climate change adaptation which was not formally well recognised among policy makers in Bangladesh. After analysing data from 120 household surveys in North-East Bangladesh, the study reported that local people changed their behaviour and implement varieties of strategies to adapt. The study suggested continuous research to document and evaluate local knowledge of climate change and adaptation.

Haque et al. (2014) examined to what extent institutional actions helped extremely poor individuals and households to cope and to attain long-term resilience to climate change, and reported that most of the institutional responses to climate change are mainly focused on short-term or immediate needs and these responses are insufficient for long-term resilience. The author argued for long-term institutional support, it was important for individuals and communities to build resilience against climate change impacts.

2.4 Risk perception and adaptation

Risk perception studies originate in the 1960s around nuclear debates (Starr, 1969), but gradually the study area became prevalent in various other fields, i.e. implications of technology, communication, environment and climate change (Fischhoff et al., 1978, Siegrist and Cvetkovich, 2000, Bord et al., 2000, Kahan et al., 2012, O'Connor et al., 1999). Risk perception studies relating to the environment and climate change became popular from the early 2000s. Most of these studies were conducted in the developed world. So far, limited studies have directly addressed coastal communities in developing countries to understand national, regional and community perceptions

of climate change (Ahmed et al., 2013, Islam et al., 2014). Public risk perception of climate change involves the examination of people's understanding, awareness, attitudes and policy preferences towards the environment, hazards and climatic changes (Leiserowitz, 2006, O'Connor et al., 1999, Whitmarsh, 2008, Hansen et al., 2012).

The study of risk perception refers to the analysis of individuals and groups intuitive judgements about the characteristics and severity of a risk (Slovic, 1987). Contributions to risk perception research come from various disciplines, e.g. geography, sociology, behavioural economics, political sciences, psychology and anthropology. Geographical research mainly focuses on how to understand human behaviour in relation to natural disasters (Kasperson and Dow, 1993, Bunting and Guelke, 1979, Ho et al., 2008). Sociological (Wilkinson, 2001) and anthropological (Boholm, 1996) studies shows risk perception depends on various cultural, social and demographic factors. Psychological research on risk perception focuses on empirical studies and cognitive factors of risk perceptions (Loewenstein et al., 2001). Messner and Meyer (2006) explain that different individuals from a community may assess the risk differently because of dissimilarities in interest, experiences, background and information on a disaster. Cultural theory by Douglas and Wildavsky (1983), one of the most influential in risk research, describes four different types of personality traits and argues that based on these traits, people 'choose' to be concerned about different hazards. Egalitarians are concerned about technological and environmental risks, individualists are most fearful of disruption and subject to severe control, hierarchists are concerned about law and order, and fatalists are not concerned about any of these (Wildavsky and Dake, 1990). Sjöberg (2000) argues that psychometric models and cultural theories do not explain the variance of perceived risks and proposed a new model that can explain 30 to 40 percent of variance. The model uses "attitude", "risk sensitivity" and "specific fear" as explanatory variables and offers a different psychological explanation, e.g. focuses on relationships between attitude and perceived risk. Slovic and Peters (2006) assert that humans perceive and act on risk in two fundamental ways: risk as feelings (individuals' instinctive and intuitive reactions to danger) and risk as analysis (logic, reason and scientific explanations). Baan and

Klijn (2004) report that experience and fear play a positive role for people to prepare better for disaster management. This view is supported by Keller et al. (2006) who explained the importance of affect (fear) on risk perception. He argues the perception of risk can be increased through experiences and experimental manipulation (showing participants pictures of flooded house). Sjöberg (2007) investigated the role of emotions (anger, fear, contempt, sorrow, interest, satisfaction, guilt, shame, worry, optimism and pessimism) in risk perceptions, and suggested emotions are moderately strong explanatory factors of risk perception and attitudes. Emotions that are experienced by the respondents are more influential than the emotions attributed to others. Slimak and Dietz (2006) point out that in the U.S.A the general public is more concerned about low-probability, high-consequence risks and environmental professionals are more concerned about long-term risks that impact on the ecosystem. Baggett et al. (2006) found that identification and characterisation of risks varies between stakeholders. Armaş (2006) suggests risk perceptions and attitudes of an individual differ depending on demographic factors (age, education sex, and location), socio-economic status, characteristics of hazards and risk exposure. Bye and Lamvik (2007) compared subjective risk perceptions and formal risk levels. The study suggested that there was no correlation between formal risk estimates and subjective risk perception.

Public perception of climate change is a critical factor in the social, economic, culture and political context within which policy makers operate (Leiserowitz, 2006). Public support and opposition to climate change response actions depend on perceptions of risk. An empirical study by Patt and Schroter (2008) reported a well thought through policy would fail if the intended beneficiaries disagree with the needs, effectiveness and benefits of an adaptation program. There is a need to engage local stakeholders, to understand local perception of policy preferences and to develop adaptation policies accordingly (Patt and Schroter, 2008, Leiserowitz, 2006).

Sometimes local people do not understand the extent and seriousness of the risks posed by climate change. A study by Mortreux and Barnett (2009) found that climate change is not a major concern for people living in Funafuti, Tuvalu. As the local people were not concerned about the seriousness of the problem, they did not intend

to migrate for reasons of culture, lifestyle and social identity. Like Tuvalu, communities in coastal Bangladesh are highly exposed to environmental hazards (e.g. permanent inundation, cyclones and floods). These hazards will or should result in large scale migration, various health hazards, economic, social and cultural loss (Mallick and Vogt, 2013, Blitz, 2014). To understand the perceptions of people to environmental risk is crucial in developing and communicating effective adaptation policies to minimise the vulnerability of coastal communities.

Understanding the local contexts of vulnerability is important for the development of effective adaptation policies. Deliberative and participatory approaches are required in adaptation policy development processes to get the trust and acceptability of the stakeholders (Holmes and Scoones, 2001, p. 76). The question is how local inclusiveness can be achieved in the context of development of acceptable adaptation policy. Ayers (2011) suggested in Bangladesh, that engaging local communities and institutes at the beginning of local adaptation policy development could be a starting point for global climate change policy making processes.

2.4.1 Dimensions of public risk perceptions of climate change

Substantial research on environmental risk perception has emerged from the late 1960s (O'Connor et al., 1999). Initial research correlates environmental risk perceptions with attitudes and personal characteristics. The assumption was made that people who perceive that a highly likely adverse event is going to occur, are also more likely to support government initiatives and to take personal actions to minimise the impacts of climate change (Stern et al., 1995). Concurrently, somewhat related research has emerged that investigates the role of knowledge and information in the formation of environmental beliefs and risk perceptions (Peters et al., 1997b). Environmental knowledge and information sources can increase or decrease perceptions of threats, and thus can influence environmental behaviour. During the 1990s' risk perception studies focused on the investigation of environmental values, attitudes and beliefs at personal, national and regional levels (Bostrom et al., 1994, Thompson and Rayner, 1998, Rebetez, 1996). It was widely believed that environmental cognitions are the basis to support or oppose environmental policy and

a key factor in environmental behaviour. O'Connor et al. (1999, p. 461) investigated the role of risk perception on environmental behaviour and found "*risk perceptions matters in predicting behavioural intentions*." The authors recommended that risk perception should be treated as an independent variable and greater attention should be given in risk perception research to understanding behavioural intentions. An empirical study by Ajzen and Fishbein (1977) showed that behavioural intentions are a strong determinant of actual behaviours. It is important to note that prediction of behaviour by analysing perceptions and actual behaviour were a challenge for the researchers (Ajzen and Fishbein, 1977).

In the past 15 years, a large and growing body of studies have investigated the dimensions and implications of public risk perceptions for climate change policy formulation. A national representative survey on U.S. citizens found that Americans with moderate risk perceptions of climate change strongly support national and international climate change mitigation policies, and strongly oppose taxes aimed to reduce greenhouse gas emissions (Leiserowitz, 2003). The empirical study demonstrates that risk perception and policy support of Americans are strongly influenced by experiential factors. The study also demonstrated that public response to climate change are strongly influenced by psychological and socio-cultural factors (Leiserowitz, 2006). Another study by Whitmarsh (2008) concluded with similar findings. This study investigated the influence of disaster experience on risk perceptions and response to climate change. The survey was conducted in the south of England, and demonstrated that flood and air pollution influences individual knowledge, perception and behavioural responses to climate change.

Concurrently, another group of researchers investigated the influence of psychological factors in adaptation decision making. Grothmann and Patt (2005) developed a model called socio-cognitive Model of Private Proactive Adaptation to Climate Change (MPPACC) to explain the psychological steps taken by individuals to understand risks and their perceived adaptation capacity of climate change. The model was tested in urban Europe and rural Africa to explore its validity. The study showed that socio-cognitive factors are more relevant to explain adaptation behaviour than socio-economic factors. The research finding had an important policy implication as policy

makers frequently ignore the influence of cognitive factors in adaptation behaviour. However, the researchers admitted that the MPPACC model was tested only in two case studies and further research was needed to test the model.

Gifford (2011) in his article "*Dragons of inaction*" describes seven categories of psychological barriers that prevent individuals to take adaptation and mitigations actions against climate change. Table 2.3 shows the seven psychological barriers to behavioural changes are limited cognition about climate change, ideologies and world views, social comparison and networks, costs and behavioural momentum, discordance towards authorities and experts, perceived risks and lack of motivation for behavioural changes. The author suggested more research is needed to investigate each barrier more closely in the context of climate change. Contextual studies may find more barriers and/or discover significant relationships between the barriers or overlap between them. Different kinds of culture and communities should experience different barriers and therefore would respond differently to different kinds of messages, policies and interventions. Addressing these differences would increase the effectiveness of adaptation and mitigation efforts.

Table 2.3: Psychological Barriers to Climate Change Mitigation and Adaptation

General psychological barrier	Specific manifestation
Limited cognition	Ancient brain Ignorance Environmental numbness Uncertainty Judgmental discounting Optimism bias Perceived behavioural control/self-efficacy
Ideologies	World views Superhuman powers Techno-salvation System justification
Comparisons with others	Social comparison Social norms and networks Perceived inequity
Sunk costs	Financial investments Behavioural momentum Conflicting values, goals, and Aspirations
Discredence	Mistrust Perceived program inadequacy Denial Reactance
Perceived risks	Functional Physical Financial Social Psychological Temporal
Limited behaviour	Tokenism Rebound effect

Source: Gifford (2011)

A survey by Semenza et al. (2008) found that awareness, concern and response actions to climate change depend on education, age and locations. Highly educated individuals are most likely to have heightened concerns about climate change, while younger people are more likely than older ones to change their behaviour. The same

study reported that a number of structural, cognitive and behavioural factors were the key obstacles to adaptation and mitigation.

Kellstedt et al. (2008) investigated the influence of media in the process of forming public perceptions of climate change in the U.S.A. The findings showed the interesting and unexpected ways people form opinions on global warming and climate change risks. For example, more informed people felt less personally responsible for climate change and showed less concern. Respondents with high confidence in scientists also felt the same. The study is based on randomly selected respondents and did not consider the influence of experiential and contextual factors in forming risk perceptions. The authors argued that these results have substantial implications for interactions between scientists and the general public about global warming and climate change.

Mertz et al. (2009) investigated perceptions of climate change and adaptation strategies by sedentary farmers in the savanna zone of central Senegal. The study reported that households were aware of climate variability and identified wind and occasional excessive rainfall as the most destructive. Respondents attributed loss of livestock and reduced crop yields to climate change factors. However, when the respondents were asked the reasons for land use and livelihood change not directly in the climate change context, individuals mentioned economic, social and political reasons rather than climate factors as reasons for change. The study argued that *"climatic narratives are likely to influence responses when questions mention climate"* (Mertz et al., 2009, p. 9).

Weber (2010) reviewed previous literature to investigate the determinants of climate change risk perceptions. The study showed that people learnt about climate change from two sources, firstly from statistical descriptions/scientific definitions and secondly through personal experiences. He claimed that detection of gradual modifications of climatic conditions through personal observation and experiences were difficult. Communicating complex scientific details of climate change from scientists to the public, politicians and policy makers is not easy. World views and political ideologies are the two key factors that guide the 'detection' and

'interpretation' of climate change information. Response actions based on disaster experiences are unlikely to motivate people because politicians and the general population are generally not worried about climate change. The author preferred a 'rule based' approach based on moral and social responsibilities to motivate the behaviour of citizens to take effective measures. Fothergill et al. (1999) undertook a literature review to understand how the meaning of disaster is different for different communities, and how disasters affect persons of different race and ethnicity in the U.S.A. The study reported that in the U.S.A some ethnic and racial communities are more vulnerable to natural disasters due to factors such as cultural insensitiveness, community isolation, language, and housing patterns.

Leiserowitz (2005) argued that the meaning and definition of climate change is different for different stakeholders. There are also differences between public and experts understanding of climate change. For example, expert definitions of climate change are mainly derived from scientific efforts to measure thresholds of physical vulnerability to natural ecosystems, and identify critical components of current climatic system (IPCC, 2007, Stocker et al., 2014, Stocker et al., 2013). Based on the analysis of scientific data, experts define thresholds in social vulnerability to climate change, e.g. severe health, socio-economic, security and cultural impacts of climate change (Stocker et al., 2013, Doney et al., 2012, Wheeler and von Braun, 2013). Expert definitions also include efforts to identify reasons and causes of the gradual increase in greenhouse gas concentrations in the atmosphere, and acceptable limits of greenhouse gas emission beneath which dangerous impacts of climate change can be avoided (Oreskes, 2004, IPCC, 2007).

The general population understanding of climate change depends on a range of socio-economic, political and cultural factors (Bulkeley, 2000, Brody et al., 2008, Weber and Stern, 2011). A substantial number of studies investigated the role of disaster experiences in forming peoples' risk perceptions of environment and climate change (Spence et al., 2011, Siegrist and Gutscher, 2006, Patt and Schröter, 2008, Le Dang et al., 2014, Marx et al., 2007, Ho et al., 2008). A study by Marx et al. (2007) reported that people process uncertainty information in two qualitatively different systems. Beside analytical processes, people rely heavily on experiential processing systems.

A study by Ho et al. (2008) in Taiwan found that risk perception is influenced by the type of disaster (flood, landslides) and the demographic characteristics of victims. Adger et al. (2013) studied the cultural dimension of climate change impacts and adaptation and argued that society's response to every dimension of climate change was influenced by culture. After reviewing modern social science research on climate change, the authors found that climate change threatened cultural dimensions of lives, preferences and livelihoods, and that includes *"culture, identity, community cohesion and sense of place"* (Adger et al., 2013, p. 112). Society's risk perceptions to climate change and adaption decisions are influenced by culture and this is often tied to places. Because of climate change impacts people frequently migrate to safer places and that impacts on the culture and composition of the community. The authors suggested that to understand social responses to climate change, policy makers should investigate how culture interact with climate change related risks, and design adaptation policies accordingly. The study recommended some methods, such as ethnography, participant observations, and the mental model approach for cultural enquiry and the need to integrate traditional and scientific perspectives of adaptation.

Sjöberg et al. (2004) argued that peoples' risk perception is often intuitive and subjective, and is often harder to measure. Nursey-Bray et al. (2012) argued that peoples perceived risk and actual risks could be different and this is partly because experts and lay citizens perceived risks differently. The study reported that lobster fishers in Tasmania observed changes in the marine environment and lobster fishery consistent with climate change predictions, and yet respondents expressed doubt about climate change and whether it was a real risk to fishery. The study suggested that to increase awareness of climate change policy makers should develop communication tools that are culturally appropriate for fishers.

Riad et al. (1999) investigated the somewhat strange phenomenon of why some people do not take any actions when authorities strongly ask them to seek safe shelters. The study was conducted in South and North Carolina, U.S.A. The research identified a combination of individual characteristics and three social psychological processes, e.g. 1) risk perception, 2) access to resources and 3) social norms that influence individuals not to evacuate before disasters (Riad et al., 1999). However, the

study could not explain the relationship between the variables that differed by individual and community that had different reasons for not evacuating. The study suggested an individual and community based approach to understand the relationship between risk and response actions. A study by Schmuck (2000, p. 90) reported that in Bangladesh, people do not move and take refuge in cyclone shelters because of their religious beliefs and claimed that hazards are an *Act of God*, so people "*cannot and should not do anything.*"

Table 2.4 summarises research findings on public perceptions on environment and climate change risks discussed in this section.

Table 2.4: Influencing factors for public perceptions about environment and climate change

Author and year of publication	Issues/Findings
O'Connor et al. (1999)	The study investigated the relationship between peoples' risk perceptions and willingness to address climate change and found risk perception was a significant factor for predicting behavioural intentions.
Stern et al. (1995)	Explored the relationship between personal values and attitudes. The study found that individual values are associated with willingness to take pro-environmental actions.
Peters et al. (1997)	Examined the key component of environmental risk communication: trust and credibility. The study argued that defying negative stereotype was key to improving perceptions of trust and credibility.
Ajzen and Fishbein (1977)	Examined the relationship between attitude and behaviour and found behavioural intention was a strong determinant of actual behaviour.
Leiserowitz (2003)	The study argues that affect and cultural world views are each important dimensions of public risk perceptions, policy preferences and behaviours.
Whitmarsh (2008)	Respondents who have direct experiences of disasters were more concerned about climate change than other people.
Grothmann and Patt (2005)	Investigated psychological factors in determining adaptation and argued cognitive factors are stronger variables in explaining adaptation behaviour than traditional socio-economic models.
Gifford (2011)	Argues that along with structural barriers, psychological barriers also impede behavioral choices that would facilitate environmental sustainability, mitigation, and adaptation to climate change.
Semenza et al. (2008)	Knowledge of climate change, locations, age and education are significant predictors of behaviour change.
Weber (2010)	Reviewed literature noted that attention catching and emotionally engaging information intervention was required to create appropriate public concern necessary for adaptation action in response to climate change.
Fothergill et al. (1999)	Different racial and ethnic communities perceived natural hazards and disasters differently.
Leiserowitz (2005)	Concept of climate change is contested among scientists, policy makers and general public.
Slovic (2000)	Peoples' perceptions and attitudes towards risks were not only determined by unidimensional statistics, but also by a variety of social, economic, political and cognitive factors.
Hanson-Easey et al. (2013)	Climate change was associated with negatively "valenced connotative meanings", images and terms that includes water shortages, extreme heat, floods, sea-level rise, lack of scientific clarity and ideas of catastrophe and extinction.
Adger et al. (2013)	People's perceptions and response to climate change were mediated by culture.
Nursey-Bray et al. (2012)	Peoples' perceived risk and actual risk could be different.

2.5 Perceptions of climate change in Bangladesh

Risk perception of climate change is a relatively new area of study in Bangladesh, and in the last five years, studies on public perceptions of climate change have been gaining momentum. These studies largely include qualitative and quantitative research by individuals and institutes at local, regional and national levels. Most of the large-scale studies are quantitative (World Bank, 2010, Kim, 2011), and small-scale exploratory studies mainly involve focus group discussions and surveys undertaken to understand public perceptions of the environment and climate change (Hasan and Akhter, 2011, Paul et al., 2014, Moniruzzaman, 2013). Unlike most of the developed nations, there are no regular surveys undertaken by the Bangladesh government to understand public attitudes and perceptions of climate change. This section reviews findings from previous studies and provides insights from related risk literature on the dimensions and determinants of public perceptions of climate change.

Kim (2011) claims that among all the developed and developing countries, awareness of climate change is astonishingly high in Bangladesh. An international public opinion poll on climate change by the World Bank showed more than two-thirds (70%) of Bangladeshis believed there is enough scientific evidence to take action against the impacts of climate change. Some 64 percent of the respondents thought that climate change would have a greater adverse effect on poorer countries (World Bank, 2010).

Rahman et al. (2011) undertook a survey on 300 respondents in Dhaka City to explore urban citizens' perception of climate change. The report found that the urban population in Bangladesh was experiencing some changes in climatic patterns but they were not severely impacted by major disasters. The report indicated there might well be differences in perception among urban and rural populations (Rahman et al., 2011). A nationwide climate change perception survey by The Asia foundation (2011) reported that most of the people in Bangladesh have heard of climate change, and there were differences in perceptions between people living in different locations

A study by Habiba et al. (2012) explored farmers' climate change perceptions from the drought-prone north-western districts in Bangladesh. Farmers had observed change in climatic patterns in recent years, especially in terms of rainfall and temperature. According to the farmers, both climatic and non-climatic factors accelerated the consequences of droughts. Farmers believed the increased frequency of drought was a severe threat to agricultural production, social life and health (Habiba et al., 2012).

A study by Haque et al. (2012) in two villages from the Northern and Southern parts of Bangladesh explored local perceived climate change in terms of longer summers, warmer winters, reduced rainfall and fewer floods. The study reported that 77 percent of respondents perceived health related problems related to temperature (heat and cold) have significantly increased (Haque et al., 2012). It was also found that people in Bangladesh believed that climate change in future meant that more droughts, floods, cyclones and salinity would occur (Haque et al., 2012b, Hasan and Akhter, 2011a, Hashizume et al., 2007).

Education, media and disaster experiences are important determinants of climate change awareness. Hasan and Akhter (2011) found that gender, age and income were not major determinants for risk perceptions. Another study by Haque et al. (2012) also found that there were no significant difference between males and females with regards to perceptions about climate change in the traditional farming society in Bangladesh.

Previous studies have demonstrated that public concern about climate change is high in Bangladesh (The Asia Foundation, 2011). According to a multi-country poll by the World Bank (2009), a large majority of the people in Bangladesh are very much concerned about climate change. About 90 percent of the people thought policies related to climate change should be prioritised even when there were economic costs. Moreover, some two thirds of people in Bangladesh believed they are already experiencing some impacts of climate change (World Bank, 2010).

Some of the survey findings highlight the influence of the contextual factors on risk perceptions of climate change in Bangladesh. It was found that peoples perceptions and response to climate change depended on geophysical, socio-economic and political factors (Rashid et al., 2014, The Asia Foundation, 2011). Peoples' perceptions of climate change are also strongly linked to the type of local disasters (The Asia Foundation, 2011) and social demographic factors (Davis and Ali, 2014, Ahsan, 2014). For example, farmers are particularly concerned about agricultural productivity, input costs and profitability (Davis and Ali, 2014). The urban poor are extremely concerned about exposure to various hazards, life stresses (loss of working days, damage to homes, infrastructure and various health hazards) and their low response capacity to cope up with increased disasters (Jabeen and Johnson, 2013).

2.6 Conclusions

Previous research explores a range of contextual factors that influences individual and community understanding of, and response to, risk perceptions. One of the key influential factors of risk perceptions is disaster experience. Contrary to current assumptions underlying current climate change adaptation policies in Bangladesh to increase awareness and influence behaviour, there is no straightforward relationship between information dissemination and also risk perceptions or individual behaviour. Economic interests do not solely motivate community and individual behaviours. Risk perceptions and response actions are a complex interplay of knowledge, perceptions, costs and benefits, world views, cultural and institutional relationships. Few studies on public perceptions of climate change have highlighted inter disciplinary views and apply mixed methodology approach in this area of research. This thesis addresses the need for inter-disciplinary studies and mixed methodology approaches to understand community risk perceptions of climate change in Bangladesh.

Based on findings from the previous literature, the subsequent chapters focus on psychological, cultural, socio-economic and demographic factors of risk perceptions of climate change among fishing communities in coastal Bangladesh. This thesis also investigates and explores the role of disaster experiential factors in community understanding and response of climate change. In Bangladesh, communities are

experiencing various impacts of climate change, especially in terms of temperature and seasonal changes and increased frequency of disasters.

The literature has emphasised the need for more qualitative and quantitative research to understand perceptions of climate change in Bangladesh. Studies conducted by the international institutes (World Bank) or NGOs are mainly large-scale quantitative surveys which are useful to gauge the extent of public agreement/disagreement of some predefined statements. However, results of these studies do not explain the context in which respondents perceive the issues. Independent research on climate change in Bangladesh mainly explores community vulnerability (mainly for paddy growers and shrimp farmers) and their adaptation practices. Some of the research explains the beliefs held by the public in relation to climate change. This research investigates the reasons for those beliefs and how they are influenced. The research also examines inconsistencies and ambiguities in beliefs and actions in relation to climate change.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology used to collect and analyse data to address the objectives of this study. It highlights the importance of mixed method research approaches to collect data and to understand contextual factors relating to the determinants and dimensions of climate change. Methods for the qualitative and quantitative stages of this study are described here.

3.2 Mixed method research approaches

According to Neuman (2003, p. 70), there are three approaches to social science research, e.g. positivism, interpretive social science and critical social science. Most social science research is based on the first two. The positivism and interpretive approach are the most widely used, and critical social science is less commonly used in social science research.

For more than a century, purist advocates of qualitative and quantitative research have been engaged in an ardent dispute. Quantitative purists (also known as positivists) argue that social science investigations should follow the principals of physical science. To improve reliability and validity of data, social science investigators should remain emotionally detached and uninvolved with the objects of study, and should test or empirically justified their findings (Nagel, 1989). Traditionally these researchers advocate “rhetorical neutrality” which involves the use of impersonal passive voice, technical terminology and description of social laws as the major focus (Johnson and Onwuegbuzie, 2004). On the contrary, purist qualitative researchers (also known as constructivists and interpretivists) reject the notion of positivism and they argue for rationality and superiority of humanism, idealism, constructivism and

sometimes post-modernism (Guba and Lincoln, 1994, Lincoln, 1995, Ponterotto, 2005). According to constructivists' reality is multi-dimensional, time and context free generalisation and is neither possible nor desirable. Qualitative pursuits tend to dislike detached and a passive style of writing, preferred detailed, rich description written directly and somewhat informally (Johnson and Onwuegbuzie, 2004). From the arguments, it can be seen that each research method has inherent strengths and weaknesses to investigate certain aspects of social science research. So, combining qualitative and quantitative research methods in research design and data collection should be considered whenever possible.

Mixed method research is increasingly recognised as the new paradigm of social science research, as it can potentiality capitalise on respective strengths of qualitative and quantitative approaches (Bryman, 2012). The United Nations University, a leading research body on climate change impacts and adaptation, extensively uses a mixed method approach to assess systematically the local impacts of extreme weather events and the slow-onset climate changes at household level in the most vulnerable countries. These case studies combine qualitative research tools, such as in-depth interviews and focus group discussions, with a questionnaire survey to understand the impacts, trends, and local peoples' perceptions of climate change (Warner and Afifi, 2013, Warner et al., 2013). One of the aims of this research is to investigate community specific issues related to climate change and adaptation, as well as to find out the extent of the concerns within the community. Qualitative research tools are particularly helpful to investigate site-based issues, while quantitative research tools are used to investigate the extent of the concerns.

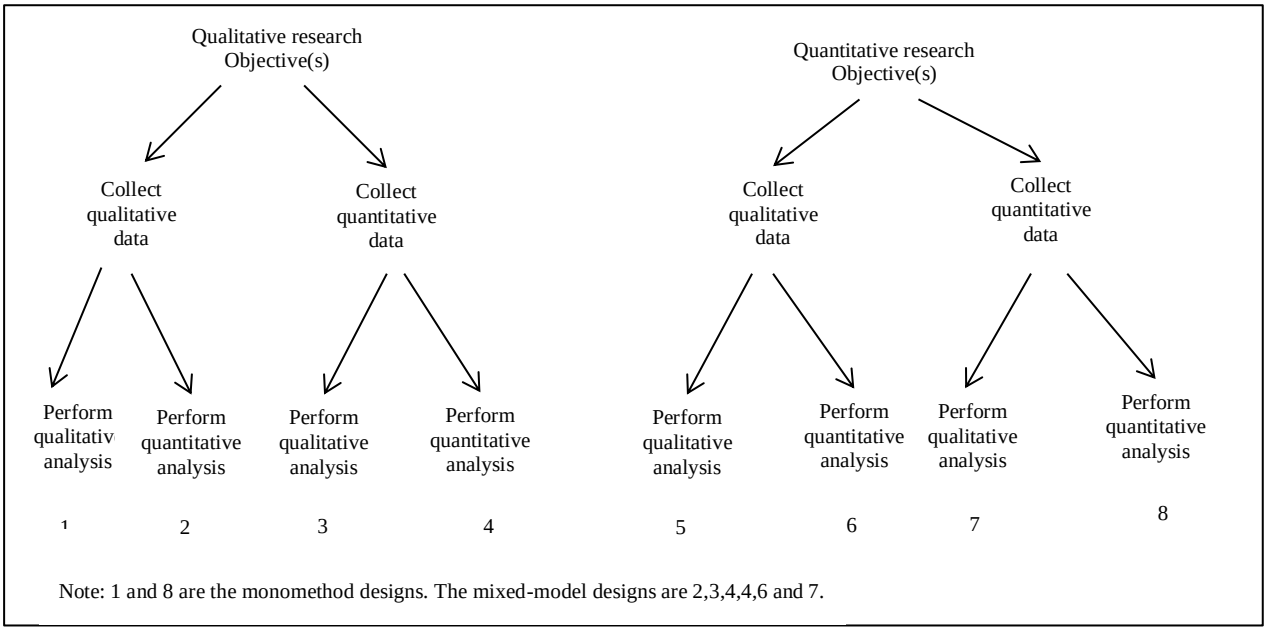
Research questions determine the choice of research method (Johnson and Onwuegbuzie, 2004). This particular social science research is to investigate human perceptions of the environment, in particular climate change. This goal of understanding the human perceptions of climate change leads to the investigation of many different phenomenon such as intentions, experiences, attitudes and culture. Besides understanding the qualitative aspects of human perceptions, one of the key objectives here is to identify the determinants of human attitudes and responses to climate change, using quantitative research tools. Applying both qualitative and

quantitative methods for data collection and analysis helps to represent "the complete picture" of the little known small-scale marine fisher's community in coastal Bangladesh.

From the literature review, it was established that qualitative and quantitative methods offer different insights to investigate different dimensions of climate change and each method is better suited to answer different research questions (Lorenzoni et al., 2007, Horlick-Jones et al., 2003). The distinction between qualitative and quantitative methods is technical, not necessarily always philosophical (Whitmarsh, 2005). Adopting a mixed method research approach provides some depth and breadth of information required to address the aims of this thesis. In Bangladesh, most of the research on climate change perceptions and adaptation has been based on descriptive survey data at national and regional levels, which offer an insight into the communal factors that influence perceptions and adaptation (Mamun et al., 2013, Ali, 1999, Karim and Mimura, 2008, Sarker et al., 2012, Ruane et al., 2013, Haque et al., 2014). However, there are limited studies that apply a qualitative approach to investigate climate change perceptions and adaptation at regional and local levels (Davis and Ali, 2014). Recently, in Bangladesh an increasing number of researchers are using a mixed method approach to explore peoples' perceptions of climate change at local and community levels (Ahmed et al., 2013, Haque et al., 2012).

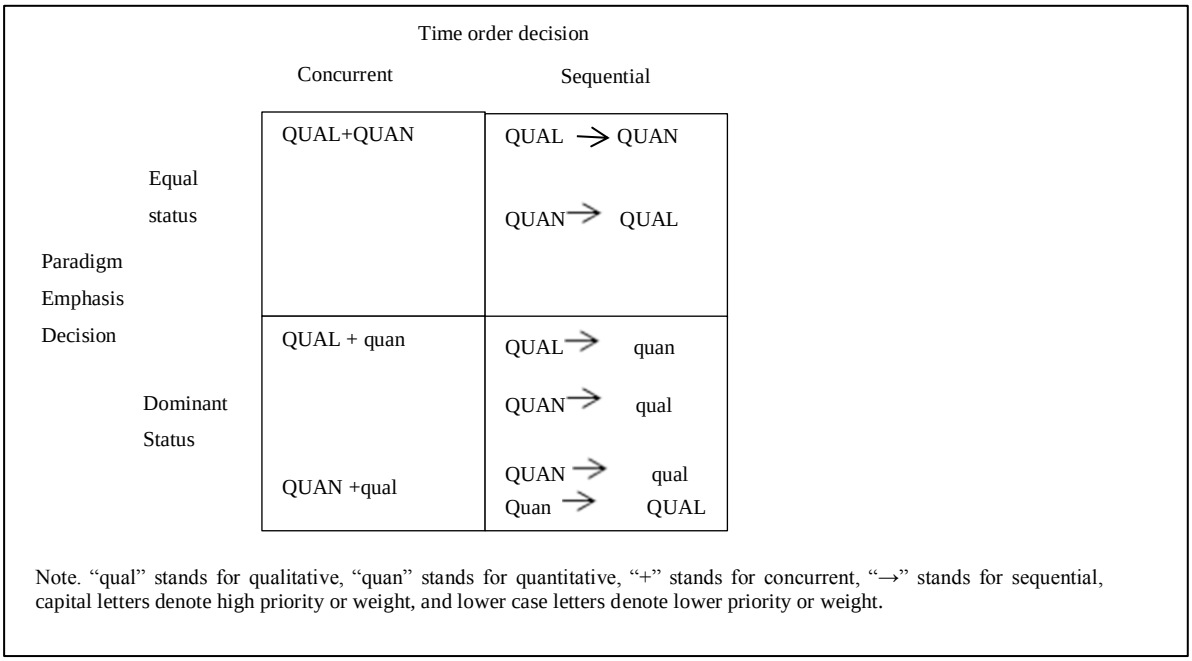
Johnson and Onwuegbuzie (2004, p. 21) provide a framework for designing and conducting mixed method research. The study explained an eight step process of mixed method design, they are: (1) identification of the research problem, (2) determine rational for the mixed method research, (3) select the mixed-method or mixed-model research design, (4) data collection, (5) analysis and (6) interpret, (7) justification and then (8) writing conclusion and finalise report. The authors argued that compared to a single research method, mixed method is superior for investigative types of studies. The study suggested that mixed research designs are a mixed model design (mixing qualitative and quantitative approaches within or across of the stages of the research process), and mixed method design (inclusion of qualitative and quantitative phase in research design strategy). A six cross stage mixed model design is shown in Figure 3.1 (design two through seven) and a nine mixed method design is

Figure 3.1: Monomethod and mixed-model design



Source: Johnson and Onwuegbuzie (2004)

Figure 3.2: Mixed method design matrix with mixed-method research



Source: Johnson and Onwuegbuzie (2004)

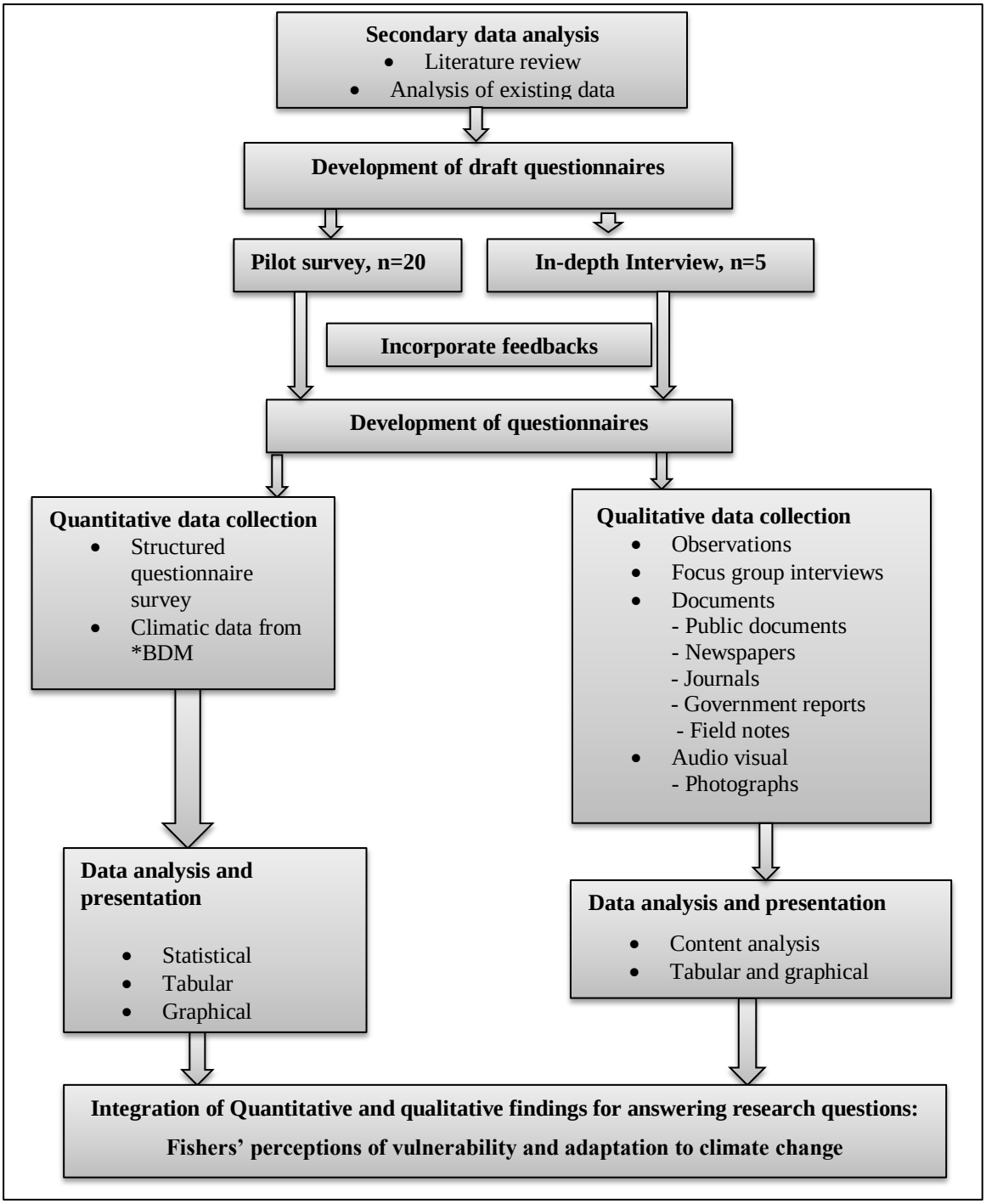
shown in Figure 3.2. However, the authors suggested that a researcher could create a more user specific and complex design of mixed method research by using questions with a rating scale for quantitative data collection and one or more open-ended

questions for qualitative data collections. This mixed method research is quantitative dominant.

Jick (1979) suggested that the mixed method research approach helps to delineate complementary qualitative and quantitative research questions. In this study, results from the quantitative surveys indicated that government support is one of the most important factors for adaptation. In-depth interviews explored further "why and how" the government should provide adaptation support to fishers. In another case, analysis of quantitative data showed that respondents from Chittagong are not very concerned about sea level rise. Qualitative interview data helped to establish the possible reasons for this finding.

A model of this research design and the methods used for data collection and analysis is presented in Figure 3.3. At the first stage, a literature review helped to understand and to identify themes, research problems and the relevant theories for this project. The literature review included the review of existing regional and thematic literature as well as published and unpublished secondary data. This helped in the research design in terms of understanding the coastal community in Bangladesh, identifying the climate change threats and areas that are most threatened by the potential impacts of climate change.

Figure 3.3: Model of research design, data collection and analysis method of this study



*BDM = Bangladesh Meteorological Department

In this study, an initial questionnaire was developed after the literature review. However, the question remained to whether the questionnaire did address the site-specific issues. Therefore, it was necessary to conduct in-depth interviews with key informants to improve the questionnaire to address all the site-specific issues. These in-depth interviews were helpful to understand the local dimensions and responses to climate change, and to establish the relationships between various climatic and non-climatic variables. The interviews also provided an understanding of some of the cultural, linguistic and professional aspects of the community. Patton (2005) argues that interviews were useful to understand experiences, feelings, opinions and knowledge of persons. Opdenakker (2006) suggested that in-depth interviews offer certain advantages over other forms of data collection and the biggest advantage is the synchronous communication of time and place. In this aspect, the in-depth interviews are more than just asking questions and writing answers.

Eisenhardt (1989) argues that qualitative research enables one to tackle sensitive issues, to appreciate the wider social context of people's thoughts and beliefs, the ability to focus on the meaning of the issue, especially in any contradictions and inconsistencies in perspectives. Contradictory opinions (e.g. belief in climate change) are quite common worldwide in climate change literature. Thus, qualitative interviews explored what individuals believed climate change to be, and what are the important experiential, economical, psychological and socio-cultural factors that influence individual perceptions and responses to climate change (Leiserowitz, 2006). Porteous (2013, p. 46) described qualitative research as follows:

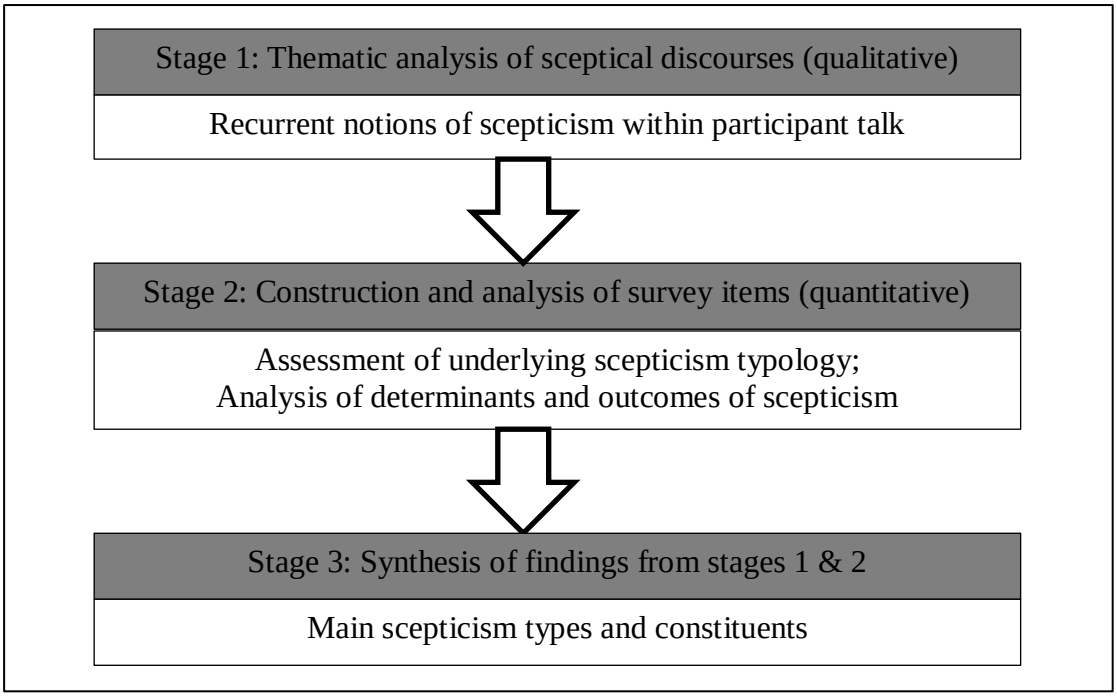
> "Humanists are the critical observer of human nature, landscape and interactions between the two. Their concern is with the life of the mind, with contemplation, rather than manipulations, of environment and human behaviour."

While qualitative research is more concerned with understanding the social phenomenon from the actors' perspective, this research method cannot indicate the extent of particular actions and perceptions. Quantitative research trends to explain the causes of changes in society through quantitative analysis and objective measurement (Firestone, 1987, p. 16). In summary, like natural science, social science quantitative research uses a systematic and technical approach for data collection and

analysis (Bahari, 2012). For this study, a face-to-face survey with a structured questionnaire was conducted to gather quantitative data from representative samples (small-scale open water fishers) from Chittagong and Chakaria. The face-to-face survey was regarded as the best data collection method for this particular research considering the education levels of the respondents, linguistic factors and remoteness of the survey locations. Collection of quantitative data through a structured questionnaire facilitated cross tabulation analysis, which helped to explore the relationship between various variables that influence respondents' perceptions and responses to climate change risks.

Quantitative survey research, however, constrains a number of options that respondents can choose. This limitation was partly addressed in this study in number of ways. Firstly, by incorporating a number of open-ended questions and space for additional comments in the survey questionnaire. Secondly, by conducting in-depth interviews, and thirdly, by gathering information through notes, observations, pictures and by participating in community social events. Another limitation of the quantitative research is that the findings tend to present perceptions and attitudes as decontextualized and static. However, in Chapter 2 (literature review), it was found that perceptions of climate change can be influenced by media coverage, recent climatic events and a number of other factors. Capstick and Pidgeon (2014) argued for a mixed method approach to understand local perceptions and scepticism about climate change. The approach includes the collection and analysis of both qualitative and quantitative data, and integrates the findings from both phases to draw overall conclusions. Figure 3.4 shows the mixed method research approach proposed by Capstick and Pidgeon (2014).

Figure 3.4: Mixed method approach to understand public perceptions and scepticism about climate change



Source: Capstick and Pidgeon (2014)

3.3 Stage 1: Development of the research approach

For this study, the literature review and pilot study were undertaken to develop a contextual and community specific questionnaire.

3.3.1 Literature review

The literature review included an analysis of existing data on climate change threats (e.g. sea level rise, cyclones, floods) and affects (e.g. salinity intrusion, coastal erosion) on coastal communities. In this study it focused on the relevant existing knowledge on public perceptions, awareness and attitude towards climate change and highlights the existing debate on public opinions of climate change, methodologies of various researches on climate change. The literature review also identified the research gaps and enabled the development of an appropriate methodology. Secondary data analysis was also used to identify key climatic variables in coastal Bangladesh by analysing existing data.

3.3.2 Pilot study

In-depth interviews and pilot surveys were undertaken to make the questionnaire contextual and community specific. A semi-structured questionnaire with a checklist of general topics was used in the interviews to cover all the research questions. Five in-depth interviews were conducted at a fish landing port and in a fisher village located in the South Kattali and Salimpur in the Chittagong district in November 2012. The respondents roles in fishery varied from fisherman, day labourer, investor, boat owners and net menders. At the beginning of the interview, the interviewers introduced themselves to the interviewees and briefly described the reason for the interview. The respondents were given sufficient information to begin the interview. The interviews were not conducted following any specific order to the questions and started with some general questions followed by questions that were more specific. To keep the smooth flow of the conversation respondents were allowed to jump from one subject to another. They were encouraged to talk about their experiences of various climatic issues and disasters, their coping mechanisms and perceptions of climatic changes. All the interviews were recorded with the research assistant writing notes during and after the interview. The broad topics covered in the interviews were:

- General environmental concerns
- Key climatic issues
- Perceptions of environment and climate change
- Climate change impacts on fishing profession
- Response and attitude towards climate change

Respondents expressed their views on environment and climate change in the local dialect. In interviews, respondents expressed a range of opinions on environment, climate change and the fishing profession. These interviews provided rich data on community specific issues about climate change and adaptation. They were helpful to understand risk characteristics, from various hazards and community apprehension of risks from both socio-economic and cultural perspectives. In-depth interviews also indicated the need to change some of the wording of the draft questionnaire and gave advice on suitable times for interviews. In-depth interviews helped to obtain

experiences with the intended respondents and to become familiar with survey sites and to get first-hand information of the unique fishers' community.

A pilot study is often called a feasibility study which is a small version of a study done in preparation for the major study (Polit and Beck, 2012). However, a pilot study can also be a pretesting or trying out of particular research instruments (Baker and Risley, 1994). For this research, there are important reasons for undertaking the pilot study. The initial questionnaire was developed in English and then translated into Bengali. During the in-depth interview stage is was found that most of the intended respondents are not formally educated and they speak in local dialects. There was a need to develop a questionnaire in a way that was easily understandable to the respondents. Beside linguistic challenges, the pilot survey uncovered some local political, ethical and cultural issues. For example, it was observed that workers were not comfortable to talk freely in front of the captain or boat owners, and they liked to be interviewed after trading hours. After the pilot survey, some of the locally important environmental issues and challenges were incorporated into the final questionnaire. The pilot survey was also helpful to record the survey time and developed wording of the questionnaire in a way that could be easily understood by the respondents. Table 3.1 summarises the important reasons for conducting the pilot study for this study.

Table 3.1: Reasons for conducting the pilot study

- Developing and testing adequacy of the questionnaire
- Assessing the feasibility of the full-scale survey
- Identifying whether the sampling frame and techniques are effective
- Assessing the likely success of recruitment approaches
- Identifying logistical problems
- Improving the research questions and research plan
- Learning experience both for the researcher and the research assistant
- To identify ambiguities and difficult questions. That helps to improve the wording and structuring of the questionnaire
- To discard a few unnecessary and ambiguous questions

The pilot survey was done face-to-face with 20 questionnaires in 7 days in South Kattali, Chittagong. The respondents were asked to provide feedback and their

thoughts about the questionnaires. The notes were written on the questionnaire by the interviewers while conducting the survey. Taking into consideration the comments and feedback of the respondents, researchers observations and field notes, some of the questions were restructured and reworded which helped to reduce the length of the survey time and to make it more relevant.

Data collected from the pilot study were not included in the data analysis. Some of the social scientists argued, *"an essential feature of a pilot study is that data are not used to test a hypothesis or included with data from the actual study when the results are reported"* (Peat et al., 2002, p. 57). The obvious concern was that data modifications made in the light of the findings from the pilot study were incomplete.

3.3.3 Study areas

For this study, three jeleparas from Chittagong and four jeleparas from Chakaria were selected. Jeleparas in Chittagong are situated on the outskirts of the city and on the shoreline of the Bay of Bengal. Jeleparas in the Chakaria sub-district are located on the estuary and within 20 to 25km of the Bay of Bengal shoreline.

Reasons for selecting study areas

These sites were selected due to their history of natural disasters, and because they are frequently ravaged by cyclones and storm surges. One of the most devastating cyclones happened in April 1991. The wind speed was 235km/hour and the storm surge was 4 to 8 metres high in different areas with 40 percent to 50 percent of the total population affected by storm surges (Haider et al., 1991). According to a local government official in Chakaria, the cyclone casualties amounted to 10 to 15 percent of the total population. The geophysical location and geomorphological conditions of these coastal areas make it one of the most vulnerable to climate change, particularly due to sea level rise (Karim and Mimura, 2008).

According to the various reports, the sea surface temperature (SST) of the Bay of Bengal has risen by 0.8 degree Celsius in summer and 0.4 degree Celsius in winter in last decades (Khan et al., 2000). For the formation of the cyclone in the tropic sea

surface temperature (SST) should be a minimum 26 to 27 degree Celsius (Ali, 1999). Any rise in SST is likely to be accompanied by an increased frequency and intensity of cyclones. It has already been observed that more tropical depressions are now intensifying into tropical cyclones, especially during November. The intensification rate to the severe cyclones has registered an increasing trend at 20 percent per hundred years (Khan et al., 2000). Beside cyclones, an increase in SST will lead to higher storm surges and a higher risk of coastal disasters. Increased erosion in the coastal areas is another big concern in Bangladesh. Ali (1999) calculated loss of land in the eastern coast due to erosion could be between 6 to 11 km^2 (Ali, 1999). Sarwar and Woodroffe (2013) have studied rates of shoreline change over a 20-year period from 1989 to 2009 and have reported the rates of change were more subdued in the coastal zones of southeast Bangladesh.

The study areas are either directly facing either the sea, or located in the lower estuaries, where the interaction with the marine environment is most extensive. These areas are referred to as "exposed coast" (Uddin and Kaudstaal, 2005). However, there are regional differentiations in vulnerability issues. Based on the region some vulnerability is more prominent than in others. For example, in the east coast of Bangladesh, cyclones are the main vulnerability factor (Islam and Ahmed, 2004).

3.3.3.1 Chittagong

In Chittagong, fishing villages are locally known as *Jeleparas,*[2] were selected from Salimpur, South Kattali and Patharghata (Table 3.2). South Kattali and Patharghata fall within the local government authority of the Chittagong City Corporation, while Salimpur is located on the outskirts of the Chittagong Metropolitan Areas (Figure 3.5). The fishing villages, in South Kattali and Salimpur are located along the coastline of the Bay of Bengal, while Patharghata is a port and fish-trading centre. Latifpur falls under the Salimpur union, and Sitakunda sub-district under the

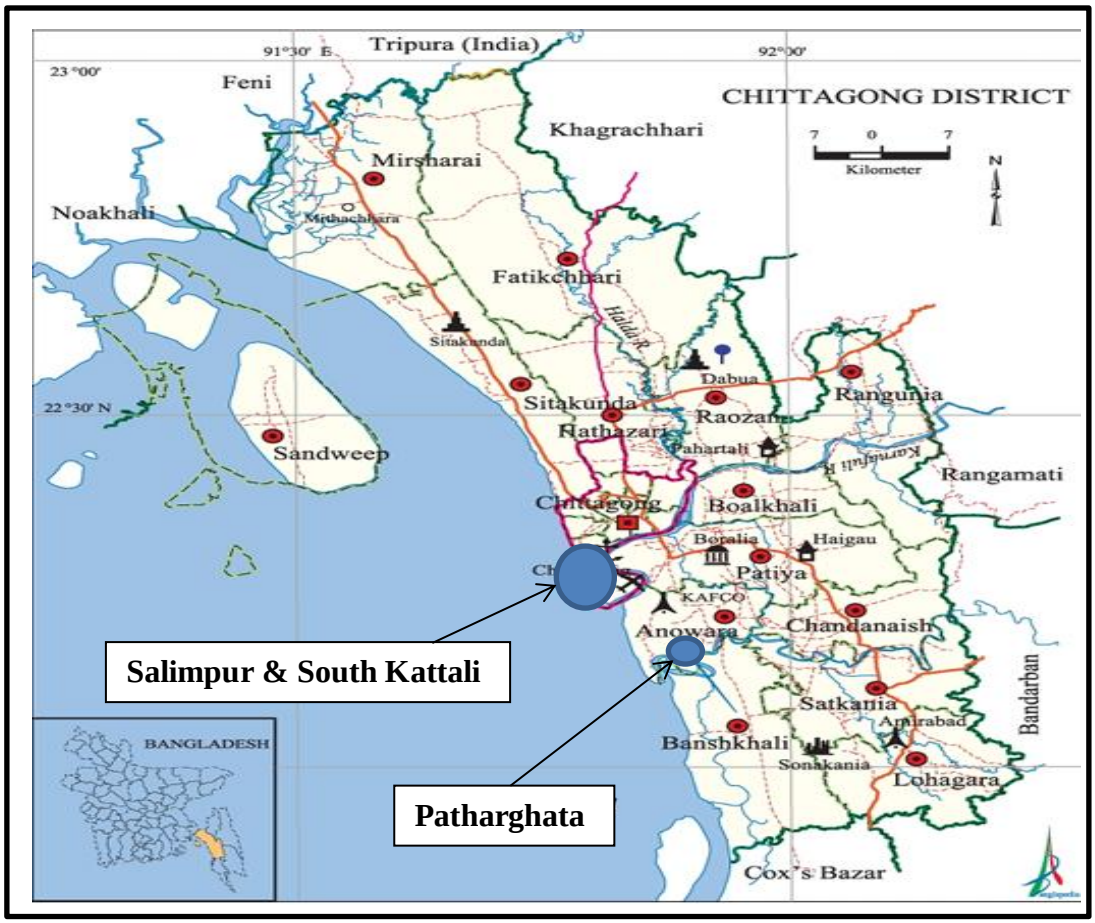
[2] Jelepara = In a village where fishing families live in a cluster of households

Chittagong district. According to locals, some of the key hazards of these areas are sea pollution, cyclones, floods, storm surges and diseases.

Table 3.2: Ward and selected unions in the Chittagong district

Ward Number	Union	Area
Non metropolitan area	Salimpur	Latifpur
11	South Kattali	South Kattali
34	Patharghata	Patharghata

Figure 3.5: Location of the case study areas in Chittagong



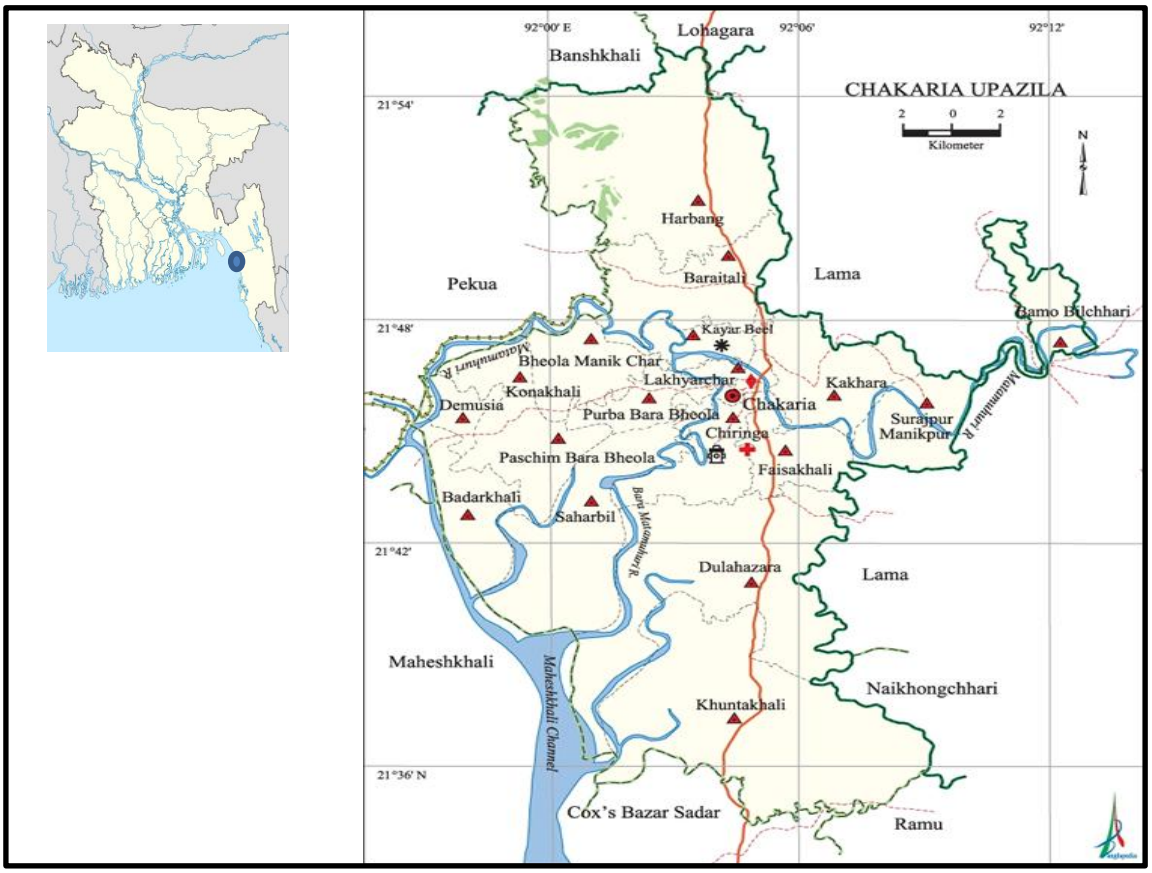
Source: Banglapedia (http://www.banglapedia.org/Maps/ChittagongDistrict.jpg)

3.3.3.2 Chakaria

Chakaria is a subdistrict of Cox's Bazar district, in which two rivers, Matamuhuri and Bara Matamuhuri pass through, with the Maheskhali and Kutubdia channels in the south (Figure 3.6). The east side of the area is hilly while the west side is low and flat

towards the Bay of Bengal. The study areas are located in the high-risk area of cyclones and storm surges and subject to regular monsoon flooding. The most devastating cyclone was in 1991 which caused extensive damage to the infrastructure resulting in a death toll of around 16,000 (Banglapedia, 2014). After 1991, other super cyclones have hit Chakaria in 1997, 1998, 2004 (GOB, 2010).

Figure 3.6: Map of Chakaria upzilla



Source: Banglapedia (http://www.banglapedia.org/HT/C_0089.htm)

Chakaria used to have the oldest and second largest mangrove forest in Bangladesh. Government policy failures, population pressure and shrimp farming projects have accelerated the destruction of the forest (Hossain, 2001). Although shrimp farming has created some employment opportunities, the socio-economic and ecological impacts of the destruction of the forest on the local people is devastating, as the locals used to depend on it for various necessities, such as source of firewood, honey, housing and boat making materials and herbal medicines. The forest used to be a good

habitat for various mammals, reptiles, amphibians and fishes and was also important to protect the community from cyclones (Hossain et al., 2001). Beside depletion of the forest, some of the other key issues in Chakaria are hill mudslides, river erosion, water logging, diseases, drinking water scarcity, floods and cyclones.

For this study, data was collected from fishing villages in four unions. Details of the unions and areas are shown in Table 3.3.

Table 3.3: Unions and selected areas in Cox's Bazar district, Chakaria upzilla

Unions	Areas
Chiringa	Charandip
Kaiarbil	Halkakara
Kakara	Kakara and Gunia
Faisakhali	Saraikhali

Chiringa

The Chiringa union is one of the most under-developed unions in Chakaria. The literacy rate is 37 percent, and the main economic activities for most of the people are agriculture and fishery with around 200-300 fisher families in this union. This area only gets electricity for a few hours a day. Currently, there are five cyclone shelters in this area and the access roads to them are not in good condition. Locals think 10 more cyclone shelters should be built to accommodate everyone. Some of the major disasters of this area are cyclone and associated storm surges, mudslides, especially due to heavy monsoon rainfall, floods, river erosion, and salinity intrusion.

Major cyclones occured in 1991 and 1997, with the 1991 cyclone associated with a 12 feet storm surge, and according to a local government official more than 2000 people died along with wide spread damage to infrastructure and agriculture. River erosion is a regular phenomenon and according to the government this area is one of the riskiest zones to various disasters (GOB, 2014) and every year due to river erosion the union is losing some of it land.

Kaiarbil

Road conditions in this union are very poor, being mostly unpaved. There is only one cyclone shelter that can accommodate a maximum of 500 people. This area gets electricity for only 4-6 hours per day. According to a local government official around 100 people depend on fishery in this area. Landslides, floods, earthquakes, cyclones, and severe cold in winter, are some of the key disasters in this area. The local climate appeared to have changed after the 1991 cyclone, with summers becoming longer and hotter and winters getting shorter but colder (GOB, 2010).

Kakara

Most of the roads in Kakara are unpaved. Electricity is available for only a few hours a day. Landslides and floods are a regular phenomenon in this union and in 2006, 50-60 houses were destroyed due to landslides. River erosion is also one of the major problems in this area (GOB, 2010).

Fasaikhali

In this union there are five cyclone shelters, although the condition of these shelters is poor. There is no electricity, water and toilet facilities in these shelters and the condition of the access road is very poor. The education rate is 60 percent, mostly only primary school level. In 1997 and 1998, there was a major disaster due to landslides. In addition, there was major cyclones in 1991 and 1997 with storm surges, and 11 people died in the 1991 cyclone. River erosion is one of the notable issues in this union (GOB, 2010).

3.4 Stage 2: Gathering and analysing empirical evidences

3.4.1 Data collection

The research applied various qualitative and quantitative approaches of data collection to address the research objectives.

a) Quantitative data collection

- Structured questionnaire survey.

b) Qualitative data collection

- Participant observations,
- Focus group discussion,
- In-depth interviews,
- Documents,
- Public documents,
- Newspapers,
- Journals and
- Government reports.

3.4.2 The questionnaire

The final questionnaire was designed after the pilot survey. From the in-depth interviews and the pilot survey it was noted that

- Most of the fishers have little or no formal education,
- Generally, respondents speak in a local dialect. They use unique expressions and phrases which are different from the widely spoken Bengali language. However, most of them can understand and speak Bengali,
- The community is quite sensitive to culture and customs,
- Generally, fishers lived together as a community in a specific area which is popularly known as Jelepara,
- In-depth interviews revealed that a closely related word to climate change in local language is "abohawa bodlai ghuu". By this phrase most of the people mean one or some of the following:
    - Temperature,
    - Seasonal pattern,
    - Changing pattern of rainfall and
    - Frequency of cyclones.
- Most of the people use one phrase "abohawa" both for weather and climate. All these issues were considered while developing and translating the questionnaires.

The initial questionnaire was in English and after incorporation of the local issues arising from the in-depth interviews, the questionnaire was translated into Bengali with the help of a translator. The translator was a multilingual, newspaper column writer, studying in the English medium, and an undergraduate student from the University of Chittagong. The translator was born and brought up in Chittagong and

can speak the local dialects and was familiar with local customs and culture. Considering the educational status, linguistic and cultural issues of the respondents great care was given to the wording and organising of the questionnaire.

The questionnaire consisted of thirty-six questions in four sections. Five questions were open-ended and the rest were closed questions. The questionnaire was divided into four sections. Each section focusing on the following themes:

Section 1: General information on fishing profession
Section 2: Perceptions of environment and climate change
Section 3: Adaptation perceptions
Section 4: Demographic information

The structured questionnaire was a combination of closed and open ended, multiple select, and Likert scale type questions as indicated in the Figure 3.7.

Figure 3.7: Example of question types in the questionnaire

Question# 5. Please indicate your seasonal involvement with fishery

- Summer
- Winter
- Rainy
- All of the above

Open-ended: Question# 10. According to you, what will be the most serious climate change threat for the fishing community in the next 10-15 years?

Likert scale: Question #9. Do you expect climate change to disrupt following elements (Please indicate your level of concern)

	Strongly concerned	**Very concerned**	**Not concerned or concerned**	**Not concerned**	**Strongly not concerned**	**Don't know**
Fish stock						
Fishing points						
Rough sea						
Soil salinity						
Salinity of sea water						
Shoreline erosion						
Profitability in fisheries						
Professional risks						
Fish marketing						
Drinking water						
*Food security						

*Food security = Earn enough money to buy rice for two meals per day for family

Multiple select question: Question #13. What you think are the reasons for climate change? (Please tick all that apply)

Authorities	**Tick**
Act of God/Natural process	
Punishment of God	
Result of sins	
Other countries	
Impossible to say	
Pollution	
Deforestation	

3.4.3 Sampling procedures

To address the research questions attention needs to be given to sampling procedures. For qualitative data collection '*purposeful random*' sampling has been applied for selecting participants for this study. '*Maximum variation sampling*' has been chosen for this study (Creswell, 2012). Diverse individuals were selected with an expectation to have different perspectives on the central research phenomenon. Respondents for this study were chosen based on their profession and location. Qualitative data were gathered through ten in-depth interviews and three group discussions. There were between 4 to 5 respondents in the group discussions. According to Creswell (2011), the size of the sample is related to the research questions and the type of qualitative approach used in the research. Typically for qualitative data collection in a case study a small sample, such as 4 to 10, can be selected (Plano and Creswell, 2011). Occupations of the respondents were net mender, day labourer, active as well as retied fishers, boat owners, widows and housewives.

For quantitative data collection surveys were administrated in five unions and two wards in the Chittagong districts and Chokoria upazilla. These areas are located on the eastern coast on the coastline of the Bay of Bengal and within 20 kilometres of the coastline. They are low-lying areas which are highly vulnerable to floods, cyclones and storm surges. Artisanal fishers live along the coast or on the banks of estuaries. The surveys were administrated at fish landing points, on fishing boats, and in fishing villages. Respondents were selected by a using purposive random sampling technique, with 103 respondents from Chittagong and 238 respondents from Chakaria selected for the questionnaire survey.

3.4.4 Applying the interviews with a structured questionnaire

Face-to-face interviews, sometimes called personal interviews are probably the most popular and oldest form of survey data collection. Lavrakas (2008) argues that face-to-face interview is the most effective method when someone wants to maximise the quality of survey data and to minimise non-responses. These interviews are particularly useful to solicit information on culturally sensitive issues, human

behaviour, and attitudes when other forms of interview are impractical due to various socio-economic and infrastructural factors (Lavrakas, 2008, Doyle, 2006). By far, one of the key advantages of the face-to-face interview as oppose to other forms, is the presence of respondents, which makes it easier for them to ask for clarification for some of the interview questions. Similarly, the respondent can be asked to clarify any answer, which the interviewer cannot interpret. Since the interviewer elicits and records data, the problems of missing data, ambiguous marking and unreadable handwriting are eliminated (Doyle, 2006). In face-to-face interviews more complicated questions can be asked, and longer interviews are possible, as well as additional materials can be used for clarification like maps, diagrams etc. (Brancato et al., 2006).

Largely due to the costs and travel time involved, face-to-face survey is more costly compared to telephone or mail out surveys. For face-to-face surveys, the interviewers must be carefully hired, trained and monitored. Daily allowances and travel expenses need to be paid to the interviewer to travel from one site to another. They can have additional disadvantages due to budgetary constraints, which typically limit the survey to comparatively small geographical areas. Some populations can be difficult to reach in person because they are rarely at home or due to the remoteness of the area, and for various security reasons. Various studies have found evidence that questions that involve disclosure of personal information are less likely to be answered fully and honestly in a face-to-face survey. In addition, face-to-face interviews put people on the spot by requiring an immediate answer. However, some answers may require some reflection or search for personal records that can be better handled by the self-paced format of a mail survey (Doyle, 2006).

Perhaps the greatest risks associated with a face-to-face survey is the possibility of "interviewer bias", that is, respondents are influenced by some intentional or unintentional words or actions of the interviewers, and they respond to them in a particular way. Interviewer bias is a concern in face-to-face surveys for two reasons. First, the interviewer is exposed to the potentially biasing effect to the respondents' appearance and environment in addition to their voices. Secondly, the interviewer may inadvertently give verbal or nonverbal clues to the respondents on how they

should respond (Doyle, 2006). However, there are a number of ways to reduce interviewer bias. For instance, the interviews should read all questions and response options exactly as written in the questionnaire rather than paraphrasing. Sometimes a small change in wording might influence the survey outcome. All the interviews should use the same procedure and instruments for data collection. Procedural consistency is important to reduce interviewer bias (Doyle, 2006).

Conducting questionnaire interviews in the field

Fieldwork was commenced on 15 December 2012 and finished on 28 April 2013. It was started in Chittagong where information was obtained about some fishing villages from the local people and a lecturer from the University of Chittagong. The survey was undertaken with the help of a research assistant who was a local person and an undergraduate student at the University of Chittagong. He worked as a volunteer for a human rights organization and had experience in conducting face-to-face surveys in coastal areas. In the beginning, he was provided with some materials on climate change and adaptation, as well as climate change policy documents of the Bangladesh government, NAPA 2005 and in particular, article and reports on marine fishers. After going to the field, the research assistant was briefed on the project, target demographics, the questionnaire and survey methodology. For the first 2 to 3 days, the author filled the entire questionnaire in the presence of the research assistant. After that, throughout the survey the author and the research assistant worked side by side to complete the questionnaires. It was noticed that for the first few days in every study site the respondents were sceptical regarding the survey objectives. The respondents thought that we were government employees and questioned why data was needed on their income and living status. Some respondents were concerned because they lived on government land illegally. The questionnaires did not bear the name of the respondents; however, their location was noted in every questionnaire. Generally, the respondents were friendly, cooperative and were interested in the survey. In a very few cases respondents declined to participate or withdrew themselves from the survey. One of the main reasons for respondent withdrawal was a sudden call from the boat owners or captain or colleagues.

It is important to note that except for one, all the six study sites were located in remote areas. The researchers lived in the study sites with a local family during the survey, and in most cases, the survey was done during daytime. On occasions, it was done during the evening, but generally, because of the poor law and order situation, it was not safe to work after sunset.

Sites of the interviews were fish landing points, fish markets, roadside tea stalls, restaurants, and the home of some fishers. For a few hours on the very first day the researchers engaged in friendly conversations with some local fishers, traders, and shop owners to build rapport. This also helped to understand the local customs and culture and to find a suitable time for the interview. Fishers who go fishing near to shore generally come back to shore every day at a specific time. Generally, after selling the fish catch they go home or sit in a tea stall or in a restaurant. This made them comfortable to be interviewed during their rest period. At the start of every interview, the researcher introduced himself to the respondent and informed them about the purpose of the research and why the area had been chosen for the interview.

3.4.5 Group discussions and in-depth interviews

Researchers have found that group discussion is one of the most popular ways of capturing respondent attitudes and perceptions on climate change (Dieye and Roy, 2012, Hares et al., 2010). It is a platform where participants are given more freedom to express their views. Table 3.4 summarises the details of the group discussions and in-depth interviews and shows that the participants were stratified by age, their role in fishery and their experiences. These interviews further explored intra and inter relationships between various climatic and non-climatic variables which influence risk perceptions and attitudes towards adaptation.

Table 3.4: Details of group discussions and in-depth interviews

Interview type	Number of persons	Age	Occupations	Interview point and area	Theme
In-depth	10	Between 25 and 70 years	Net mender, day labourer, fisherman	At boat, restaurant, fish landing points, home in Chittagong and Chakaria.	Climate change, disasters and adaptation.
Group discussion	5	Between 43 and 70 years	Fisherman, Labour, boat owner	Fish landing point, Chakaria	Impacts of various climatic variables on fisheries
Group discussion	4	Between 40 and 60 years	Boat owner, retired fisherman and active fisher	Fish landing point, Chakaria	Disasters and adaptation practices
Group discussion	4	Between 25 and 60 years	Widow, house wife	At home, Chittagong	Climate change, adaptation and gender specific issues

3.4.6 Participant observation

In qualitative research, participant observation is a widely used tool for data collection about people, process and culture (Kawulich, 2005). This observation method is useful in a variety of ways. It helps a researcher to understand non-verbal expressions, grasp intra and inter group communications of participations and record respondent activities (Schmuck, 2006), observe events that informants are unwilling to share, and gather data and information without asking questions to respondents may be insensitive or impolite (Marshall and Rossman, 2014). DeWalt and DeWalt (2002, p. 92) stated:

> "the goal for design of research using participant observation as a method is to develop a holistic understanding of the phenomena under study that is as objective and accurate as possible given the limitations of the method."

Kawulich (2005) suggested that participant observations could be a beginning stage of ethnographic studies, while Schensul et al. (1999, p. 91) listed reasons for using participant observation in research. They are: to identify the relationship with respondents, for the researcher to get ideas about how to interact with respondents and the cultural parameters. These will help a researcher to get familiar with the community, ask the appropriate questions and will ease the research process. Kawulich (2005) argued that participant observation is a way to increase the validity of a study as observations help a researcher to understand the context and phenomenon under study. DeWalt and DeWalt (2002, p. 9) suggested that the validity of data collected through participant observation is stronger when this is supported by additional strategies, such as interviews, survey questionnaires, document analysis. For this study, various quantitative and qualitative forms of data collection, such as structured questionnaire surveys, group and in-depth interviews, and support data collected through participant observation.

3.4.7 Other data sources

3.4.7.1 Previous literature

Previous literature on coastal Bangladesh was reviewed to understand the biophysical and socio-economic impacts of climate change and adaptation practices and policies, and to identify research gaps. The work of independent researchers, international agencies, government laws, policies and reports on coastal climate change and adaptation were extensively reviewed as indicated below.

Media/newspaper reports

Newspaper articles, editorials on climate change and adaptation, and coastal fisheries are some of the sources of information for this study. Articles were reviewed from various local, national and international published and online newspapers such as The

Daily Star, The New Age, Protom Alo, Ittefaque, The Independent, Bdnews24.com, Banglanew24.com.

Discussion with journalists and academicians

Discussions with various academic, journalists and people from various professions who contributed important information on coastal climate change, impacts and adaptation. A journalist from the Banglanews24.com provided important information the way of life of small-scale fishers from all around the coastal belt in Bangladesh.

Ethical issues

The study was conducted by following the university regulations. Before the fieldwork, the questionnaire was reviewed by the supervisors and then cleared by the Adelaide University Human Research Ethics committee. Before every interview, respondents were informed about the objective of the study and why they had been selected. They were also briefed about the confidential nature of the study and were assured that the information was collected only for the purpose of the study. Participation of the respondents was voluntary and they could decide on whether to participate or not, and were free to withdraw at any stage of the interview process.

3.6 Data validity, analysis and presentation

Data collected in the survey questionnaires were entered during and after the field visit. Initially data were entered into the Excel spreadsheet and then transferred into SPSS. All the analysis was performed through SPSS version 20. In total 371 questionnaires were collected and from them 341 questionnaires were selected for the analysis.

3.6.1 Validity – Qualitative data

Qualitative data collection through in-depth interviews and group discussions was not without methodological dilemmas. Members checking[3] and inter researchers triangulation[4] can be problematic in any qualitative research. Baxter and Eyles (1999) suggested to overcome the limitations, qualitative research should be rigorous in design, coding, analysis, interpretation and reporting (Baxter and Eyles, 1999).

Guion et al. (2011) describe validity in qualitative research refers to whether the findings of the study are true and certain. "True" in the sense that reporting is accurately reflected in the situation and "certain" in the sense that findings are supported by evidence. Triangulation is a method through which qualitative researchers can check and establish validity in their studies by analysing research questions from multiple perspectives. Quinn (2002) cautions that the goal of triangulation is not to arrive at consistency across data sources or approaches. Such inconsistencies might present the relative strength of different approaches. In Quinn's view, inconsistency in data should not be looked at as weakening the evidence of data rather it should be viewed as an opportunity to uncover data that are more meaningful. Guion et al. (2011, P. 1-3) describes five type of triangulation. They are: 1) *Data triangulation* involves using different sources of information in order to increase validity of a qualitative study. In this study data triangulation was addressed by interviewing different stakeholders, different community members and so on, 2) *Investigator triangulation* involves using several different investigators in the data analysis process. Then findings from each investigator are compared for broader and deeper understanding of the research issue. In most cases my research assistant and

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[3] **Member Checking** While philosophical debates concerning potential tensions between researcher interpretations and participant understandings are dealt with elsewhere (e.g., Borland 1991; Hammersley 1992; Baxter and Eyles 1997), this section focuses on equally important practical issues. Three challenges for checking the interpretations of data with study participants are as follows:
i) With whom should interpretations be checked?
ii) What should be the mechanism of feedback and checking?
iii) What should be the level of refinement for presenting findings?

[4] **Inter-researcher Triangulation** Researcher triangulation is intended to show that the themes which emerge from a set of interview data would be connected to the same discrete units of text by *any* interpreter informed of the objectives of the research. It may be argued that all interpretations will be idiosyncratic and there is no "truth" upon which to triangulate (Hammersley 1992).

me discussed and came to a same or close conclusion, that increase the confidence of the research findings, 3) *Theory triangulation* involves the use of multiple professional perspectives to interpret a single set of data, 4) *Methodological triangulation* involves the use of multiple methods (qualitative and/or quantitative methods) for triangulation. Survey results, findings from interviews are compared to check if similar results are being found. If finding from all the methods are similar, then validity is established, 5) *Environmental triangulation* involves the use of different temporal and spatial setting for data collection. Study takes place in different areas, time, seasons. The key is to identifying how environmental factors influence research findings (Guion et al., 2011). Environmental and Theory triangulation were not applied in this research while the concept of Data, Investigator and Methodological triangulation were applied in this study.

3.6.2 Data analysis and presentation

Results are presented in text, table and chart form. Chi-square analysis was used to explore relationships between variables. This analysis determines whether the different types of respondents (e.g. different education levels and age) and location gave different survey responses.

Trend analysis used the Mann-Kendall test and Sen's test through the program MAKESENS that was developed by the Finish Metrological Institute for detecting and estimating trend annual values of atmospheric and precipitation concentrations. Since then it has been widely used for trend analysis. The MAKESENS procedure is based on the nonparametric Mann-Kendall test for the trend and the nonparametric Sen's method for the magnitude of the trend. The Mann-Kendall test is applicable to the detection of a monotonic trend of a time series with no seasonal or other cycle. The Sen's method uses a linear model for the trend. The MAKESENS template was created using Microsoft Excel 97 and the macros were coded with Microsoft Visual Basic. Details information on MAKESENS can be found from the website of the Finish Metrological Institute (http://en.ilmatieteenlaitos.fi/makesens). Shahid (2010) and Shahid (2011) used Mann-Kendall test and Sen's test to analysed rainfall trends and extreme rainfall events in Bangladesh. Duhan and Pandey (2013) used the same

tests to analyse long-term spatial and temporal trends of precipitations in-between 1901 and 2002 in India.

3.7 Socio-cultural and demographic profile of the survey respondents

The respondents of this study belong to the artisanal marine fisher community and they are:

- Fishers fishing in the deep sea, near shore and/estuary,
- Involved in fish dying and salting,
- Involved in small and/or large scale fish trading,
- Owned a fishing boat and/or net,
- Invested in the fishing business.

3.7.1 Socio-cultural context

Socio-cultural characteristics of the small-scale marine fishers are unique and different from the mainstream Bangladeshi society in a number of ways. Traditionally most of the artisanal fishers live in remote areas mostly along the coastline of the Bay of Bengal and on the banks of estuaries. Fishers live as a community in a specific area locally known as "Jelepara". In the jelepara the majority of families directly or indirectly are involved with different aspects of the fishing sector (Figure 3.8).

Plate 3.1: A fishing village (jelepara) along the coastline of the Bay of Bengal, Chittagong

Source: Field visit (2013)

Traditionally fishing is practiced by the "Jaladas" of the Hindu communities. According to the Hindu caste system these Jaladas are treated as the lowest among all the casts or the untouchables. A 70 year old Hindu fisher from Chakaria expressed his anger against mother nature in this way:

> "We committed sins in the past life, as a retribution mother Sheta (a Hindu goddess) send us as jele (fishers) in this life." (Case 19, Respondents 359)

Beside Hindus, Muslims have taken fishing as a full-time profession for the last two to three generations. Increasing population pressure, loss of homeland, limited inland jobs and an increasing demand for fish are encouraging factors for Muslim fishers to enter into the fishing profession. However, the Muslims fishers have the same kind of perception about environmental disasters with different beliefs than the Hindus. A 70 year old retired Muslim fisher from Chakaria said,

> "Disasters (floods, cyclones) are increasing because of increasing number of sinners in the land…no doubt; it's a punishment and warning from the God." (Case 13, Respondents 354)

His 66 year old colleague from Chakaria added,

> "No one can predict anything with minimum level of certainty in this profession. This profession can make one rich or poor with the blink of an eye." (Case13, Respondents 355)

Cultural influences on perceptions and response strategies to climate change are further explored in the later chapters. Beside culture and traditions, another important aspect in the fishing community was the community power structure. In the study areas it was found that there are three categories of marine fishers. They are:

- Fishers who go for deep-sea fishing for 15 to 20 days,
- Near-shore fishers who go and come back to shore on a daily basis,
- Fishers who fish in the estuary.

One of the most influential groups in the fishers' community was boat owners. Fishermen who own boats are known as "bohoddar" who generally organise large crews for fishing expeditions. As an owner of the boat, a bohoddar generally takes a significant portion of the profit and there is always tension between them and the crew members. Head fishermen or locally known as "majhi" are an experience fisher who

knows the fishing points and the sea very well, and heads the team on the fishing boat. Generally the majhi is the most experienced among all the crew members and is responsible for the entire fish catching operation. The bahaddar and the majhi could be one and the same or a different person. In most of cases the salary of majhi is the highest among all crew members, who have their wages fixed or have a share of the catch. The crew members salary depends on the nature of work they perform on the boat.

The families who do not go to sea or to the estuaries to catch fish and are involved in small and large scale trading are called “aratdar” or fish traders. These people have access to the market, they sometimes own a warehouse or cold storage. Aratdars are particularly known for providing loans to fishers at very high interest rates, sometimes with difficult conditions (e.g. they sell fish to traders below the market price) and they are very influential in setting the market prices.

Local ecological knowledge is another important intellectual and cultural component of the fishers community. Some of the knowledge related to specific families or fisherman who specialise in that particular field. For example, fishers who have extremely good knowledge on fishing points and sea navigation are usually recruited as the captain (head fisher) of the boat with a high salary. Some of the knowledge is shared by most of the community members. Marine fishers communities use the traditional Bengali calendar to keep records of fishing times and seasons. Details of the fishing calendar are given in Table 3.5. According to fishers this calendar is subject to change due to weather patterns and government regulations. According to fisheries law, the catching of Juvenile Hilsa (Jatka) below 23cm during the period from November to April is prohibited.

Table 3.5: Fishing by season and traditional fishing calendar

Season		Month		Seasonal impact
Bengali	**English**	**Bengali**	**English**	
Grissho	Summer	Boishakh- Jaista	Mid-April to Mid-May	Off season
Borsha	Monsoon	Ashar-Srabon	Mid-June to Mid-July	Pick season
Sharat	Autumn	Varda-Aswin	Mid-August to Mid-September	Good season
Hamanta	Late autumn	Kartick-Ograhaiyan	Mid-October to Mid-November	Good season
Siit	Winter	Poush-Megh	Mid-December to Mid-January	Good season
Basanta	Spring	Falgun-Choitra	Mid-February to Mid-March	Not so good season

Source: Field survey (2013)

3.7.2 Demographic profile

During the survey demographic data on the respondents were collected and like in previous studies, and these demographics can influence risk perceptions (Savage, 1993, Finucane et al., 2000). Table 3.6 shows the demographic profile of the survey respondents. This study focused on the fishers who go to sea and estuary to fish, traders, investors and labours. It was observed in the study areas most of the fishers in these categories were male, some 94 percent. According to the World Bank (2015) half of the population in Bangladesh was female.

Adger et al. (2009) suggest that social status and age significantly influence attitudes and perceptions of climate change and adaptation. Respondents were somewhat evenly distributed by age, the largest variations between those aged 15-30 years and 40+ years. In Chittagong, some 43 percent fishers were aged between 15 and 30 years and one fifth were aged above 40 years. In total 68 percent of respondents were aged below 40 years and this is consistent with other studies. Faruque et al. (2012) reported most of the fishers involved in dry fish market in Chittagong were young and mostly aged 25 to 30 years. Siddiq et al. (2013) also found that 74 percent of marine fishers in the southeast coast of Bangladesh were below 50 years of age.

Table 3.6: Demographic profile of the survey respondents

Survey total		Total		Chittagong		Chakaria	
Age	**15-30 years**	121	35.5	44	43.1	77	32.2
	31-40 years	113	33.1	36	35.3	77	32.2
	40+ years	107	31.4	22	21.6	85	35.6
Average monthly Income (Taka)	**<5,000**	72	21.7	6	6.2	66	28.1
	5,000-9,999	193	58.1	63	64.9	130	55.3
	10,000-14,999	34	10.2	13	13.4	21	8.9
	15,000+	33	9.9	15	15.5	18	7.7
Education	**No formal education**	220	64.5	57	55.9	163	68.2
	Educated	121	35.5	45	44.1	76	31.8
Residency status	**Permanent**	210	66.7	44	55.7	166	70.3
	Not permanent	105	33.3	35	44.3	70	29.7
Media ownership	**Yes**	106	31.8	51	54.3	176	73.6
	No	227	68.2	43	45.7	63	26.4
Religion	**Muslim**	126	37.1	26	25.7	100	41.8
	Hindu	214	62.9	75	74.3	139	58.2
Experience in fishery	**<10 years**	101	29.7	34	33.3	67	28.2
	10 to 19 years	106	31.2	36	35.3	70	29.4
	20+ years	133	39.1	32	31.4	101	42.4

Source: Field survey (2013)

The survey data shows that there are differences in income of respondents by districts. The income of 65 percent from Chittagong and 55 percent from Chakaria were

earning between Taka 5,000 and 9,999. About one-third of fishers in Chakaria earnt below Taka 5,000 compared to only 6 percent in Chittagong, where 15 percent of those from Chittagong reported that they earnt more than Taka 15,000 per month compared to only 8 percent from Chakaria. Data indicate that in Chittagong, the income of fishers was higher than Chakaria. Siddiq et al. (2013) reported the annual income of marine fishers varied from Taka 30,000 to 96,000, and mean average annual income was Taka 61,375. Ahmed et al. (2010) found a significant difference in income among prawn post larvae fishers. Islam et al. (2014) studied limitations and barriers for adaptation to climate change in fishing communities in Bangladesh and argued that low-income groups were constrained by economic barriers for adaptation.

Table 3.6 also shows that in Chittagong, 44 percent of respondents were educated which is 13 percent higher than Chakaria and this literacy rate is far below the national average of 57.7 percent (UNICEF, 2015). Moreover, the majority of respondents (80 percent) were educated up to primary level. Brody et al. (2008) reported education has a strong positive effect on climate change risk perception. Bostrom et al. (1994) found that the level of education is important and highly educated people are able to better understand the causes and consequences of climate change. The proportion of educational attainment of respondents' was found to decrease with age, and 75 percent of respondents who aged more than 40 years were illiterate, while 38 percent aged between of 15 to 30 years were educated. Siddiq et al. (2013) reported the proportion of fishers in coastal Bangladesh who can read or sign only was about 55 percent.

Reuveny (2007) argued that environmental problems play a role in migration and the displacement of people can lead to conflict in the receiving areas. People living in disaster prone areas are most likely to leave and move to safe areas, while a number of studies have indicated significant movement of people in Bangladesh due to climate change induced disasters (McAdam, 2011, Hassani-Mahmooei and Parris, 2012, Siddiqui and Billah, 2014). Black et al. (2011) pointed out that moving to cities from rural disaster prone areas is a common coping strategy in Bangladesh. The residential status of respondents was collected to investigate how the risk of climate change is perceived by permanent and non-permanent residents. Permanent residents

were more likely to be in Chakaria compared to Chittagong (70 percent and 56 percent permanent residences respectively). According to respondents fishers migrate to Chittagong for a better income, however this migration pattern is smaller, than indicated in a study by Afsar (2003) that found moving to urban cities was the most popular form of migration in Bangladesh.

3.8 Research constraints

The fieldwork was carried out between December 2012 and April 2013 and during this period, Bangladesh faced one of its worst political crisis in recent history with widespread political violence and clashes between the government and opposition. The opposition called a weeklong strike on several occasions. A curfew had been called on several occasions to maintain law and order in Chittagong and Cox's Bazar. Generally the law and order situation in the fishers villages and at sea are very poor. However, this situation further deteriorated due to the political crisis with respondents reporting increased piracy at sea. During the survey time it was observed that respondents were worried about their personal security due to deteriorating law and order, which may have impacted on respondents' perceptions and opinions. At the same time the political crisis made it difficult to work in the field as planned.

Another constraint on the research was the respondents false disclosure of information, especially in relation to land ownership, age and income. During the quantitative survey, some of the respondents did not disclose their true status of home ownership. During the in-depth interviews respondents revealed that a good number of fishers lived on government lands and these lands were illegally occupied. It was also found that illegal land occupation by the poor fishers made it difficult for these fishers to disclose true land ownership status.

Besides giving false information on land ownership status, on a few occasions fishers struggled to calculate their age and income. Generally, fishers are illiterate and the numeracy skills of some fishers were quite poor. Moreover, calculating income was difficult for a number of reasons, for instance, most of the fishers income was variable, with two/three times higher income during peak seasons compared to regular

seasons, and a good number of fishers do not fish for three months in a year, with some of them unemployed or only occasionally employed during that time.

3.9 Conclusion

This chapter has discussed methodologies applied to collect and analyse data to understand community perceptions, attitudes and dimensions of climate change. Considering the complex and dynamic interactions between of the socio-economic system, political and cultural values, geomorphological system and ecosystem of the coast, this chapter has described the reasons for selecting a mixed method approach to address the research aims and objectives. This chapter also outlines the demographic and the socio-economic characteristics of the community and the physical characteristics of the study areas, as well as the limitations of the study. It also discussed the characteristics of survey respondents and how the sample was achieved.

CHAPTER 4

OVERVIEW ON CLIMATE VARIABILITY, DISASTERS AND MANAGEMENT ISSUES IN COASTAL BANGLADESH

4.1 Introduction

Coastal areas are one of the most disaster prone in Bangladesh and climate change and its consequent impacts are most likely to worsen the disaster scenarios (Ali, 1996, Agrawala et al., 2003, Karim and Mimura, 2008, Black et al., 2013, Mechler and Bouwer, 2014). Elevated sea surface temperature may increase the frequency and intensity of cyclonic activities that originate from the Bay of Bengal. Future sea level rise, an increase in cyclonic intensity and frequency, and consequent storm surges, will have disastrous impacts on lives and properties, especially for the communities living in the coastal areas (GOB, 2009). This chapter outlines climate variability and disaster management issues in coastal Bangladesh. Historical and current climatic trends, disasters and management issues are analysed and discussed here. Findings of this chapter provide an understanding of the climatic trends, projections and management issues related to disasters and climate change in southeast Bangladesh.

4.2. Trends in cyclones and storm surges

On average once in three years there is a severe cyclone strike the Bangladesh coast (GOB, 2009). According to a study by Paul and Dutt (2010), between 1877 and 2010 more than 1 million people have died in Bangladesh as a result of cyclones and storm surges. A Government disaster assessment report indicated that more than 50 percent of total deaths in the world due to cyclones and associated storm surges have occurred in Bangladesh (GOB, 2008).

Table 4.1 summarises the history of major cyclones in Bangladesh between 1960 and 2009, and shows that during this time period 29 major cyclones hit the Bangladesh

coast, with 75 percent of them hitting the eastern coast (Chittagong and Cox's Bazar). Associated storm surges are recorded between 5 and 33 feet and wind speed between 74 and 278 km/hr. In the recent past the most devastating and the deadliest were the Bhola cyclone (1970) and the Bangladesh 1991 cyclone (NBC, 2013).

On the night of November 12 1970, a severe cyclone associated with a 20 feet storm surge struck the southern coast of Bangladesh. Due to difficulties in transportation and communication during that time, the cyclone was largely unrecognised by the Government and press. When the news spread gradually, relief supplies and volunteers started to pour in. Various studies have reported a different number of deaths. Sommer and Mosley (1972) in 1972 estimated the mean mortality figure at 16.5 percent which represented a minimum death toll of 224,000. Frank and Husain (1971) reported that the cyclone affected 4.7 million people, deaths of 300,000 people approximately, and caused extensive damage to property. The official death toll figure showed 200,000 confirmed deaths and 50,000 to 100,000 missing people. Therefore, the November 1970 cyclone is considered as one of the deadliest cyclones in the history of the world (Frank and Husain, 1971, Fritz et al., 2009).

Table 4.1: List of major cyclones in coastal Bangladesh in-between 1960 and 2009

Date of Occurrence	Nature of Phenomenon	Landfall Area	Maximum Wind Speed in km/hr.	Tidal Surge Height in ft.
11.10.60	Severe Cyclonic Storm	Chittagong	160	15
31.10.60	Severe Cyclonic Storm	Chittagong	193	20
09.05.61	Severe Cyclonic Storm	Chittagong	160	8-10
30.05.61	Severe Cyclonic Storm	Chittagong	160	6-15
28.05.63	Severe Cyclonic Storm	Chittagong and Cox's Bazar	209	8-12
11.05.65	Severe Cyclonic Storm	Chittagong and Barisal	160	12
05.11.65	Severe Cyclonic Storm	Chittagong	160	8-12
15.12.65	Severe Cyclonic Storm	Cox's Bazar	210	8-10
01.11.66	Severe Cyclonic Storm	Chittagong	120	20-22
23.10.70	Severe Cyclonic Storm of Hurricane intensity	Khulna-Barisal	163	Moderate
12.11.70	Severe Cyclonic Storm with a core of hurricane wind	Chittagong	224	10-33
28.11.74	Severe Cyclonic Storm	Cox's Bazar	163	9-17
10.12.81	Cyclonic Storm	Khulna	120	7-15
15.10.83	Cyclonic Storm	Chittagong	93	-
09.11.83	Severe Cyclonic Storm	Cox's Bazar	136	5
24.05.85	Severe Cyclonic Storm	Chittagong	154	15
29.11.88	Severe Cyclonic Storm with a core of hurricane wind	Khulna	160	2-14.5
18.12.90	Cyclonic Storm (crossed as a depression)	Cox's Bazar	115	5-7
29.04.91	Severe Cyclonic Storm with a core of hurricane wind	Chittagong	225	12-22
02.05.94	Severe Cyclonic Storm with a core of hurricane wind	Cox's Bazar	278	5-6
25.11.95	Severe Cyclonic Storm	Cox's Bazar	140	10
19.05.97	Severe Cyclonic Storm with a core of hurricane wind	Sitakundu (Chittagong)	232	15
27.09.97	Severe Cyclonic Storm with a core of hurricane wind	Sitakundu (Chittagong)	150	10-15
20.05.98	Severe Cyclonic Storm with core of hurricane winds	Chittagong	173	3
28.10.00	Cyclonic Storm	Sundarban	83	-
12.11.02	Cyclonic Storm	Sundarban	65-85	5-7
19.05.04	Cyclonic Storm	Cox's Bazar	65-90	2-4
15.11.07	Severe Cyclonic Storm with core of hurricane winds (SIDR)	Khulna-Barisal	223	15-18
25.05.09	Cyclonic Storm (Aila)	West Bengal –Khulna	70-90	4-6

Source: Bangladesh Metrological Department (2013)

In 1991 another super cyclone hit the Chittagong coast with the wind speed at 225 km/ hour and storm surges of 12 to 22 feet that claimed 140,000 lives and 1.8 billion property damage (Hossain et al., 2008). Despite the fact that the Government issued warnings about the impending severe cyclone and storm surges and about 3 million people did move to safety, many inhabitants remained behind to protect their land and property. Consequently, about 138,000 people were killed and a large number of houses, infrastructure and agricultural lands were destroyed. During the cyclone seven to eight thousand boats were lost and many more damaged (Damen and Van Westen, 2011). In respect to disregarding storm warning by a large number of people, Chowdhury et al. (1993, p. 299-302) and Bern et al. (1993, p. 75-77) have documented a number of reasons for the high death toll and property damage in the 1991 cyclone. These are:

1. Poor housing In the coastal areas most of the houses were made of straw and mud. Few houses were semi concrete (Semi-pacca) and even fewer houses concrete houses. Only 3 percent of houses were strong enough to withstand high tidal surges and strong winds. Most of the deaths occurred in poorly constructed houses (Bern et al., 1993, p. 77).

2. Poverty and high population density Bangladesh is one of the most densely populated countries in the world. Because of the shortage of land many people moved to vulnerable coastal areas and small islands in search of livelihoods such as fishing. These people are generally without resources and are easy victims of various disasters like floods and cyclones (Bern et al., 1993, Dove and Khan, 1995). Moreover, the mortality rate was high in coastal Bangladesh due to the poor socio-economic conditions of the coastal population (Bern et al., 1993).

3. Few cyclone shelters Chowdhury et al. (1993, p. 297) reported only one shelter per 8000 people in the most affected areas and found that they were unevenly distributed. During the cyclone most of the shelters were full to their maximum capacity and were very helpful in saving lives. However, in realities, these shelters were poorly maintained and lacked the supply of basic facilities like a water supply and latrines.

4. Problems with signals and warnings The warning system in Bangladesh that is mainly developed for ports and shipping is sometimes misleading and creates the wrong perception among the population. The common perception that the danger increases with the increase in signal number is unfortunately wrong. For example, according to the official category signals 10, 9, 8 mean grave danger. In 1991 when the signal was reduced from 10 to 9 it created a wrong impression among the public that the cyclone had weakened. Moreover, the warning communication system has some major flaws. For example, in the 1991 cyclone a more severe warning was received in offshore islands rather than in coastal regions, although it was equally vulnerable to the cyclone (Haque, 1995, Alam and Collins, 2010).

5. Perceptions Among the coastal communities there is a widespread belief that severe cyclones occur only at certain times and seasons of the year and cyclones are potentially disastrous if the wind blows from certain directions (Chowdhury et al., 1993, p. 301).

6. Vulnerability of particular groups Women and children are more vulnerable to disasters for various reasons (Begum, 1993). The willingness of women to leave home, the protective nature of mothers (self-sacrifice to protect children), traditional outfit (saree) and long hair increases vulnerability of Bangladeshi women (Alam and Collins, 2010, p. 6).

Since 1991, Bangladesh has made significant improvements in disaster management. The construction of multipurpose cyclone shelters, Cyclone Preparedness Program (CPP), coastal afforestation projects are all playing a role in this regard (Mallick and Rahman, 2013, Alam and Collins, 2010). Alam and Collins (2010) studied disaster vulnerability and response experience in coastal Bangladesh and found that despite significant progress in disaster management of the Bangladesh Government, localised vulnerability factors are seldom considered for adaptation policy formulation. Their study highlights the importance of considering local vulnerability factors in adaptation policy formulation. Being aware of local conditions will help the policy makers to develop acceptable adaptation policy and implement the policies effectively. Various studies have indicated that without an in-depth understanding of local vulnerabilities

to natural hazards, the basis of local people's perceptions and behaviour, the goals of disaster management strategies are considered unlikely to succeed (Khan, 1974, White, 1974, Weisner et al., 2004, Davis and Ali, 2014).

Singh et al. (2001) reported that cyclonic activities in the Bay of Bengal had increased two fold, especially in the month of November, that account for the highest monthly average of severe cyclone frequency. Ahmad (2003) investigated the occurrence of cyclones in the Bay of Bengal between 1795 and 1991 and showed an increasing trend of cyclone occurrence.

Chowdhury et al. (2012) also analysed 1985 to 2005 cyclonic trends in the Bay of Bengal and found that on an average six storms per year are produced and that tropical cyclones have increased by an annual frequency by 0.045 cyclones per year, and with this increasing rate, the Bay of Bengal will be likely to experience eight storms per year by 2050.

4.3 Floods

Flood is a regular hazard for people living in coastal Bangladesh. Recently Bangladesh experienced five major floods in 1987, 1988, 1998, 2004 and 2007. Human and economic damage caused by these floods was extensive. The most recent devastating flood occured in November 2007 when cyclone Sidr hit the Bangladesh coast which affected 2.3 million households to some degree, and about 1 million households were seriously affected, with estimated death numbered 3,406, and physical injuries to 55,000 people with physical assets worth near USD 1.1 billion destroyed (GOB, 2008).

Rasid and Paul (1987) divide floods in Bangladesh into two distinct categories, 1) river floods resulting from excessive runoff contributed by monsoon precipitation and 2) coastal floods induced by cyclones associated with storm surges. Younus (2010) divided floods in Bangladesh into four types. They are 1) Flash floods, 2) Monsoon floods, 3) Storm surges and 4) Rain-fed floods.

To protect the coastal areas of Bangladesh from tropical cyclones and associated storm surge flooding, many coastal embankment projects were initiated by the government in the 1960s and those embankments were reconstructed in 1991. Choudhury et al. (2004) argued that due to the faulty design of the embankments, flash floods in the Chakaria thana of the Cox's Bazar district had increased. In June 2012, 95 people in Chittagong and Cox's Bazar died due to landslides and flashfloods caused by torrential rain (Ahmed, 2012).

Another reason for flooding in coastal Bangladesh is excessive rainfall during the monsoon. More than 80 percent of annual rainfall occurs during the monsoon and river basins experience extensive rainfall during July and August when most of the floods occur (Mirza, 2011). Coastal areas of Bangladesh are subject to tidal flooding (tidal bores) known as 'ban' in the Bengali language. Tidal bores are observed in the month of April to May and September to December, which can be devastating, especially to central and eastern coastal areas (Chittagong and Cox's Bazar) (Banglapedia, 2014).

From previous studies we can divide coastal floods in Bangladesh into three categories. They are: 1) Storm surges and tidal floods **(**Banglapedia, 2014), 2) Flash floods (Ahmed, 2012), 3) Monsoon floods (Ahmed, 2012, Mallick et al., 2005) and the reasons for flooding can be summarised as follows:

- Storm surges due to tropical cyclones generated from the Bay of Bengal (Alam and Collins, 2010),
- Excessive water flows from upstream cause over spilling (Mirza et al., 2003),
- Heavy precipitation especially during the monsoon season (Ahmed, 2012, Mallick et al., 2005),
- Regular coastal lowland inundation due to high tides in the Bay of Bengal (Banglapedia, 2014),
- Siltation of river channels reducing the carrying capacity of the river (Ali, 2007),
- Dam failure, unplanned infrastructural developments and inadequate drainage facilities cause water and drainage congestion (Richter et al., 2010, Hossain and Sakai, 2008),
- Deforestation and changing land use patterns (Ahmed and Uddin, 2008, Sajjaduzzaman et al., 2005) and
- Climate change (Mirza, 2011).

4.4 Rainfall trends

To understand rainfall trends on a spatial and temporal scale is of great interest for scientists and policy makers analysing the impacts related to climate change. The life cycle of many fish species is correlated to rainfall and temperature patterns (Meynecke et al., 2006). The speculation that climate change might affect fish production and distribution suggests a need to understand the changing patterns of rainfall and temperature (Rijnsdorp et al., 2009). This section analyses the rainfall and temperature trends in Chittagong and Cox's Bazar for the period between 1980 and 2011.

Mirza (2002) reported rain induced floods that are caused by high intensity local rainfall for a long duration in the monsoon, and together with storm surges are some of the common natural disasters in coastal Bangladesh. The study indicated that because of climate change the timing, intensity and frequency of the events of intense monsoon precipitation might change in coastal Bangladesh and predicted a substantial increase in flooding due to climate change in Bangladesh. Shahid (2011) analysed the trend of extreme rainfall events in Bangladesh between 1958 and 2007 and found significant change. Dasgupta et al. (2015) studied soil salinity of coastal Bangladesh estimated to 2050, and concluded projected change of river salinity, rainfall and temperature due to climate change, poses a significant risk of soil salinization in coastal areas. Hossain et al. (2014) suggested that the marine brackish-freshwater ecosystem with favourable ecological parameters (including rainfall and temperature) is important for supporting juvenile Hilsha fish which is one of the most valuable species for marine fishers in Bangladesh.

Seasonal and annual distribution of rainfall

Table 4.2 shows the annual distribution of mean precipitation in mm and mean precipitation days in Chittagong and Cox's Bazar during 1980 and 2011, and the total amount of mean rainfall is 2937mm and 3678mm in Chittagong and Cox's Bazar respectively. During this period Cox's Bazar received 20 percent more annual rainfall than Chittagong, and 75 percent of the total precipitation occurred during the

monsoon and autumn seasons (Table 4.3). In Chittagong 73 percent (2144mm) of the total annual rainfall occurred in 77 days during the monsoon and autumn seasons and for Cox's Bazar it was 78 percent (2869mm) in 92 days. On average 28mm of rainfall occurred in a rainy day during the monsoon-autumn season in Chittagong and for Cox's Bazar the average rainfall in a rainy day during the monsoon and autumn season was 31mm, with 15 percent and 12 percent of the total annual rainfall occurring in summer in Chittagong and Cox's Bazar respectively. The lowest amount of rainfall occurred in winter and spring, with only 1 percent and 2 percent of the total annual rainfall occurring then in both Chittagong and Cox's Bazar.

Table 4.2: Annual mean rainfall and rainy days in Chittagong and Cox's Bazar during the period 1980 and 2011

	Chittagong		Cox's bazar	
	Mean rainfall mm	**Mean annual rainy days**	**Mean rainfall mm**	**Mean annual rainy days**
Annual	2937	117	3678	128

Source: Bangladesh Metrological Department (2013)

Table 4.3: Seasonal mean rainfall and rainy days in Chittagong and Cox's Bazar during the period 1980 and 2011

	Chittagong		Cox's bazar	
Seasons	**% of annual rainfall**	**Mean rainy days**	**% of annual rainfall**	**Mean rainy days**
Winter	1	1	1	1
Spring	2	4	1	3
Summer	15	17	12	14
Monsoon	45	34	48	38
Autumn	28	32	30	34
Late autumn	9	11	8	10

Source: Bangladesh Metrological Department (2013)

Rainfall trends

Table 4.4 shows seasonal and annual trends of rainfall in Chittagong and Cox's Bazar between 1980 and 2011 and there was a declining trend of rainfall in winter and spring seasons in both areas though the results were not statistically significant. Table 4.3 shows that in Chittagong and Cox's Bazar the lowest amount of rainfall occurred in winter and spring, which appeared to be getting drier. In Chittagong, rainfall in summer had decreased and increased significantly in Cox's Bazar. Sen's result showed that the amount of increased rainfall during summer was 7mm per year, while the increase in rainfall in autumn was not statistically significant. However, Sen's test reveals rainfall in autumn in Chittagong had increased at 7 mm per year and 10 mm per year in Cox's Bazar. The annual trends showed an increasing trend of rainfall both in Chittagong and Cox's Bazar, which was not statistically significant. Sen's test reveals an annual increase of rainfall in Cox's Bazar was 13mm per year.

Shahid (2011) analysed rainfall of nine weather stations in Bangladesh for the time period between 1958 and 2007, and found a significant increase in annual and pre-monsoon rainfall in Bangladesh. This study found a positive increase in annual rainfall in southeast Bangladesh. Annual rainfall increased by 0.28 mm and 0.86 mm in Chittagong and Cox's Bazar (Table 4.4). The result also shows that unlike Chittagong, rainfall in Cox's Bazar had increased significantly in summer. Mirza (2011) noted that according to most of the climatic models, precipitation in Bangladesh will increase significantly during summer and the monsoon precipitation pattern will change.

Table 4.4: Seasonal and annual trends of precipitation in Chittagong and Cox's Bazar during the period 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	-0.48	↓	NS	0.00	-0.27	↓	NS	0.00
Spring	-1.58	↓	NS	-2.26	-0.67	↓	NS	-0.43
Summer	-0.18	↓	NS	-0.96	1.95	↑	S	7.40
Monsoon	-0.47	↓	NS	-3.61	-0.42	↓	NS	-3.74
Autumn	1.05	↑	NS	6.31	1.31	↑	NS	10.47
Late autumn	0.00	↑	NS	0.02	0.70	↑	NS	2.47
Annual	0.28	↑	NS	4.64	0.86	↑	NS	13.08

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward

Source: Bangladesh Metrological Department (2013)

Table 4.5 shows seasonal and annual trends in rainy days in Chittagong and Cox's bazar, which had increased significantly in autumn (2.62 days per year). Rainy days were found to increase in autumn, late autumn and decreased in winter, spring and the monsoon. These findings support the previous research by Shahid (2011) that reported a significant increase of dry days during the monsoon had occurred in Chittagong.

Table 4.5: Seasonal and annual trends in rainy days in Chittagong and Cox's Bazar during 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	-1.42	↓	NS	0.00	-0.40	↓	NS	0.00
Spring	-1.75	↓	S	-0.12	-1.42	↓	NS	-0.06
Summer	-0.39	↓	NS	0.00	0.56	↑	NS	0.00
Monsoon	-0.77	↓	NS	-0.07	-1.57	↓	NS	-0.10
Autumn	2.62	↑	S	0.18	3.13	↑	S	0.26
Late autumn	0.96	↑	NS	0.07	0.62	↑	NS	0.05
Annual	0.33	↑	NS	0.02	0.86	↑	NS	0.16

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward

Source: Bangladesh Metrological Department (2013)

Tables 4.6, 4.7 and 4.8 show seasonal and annual rainfall distribution of different categories (light rainfall days, moderate rainfall days and heavy rainfall days) in Chittagong and Cox's Bazar between 1980 and 2011. These tables further confirm that precipitation days and rainfall amounts had decreased in winter and spring.

Table 4.6 shows a positive trend of increasing light precipitation days during summer, the monsoon, autumn and in late autumn in Chittagong. In Cox's Bazar the trend of light rainfall days in summer and the monsoon had decreased while light rainfall days in autumn and late autumn increased in both Chittagong and Cox's Bazar.

Table 4.6: Seasonal and annual trends in light rainfall days (1- 10mm/day) in Chittagong and Cox' Bazar between 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	-1.75	↓	S	0.00	-0.89	↓	NS	0.00
Spring	-0.33	↓	NS	0.00	-1.04	↓	NS	0.00
Summer	0.98	↑	NS	0.00	-0.44	↓	NS	0.00
Monsoon	0.35	↑	NS	0.00	-0.34	↓	NS	0.00
Autumn	1.21	↑	NS	0.06	0.70	↑	NS	0.07
Late autumn	0.42	↑	NS	0.00	0.41	↑	NS	0.00
Annual	1.14	↑	NS	0.10	-1.24	↓	NS	-0.17

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward
Source: Bangladesh Metrological Department (2013)

Table 4.7 shows that moderate rainfall days during autumn and late autumn had increased in Chittagong and Cox's Bazar between 1980 and 2011. In Cox's Bazar moderate rainfall days had increased significantly (99.99% confidence interval).

Table 4.7 Seasonal and annual trends in moderate rainfall days (11-20mm/day) in Chittagong and Cox' Bazar between 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	-0.30	↓	NS	0.00	0.69	↑	NS	0.00
Spring	-0.94	↓	NS	0.00	-2.21	↓	S	0.00
Summer	0.07	↑	NS	0.00	-0.48	↓	NS	0.00
Monsoon	0.84	↑	NS	0.00	-0.02	↓	NS	0.00
Autumn	1.13	↑	NS	0.05	1.74	↑	S	0.09
Late autumn	0.97	↑	NS	0.00	0.30	↑	NS	0.00
Annual	1.14	↑	NS	0.08	0.73	↑	NS	0.05

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward
Source: Bangladesh Metrological Department (2013)

Table 4.8 shows that there was a significant decrease in heavy rainfall days in spring in Chittagong. However, heavy rainfall days had increased in autumn and late autumn both in Chittagong and Cox's Bazar. Results also showed that there was an increasing trend of the annual heavy rainfall days.

Table 4.8: Seasonal and annual trends in heavy rainfall days (>20mm/days) in Chittagong and Cox's Bazar between 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	-0.25	↓	NS	0.00	-0.68	↓	NS	0.00
Spring	-1.76	↓	S	0.00	0.15	↑	NS	0.00
Summer	-0.13	↓	NS	0.00	1.49	↑	NS	0.07
Monsoon	0.16	↑	NS	0.00	-0.72	↓	NS	-0.05
Autumn	0.80	↑	NS	0.08	1.50	↑	NS	0.17
Late autumn	0.54	↑	NS	0.00	1.06	↑	NS	0.04
Annual	0.24	↑	NS	0.00	0.52	↑	NS	0.11

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward
Source: Bangladesh Metrological Department (2013)

The trends show that in Chittagong and Cox'Bazar the least amount of rainfall occurs in winter and spring (average 117mm per year), indicating a decreasing trend in

rainfall in this period. Some 76 percent (2506 mm) of total annual rainfall occur in monsoon and autumn, indicating that in the monsoon season rainfall is decreasing at a rate of 4mm per year and autumn rainfall at 8mm per year. In Cox's Bazar rainfall is increasing significantly in summer, with a rate of increase of 7mm per year. In autumn the number of rainy days are increasing significantly in Chittagong and Cox's Bazar.

4.5 Temperature trends

Table 4.9 shows the test results on running the Mann-Kendall test and Sen's test on monthly temperature data for Chittagong and Cox's Bazar. Annual temperatures increased significantly in Chittagong (0.02 ^{0}C per year) and Cox's Bazar (0.01^{0}C per year). The trend shows that the rise of temperature in all seasons was positive. In Chittagong, the temperature increased significantly during spring, summer and the monsoon. In Cox's Bazar, the temperature significantly increased in spring and in the monsoon. The findings of this study are consistent with previous studies by Khan et al. (2000) who studied the relationship between temperature, sea-level rise and cyclones and reported that sea surface temperature rise in the Bay of Bengal was about 0.8^{0}C in May and about 0.4^{0}C in November during the 14 years period (1985-1998). The study reported that a rise in sea surface temperature in the cyclone months was correlated with the frequency and intensity of tropical cyclones. Hashizume et al. (2009) found that in rural Bangladesh the mortality rate increased to correspond with the low temperatures in the preceding weeks. Ali (1996b) found that temperature can increase the intensity of tropical cyclones and vulnerability of the coastal communities. Harley et al. (2006) also reported that rising temperatures have significant impacts on coastal ecosystems.

Table 4.9: Seasonal and annual trends in temperature in Chittagong and Cox's Bazar between 1980 and 2011

Series	Chittagong				Cox's Bazar			
	Test Z	Trend	Result	Sen Q	Test Z	Trend	Result	Sen Q
Winter	1.22	↑	NS	0.01	0.57	↑	NS	0.01
Spring	2.87	↑	S	0.04	1.86	↑	S	0.02
Summer	2.68	↑	S	0.02	1.02	↑	NS	0.01
Monsoon	2.22	↑	S	0.02	2.51	↑	S	0.02
Autumn	1.41	↑	NS	0.01	0.86	↑	NS	0.00
Late autumn	1.44	↑	NS	0.01	1.38	↑	NS	0.01
Annual	3.23	↑	S	0.02	2.22	↑	S	0.01

NS = Not significant, S = Significant, ↑= Upward, ↓= Downward
Source: Bangladesh Metrological Department (2013)

Annual temperature had increased significantly in Chittagong and Cox's Bazar. The rate of increase was 0.02^0C and 0.01^0C per year in Chittagong and Cox's Bazar respectively. In Chittagong, the temperature had increased significantly in spring, summer and monsoon, while in Cox's bazar, it increased in spring and monsoon.

4.6 Coastal vulnerabilities: Socio economic and institutional context

4.6.1 Geo-social context

The coastal areas of Bangladesh include coastal plain islands, tidal flats, estuaries, neritic and offshore waters. Vast river networks and a dynamic estuarine system are the potential source of diversified flora and fauna. The coastal areas of Bangladesh are different from the rest of Bangladesh not only because of its unique geo-physical characteristics, but due to different socio political characteristics of its population that limits people to be endowed with resources, and perpetuates the potential risks and vulnerabilities.

Bangladesh is one of the most densely populated countries in the world with a population density (people per square kilometre) estimated to be 1020 in 2011 (UN, 2014). Due to population pressure, land is generally scarce in Bangladesh. A study by

Shamsuddoha and Chowdhury (2007) revealed that due to population pressure and the unequal distribution of assets, people in rural coastal Bangladesh perceived land as one of the most critical resources. Moreover, the 1996 agriculture survey revealed that a little more than half (53 percent) of the rural coastal population are functionally landless (Shamsuddoha and Chowdhury, 2007).

Some research has identified that living standards, average life expectancy, per capita income, access to education, health and other basic services are poor in fishing communities compared to the national average (Ali et al., 2014, Ratner and Allison, 2012). In addition, increasing trends of natural disasters are gradually making the life of the coastal population even more difficult (Islam et al., 2014). Vulnerability of the coastal population is closely linked with the natural disasters as most of the people's livelihoods depend on natural resources. The response and rebuilding capacity of the population depends on both ownership and access to resources. The poor are the most vulnerable as their asset base is weak and scanty (Islam et al., 2014). The poverty monitoring survey of the Bangladesh Bureau of Statistics (BBS) cited by Shamsuddoha and Chowdhury (2007, p. 7) places the source of vulnerabilities of the coastal population into four categories:

Human factors: i.e. sudden death, injury of the key income earner, medical bills due to illness, social injustice, conflict,

Natural disasters like floods, cyclones, water logging, tidal surges, erosion, salinity intrusion,

Governance i.e. deterioration of law and order situation, abduction, death threats, occupying government land,

Others i.e. destruction of the mangrove forest, over exploitation of natural resources (Ahmad, 2003).

4.6.2 Coastal and marine pollution

At present the coastal and marine ecosystems within the Bay of Bengal are threatened by different types of pollution dumped directly into it or washed down through a large number of rivers and estuaries. Some of the key sources of marine pollution in the Bay of Bengal are illegal oil discharge by the ships, a poorly regulated ship breaking industry, fertilizer factories and other industries, municipal wastes and agro-chemical wastes (Islam, 2003). One of the most deleteriously affected areas of localised oil pollution in Bangladesh is the Chittagong port. The major sources of pollution threatening the ecosystem of the upper Bay of Bengal are increased port activities and resulting crude and refined oil transportation, oil slicking from vessels, refinery and workshop spillage, and accidental oil spillage by tankers. Due to a lack of effective legislation and surveillance, foreign and domestic ships often discharge their oily waste into the sea (Islam, 2003). There are reports on dead fishes and the mortality of post-larvae and juveniles in the nursery grounds, due to the toxic effects from sea pollution (Ansari et al., 2012, Islam, 2011). Moreover, Kime (1995) has reported that the pollution of sea water also negatively affects fish reproduction systems.

4.6.3 Impacts of the shrimp industry

In the last few decades, a number of studies have investigated the environmental and social effects of shrimp farming in coastal Bangladesh (Bashirullah et al., 1989, Shahid and Pramanik, 1986, Islam and Haque, 2004, Ali, 2006, Paul and Vogl, 2011). Shrimp farming is growing in Bangladesh due to favourable environmental conditions, adequate water resources, cheap labour, support from international donor agencies and the involvement of multinational corporations. Although shrimp farming provides immediate economic benefits, the industry is facing a number of environmental and social challenges. Some of the key socioeconomic impacts of the shrimp farming include traditional livelihoods displacement and social unrest. Environmental impacts of shrimp farming are degradation of mangrove forests and coastal agricultural land, salt-water intrusion, pollution and disease outbreak. Inappropriate management practices and lack of monitoring by the government

agencies on shrimp farming are contributing to environmental degradation and social unrest in the coastal region (Paul and Vogl, 2011, Islam, 2003).

In Bangladesh, the shrimp culture mostly depends on wild sources of tiger shrimp fry from the near shore waters of the Bay of Bengal (Segers and Martens, 2006, p. 175). Thousands of fishers and poor unemployed coastal folk engage themselves in catching tiger shrimp fry from the bay. Fishers in the business sort the tiger shrimp fry from the catch and remainder of the catch are thrown away. In this way a large number of young shrimps and fishes are killed before attaining a biological sustainable size. Moreover, overexploitation of resources has resulted in the decreased availability of shrimp fry from year to year. Islam (2003) argues that over fishing will undoubtedly have a disastrous impact on artisanal and commercial fishery in the near future.

In the last few decades, a large area of natural mangrove forest has been cleared for the construction of dykes, ponds and canals for shrimp farming in the coastal belt of Bangladesh which has irreversibly altered the hydrological characteristics of the areas, and in the long term will affect the coastal communities negatively. One of the oldest mangrove forests in Bangladesh "Chakaria sundarbon" was completely destroyed by implementing various projects in the name of "improvement of shrimp culture technology". Rapid deforestation along the Matamuhuri river basin in Chakaria has led to an increase in both the discharge rate and sediment load of the river (Islam, 2003). Mangrove deforestation has resulted in increased coastal erosion, changed sedimentation patterns and the shoreline configuration (Sohel and Ullah, 2012). Natural breeding grounds and the production of shrimp and fish has been reduced largely due to the large-scale destruction of mangrove forest in the coastal areas of Bangladesh. The impacts of the destruction of mangrove forest in biodiversity and wild fish stock is likely to be profound. Hussain and Acharya (1994) reported that Sundarban mangrove forest ecosystem in southeast Bangladesh supports 53 species of pelagic fish and 124 species of demersal fish. Beside large number of fish species, the mangroves also support many non-piscine species of high commercial and ecological value. Islam and Wahab (2005) claim that frequent occurrence of disease and mortality of fish species in Chakaria area is due to

destruction of mangrove forests. Islam (2003) argued that clearing mangrove forest resulted in an increased vulnerability to cyclones and tidal waves.

4.6.4 Governance issues

Governance issues of the coastal and marine areas in Bangladesh are many and varied. Government policies mostly focus on the economic benefits from the coastal resources. The complex biophysical mechanism of the ecosystem and its relationship with management are rarely considered and evaluated (Islam, 2003). Corruption at different levels of management, illegal fishing, and the use of illegal gear are some of the major management problems in fisheries that have been highlighted in Bangladesh (Bennett et al., 2001b, Islam and Chuenpagdee, 2013). There are frequent claims that law enforcer agencies directly or indirectly are involved in illegal activities like extortion and land grabbing. As a result, law and order is generally poor in the coastal areas (Mahmud and Prowse, 2012). The development and implementation of management policies are also hindered by a shortage of workers for maintaining law and order, and to monitor and supervise development policies (Chowdhury et al., 2006). Poor management policies, weak organisational and legal efforts and population pressure have subjected coastal areas to exploitation and massive ecosystem destruction. A study by Mahmud and Prowse (2012) indicated that the ultra-poor suffer most because of the corruption.

4.7 Vulnerability of marine fishers

Various studies have identified rising ocean temperature (Graham, 1995, Collins et al., 2010) and ocean acidification (Hoegh-Guldberg et al., 2007), are radically altering aquatic ecosystems and these changes are eventually impacting marine and estuarine fish and fishing communities (Roessig et al., 2004, Kennedy, 1990). Roessig et al. (2004) in the paper “Effects of global climate change on marine and estuarine fishes and fisheries” describes the migration pattern of fishes which can change with relatively small temperature changes that will impact on the abundance of fish. This will undoubtedly affect the communities depending entirely on fisheries. Furthermore,

low-lying developing countries like Bangladesh will be negatively affected by relatively low temperatures and sea level rise.

4.8 Government's climate change policies and strategies

The Bangladesh National Adaptation Program of Action (NAPA) 1995 is the first major government report to address the climate change issue at the national level. NAPA 2005 was developed with the participation of various stakeholders and includes policy makers at the national level, local representatives of government, scientific community, ethnic groups and NGOs. The report suggested various programs for adaptation.

In 2009, the government revised and expanded the NAPA 2005, and developed another policy paper called Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009). This is a ten-year long program aimed to build the capacity and resilience of the country to meet the challenges of climate change. The strategy paper also outlines the 44 adaptation programs that are in line with the general development goals of the country, as well as focusing on immediate and long-term needs of the most vulnerable communities. The strategy paper identified the coastal zone of Bangladesh as one of the most vulnerable areas and thus emphasises the importance on adaptation programs for the coastal Bangladesh. Some of the adaptation programs emphasising the coastal zone are as follows:

- Improvement of flood forecasting and early warning,
- Improvement of cyclone and storm surge warning,
- Programs for awareness rising,
- Maintenance and development of cyclone shelters,
- Repair and maintenance of flood embankment and coastal polders,
- Improvement of drainage system,
- Development of water and sanitation program,
- Programs for risk management against loss of income and property.

This policy paper also outlines climate change adaptation policies and programs especially for the small-scale fishing sector as well (Table 4.10).

Table 4.10: Outline of the Bangladesh climate change strategy paper outline adaptation policy and programs especially for the fishing sector

Theme	Food security, social protection and health
Program	Adaptation in the fisheries sector
Objective	Development of adaptation strategies for the fishing sector
Actions	- Assess potential threat to fish spawning and growth of fish in the coastal zone - Assess potential threat to the marine fish sector and develop adaptation strategy - Assess potential impacts on the shrimp sectors and develop appropriate measures and practices - Assess potential impacts on fish migration

Source: BCCSAP (2009)

4.9 Conclusion

This chapter reviewed the key disasters in coastal Bangladesh, trends in various climatic indicators like temperature and rainfall, as well as the climate change response strategy of Government. The key themes that emerge from this chapter are:

- The southeast coast of Bangladesh is vulnerable to various natural disasters like floods, cyclones and storm surges, which are the most devastating to lives and properties.
- Trends reveal a significant increase in annual temperature in the southeast coast. Annual rainfall is increasing but does not appear to be statistically significant.
- Due to climate change different climatic variables like water salinity, sea surface temperature, and sea levels are expected to rise, and rainfall and seasonality patterns will become erratic. All these will have a negative impact on fishing stock.
- Disaster management in Bangladesh has improved significantly, as seen by the dramatic reduction of lives lost to natural disasters, although, challenges remain.

- According to experts due to climate change, current disasters in coastal Bangladesh are anticipated to increase in terms of both frequency and intensity.
- Poor communities are expected to be hit hardest due to impacts related to climate change.
- Poor governance and the socio-economic status of fishing communities are some of the key non-environmental challenges for climate change adaptation and disaster management in coastal Bangladesh.

CHAPTER 5

SMALL-SCALE FISHERS' PERCEPTIONS OF CLIMATE CHANGE

5.1 Introduction

Public opinion and perception of climate change is important for risk communication and environmental policy development (Pidgeon, 2012, Capstick and Pidgeon, 2014). Linden (2015) argues that understanding the factors that drive and shape community risk perception of climate change is complex and multidimensional. Moreover, there are many factors that influence people's risk perceptions, and they are socio-demographic (Deressa et al., 2011), experiential (Marx et al., 2007), cognitive (Grothmann and Patt, 2005), and socio-cultural (Whitmarsh, 2011). This chapter investigates whether risk perceptions of climate change differ between people. Here 'perception' is defined broadly in terms of people's understanding, knowledge, attitudes and concern in relation to climate change. Data used in this chapter are derived from questionnaire surveys and analysed by using descriptive statistics, such as frequencies and cross tabulations to test whether responses vary by the characteristics of respondents and between the areas selected for this study.

5.2 Relative importance of environment and climate change

A study by Mamun et al. (2013) reported that awareness of climate change is high in Bangladesh. Another study by Habiba et al. (2012) also found that farmers' awareness of the environment and climate change was high in Bangladesh. However, none of these studies investigated community concern about the environment and climate change relative to other social, economic and political issues in Bangladesh. Whitmarsh (2005, p. 138) suggested that "in isolation,… measuring a concern about a particular issue is unlikely to produce much differentiation between respondents." Several studies have demonstrated that more revealing results have been found for

measuring particular environmental concerns whenever interview data were collected in a broader context on a range of environmental, personal, economic and social issues (Hedegaard et al., 2013, Scruggs and Benegal, 2012, Bostrom et al., 2012). In order to compare the extent to which the environment and climate change is seen as an issue of importance, relative to other major social, economic and political issues, respondents were asked to mention the three most important challenges facing the fishing community. This question was asked at the beginning of the survey before asking specific questions on climate change. Then the responses were coded and summarised into eight categories, they are: safety and security, population density, social problems, disasters and climate change, housing related problems, poor coastal management, economic problems and declining fish stocks. Further explanations of these categories are shown in Table 5.1.

Table 5.1: Categories for respondents' perceptions on critical challenges in the fishing community

Number	Category	Description
1	Safety and security	Piracy, thefts, robbery, hooliganism, poor law and order, extortion, forced evacuation, no safety equipment on board, and work related injuries and fatalities,
2	Population density	High density of population, increasing numbers of fishermen, and overfishing,
3	Social problems	Illiteracy, child marriage, diseases, oppressive local elites, prostitution, drugs, alcohol and gambling,
4	Disasters and climate change	Floods, cyclones, lightening, storms, earthquakes, erosions, strong sea waves, salinity, landslides, tidal surges, sea turbulence, decreasing soil fertility, sea level rise, increased salinity of the sea surface water, hotter summers, abrupt rainfall, and seasonal changes,
5	Housing problems	Poor construction of housing, housing shortages,
6	Poor coastal management	Lack of government support, poor dam management, dam failures, deforestation, salinity intrusion, pollution, and frequent blackouts,
7	Economic problems	Poverty, poor income, high debt, formal credit inaccessibility and high inflation,
8	Decline in fish stocks	Declining fish stocks and varieties, and frequent change of fishing points.

Source: Field survey (2013)

A study by Brody et al. (2008) noted the importance of location and hazard experiences on individuals perceptions about climate change risk. The study reported that peoples' vulnerability and hazard experiences vary from one location to another. For this study, data were collected from fishing villages in Chittagong and Chakaria. These areas are located on the southeast coast of the Bay of Bengal and all the selected areas are categorised as high hazard prone areas by the Bangladesh Disaster Management Bureau (GOB, 2010). Distance between the two areas is about 100 kilometres. Fishing villages in Chittagong are located along the Bay of Bengal and villages in Chakaria are located on the bank of an estuary of the Matamuhuri river located about 20 kilometres inside the coastline of the Bay of Bengal. They were chosen as case studies to establish whether there were any differences in opinions regarding major challenges of fishing communities located in two different locations within the same coastal region.

Table 5.2 shows the response of the community to the environment and climate change compared to other economic, social and political challenges facing the fishing communities. The most important concern reported by 54 percent of respondents was safety and security, and fishers claimed that some of their biggest safety concerns were piracy, thefts, robbery, hooliganism, poor law and order in the coastal areas, extortion, forced evacuation from dwellings, and work related injuries and fatalities. These findings are consistent with those of Islam et al. (2014) who reported that piracy was one of the key non-climatic factors affecting fishing activities negatively, and a key institutional barrier for community adaptation to climate change. Respondents from Chittagong were significantly more concerned about safety and security, 68 percent compared to 48 percent of fishers in Chakaria. This concern by fishers was very real, as on the 31 March 2013 in Basaikhali, which is an adjacent fishing village to those in Chittagong, twenty fishers were killed and around fifty were injured by pirates and that incidence had made headlines in various national and international media (BBC, 2013).

Table 5.2: Social, economic and environmental concerns of the fishing communities in Chittagong and Chakaria

Most important concern	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Safety and security	64	68.1	104	47.9	168	54.0
Social problems	58	63.7	97	46.0	155	51.3
Economic problems	22	23.4	98	45.0	120	38.5
Population density	29	30.9	87	40.3	116	37.4
Declined fish stocks	34	36.2	74	34.1	108	34.7
Disasters & climate change	25	26.6	82	37.6	107	34.3
Housing problems	26	27.7	55	25.3	81	26.0
Poor coastal management	9	9.6	31	14.3	40	12.9

Source: Field survey (2013)

Overall, a little more than half of the respondents were concerned about various social problems that include illiteracy, child marriage, diseases, oppressive local elites, prostitution, drugs, alcohol and gambling. The fishers from Chittagong were significantly more concerned about these social problems, 63 percent compared to 46 percent in Chakaria. Again, this finding supports the study by Islam et al. (2014) who reported that social barriers were more pertinent in some fishing villages than others.

Almost four in ten respondents mentioned economic problems were one of their biggest concerns, which included poverty, poor income, high debt, formal credit inaccessibility, and high inflation. Respondents from Chakaria were significantly more concerned about economic problems, 45 percent compared to only 23 percent in Chittagong. Islam (2011) also reported that small-scale coastal fishers were extremely concerned about high levels of poverty. Islam (2011, p. 71) argued that because of poverty *"small-scale fishers are forced to live on the margin of existence where they are extremely vulnerable to shocks such as environmental disasters"*. Overall, a little more than one-third of respondents were concerned about high population density and overfishing, with forty percent of respondents from Chakaria concerned about

population density issues compared to 31 percent in Chittagong. Table 5.2 shows that a little more than one-third of respondents were concerned about declining fish stocks and species, although they mentioned an increased number of cases where there were dead fishes at sea and a gradual decline and/or frequent change of traditional fishing points. Fishers from Chittagong and Chakaria showed little difference in their concerns about fishing stocks and any perceived declines.

Survey results showed that environmental disasters and climate change ranks sixth in the list of the key environmental and non-environmental challenges of the fishing community. A little more than one-third of respondents mentioned disasters and climate change as one of their major concerns, specifically floods, cyclones, lightening, storms, earthquakes, erosions, strong sea waves, salinity, landslides, tidal surges, sea turbulence, decreasing fertility of soil, sea level rise, the increased salinity of sea surface water, temperature and rainfall changes. However, respondents in Chakaria (38 percent) were more concerned about climate change, compared to those in Chittagong (27 percent).

One-quarter of respondents were concerned about issues related to housing, which was the same for Chittagong and Chakaria. These include the poor construction of housing and housing shortages. During the survey, it was observed that generally, fishers lived in thatch roof houses; and few houses were constructed with bricks and tin. These fragile houses are vulnerable to disasters.

Overall, almost one in ten fishers were concerned about poor coastal management, in particular, lack of government support, poor dam management, dam failures, deforestation, salinity intrusion, pollution, and frequent blackouts. An interview with a community leader from Chakaria highlighted some of the mismanagement of floods control system in the coastal areas.

> A 60 year old community leader from Chakaria said that the government did not allocate enough funds to construct flood control dams. The corruption of contractors and government officials were associated with poor quality of the construction of infrastructure. Poor quality infrastructure generally needed frequent maintenance. Moreover, damaged dams were also not repaired on time by the authority. As a result, tidal surges and heavy rain flooded vast areas at regular intervals. He also complained that in some areas of Chakaria frequent floods have recently increased due to the faulty

> design of dams. Poor land use planning and deforestation were increasing the risk of disasters (Case 1, Respondent 13).

The survey results highlight the key environmental, institutional, political, social and economic concerns of the fishing communities. Some of these are linked to each other. For example, a disaster can cause immediate and significant economic pressure for a fisher. The following case study shows how a disaster can change social-economic status of a fisher.

> For example, a 45 year old day labourer who lived in Salimpur, Chittagong with three children and a wife. He used to be a boat owner and financially solvent. In the 2008 cyclone, he lost his boat. Against that boat he had a loan of taka 45,000 from a local moneylender with a high interest rate. In 2012, even four years after the cyclone, he could not manage to repay the loan. He thought it would take a few more years to repay the loan and rebuild his life. He was worried about his future (Case 24, Respondent 364).

Survey data showed that environmental concerns were closely related to local experiences that pose a direct threat to individuals. Respondents mentioned floods, cyclones, storm surges, longer summers, and increased temperature as environmental and climatic threats, and these disasters were quite common in coastal Bangladesh. This finding was consistent with previous research that shows direct experiences have a major influence in shaping individuals risk perceptions (Whitmarsh, 2008, Spence et al., 2011). Myers et al. (2013) also found a relationship between personal experiences and their perceptions of climate change.

The survey results indicated that the risk perceptions of respondents differed by location. Respondents living in Chakaria were more concerned about safety and security, economic and social problems, disasters and climate change. It was observed that among the two study areas, the flood control system and dam management was better in Chittagong, and therefore, fishers in Chakaria were more exposed to disasters and climate change related impacts.

5.3 Knowledge of climate change

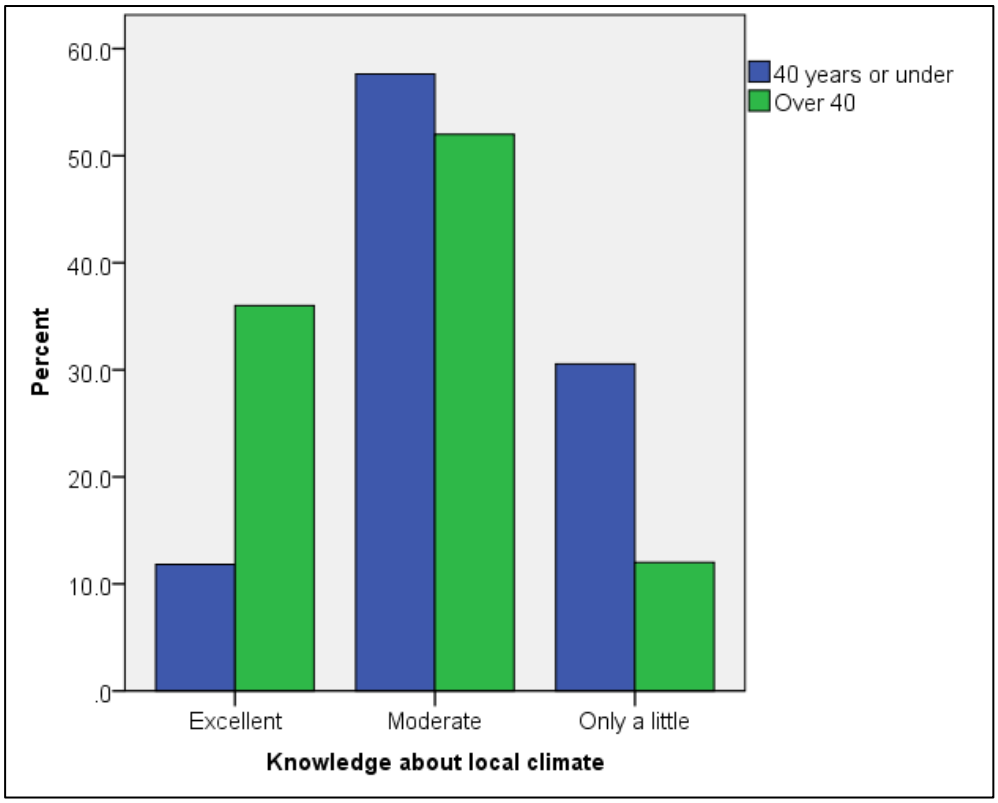
Understanding people's knowledge of climate change has been the major theme of research on risk perception. Maslin and Austin (2012) reported that in general, people have limited knowledge on the physical processes contributing to climate change, and

were confused about how particular actions are connected to the issues. Weber (2010) in his article, "What shapes perceptions of climate change?" argued that people mainly understand climate change through experiences and observations. A study by Mamun et al. (2013) reported that over eight in ten people in Bangladesh had heard the term climate change and six in ten people knew what it meant. The study reported that awareness of climate change was highest amongst the most educated. Some 64 percent of respondents in this study were uneducated, while 28 percent of respondents only had education up to primary school which was far below the national average of 57.7 percent (UNICEF, 2015). In the focus group discussion and in-depth interviews it was also observed that fishers had little understanding about the scientific definition of climate change. However, it was noted that because of professional requirements, generally fishers were keen observers of environment and climate. It was also observed that generally fishers do not differentiate climate from weather. However, this aspect of peoples' perceptions is not uncommon. Reynolds et al. (2010) found that many lay people in the United States (US) found it difficult to distinguish between weather and climate. The authors suggested that confusion between them might have important implications for climate change policy development and risk communication. Considering fishers lack of understanding regarding the scientific processes of climate change, direct questions regarding physical processes underlying climate change were not asked. In this study, the survey respondents were asked to indicate their level of concern on different parameters related to climate change, such as rainfall, temperature, seasonal pattern and environment. According to the IPCC fifth assessment report some of the impacts of climate change are already visible in Bangladesh (IPCC, 2014).

Previous studies have indicated that people's perceptions of climate change are influenced by personal experiences and knowledge of local environments (O'Connor et al., 1999, Berkes and Berkes, 2009). This study investigated respondents' level of knowledge on local climate. Figure 5.1 shows that about one third of respondents over 40 years thought that they had a good knowledge on the local environment, while only 10 percent of those under 40 years perceived so. A little more than half the respondents in each age group thought they had moderate knowledge on the local

environment. The results indicated that respondent's knowledge on local climate increases with age.

Figure 5.1: Survey respondents knowledge on the local environment by age



Source: Field survey (2013)

Causes of climate change

Respondents were asked to indicate their perceptions about the causes of climate change. Table 5.3 shows that about 42 percent of respondents in Chittagong and 66 percent in Chakaria thought climate change was an *Act of God* or it is a natural process. It was observed that Chakaria respondents appear to be more vulnerable to natural disasters than those in Chittagong. Decades ago Schmuck (2000) reported in Bangladesh that religious people believed floods, tornadoes and cyclones were an *Act of God*. Results of this study indicated that the small-scale marine fishing community in Bangladesh relate climate change as an *Act of God* or a natural phenomenon too.

Table 5.3: Survey respondents perceived causes of climate change by area

Reasons for climate change	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Act of God/natural process	36	42.0	151	66.0	187	59.9
Deforestation	29	34.1	52	22.9	81	26.0
Pollution	24	28.2	53	23.3	77	24.7
Impossible to say	22	25.9	53	23.3	75	24.0
Punishment of God	18	21.2	25	11.0	43	13.8
Other countries	2	2.4	4	1.8	6	1.9

Source: Fields survey (2013)

Overall, one in four respondents also chose deforestation and pollution as one of the reasons for climate change. A fisher claimed that in coastal areas, people were cutting down trees indiscriminately which had contributed to increased temperature and vulnerability to natural disasters.

> A 35 year old fisher from Chittagong said that overuse or misuse of natural resources were abusive to nature. Because of increased population and increased demand, people were cutting down trees indiscriminately. Trees were natural barriers to soil erosion, and to reduce the force of cyclonic wind. Human disregard to the environment were the reasons for climate change (Case 1, Respondent 5).

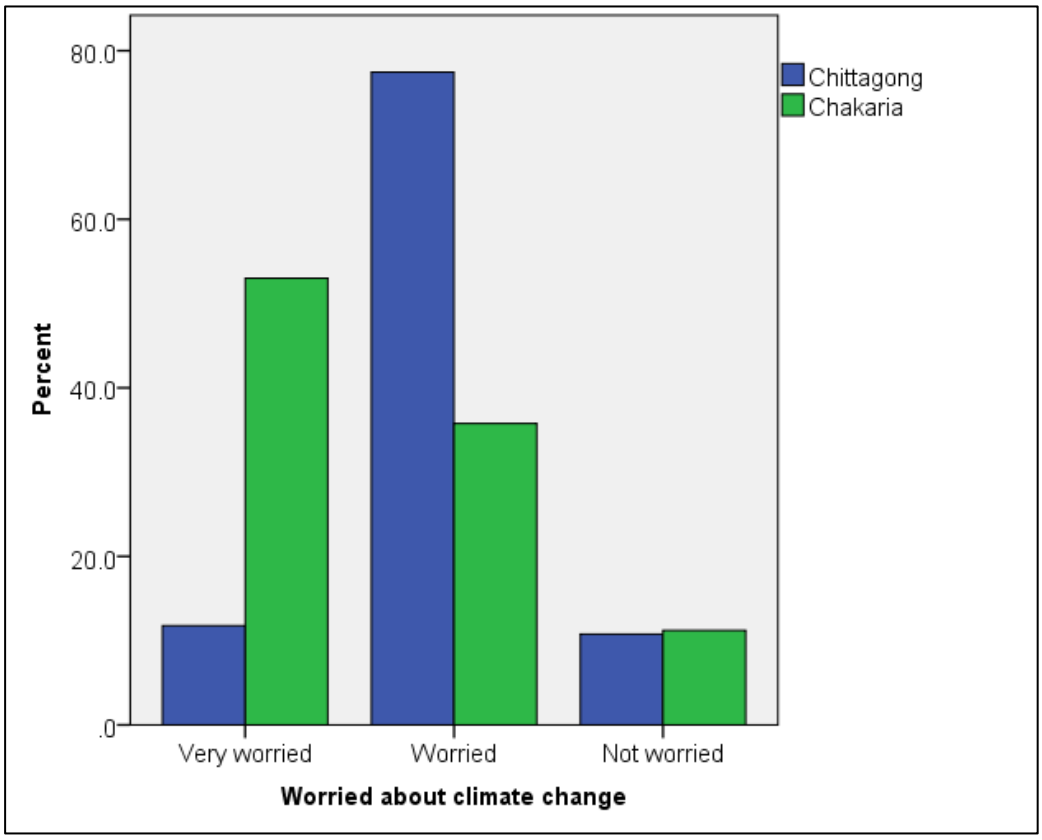
A quarter of respondents in Chittagong and one-tenth in Chakaria perceived that it is beyond human capacity to understand reasons behind climate change, while only two percent thought the activities of other countries were responsible for climate change. Results of this study indicate that respondents are mostly unaware about the causes and the physical processes of climate change explained by scientists.

5.4 Concern about climate change

Figure 5.2 shows that the majority of respondents from Chittagong and Chakaria are ‘worried’ or ‘very worried’ about climate change, with respondents from Chakaria more worried than those in Chittagong. A little more than 10 percent of the respondents in Chittagong were very worried compared to more than half in Chakaria. Most of the deep sea going fishers were worried about climate change. The findings

of this study support the study by The World Bank (2010) that reported concerns about climate change were high in Bangladesh and that most Bangladeshi thought climate change was a serious problem. Some 10 percent of respondents from Chittagong and Chakaria were not worried about climate change.

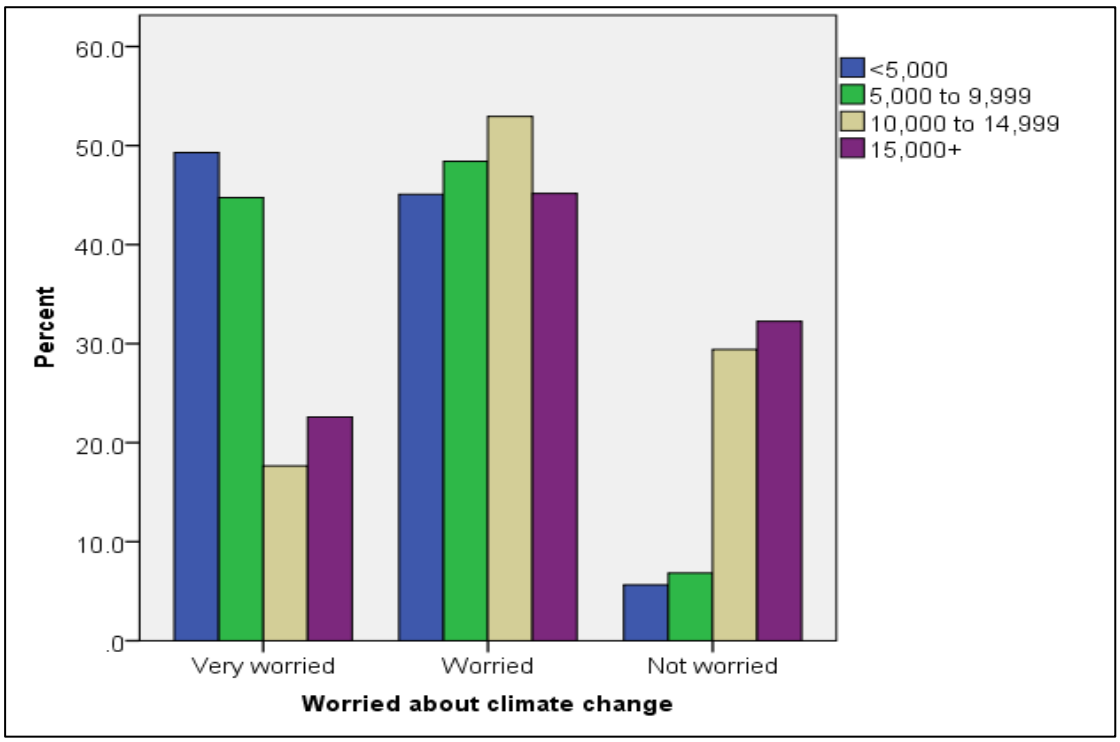
Figure 5.2: Survey respondents worried about climate change by area



Source: Field survey (2013)

Figure 5.3 shows that the majority of respondents whose average monthly income was below Taka 5,000 were either very worried or worried about climate change. By contrast, one third of respondents whose average monthly income was more than Taka 15,000 were not worried about climate change. Results showed that the degree of concern decreased with increased income. Brouwer et al. (2007) reported that low-income families living in flood plain areas in Bangladesh are more exposed to disasters and therefore are more likely to be the most vulnerable.

Figure 5.3: Respondents level of worry about climate change by income group

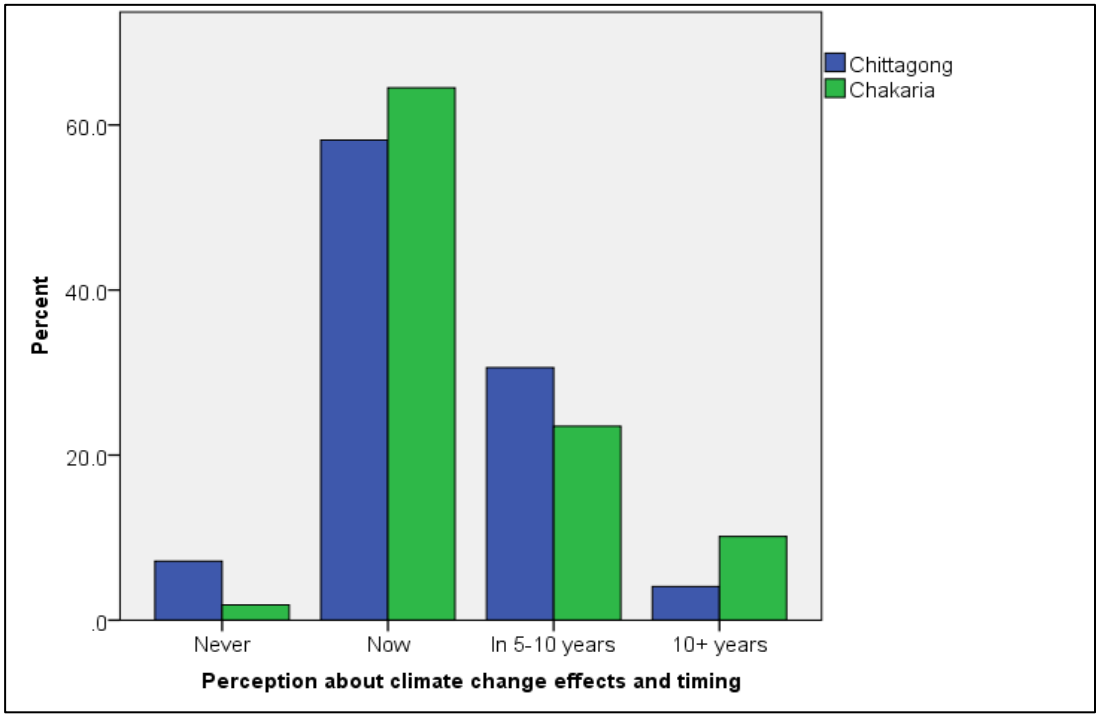


Source: Field Survey (2013)

Figure 5.4 shows that almost six in ten respondents from Chittagong and Chakaria thought that they have been affected by climate change, with respondents in Chakaria were more concerned about the ongoing impacts of climate change than those in Chittagong. One third of respondents in Chittagong and one quarter in Chakaria thought that they would be affected by climate change in the next five to ten years. Interestingly more respondents in Chittagong thought that they would be impacted by climate change in the near future. Most of the fishing villages in Chittagong were located along the shoreline of the Bay of Bengal and were protected by dams and mangrove forests. Fishing villages in Chakaria were located in low-lying areas of estuaries, which made it more vulnerable to disasters. Fishers in Chakaria perceived that they had become frequent victims of disasters, such as erosion and floods. One in ten respondents in Chakaria also thought that they would be affected by climate change in more than ten years. Only a small proportion of respondents perceived that they would never be harmed by climate change (7 percent in Chittagong and 2 percent

in Chakaria). Results clearly indicate that respondents in Chakaria were more concerned about the effects of climate change.

Figure 5.4: Survey respondents perception about climate change effects and timing by area



Source: Field survey (2013)

5.5 Threats

5.5.1 Immediate threats

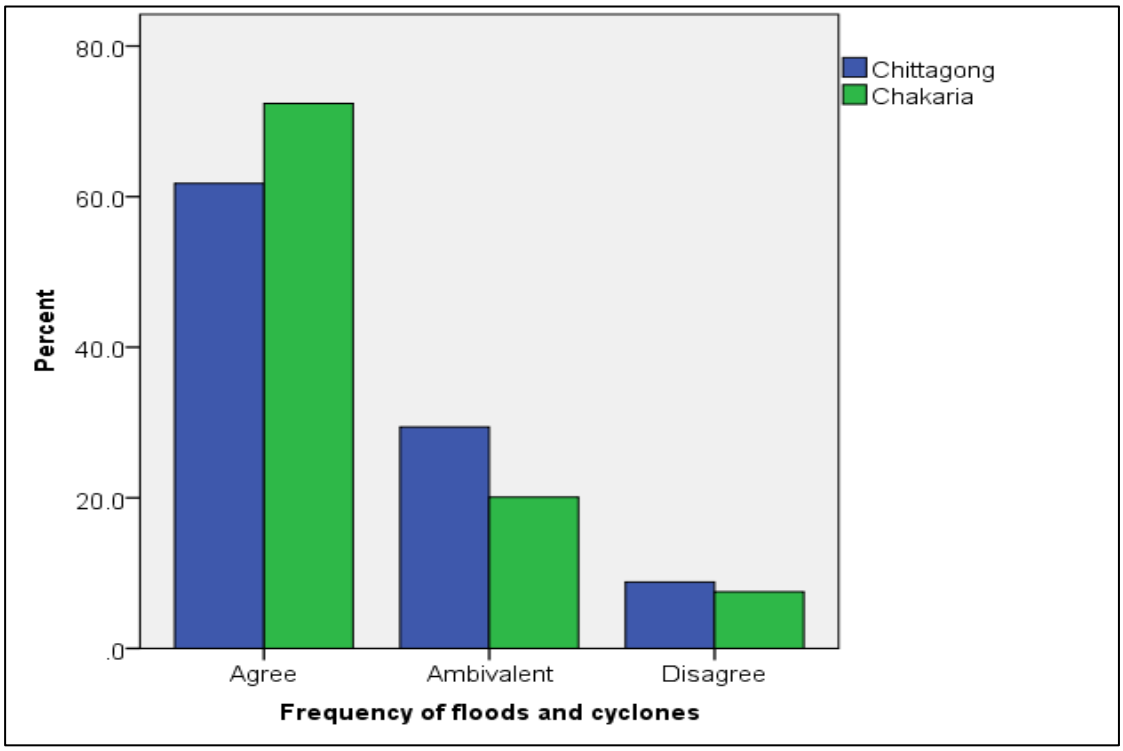
Respondents were asked to indicate their level of concern relating to various climatic indicators (such as rainfall, temperature, frequency of disasters) based on their observations in the last five to ten years. The following section describes respondents' response based on observed changes in the last 5 to 10 years.

Frequency of disasters

Figure 5.5 shows that the majority of respondents in Chittagong and Chakaria thought that the frequency of floods and cyclones had increased. It is important to note that

about one-third of respondents from Chittagong and one fifth from Chakaria neither agreed nor disagreed with the increased frequency of key disasters. In interviews fishers mentioned that it was not easy to understand the trends in disasters, as the frequency and intensity of disasters changed year by year and some years were better than others. Less than 10 percent of respondents from Chittagong and Chakaria disagreed about the increased frequency of disasters.

Figure 5.5: Survey respondents perception about the increased frequency of disasters by area



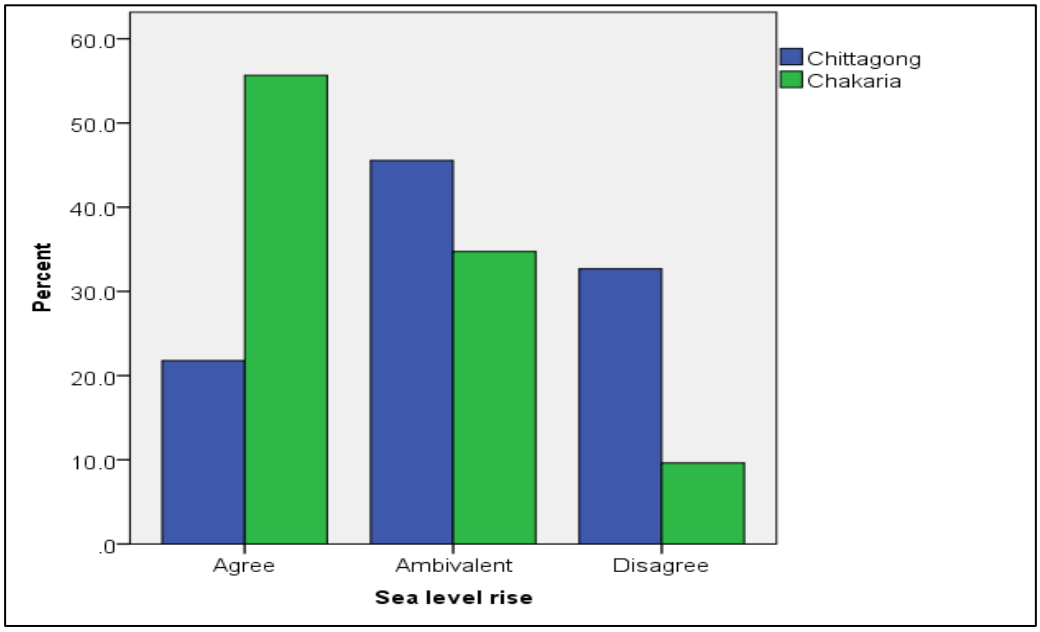
Source: Field survey (2013)

Sea level rise

Respondents in Chakaria who live 10 to 15 km inside the coastline, were more concerned about sea level rise than those in Chittagong who live along the coastline of the Bay of Bengal. Figure 5.6 shows that almost half of the respondents in Chakaria agreed with the statement about rising sea levels compared with only one fifth from Chittagong, with about half of those from Chittagong and one third respondents from Chakaria confused about sea level rise. In the group discussions and in-depth

interviews respondents mentioned that the coastline of Bangladesh is dynamic. Whenever land erodes on one side of the river, new lands emerge on the other side. Therefore, at the local level it was not easy to understand and to measure eroded coastlines. A good number of respondents also mentioned that they had observed in the last 5 to 10 years that the sea had become flatter in Chittagong areas. Respondents in Chakaria reported that high sea levels had been putting tremendous pressure on dams in Chakaria and causing frequent failure of the flood management system. More details on fishers' perceptions on sea level changes are discussed in Chapter 7.

Figure 5.6: Survey respondents perception about sea level rise by area



Source: Field survey (2013)

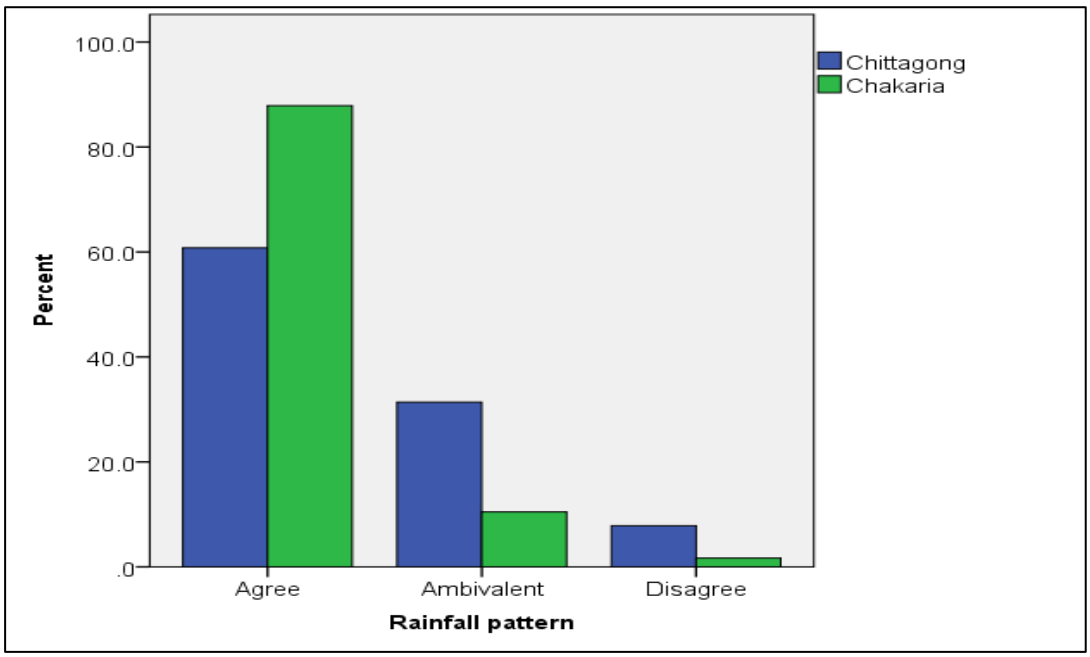
These finding are quite a surprising finding as most of the physical science studies mentioned sea level rise as one of the biggest climate change threats in Bangladesh. Karim and Mimura (2008) reported 0.3 metre sea level rise in coastal flood risk areas by 15.3 percent and the depth of flooding would be increased by 20.7 percent within 20 km of the coastline. Kay et al. (2015) applied a shelf-sea model of the Bay of Bengal to investigate how the combined effects of sea level rise and other environmental conditions may have altered the frequency of extreme sea level events on the coastlines for the period 1971 and 2099. The study suggested climate change would lead to large areas of land being subject to increased salinization, flooding and

ultimately abandonment in West Bengal, India and coastal Bangladesh. Warrick and Ahmad (2012, p. xi) in their book *"The Implications of Climate and Sea Level Change for Bangladesh"* pointed out that there is a major knowledge gap concerning human perception and response to sea level rise and global warming in Bangladesh.

Changing Rainfall Patterns

Figure 5.7 shows that the majority of fishers agreed that the rainfall pattern was changing in coastal Bangladesh. Respondents in Chakaria were more concerned about rainfall than Chittagong (80 percent in Chakaria and 60 percent in Chittagong). Results of 30 years (between 1980 to 2011) rainfall data analysis showed that on average Chakaria received 20 percent more annual rainfall than Chittagong (discussed in Chapter 4). In interviews, respondents mentioned that they have observed rainfall days were spread fairly evenly throughout all seasons except winter, and that there had been an increase in heavy rainfall days in the monsoon, and they attributed this to increased floods, landslides and waterlogging. In Chakaria, 78 percent of the annual rainfall, which was 3678mm, occurred in the monsoon and autumn (discussed in Chapter 4). This result supports the research findings by Shahid (2011) who reported a significant increase in annual and pre-monsoon rainfall in the period 1958 and 2007 in Bangladesh. Some one-third of respondents in Chittagong and one sixth in Chakaria were ambivalent about changing patterns of rainfall. It was observed that the flood management system was better in Chittagong than in Chakaria and was another reason for respondents in Chakaria to be more concerned about water-induced disasters, such as water logging, floods, storm surges, tidal bore and salinity intrusion. Only a small fraction of respondents disagreed about the changing pattern of rainfall.

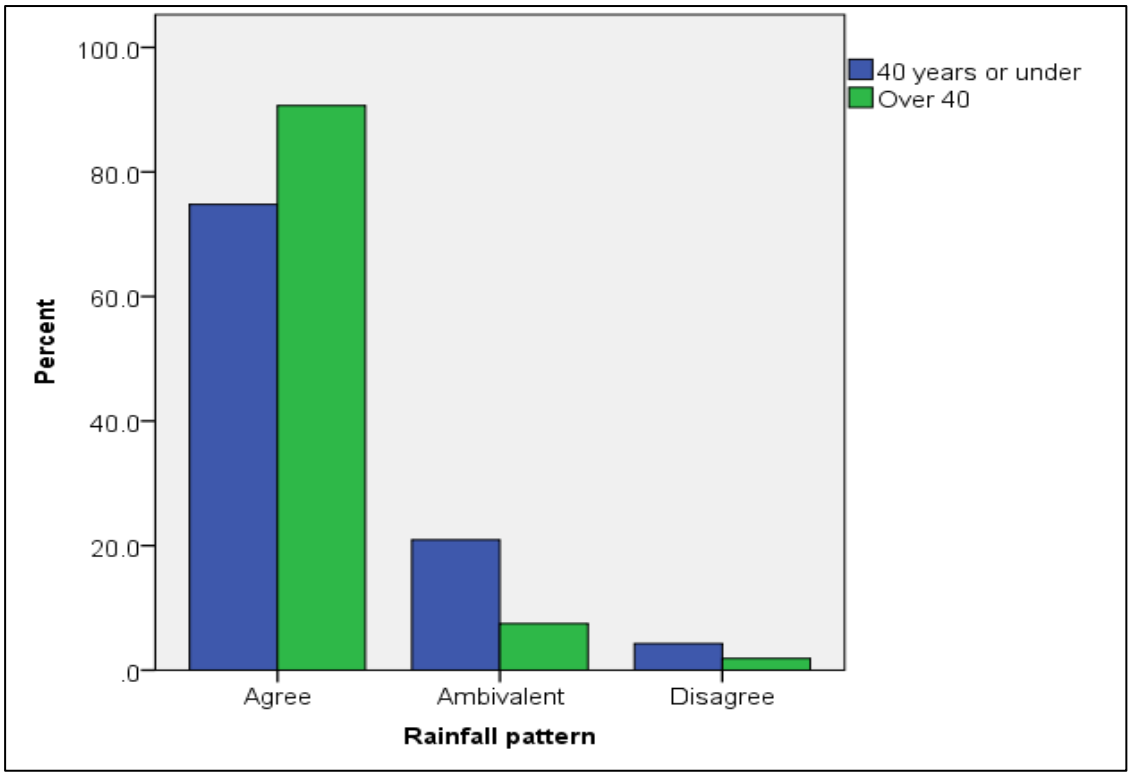
Figure 5.7: Survey respondents perception of rainfall by area



Source: Field survey (2013)

Figure 5.8 shows that 90 percent of respondents over 40 years of age and about 80 percent of those under 40 years agreed with the changing rainfall patterns. Moreover, one fifth of the younger respondents and one-tenth of the older ones were ambivalent about the change in rainfall patterns. Results indicate that most had observed changes in rainfall patterns and with increasing age, respondents are more likely to anticipate the changes. Menny et al. (2011) also argued that age and lived experiences influence respondents knowledge about climate change.

Figure 5.8: Survey respondents perception about changes in rainfall patterns by age

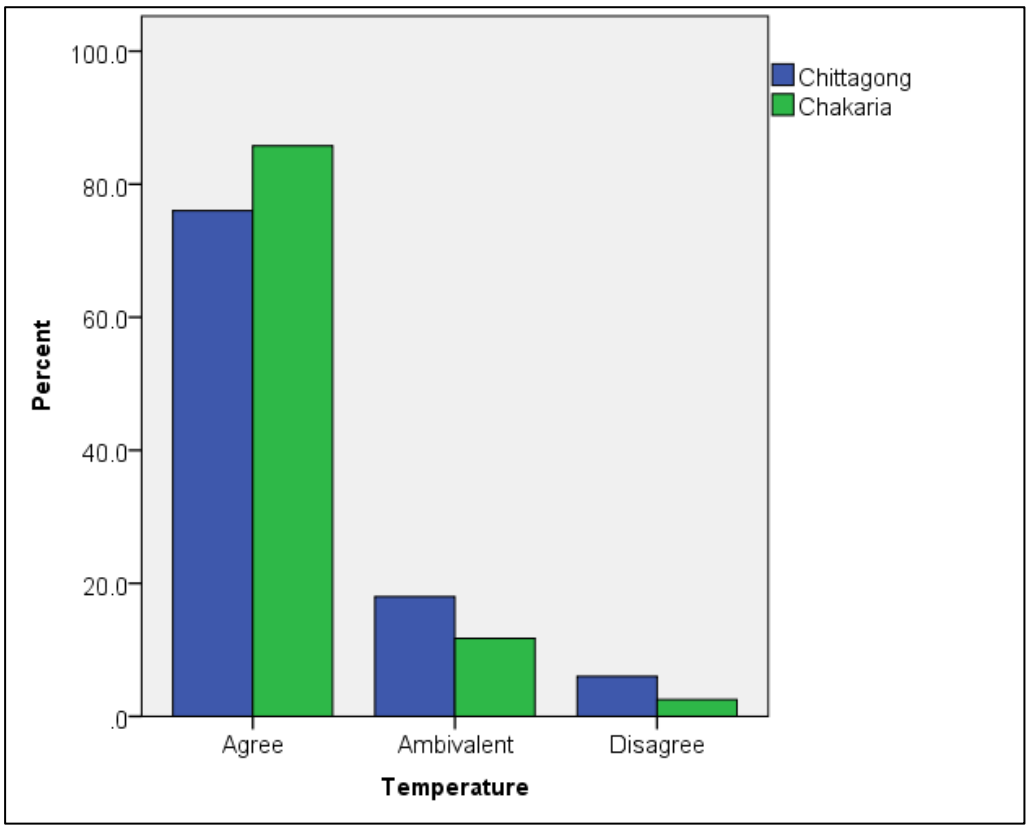


Source: Field survey (2013)

Temperature Increases

An overwhelming number of respondents from Chittagong and Chakaria agreed that average temperature was rising and of the two areas, respondents in Chakaria were more likely to agree about rising temperature (Figure 5.9). This finding is in agreement with the findings of the temperature trends discussed in Chapter 4. Respondents attributed fatigue, increased cyclones and professional risks to higher temperatures. Chowdhury et al. (2010) argued that increased temperature could affect the migration patterns of fish species and some species might migrate to a higher latitude for a cooler place. The authors also reported that increased temperature might cause increased cyclones, storm surges and sea level rise. Reid et al. (2015) argued that changes in temperature and rainfall affect the growth and reproduction of fish species.

Figure 5.9: Survey respondents perception of temperature by area



Source: Field survey (2013)

Table 5.4 shows that additional comments made by respondents indicated that they had observed climatic changes in the last 5 to 10 years. Respondents thought summer became hotter and longer and winter became shorter with intense cold days for a week or two. The respondents also indicated that the seasonal pattern was also changing. The most prominent seasons being summer, winter and rainy season.

Table 5.4: Selected responses by respondents relating to observed climate change in the last 5 to 10 years

Climatic variables	Perception
Temperature	Summer is getting longer and hotter (n= 15), Warmer winter (n=3), Increased frequency of hot waves in summer (n=10), Shorter winter with intense cold days for a week or two (n = 5),
Rainfall	Increased events of extreme rainfall (n= 6), Drier winter (n = 5), Number of days without rainfall has increased (n= 2), Extreme rainfall cause floods and landslides (n = 12) ,
Seasonal pattern	Decreased seasonal variation (n = 12), Summer, winter and rainy seasons are most prominent (n = 20), Seasonal pattern does not follow the historical trends (n = 3),
Cyclone	Difficult to predict, can happen any time of a year (n = 2).

n = Number of respondents
Source: Field visit (2013)

Most of the respondents were concerned about the frequency of disasters, increased temperature, changed seasonal and rainfall patterns. Respondents mentioned that historial seasonal and rainfall patterns had changed. The majority of these perceptions were in-line with the IPCC fifth assessment report that states the impacts of climate change in Bangladesh were already being felt (IPCC, 2014). A study by Warrick and Ahmad (2012) found that the rainfall and temperature scenario was changing in Bangladesh because of climate change. Respondents tended to be divisive or not in strong agreement with the rise in sea level. However, respondents from Chakaria were more likely to agree that sea levels were rising. Results indicated that the respondents' location and age were important factors for shaping differences in climate change perceptions.

5.5.2 Future threats

Respondents were asked about the most serious climate change threat for the community in the next ten to fifteen years. Table 5.5 shows that overall half of the respondents mentioned floods and cyclones as the most serious climate change threat for the community. Fishers mentioned that cyclones, floods, storm and tidal surges are some of the most serious disaster threats related to climate change. Respondents from Chakaria were much more concerned about floods and cyclones (58 percent) than those in Chittagong (38 percent). The second most serious concern for the community

after floods and cyclones was lightening. Fifteen percent of fishers mentioned lightening as one of the most serious threats for the community. Fishers who mainly fish in the sea were more concerned about lightening than estuarine fishers and in this study the proportion of seagoing fishers were more likely to live in Chittagong (95 percent) than Chakaria (72 percent). So far, no study has reported lightening as a major climate change threat for Bangladesh. There are several possible explanations for this result. For this study, data were collected right after the monsoon season and in the southeast coast of Bangladesh where seventy percent of annual rainfall occurs during this season (Ahasan et al., 2010). Compared to other seasons, the incidence of lightning strikes are more likely in the monsoon season and that might have a role in fishers' perceptions. Romer and Jamieson (2001) argued that risk of immediate harm tends to influence human risk perception. A recent study by Romps et al. (2014) found that there was a link between frequency of lightning strikes and climate change. The study reported that in the United States (US) incidences of lightning strike could increase by about fifty percent over this century due to climate change.

Table 5.5: Fishers' perceptions of climate change threats in the next 10-15 years by area

Threats	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Floods and cyclones	35	37.6	108	57.8	143	50.9
Lightning	22	23.7	21	11.2	43	15.3
Sea level rise	5	5.4	35	18.6	40	14.2
Change of seasonal patterns	14	15.1	11	5.9	25	8.9
Earthquakes	10	10.8	6	3.2	16	5.7
Shortage of drinking water	7	7.5	7	3.7	14	5.0
Total	93	100.1	188	100.4	281	100.0

Source: Field survey (2013)

Sea level rise was ranked as the third most important concern for the community. Respondents from Chakaria were significantly more concerned about sea-level rise.

Overall, nine percent of fishers mentioned change in seasonality patterns as their biggest concern. Fishers mentioned longer and hotter summers, erratic rainfall, changes in cyclonic season and extreme cold days during winter as some of their important concerns. Moreover, fishers in Chittagong were more concerned about the changes in the seasonality pattern. Fishers claimed that the migration pattern of fish species and fishing points changed with the season. Frequent change in temperature and rainfall make it difficult for fishers to find suitable fishing points and that increases the costs for fishing. Only a small percentage of respondents mentioned earthquakes and shortages of drinking water as one of their concerns about climate change.

Previous research has identified threats of climate change in coastal Bangladesh that include sea level rise, increased frequency and intensity of regular disasters, change of rainfall and seasonality pattern (Discussed in Chapters 1, 2 and 4). However, so far no research has identified lightning as a climate change threat in Bangladesh. It is interesting to note that fishers' perceptions of future threats of climate change were linked to their present perceptions of climatic trends. For example, those who agreed with the statement "frequency of floods and cyclones are increasing" also mentioned floods and cyclones were the most serious future threat of climate change (57.2 percent).

5.5.3 Community specific threats

Previous studies have indicated that sea level rise and the consequent changes in marine environment in the coastal Bangladesh can trigger changes in fish habitats and breeding grounds (Hussain and Hoq, 2010). Climate change and extreme weather events can disrupt fishing operations, fish production, livelihood strategies and overall outcomes of the fishing communities (Badjeck et al., 2010). In this study respondents were asked to indicate their level of concern about the possible disruptions of climate change on fishing operations, the marine ecosystem and oceanographic variables, such as fish stock, fishing points, wind velocity and sea waves, salinity, profitability, professional risks and food security.

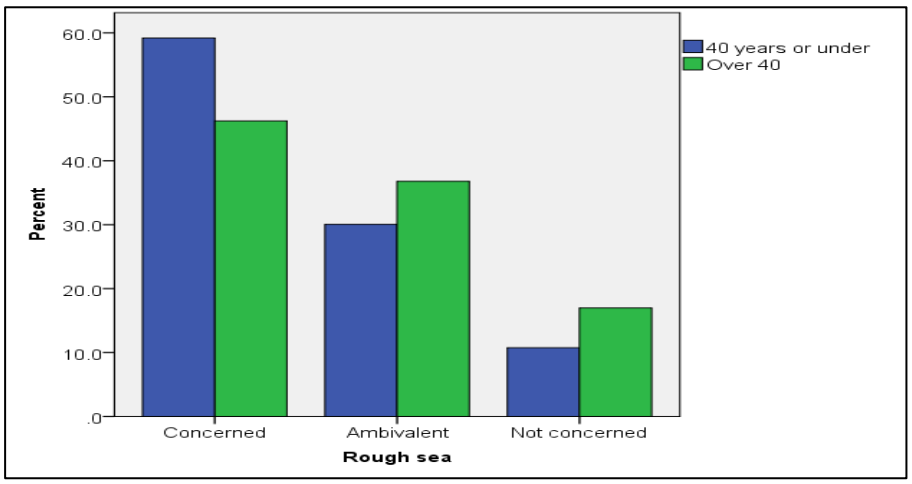
From the field survey, it was found that the majority (about 80 percent) of respondents from Chittagong and Chakaria were concerned about fish stocks with few showing no concern. Findings of this study support some of previous studies, such as Yazdi and Shakouri (2010) who reported that climate change is modifying the distributions and productivity of marine and fresh water species and affecting their biological processes. Another study by Guinotte and Fabry (2008) suggested that the current rate of ocean acidification can trigger mass extinctions and changes in distribution and abundance in species. In the in-depth interviews fishers mentioned over fishing and pollution as well as climate change had resulted in the gradual decline of fish stock. Hussain and Hoq (2010b, p. iii) in his book "*Sustainable Management of Fisheries Resources of the Bay of Bengal"* argued that in the Bay of Bengal artisanal and industrial fishers exploited fish resources without any management plan, and the absence of data on the status of fish stock in the bay resulted in over exploitation of near shore stocks and the under exploitation of those off shore resources. Further study is needed to know exactly the extent to which climate change is responsible for the depletion of fish stocks in the Bay of Bengal and its estuaries. The survey results show that 96 percent of respondents aged over 40 years were concerned about fish stocks compared to about 80 percent of younger respondents. Results indicated that concern about fish stocks increased with age and it was observed that most of the captains (locally know as head majhi) and boat owners (locally known as bohoddar) were in the older ages. Because of professional reasons, aged fishers were more concerned about fishing stocks than their younger counterparts.

The survey results indicated that about fifty percent of respondents from Chittagong and Chakaria were concerned about changes in fishing points, with about forty percent of fishers ambivalent about the impacts of climate change on fishing, and very few respondents not at all concerned. In the in-depth interviews fishers mentioned that they had exploited fish resources from some specific fishing points, and that generally, the boat captain was responsible for tracing and selecting fishing points. These new fishing points change for various climatic and non-climatic reasons, such as the time of the day, season, time of the tides, wind direction and waves,

composition of fish species and fish migration patterns. Boat captains, boat owners and experienced fishers were more concerned about fishing points. Boat captains lead teams of between 4 to 18 crew members who mainly follow instructions from them and the boat owners. It was observed that labourers in fishing boats were not very concerned about fishing points. Ficke et al. (2007) reported that the impacts of climate change on fish based livelihoods is significant. Change in water temperature, precipitation and oceanographic variables such as wind velocity, wave action and sea level rise, can bring ecological and biological changes to marine and fresh water ecosystems. Further investigation is recommended to find out how climate change impacts on fishing points at the Bay of Bengal.

Figure 5.10 shows that respondents under 40 years of age were more concerned about rough seas compared to the older ones. It was observed that younger fishers were also more worried about their future because of increased disasters (e.g. cyclones) and their risks in fishing. However, some fishers believed that risk had always been an integral part of the fishing community and fishers should never be scared off the sea. Although the majority of fishers admit that the sea had become rougher, some of them were not ready to anticipate that they were worried or concerned. About one third of young respondents (aged 40 year or under) and 40 percent of older ones were ambivalent or confused about whether they should be concerned about rough seas and a little more than 10 percent of respondents over 40 years were not.

Figure 5.10: Survey respondents concern about rough sea by age



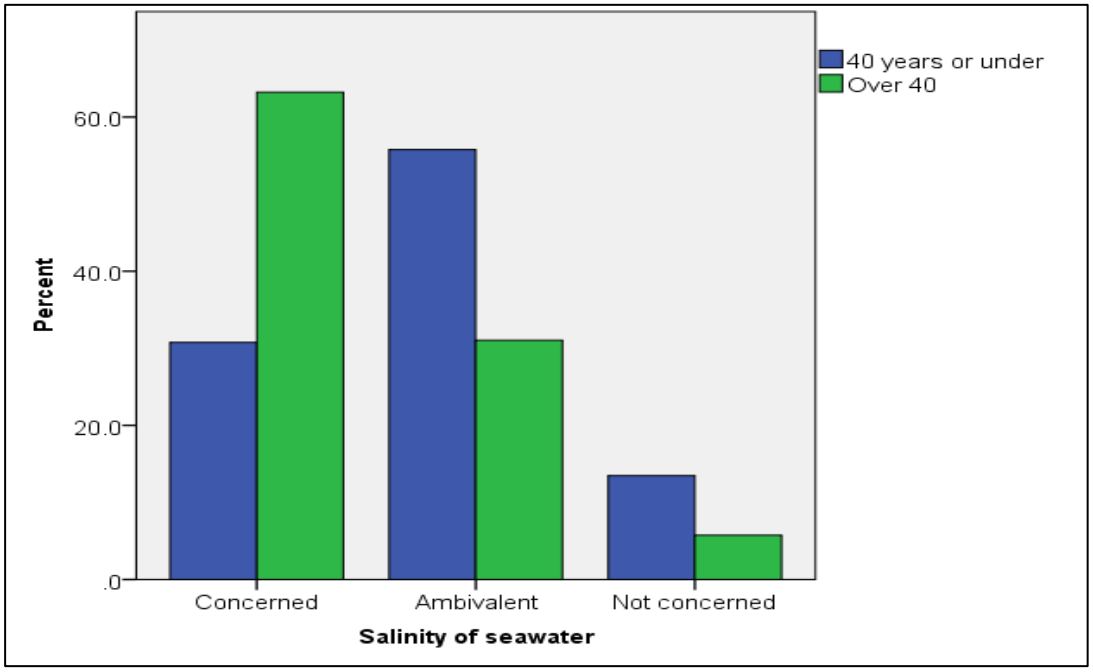
Source: Field survey (2013)

Results of this study also indicated that respondents were concerned about salinity, fifty percent of respondents in Chittagong and sixty percent in Chakaria being concerned about soil salinization. One-third of respondents from both areas were ambivalent about the issue, but concern over soil salinization was 10 percent higher in Chakaria (Figure 5.11). Most of the study areas in Chakaria were located in the flood prone areas and respondents claimed that these low-lying areas near the Matamuhuri River frequently flooded with saline water. Hanifi et al. (2010) found that because of salinity, the child mortality rate in the low-lying areas in Chakaria was 1.5 times higher than outside them. It was observed that in Chittagong the extent of the problem was not that critical. Almost one-fifth of respondents from Chittagong were not concerned about soil salinization. Previous studies have reported that coastal Bangladesh is threatened by sea-level rise and salt-water intrusion (Dasgupta et al., 2014). A study by Haque (2006) reported that coastal areas of Bangladesh were affected by salinity due to tidal flooding during the monsoon season, due to inundation by flood and storm surges. Increased salinity would result in loss of agriculture land and biodiversity (Rahman et al., 2011), change in land use planning (Alam, 2014), scarcity of safe drinking water and be a health crisis (Khan et al., 2011) in coastal Bangladesh. Consequently, salinity has become a major concern of climate change impacts for coastal Bangladesh, particularly in Chakaria.

Figure 5.11 shows that respondents over 40 years of age were much more concerned about the salinity of seawater compared to the younger ones, who were more likely to be neutral or not concerned. It was observed that experienced fishers and boat captains (head majhi) had a good idea about how rainfall changes seawater salinity and its impacts on fish migration and species composition. Experienced fishers can also explain how the salinity of seawater changes by season and how that influenced the migration pattern of fish species. Impacts of seawater salinity on fishing activities are described in Chapter 7. Scientists have reported that unexpected changes in seawater salinity can accelerate the water cycle and increase extreme climatic events like floods and cyclones (Matthews, 2012). Increased seawater salinity threatened marine fisheries in many ways, such as change in nutrient availability, change in

abundance and distribution of fishes, and also had negative impacts on corals (Roessig et al., 2004).

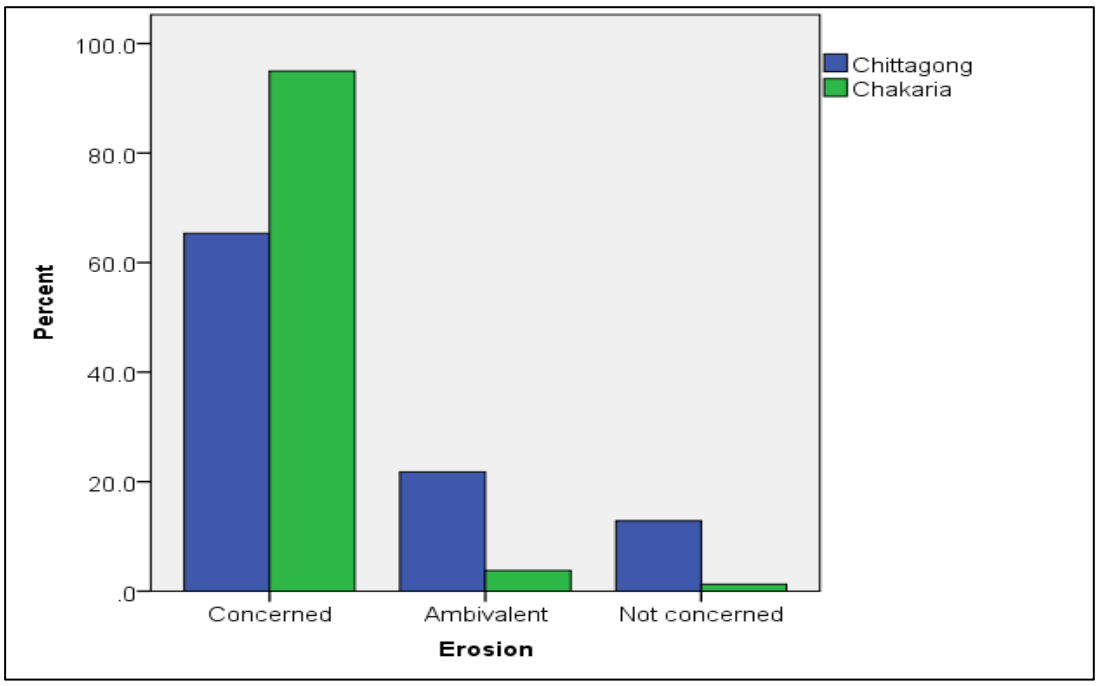
Figure 5.11: Survey respondents concern about salinity of the seawater by age



Source: Field survey (2013)

Coastal land erosion has been identified as one of the major climate change threats for coastal Bangladesh (Islam et al., 2014, Brammer, 2014). Figure 5.12 shows that the majority of respondents were extremely concerned about coastal land erosion which was higher in Chakaria, 95 percent compared to 60 percent of respondents in Chittagong. Respondents attributed deforestation, unplanned development and sea level rise to increased erosion in Chakaria. Respondents in Chittagong thought that forests along the coastline and dams were providing a buffer against storms and erosion. One fifth of respondents in Chittagong were concerned or not concerned about erosion with one tenth not concerned at all.

Figure 5.12: Survey respondents concern about erosion by area



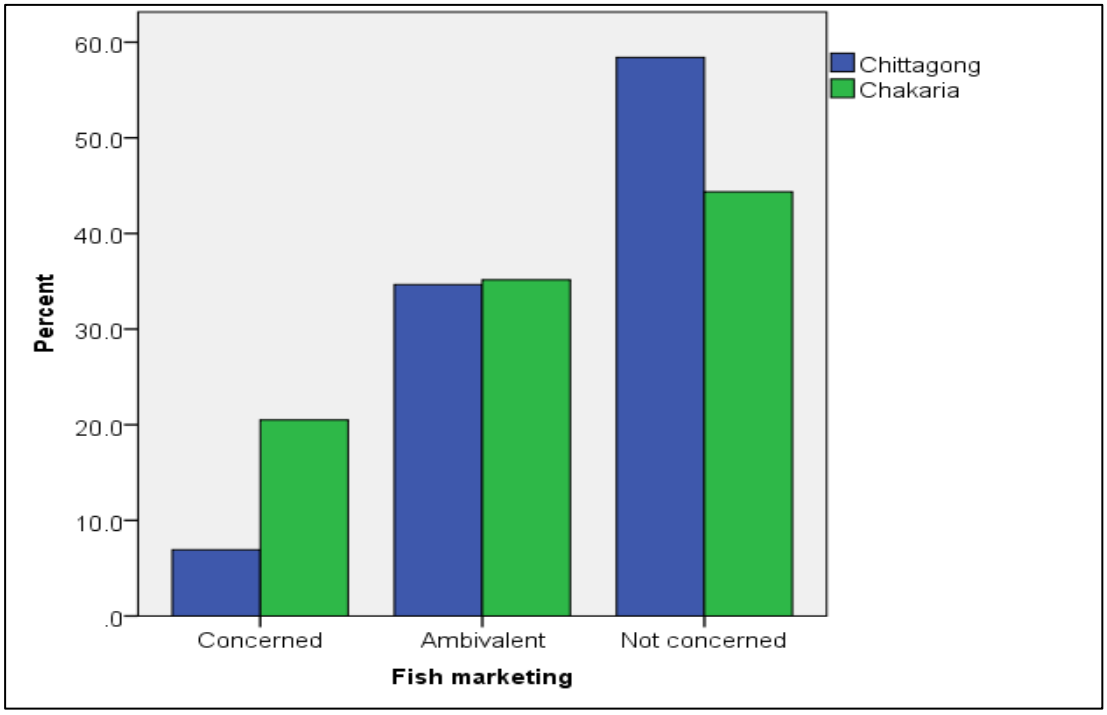
Source: Field survey (2013)

Survey results showed that the majority of respondents from Chittagong and Chakaria are concerned about the impacts of climate change on income from fishing activities and increased professional risks. Respondents claimed that extreme events like storms and cyclones at sea had increased and because of frequent warnings, boats had to return half way into the trip and that caused economic loss for boat owners and fishers. Fishers were also concerned about low wages and increased costs of living, and claimed fish catches per fishing trip had dropped dramatically over the past 15 to 20 years, due to over fishing, unregulated fishing and changing climate. However, fishers indicated that the market price and demand for marine fish had increased and this also caused a decline in fish stocks. Mahmud et al. (2015) found that most fishers in Bangladesh are extremely poor and they struggled to meet their basic needs.

Figure 5.15 shows one in five fishers in Chakaria were concerned about the impacts of climate change on fish marketing. They were more concerned about marketing compared to less than 10 percent in Chittagong. Respondents mentioned that demand for fish was high in the market because of the limited supply. Fishing villages in Chittagong were at the outskirts on the Chittagong city corporation, so transportation

and communication were not a major issue for them. By contrast, fishing villages in Chakaria were in rural areas and in the monsoon season they were affected by days of heavy rainfall, collapsed riverbanks and blocked roads which severely disrupted communications. One-third of fishers from both study areas were neutral about fish marketing, although 60 percent fishers in Chittagong and 40 percent in Chakaria were not concerned, indicating that it was not expressed as a major concern.

Figure 5.13: Survey respondents concern about fish marketing by area



Source: Field survey (2013)

5.6 Sources of information on climate change

Respondents were asked to choose the trusted sources of information about climate change and the results are shown in Table 5.6. The majority of respondents thought that the government agencies were the most trusted source of information, and fishers mentioned that in the event of disasters they closely followed announcements from the government to make response decisions. Eight in ten fishers thought friends and family were a trusted source of information regarding climate change. In their social life, fishers maintain a strong bond of kinship and friendship. They believed community was an important source of environmental and professional knowledge.

Seventy percent of respondents choose media as a trusted source of information about climate change, while six in ten respondents chose the Red Crescent Society. Fishers claimed that volunteers from the Bangladesh Red Crescent Society disseminate disaster-warning messages and help people to evacuate. Sometimes they also organised training for the volunteers. It was found that respondents in Chakaria were more dependent on the Red Crescent Society for climate change information than in Chittagong (66 percent in Chakaria and 44 percent in Chittagong).

Table 5.6: Survey respondents perceived trusted source(s) of information about climate change by area

Information source	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Government	80	79.2	214	90.7	294	87.2
Friends & family	87	86.1	178	75.4	265	78.6
Media	69	68.3	169	71.3	238	70.4
Red Crescent Society	44	43.6	155	65.7	199	59.1
Others (NGOs, mobile phones)	6	6.0	11	4.7	17	5.1

Source: Field survey (2013)

5.7 Conclusion

This chapter explored dimensions of small-scale marine perceptions of climate change from southeast Bangladesh. There was significant concern about climate change in the fishing communities which was ranked as among the most important concerns of these communities and respondents living in high-risk areas were strongly concerned about impacts associated with climate change. The study participants had a clear perception about the changes in temperature, seasonal and rainfall patterns that had occurred over the past five to ten years. Respondents perceived that summer had become longer and hotter, winter had become warmer with intense cold waves for one to two weeks. Respondents identified floods and cyclones, lightening and sea level rise as the top threats posed by climate change in the near future. Knowledge and concern about climate change increases with age. For example, older fishers were more concerned about rough seas and the salinity of seawater. Some perceptions

varied by location, for example, compared to Chittagong respondents in Chakaria were more concerned about floods and cyclones. These perceptions vary due to various socio-economic, geo physical and natural reasons. Respondents perceived that the effects of climate change were mostly negative to their lives and livelihoods of the community. Fishers were strongly concerned about increased professional risks, erosion, declining fish stocks and profitability from fishing activities due to climate change. Most of the community perceptions on the impacts of climate change were consistent with the scientific evidence regarding the vulnerability of coastal Bangladesh to climate change. In terms of understanding the processes and reasons for climate change, respondents' perceptions were not consistent with scientists. The majority of respondents thought climate change was a natural process or it is an *Act of God*. They also attributed local reasons like deforestation and pollution as some of the reasons for climate change. Respondents indicated that the Government, friends and family, media and the Red Crescent Society were some of the trusted sources of information about climate change.

CHAPTER 6

ADAPTATION TO CLIMATE CHANGE

6.1 Introduction

This chapter focuses upon adaptation to climate change and discusses the results of the survey and the views of the focus group that relate to climate change responses by the small-scale marine fishing community. The chapter first discusses the traditional adaptation practices of the fishing community in relation to various extreme climatic events. Data and information regarding these practices were derived from discussions with fishers from Chittagong and Chakaria. This chapter also discusses fishers' perceptions on adaptation policy and attitudes towards climate change. Data for this analysis were mainly derived from interviews and the survey questionnaire.

6.2 Local disasters and adaptation strategies

Table 6.1 outlines the local disasters and adaptation strategies (short-term, long-term and widely used strategies) of the small-scale marine fishing community. Respondents indicated that fishers took a wide variety of response strategies to cope with disasters. Transcripts from the interviews were coded and summarised into twelve adaptation categories, such as migration, searching for safe shelters, drinking water, borrowed money, getting relief, home improvements, sell off assets, boil water, alternative income, sent children to work, seek medical advice and strengthen fishing boats and nets.

Table 6.1: Adaptation strategies of survey respondents to extreme climatic events

Adaptation / Disasters	Migration (S& L)	Safe shelters (S)	Loan (S & L)	Wait for relief (S)	Home improvement(S & L)	Mortgage resources(S &L)	Sell assets/ labour (S &L)	Boil water & save rainwater (S)	Alternative income (S &L) source(S& L)	Send kids to work (S & L)	Seek medical service (S & L)	Strengthen fishing boat sand net s (L)
Cyclones	++	++	++	++	++	++	++	++	++	++	++	++
Floods	++	++	++	++	++	++	++	++	++	++	++	++
Tidal surges	++	++	++	++	++	++	++	++	++	++	++	++
Strong wind					++							++
Salinity intrusion		++		++	+			++				
Heavy rainfall	+		++		++	+			+			
River erosion	++		++		++	++	++		+	+		
Drinking water crisis		++		++				++				
Water borne diseases			++			++					++	
Sea level rise	++	++	++	++	++	++	++	++	++	++	++	
Landslides	+		++		++							

Widely practiced ++, Moderately practised + , S= Short term , L= Long term.

Source: Field visit (2013)

Some of the most popular long-term adaptation techniques in response to cyclones, floods and storm surges are:

- Migration,
- Borrowing money from the local moneylenders or from friends and family members,
- Home improvements (for example, to raise the height of plinth),
- Strengthen nets and fishing boats,
- Sell off assets to get some funds to rebuild their lives,
- Strengthen fishing boats and nets.

Short-term strategies include:

- Move to safe shelters,
- Getting relief,
- Save drinking water/rainwater, boil water and
- Seek medical assistance.

Some of the response strategies could be both short-term and long-term, and they are:

- Migration,
- Send kids to work and
- Search for alternative income sources.

A 55 year old fisher said:

> Some parts of Chakaria are vulnerable to river erosion and some parts are vulnerable to landslides and depended on the financial capacity fishers to take response actions. (Case 1, Respondent 369)

Another 40 year old fisher suggested:

> Fishers who live near the coast or on the banks of rivers were more vulnerable to cyclones, floods, storm surges and erosions. (Case 1, Respondent 153)

It was observed that most of the houses in fishing villages were constructed with fragile materials like bamboo, mud and tin and only a few well off families lived in cement-brick houses. It appears that the types of disasters associated with location and socio-economic status are important to determine the vulnerability and the response decisions of fishers. A study by Alam and Collins (2010) reported similar findings and suggested that location and patterns of settlement are the most important determining factors of people's vulnerability to tropical cyclones in Bangladesh. In the words of a fisher:

> An experienced fisher outlines a fishers' survival strategy during pre and post cyclones and storm surges. On the event of a cyclone, some fishers sought shelters in higher places, strong buildings and cyclone shelters. Some moved to a relative's house in the inner areas. After a disaster, most of the fishers return home. In some cases, fishers migrate to urban areas permanently. Relief generally arrives within one to three days after a major disaster. In a few days after a disaster, fishers seek out their means of survival and livelihoods. Some fishers go to the sea for fishing and some move to urban areas for a better income. The occupation of fishers changes a lot during this period. Another top priority of fishers after a disaster is to rebuild their homes or to find safe shelters. If the regular dwelling place is eroded or flooded, fishers construct temporary tents on embankments using whatever materials are available (Case 25, Respondent 365).

It was observed that most of the landless and very poor fishers of Chakaria live along the embankments and on government owned lands. Respondents said that some fishers live temporarily and some live permanently on the embankments as some

places in Chakaria got flooded two or three times a year, with the temporary houses made out of plastic and bamboo. Alam and Collins (2010) investigated local peoples' experiences of cyclone hazards in coastal Bangladesh and reported that generally after cyclones and storm surges they moved to embankments along the coast and islands and built temporary accommodation with bamboo straw. The following case study describes various coping strategies undertaken by fishing families at the time of disasters.

> A boat owner aged 50 year said that he had been fishing in the sea and estuaries from the age of twelve. Like his father and grandfather, he entirely depends on fishing to provide food for his family. As a boat owner, he hires eight to ten fishers to go out in the sea for 10 to 15 days at a time. He has noticed changes in the disaster and weather pattern over the past decades or so. He thought when he was a kid the sea was not this rough, waves and winds were not this strong and the frequency of storms were less. Stronger storms and cyclones are making fishing activities more dangerous. Traditional boats are no longer feasible because of the growing intensity of storms. He fixed his boat with a metal clamp to prevent it from capsize and make it stronger against storms and strong waves. When a cyclone signal crosses six, fishers prepare to save their belongings and leave their homes for cyclone shelters or other safe places. However, even in that situation some families adopt a wait and see approach. Their response depends on their experience of hazards, local beliefs and level of early warning signal issues by the government. After a disaster, many fishers' families face severe shortages of food and income opportunities. Fishers mortgage or sell assets to get fast cash or borrow money from relatives and local moneylenders. Some parents are forced to send their kids to work as they cannot afford to feed them. In many cases, these children never go back to school. The informant himself started working at the age of twelve because of poverty and starvation. (Case 28, Respondents 368)

Respondents agreed that the frequency of storm warning signals at sea had increased recently. It was understood that traditional fishing boats had served the community for generations, however these boats can no longer cope with the growing intensity of storms and waves. To cope with frequent disasters, fishers are trying to strengthen fishing boats and nets with locally available technology and materials.

6.3 Perceptions of adaptation preferences

Given the potential risks associated with climate change in coastal Bangladesh, it is important to understand respondents' perceptions of policy preferences for adaptation. In the past decades, there have been limited studies that investigated local perceptions of adaptation in developing countries like Bangladesh (Grothmann and Patt, 2005). A

study by Ayers (2010, p. 144) found that community adaptation priorities in coastal Bangladesh sometime contrast with the national priorities. In the questionnaire survey, respondents were asked to mention the most important needs in the community to minimise vulnerabilities to the impacts of climate change. The responses were coded and summarised into nine categories shown in Table 6.2. They are: infrastructure development, financial support, safety and security, improved housing, on board communication and safety equipment, reinforcement of fishing boats and nets, community representative in disaster management, coastal afforestation, Information dissemination, medical support, and disaster management training. An explanation of these categories is shown in Table 6.2.

Table 6.2: Category and explanation of respondents' perceptions on adaptation preferences

Number	Category	Explanation
1	Infrastructure development	New roads, Construction and maintenance of dams and cyclone shelters, improve mobile phone network, electricity supply, supply of drinking water
2	Financial support	More government aid, support for easy loans, disaster recovery and in lean fishing season and in the period of government embargo on fishing
3	Safety and security	Improve law and order, monitor and implementation of laws by respective government department
4	Improved housing	Improvement of kacha houses (houses made of bamboo, sticks, tins and mud), allocation of land to homeless, shifting houses to less disaster prone areas, rising houses above flood levels, build concrete houses
5	On board communication and safety equipment	Safety gear, life jackets, compass, wireless, mobile phones, and radio
6	Reinforcement of fishing boats and nets	Stronger boats and nets
7	Community representative in disaster management	Inclusion of community representatives, leaders in disaster management committee
8	Coastal afforestation	Plant trees, protection of forest
9	Others	Information dissemination, medical support, disaster management training

Source: Field survey (2013)

Table 6.3 summarises respondents' perceptions of adaptation preferences to climate change. Two thirds of respondents indicated infrastructure development as one of the most important priorities of the community to cope with impacts related to climate

change, and significantly more respondents in Chakaria than Chittagong were concerned of this (26 percent in Chittagong and 87 percent in Chakaria). This included the construction of roads and highways, dam and cyclone shelters, improved mobile phone and radio communications, and electricity and water supply. A study by Paul et al. (2010) reported that the inadequate numbers of cyclone shelters, logistics issues, problems with the cyclone warning system, gender issues and anxiety over security, discouraged coastal people in Bangladesh to evacuate before a cyclone. A study by Mallick (2014) also reported that in coastal Bangladesh extremely vulnerable households have disproportionately limited access to cyclone shelters compared to less vulnerable households. Results indicate that respondents perception of adaptation is linked with local infrastructure base.

Table 6.3: Respondents perceptions about adaptation preferences in Chittagong and Chakaria

Adaptation preferences	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Infrastructure development	25	25.5	202	87.1	227	68.8
Financial support	78	79.6	131	56.5	209	63.3
Safety and security	54	55.1	107	46.1	161	48.8
Improved housing	54	55.1	94	40.5	148	44.8
On board communication and safety equipment	59	60.2	91	39.2	150	45.5
Reinforcement of fishing boats and nets	52	53.0	67	29.0	119	36.2
Community representative in disaster management	27	27.6	84	36.2	111	33.6
Coastal afforestation	32	31.4	25	10.5	57	16.7
Others (Information dissemination, medical supports, disaster management training)	9	9.2	27	11.7	36	10.9

Source: Field survey (2013)

Table 6.3 shows that sixty three percent of respondents mentioned that they need financial assistance to rebuild their lives after disasters, in the lean fishing season and for business purposes. A 35 year old fisher mentioned that

> financial assistance should also be provided during the month long government embargo on fishing. (Case 1, Respondent 161)

Fishers from Chittagong were found to be more concerned about financial assistance (79.6 percent) compared to 56.5 percent in Chakaria. The majority of respondents from Chittagong were deep sea going fishers and investment costs were higher than others. Deep sea going fishers reported that there were no mobile and radio networks in the deep sea and they had to depend entirely on natural instincts for survival against any climatic shocks. Therefore, deep sea fishers were considered to be one of the most vulnerable groups to disasters. It is also important to note that the income of respondents from Chittagong was 25 percent higher compared to Chakaria. Results indicated that respondents' perceptions about financial assistant for adaptation were linked with income and investment.

Overall half of the respondents mentioned improved safety and security at sea as one of their top priorities for adaptation. An experienced fisher claimed that improved safety and security could increase fishers' adaptive capacity.

> A 60 year old fisher claimed that piracy become the most critical non-climatic disasters for the fishing community. Besides robbing money, boats and fishing assets sometime pirates also kidnapped, killed and injured fishers. Piracy increased investment and the economic losses of fishers. (Case 1, Respondent 162)

The respondents thought that improved law and order should decrease the financial barriers for adaptation. Respondents also thought that government authorities should monitor and implement maritime laws for fishing boats. If the boats were equipped with proper safety gear, life jackets and basic communication tolls the fishers' adaptability to climate change would eventually increase. A 35 year old fisher expressed the importance of fishers safety and its impacts on adaptation in the following way:

> Ask the government to protect the community from pirates. Fishers know well how to deal with the sea and climate. (Case 1, Respondent 4)

About half the respondents mentioned improved dwellings as one of their adaptation priorities. Respondents indicated that a good adaptation policy would be to make housing more cyclone resilient, and to raise houses above the flood level and shift them to less disaster prone areas. A little less than a half of the respondents mentioned on-board communication and safety equipment to be an adaptation priority. However, about one-third of respondents indicated the need to strengthen boats and fishing nets as one of their top adaptation priorities. Respondents in Chittagong were more concerned about stronger fishing boats and nets than Chakaria (53 percent in Chittagong and 29 percent in Chakaria). The majority of deep sea fishers in Chittagong were concerned about the reinforcement of fishing boats and nets, while another one-third of respondents thought that the inclusion of a community representative in the local disaster management committee would be a good adaptation priority. Only about seventeen percent of respondents thought coastal afforestation was an important adaptation priority, much more in Chittagong (31%) compared to 10 percent in Chakaria. Poor respondents in Chakaria were more concerned about direct costs and benefits of adaptation actions. A study by Ayers (2010) reported that respondents rarely mentioned coastal afforestation as an adaptation priority in the Nokhali district that is also located in the southeast coast area of Bangladesh. Respondents were questioned about the sustainability of benefits of the coastal afforestation projects. Planting mangrove trees beyond the coastal embankments were seen to displace people who lived there and in this way, it exacerbated the vulnerability of the most vulnerable groups. Therefore, respondents perceptions about adaptation was influenced by costs and the benefit of a policy.

Fishers' adaptation priorities suggested that some interventions would reduce vulnerability to climate change impacts (for example, improvement of law and order), and address climate change impacts directly (for example, construction of more cyclone shelters). Some of the adaptation priorities are community specific, such as to provide aid during lean fishing seasons and in the period of government embargo on fishing. Fishers also indicated that they need access to formal credit channels and fast

and easy loans to rebuild their lives after a disaster. Respondents' perceptions about adaptation was influenced by local disasters and its impacts, infrastructure, income and investment, individual and community costs and benefits.

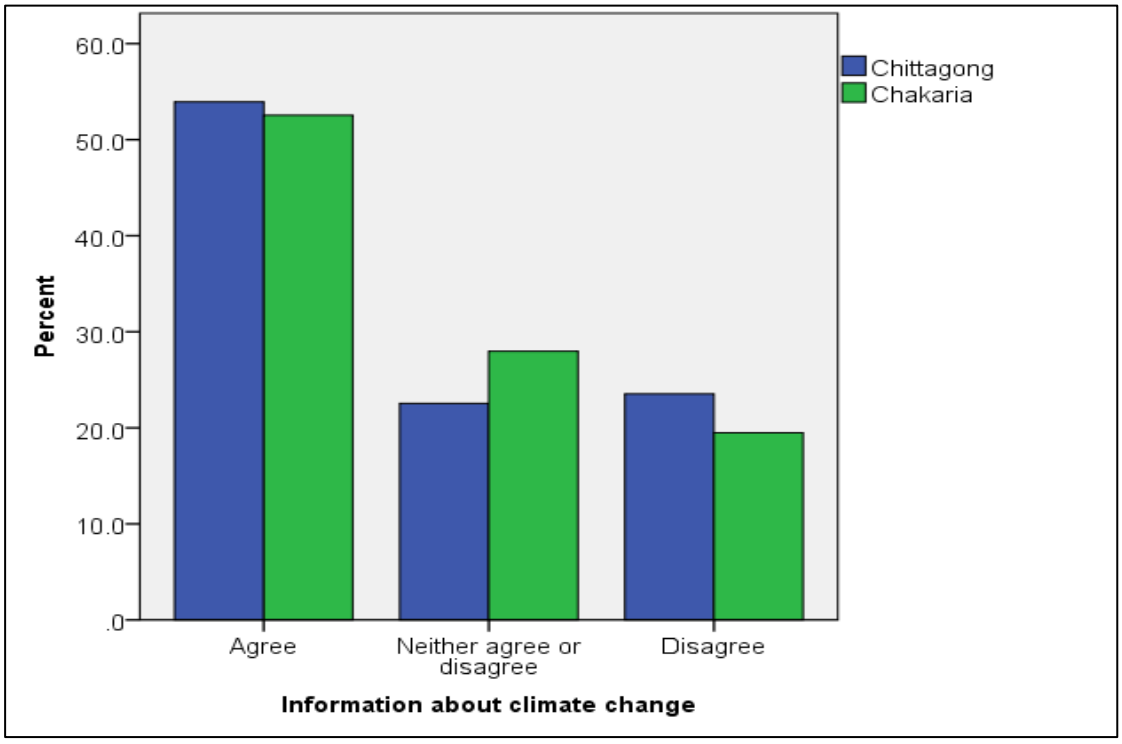
6.4 Attitude towards adaptation

This section investigates respondents' beliefs and attitudes towards adaptation to climate change. Respondents were asked to indicate their level of agreement about climate change adaptation through proper planning and support. The survey found that 63 percent of respondents in Chittagong and 59 percent of respondents in Chakaria perceived that adaptation to climate change is possible through proper planning and support. In total one-third of respondents from the study areas were neutral, and only a fraction of the respondents thought adaptation to climate change was not possible. Some of the respondents described the enormity and complexity of climate change impacts and felt that they had limited capacity to adapt. Respondents mentioned that fishing villages in coastal areas were highly exposed to natural disasters. Cyclones, floods and erosion can easily wash away their savings and resources. However, most respondents (about 90 percent) from Chittagong and Chakaria perceived that it would be easier to adapt with some financial support. Respondents mentioned that they desperately needed some financial support from the government to rebuild their lives after a disaster and during restricted fishing periods. They had limited access to formal credit channels, and fishers mainly depended on informal local moneylenders for loans and cash and they generally charge high interest.

Figure 6.1 shows that about half of the respondents from Chittagong and Chakaria agreed that they would love to get more information on climate change adaptation to respond appropriately. One quarter of respondents in Chittagong and one third in Chakaria neither agreed nor disagreed to get climate change information, and about one quarter of respondents from both areas were not at all interested. An experienced fisher and a father of four children described his inability to protect his house from erosion.

A 50 year old respondent who is a father of four children mentioned that he used to be a land and boat owner. Over five years he gradually lost his home due to erosion and became a refugee. The family could not do anything to stop the erosion. (Case 1, Respondent 5)

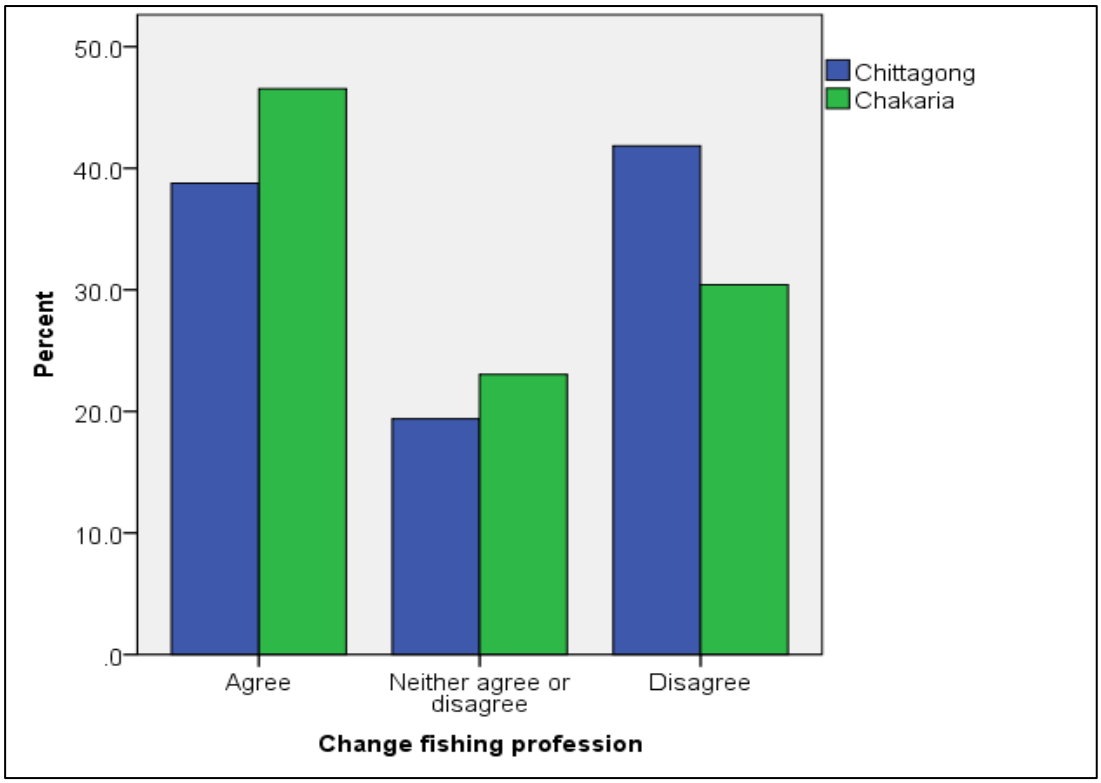
Figure 6.1: Respondents' perceptions about getting more information on climate change adaptation



Source: Field survey (2013)

A study by Badjeck et al. (2010) raised concern over the consequences of climate change for the food security and livelihoods of the small-scale fishing community in Bangladesh. This was evident during the in-depth interviews as fishers frequently mentioned overfishing and decreased profitability as one of their biggest concerns. In the questionnaire survey, the respondents were asked whether they would change profession as an option for adaptation. Figure 6.2 shows that 39 percent of respondents from Chittagong and 47 percent from Chakaria thought that such a change would be an option for adaptation, although about one fifth of respondents from both areas neither agreed nor disagreed with the statement. However, 30 percent of respondents in Chakaria and 42 percent in Chittagong disagreed with changing profession as an adaptation option. Results indicate that geo-physical vulnerability and sensitivity to climate change impacts influence individual adaptation decision.

Figure 6.2: Respondents' perceptions about change of profession as a climate change adaptation option



Source: Field survey (2012-2013)

6.5 Attitudes to climate change risk management

In a multiple select question respondents were asked to mentioned the name of agency(ies) they thought were responsible for managing risks associated with climate change. Table 6.4 shows that overall 94 percent of respondents thought that the Government was responsible for protecting the community, while those from Chakaria were significantly more likely to mention that it was the Government's responsibility to manage the risks associated with climate change. Survey data show that the income of 28 percent respondents in Chakaria and 6 percent respondents in Chittagong was very low (less than Taka 5000 per month). There was a higher number of extremely poor respondents in Chakaria than in Chittagong. Moreover, average per month median income of respondents in Chakaria was Taka 6000 and in Chittagong Taka 8000, and income of fishers was generally lower in Chakaria. It was observed that disaster management, infrastructure and communication systems were better in Chittagong than Chakaria. For these reasons, respondents in Chakaria were

more likely to depend on government support for adaptation. Adger et al. (2007) also found that at a personal and community level adaptation capacity depends on infrastructure bases, level of poverty and disparities in income.

Table 6.4: Perception of survey respondents to climate change risk management by study area

Responsibility for climate change risk management	Study areas				Total	
	Chittagong		Chakaria			
	N	%	N	%	N	%
Government	77	79.4	237	100.0	314	94.0
Self-responsibility	45	46.4	191	80.6	236	70.7
Local community	15	15.5	112	47.3	127	38.0
God	52	53.6	64	27.0	116	34.7
Red Crescent and NGOs	24	24.7	50	21.1	74	22.2
Others(Scientists, Boat captains, Local elites)	9	9.3	34	14.3	43	12.9

Source: Field survey (2013)

Despite the tendency to place responsibility on the government for managing climate change risks, two thirds of respondents also thought they have an individual responsibility. Respondents mentioned that to survive in a disaster they had to trust their instincts and take action. The community members had to do everything to protect themselves and their families from disasters. Interestingly a higher portion of respondents in Chakaria (80 percent) than Chittagong (46 percent) mentioned that they had individual responsibility for adaptation. Overall thirty-eight percent of respondents thought that they had a community responsibility to tackle impacts of climate change, 47 percent of respondents in Chakaria and 16 percent in Chittagong. Disaster threats and vulnerability might have enhanced individual and communal sense of responsibility for adaptation. A little more than one-third of respondents believed that God is responsible for protecting the community from climate change related impacts, a half of the respondents in Chittagong perceived it was God's responsibility compared to 27 percent from Chakaria. Results clearly show that a higher proportion of sea going fishers mentioned that God was responsible for climate

change and protecting the community from disasters, while one fifth perceived that the Red Crescent Society and NGOs were responsible.

6.6 Conclusion

The study documents the traditional coping strategies for various disasters and explains how traditional coping strategies can significantly reduce communal vulnerability to disasters related to climate change. However, traditional adaptation strategies are not enough to cope with the impacts of climate change. As some of the policy preferences for adaptation, the respondents indicated that they need more government support to cope and mentioned more financial support, improved safety and security, better housing facilities, enforcement and monitoring of laws regarding safety and security, reinforcement of fishing boats and nets, and the inclusion of community representatives in the local disaster management committee. The majority of respondents also thought they had an individual and community responsibility for adaptation. Results indicate that respondents' perceptions about adaptation were influenced by geo-physical vulnerability, infrastructure base, professional type, income and investment, and effect of adaptation programs on individual and community.

CHAPTER 7

PERCEPTION OF CLIMATE CHANGE: CULTURAL DIMENSIONS

7.1 Introduction

Adger et al. (2013) found that climate change threatens cultural dimensions of lives and livelihoods of people and that includes identity, sense of attachment to place, community cohesion and traditions. The authors argued, "*Society's response to every dimension of global climate change is mediated by culture*" (Adger et al., 2013, p. 112). Whitmarsh (2008) suggested that community disaster experiences also effect individuals perceptions and behavioural responses to climate change. Previous studies on climate change adaptation in Bangladesh have indicated that disaster preparedness, prevention and relief does not always have the expected outcome (Paul and Hossain, 2013, Karim and Noy, 2015). Moreover, even when people are warned about cyclones, they hesitate to leave properties and take safe refuge in cyclone shelters (Paul and Routray, 2013). Coirolo et al. (2013) highlight the limitations of current adaptation programs in Bangladesh and recommend that the Bangladesh government should gather more information on local communities to understand the nature of disaster vulnerability and to develop adaptation programs that address local needs. Islam et al. (2014) also discussed some of the social barriers for adaptation of the fishing communities in Bangladesh.

This chapter investigates marine fishers' perceptions understanding and meaning of climate change, and response strategies. Data in the field study were collected through participant's observation, collection of life stories, formal and informal interviews, and group discussions. The content here helps to conceptualise and measure fishers' social vulnerability and resilience, to understand response related activities and the recovery process, and to assess the ways in which various socio-economic, political and cultural factors affect the risk perceptions of fishers.

7.2 Community perceptions on climate change, disaster risks and vulnerability type

Previous studies have highlighted the relationship between community disaster experiences and risk perceptions (Paton and Johnston, 2001, Riad et al., 1999, Ho et al., 2008). Ho et al. (2008) reported that disaster types and experiences are good predictors of victims perceptions and attitudes towards the environment. This section highlights local disaster types and the experiences of the community.

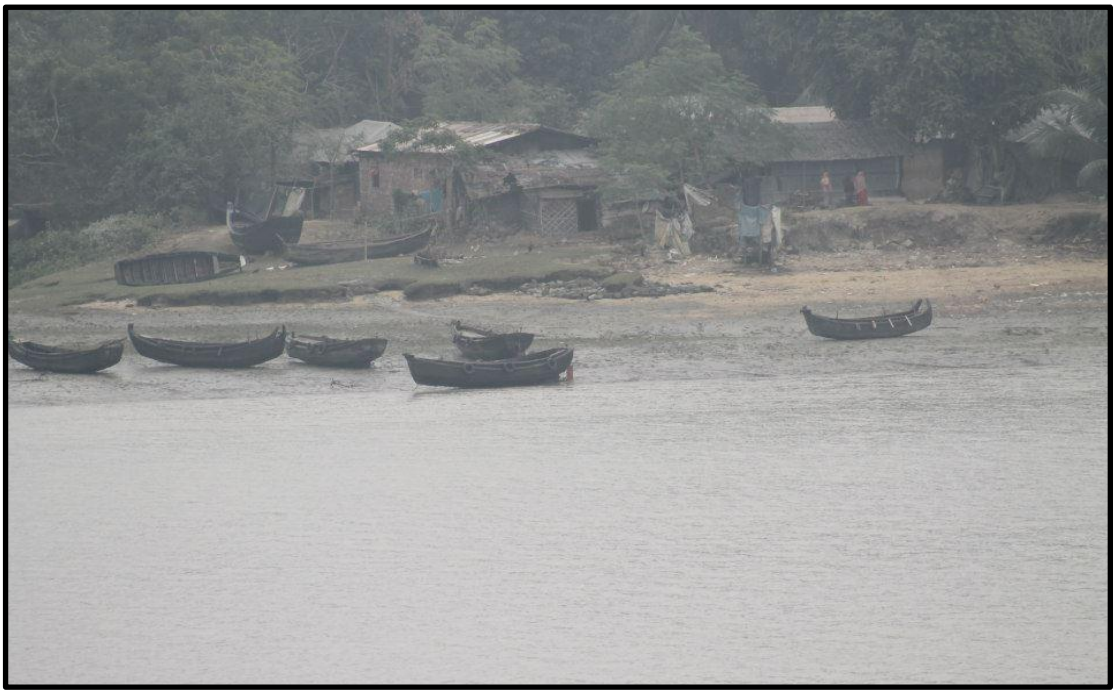
Results from the survey data indicated that fishers perception about climate change understanding, impacts and adaptation decisions vary by location, age, professional category, investment and income and individual and community effects of adaptation programs. In the field study it was observed that a good number of people in Chittagong were migrants/internally displaced people from other coastal areas in Bangladesh. Loss of land due to erosion as well as income generation were some of the reasons for migration mentioned by respondents.

> Families of a 40 year old fisher and his 30 year old brother reported that they had migrated 10 years ago to Chittagong from Swandip. The family lost everything to river erosion. According to the brothers, "super cyclones come occasionally but the tidal floods had squandered fishers lives every year." A few years ago, the family moved to Chittagong empty handed after they lost all the belongings to erosion. One of their relatives in Chittagong helped them get a job in a fishing boat. Now they earn enough money to feed their family. (Case 2, Respondents 342 and 343)

Fisher villages in Chakaria are situated along an estuary. The east side of Chakaria is hilly and the west side is low-lying land situated on the bank of the Matamuhuri river and Kutubdia channel. Most of the fishers' villages are located along the banks of these rivers, and they lived in thatched houses located mostly in low-lying areas (Plate 7.1). Because of physical location and the pattern of settlement the fishing communities are often frontline victims of various disasters like cyclones, floods, erosion and storm surges (Hossain et al., 2014b). A study by Rahman and Schmidlin (2014) on the fishing community in Kutubdia Island (near to Chakaria) reported that migration is a common phenomenon within fishing communities and fishers relocate or migrate to other villages or cities due to the loss of land from coastal erosion. Some families were found to migrate multiple times a year. The study also reported that due

to continuous erosion, cyclones, storm surges and floods, the coastal island was gradually swallowed up by the sea and that was forcing shoreline inhabitants to relocate.

Plate 7.1: A fishing village in Chakaria



Source: Field visit (2013)

Personally or through family members, most respondents in the study areas had experienced natural disasters in one form or another. Flooding is a regular seasonal phenomenon in both Chittagong and Chakaria. Besides annual flooding these areas are prone to nor'westers[5], landslides, erosions and cyclones. According to a local government report of these study areas, in recent decades, the most devastating flood and cyclones occurred in 1998, 1991, 1997 and 2007 (GOB, 2010). These events have caused great financial hardship for individuals and communities which has resulted in the loss of lives to the extent that they have become a part of folklore. Peoples' risk perception is shaped by the type of disasters and socio-demographic characteristics of the victims (Ho et al., 2008). Siegrist and Gutscher (2006) found that risk perception

[5] Nor'westers storms occasionally occur in the late spring and summer.

is also influenced by the location, for example, people living in high risk areas are more concerned about disasters.

Two major floods occurred over two consecutive years in both 1987 and 1998 (GOB, 2010a). Some people dubbed the 1998 flood as the "flood of the century" in Bangladesh. Two fishers described their experiences in the following way:

> According to a 60 year old experienced fisher from Chakaria, the 1998 flood caused most of the houses in Chakaria to be inundated for a little more than a month. Hundreds of people took refuge in cyclone shelters, on highways and embankments. However, some children and elderly were drowned. In addition, the trees and crops died due to salt-water inundation. Despite the best efforts of the government and other aid agencies it was difficult to supply relief to the victims and commodity prices went up sharply. Right after the flood there was not enough food and safe drinking water. Over time, dead bodies of animals and humans decomposed, as there was no place to bury them. As a result, various water borne diseases like diarrhoea and cholera spread rapidly. Many died because of the outbreak of diseases. Many people also ran out of money and could not find work as most of the areas were submerged. Adult male members of most of the families were forced to go to cities to find work to support their family. Moreover, some families left the area and did not return. Because of the flood many people had become homeless, all the livestock were lost, crops were destroyed, fishing equipment, boats, roads and embankments were damaged. (Case 4, Respondent 344)

> A 43 year old farmer and a part-time fisher from Charandip, Chakaria describes, "(in the 1998 flood) drinking water was scarce. Saline water intruded into the fresh water system, even water from the tube well was salty. After the flood I could not use the land for farming for nearly 5 years." (Case 5, Respondent 345)

It was observed that a number of injuries, fatalities, the extent of damage, suffering and issues with disaster management were a point of reference used by fishers to recall an extreme disaster event. By extreme event fishers mean something that is severe and surprising. An experienced fisher described the intensity and severity of the 1991 super cyclone in the following way:

> According to a retired fisherman aged 70 years from Chakaria, the 1991 super cyclone was one of the deadliest in recent history and it struck on a full moon night and slammed into coastal villages with high velocity winds and associated storm surges that ravaged coastal areas in Chittagong and Cox' Bazar (including Chakaria) for a couple of hours. The surge was 3 to 4 metres high in Chakaria and damage was widespread and severe as storm surges washed away small villages, swamped land and destroyed livelihoods. Many survivors were marooned without shelter for many days after the storm. For several days after the storm, the sea was rough and a continuous heavy downpour made the disaster situation worse. There was no safe drinking water, and the power supply, transportation and communication systems were severely disrupted. Most of the deaths were associated with drowning and trees falling during the cyclone. Children and elderly

> were the worst victims and a few weeks after the cyclone there was a break out of various water borne diseases and several people died due to a lack of medication and health care. Even after receiving warnings many people in the community, including the interviewee, did not believe that the storm would be that bad. More than 50 percent of the fishing boats were sunk and almost all the boats were damaged due to the cyclone and storm surges. Several fishing boats went missing after the cyclone. Most importantly, fishers who had gone for deep-sea fishing were unaware of the super cyclone, some died and boats and coast guards rescued others. (Case 6, Respondent 346)

A 60 year old fisher whose family was a victim of both the 1970 and the 1991 super cyclones added that after the cyclones the villagers found human remains in the branches of trees.

> "Our family was a victim of the 1970 Bhola cyclone. My late father told me that we migrated to Chakaria as we lost everything in 1970….. As far I remember, the cyclone in 1991 and 1997 were the most devastating in this area…. 1991 cyclone hit in the middle of night…fortunately we were in the shelter…not all the villagers took refuge in cyclone shelters. The cyclone ravaged the area all night long. In the morning, people found human remains even on the branch of trees. All these areas including surrounding villages were inundated…as far as the eye goes it was water everywhere …" (Case 7, Respondent 347)

Another 45 year old fisher added that after the cyclone water borne diseases spread from the dead bodies.

> "…after the cyclone (in 1991)...the dead bodies of animals and human remains were left in the open, the smell was strong…still no one cared. Everyone was running for life…and various water borne diseases spread after the cyclone." (Case 8, Respondent 348)

Respondents indicated that deep-sea fishers were the most vulnerable group in the event of a cyclone. A few miles from the shore at fishing points in the deep sea there were no mobile and radio network coverage. As a result, fishers have to depend on traditional knowledge to predict and respond to cyclones. An experienced 50 year old fisher who was a survivor of the 1997 cyclone explained that no radio and mobile network, caused disbelief and confusion about the strength of cyclone which were key reasons for the high fatality rate of the deep sea going fishers.

> "We were 11 fishers on the boat about 100km from the shore. We were suspecting a storm but not this strong. A few hours before the cyclone stuck our boat it was drizzling and the sea was calm. Everything changed suddenly. Never in my life have I experienced such strong wind and waves. The rolling was strong. Something hit my head, then I found myself floating with the help of a piece of wood. I managed to float

> for several hours. The next day I was rescued by another fishing boat. Out of 11 fishers only four of us survived." (Case 9, Respondent 349)

In 2011 during the monsoon season, the heavy downpour and tidal bore caused an overflow of the Matamuhuri river bank. The displaced fishers took refuge in cyclone shelters and on the embankments.

> A fisher aged 46 years lived in Charandip, Chakaria with three sons and said that generally his dwelling got flooded annually 2 to 3 times. During floods he took shelter on embankments or on government lands. He thinks the 2011 floods was one of the biggest of all floods in terms of devastation and longevity. "When the water started rising we left out house and took shelter on the embankment. We were forced to live on the embankment for a couple of months. It was a surprise for all of us. We have never seen such inundation of huge area for so long." He also added, "Continuous rain for a couple of days in monsoon is nothing new for this area. What is surprising was the unprecedented level of flooding. (Case 10, Respondent 350)

Sometimes fishers are reluctant to move to cyclone shelters or to any other safe places even when the warning signal is at 10 (very high risk). Fishers feel an emotional attachment to home, their fishing possessions and domestic animals. In some cases, women and children do not go to cyclone shelters because of hygiene and security concerns. Paul and Routray (2013) investigated the causes of non-response of cyclone warnings in Bangladesh and found that coastal inhabitants are well aware of the potential risks of cyclones. However, they do not respond to cyclone warnings because of the poor road network, long distances from home to a cyclone shelter, the low capacity of the cyclone shelters, burglary and thefts of household assets and misinterpretation of warning information. The following case study helps to explain why women are reluctant to move to cyclone shelters.

> A 35 year old woman who is a wife of a fisher in Chittagong and a mother of a teenage daughter and a son said that on several occasions the family did not respond to cyclone warnings. She reported that many of their neighbours did not move to cyclone shelters as they were reluctant to leave their belongings. In cyclone shelters, there is no separate facilities for woman. Without a husband, a woman is not comfortable to live with males. According to her, cyclone shelters are also not safe for children. (Case 31, Respondent 371)

> The rainy season is the best fishing season and according to a 46 year old fisher, more rain means more fish and at the same time, bad weather makes it the riskiest season for fishing. (Case 10, Respondent 350)

However, every year in the monsoon fisher villages, both in Chittagong and in Chakaria, face some catastrophic events like floods, landslides and cyclones. The disaster situation becomes even more complicated in the month of the rainy season, and locals say this is due to the daily tidal cycle that leads to some of the areas in Chakaria being inundated twice a day. In addition, more areas get flooded during high tides under the impact of the full moon and the new moon cycle. Existing flood control systems are frequently failing to protect the community.

> According to a 30 year old fisher from Halkakara, Chakaria, "The river (Matamuhuri) and the channels are flattened. As the channels clog up, the water cannot flow away. The river overflows very easily when it rains. (Case 10, Respondent 351)

Due to increased water pressure, there have been cracks frequently appearing in the embankments. Most of the respondents had noticed that in recent years the height and pressure of tidal water had increased. Families that had been affected in Chakaria were forced to live on high lands or on embankments for six months in a year. Moreover, heavy downpours caused landslides and flash floods. Respondents thought that heavy downpours and also the number of days without rain had increased recently and the Government authorities had issued warning signals more frequently. When the sea becomes rough, fishers had to suspend fishing activities and keep their boats in a safe place until the weather improved. However, some fishers struggle to return or ignore warnings and stay out at the sea hoping they could survive in the storm and can catch more fishes.

> A 25 year young fisher said, "The rainy season is one of the riskiest fishing seasons. A good number of fishers die in the rainy season. Some boats go out deep sea fishing defying storm warnings, lured by the hope of more big catches." (Case 10, Respondent 352)

The respondent also mentioned that often boat owners and boat captains forced fishers to continue fishing up to 4 to 5 cyclone signals. In most cases, this strategy results in economic benefits for boat owners and captains. Boat owners want to get a good return from their investment on a fishing trip and the boat captain's reputation and payment increases with the amount of fish caught. However, this strategy increases professional risks for fishers. In these situations, most fishers cannot protest strongly due to fear of job loss. The interviewee also added that his boat owner and the captain

of his boat never force them to catch fish in storms and they always come back to shore whenever they become aware of a cyclone signal.

Mangrove forests are an important part of the coastal ecosystem. These forests are breeding grounds for various fish species (Ahmed et al., 2013). Mangrove forests and trees in coastal Bangladesh are important in limiting climate change impacts. Vegetation and forests are natural barriers to erosion and provide protection from the impacts of cyclones, floods and storm surges (Saenger and Siddiqi, 1993). Giri et al. (2015) argued that these forests are under threat from both natural and anthropogenic stressors. Hossain et al. (2001) reported that the entire Chakaria mangrove forest which was one of the oldest in South Asia, has been cleared for multiple development reasons. An experienced fisher claimed that forestlands were declining due to over population, unplanned development and increased disasters.

> According to a fisher aged 50 years, forestlands in the hills have declined due to increased population and disasters. After losing lands to soil erosion people are moving to the hills and cut down trees to construct roads, houses and other amenities. As a result, the incidence of landslides in Chakaria, particularly in the monsoon has increased. (Case 28, Respondent 368)

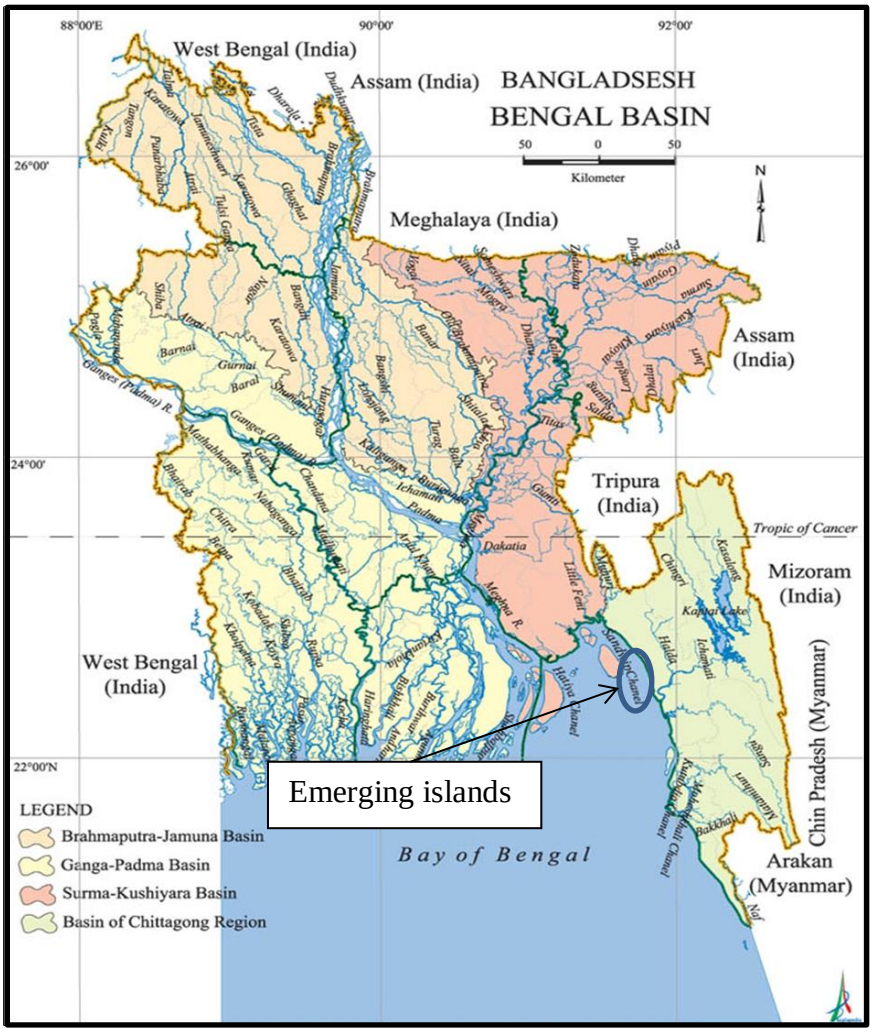
Respondents were concerned about the cumulative effect of significant and non-significant disaster events. Accumulation of small damaging events interacting with one another, are posing significant threats to socio-economic and disaster management systems. For example, longer summers, heat waves followed by rainfall and storms, the late arrival of winter and a severe cold wave for a few days, all have negative impacts on fishers health and hamper fishing operations significantly.

> A 60 year old fisher from Chakaria thought that when he was a kid the wind (storm) and the waves were less frequent. However, currently the situation is critical. He further stated, "We are hit by a new disaster before we recover from the previous one. The sea is rough and fish stock have declined and fishing not profitable. There is no end of stories about problems in fishers' life. We are caught in a vicious cycle of debt, poverty and disasters." (Case 13, Respondent 355)

It was observed that compared to Chittagong, fishers in Chakaria who live 10-20 km inside the coastline were strongly concerned about the sea level rise. Fishers reported that high sea levels were putting tremendous water pressure on the dam and causing frequent failure of the flood management system. As a result, the incidence of floods,

water-logging and saline water intrusion had increased. Unlike in Chakaria, fishers in Chittagong reported that the sea was becoming flatter and new islands were emerging in the sea. Figure 7.1 shows the approximate locations of submerged islands near the shoreline of the Chittagong districts reported by respondents from these areas. This unexpected finding contradicts the majority of research findings that predicted a good proportion of coastal Bangladesh will submerge and become uninhabitable in future due to sea level rise (Bhuiyan and Dutta, 2012, Dasgupta et al., 2009). Further scientific investigation is suggested to establish the reasons for the emergence of new near shore islands.

Figure 7.1: Approximate locations of emerging sub-merged islands in the Bay of Bengal reported by the respondents from Chittagong



Source: Bangladesh map from the Banglpedia (http://en.banglapedia.org/index.php?title=Bengal_Basin)

7.3 Perceived causes of climate change and disasters

In interviews, people expressed their perceptions and knowledge of climate change and disasters, and actions taken before and after them. Various respondents expressed their experience in different ways. Most of the traditional fishers are Hindus and are known as 'jaladas" (literal meaning slave of water) (Sultana et al., 2002). Jaladas are one of the lowest/untouchable castes in the Hindu religion and they believe that their family genealogy is tied to fishing occupations (Deb, 2009). Hindu fishers' customs are unique to mainstream society. Traditional fishers are bound by social and cultural norms and seem reluctant to change traditional lifestyle and professional norms. Apparently, traditional fishers follow some self-regulations in relation to fishing practices and try to refrain from any kind of efforts they believe might disrupt the reproduction of fish species. Fishers believed self-injunctions and traditional practices are important to conserve fisheries resources. Jaladas strongly believe that taking care of the environment is a part of their religious commitment and God will punish them if they do not do so.

Muslim fishers are relatively new in the fishing profession. Because of resource scarcity, loss of land and various other socio-economic reasons non-fisher communities are increasingly getting into the fishing profession. Therefore, attitudes and behavioural patterns of non-traditional fishers are different from the traditional "jaladas' fishers, and they are often opportunistic and many frequently switch occupations. Some seasonal fishers think fishing is a temporary means of earning and are often involved in destructive fishing methods. For example, catching undersized fish by using a small mesh net and catching mother *Hilsha* fish during the breeding season. Hindu fishers believed that the number of fishers had risen dramatically in a relatively short span of time since the Muslims enter the profession. Fish stocks are decreasing constantly due to the increased number of fishers, as well as unregulated and unethical fishing practices.

Irrespective of the faith, most of the fishers believed that overall climate is changing; it is becoming increasingly difficult to predict the climate, with seasons not following historical trends. Gradually disaster scenarios are becoming more complex. However,

irrespective of the faith, fishers do not believe that vast coastal areas will be inundated and become uninhabitable in the future. They strongly believe that supernatural power or divine authority will protect the community in the same way that the community has been protected for centuries. However, most of the respondents thought that disasters are the will and punishment from God and believe there is nothing people can do to prevent them. It was observed that this perception of disasters is resonated amongst most of the respondents in coastal areas irrespective of their religious faith. The following comments are good examples of fishers' world views and perceptions on climate change and disasters.

> Aged 40 years a retired fisher from Chittagong claimed that he used to be a deep-sea fisher. Two years ago he was injured in a fishing trip and became disabled. After that incidence he started his own business. He stated, "We are the people of the sea. Sea has been providing us sustenance for generations. We, the worshippers of sea. When the sins in the land increase, mother (sea) gets angry and violent. Then she punishes us with various disasters. She calms down when some lives of the fishers are sacrificed." (Case 20, Respondent 360)

> A 50 year old first-generation deep-sea going fisher from Chittagong claimed that after the 1997 cyclone their family moved to Chittagong from a remote island of the bay. He said, "People have been living in this coastal area for hundreds of years. It is a land of believers. The Almighty will protect us from every single difficulty. By sending disasters He tests the faith of believers…. Fishers have to live in harmony with the nature….God has protected us in the past. God will protect us in the future. (Case 9, Respondent 349)

According to one young net mender from Chakaria, natural disasters can happen any time and humans cannot predict and control it.

> No one can predict natural disasters. It is a natural phenomenon. If it is less in one year, then next year it is more. (Case 10, Respondent 352)

Another 30 year old fisher argued that natural disasters are increasing gradually, both on the land and at sea.

> Yes, I do agree with the fact that natural disasters are not preventable and it will happen from time to time…. We can see the frequency of disasters is increasing. When I was a kid my area used to be inundated annually for a few months, for the last few years it remains under water for almost half of the year. These days the frequency of warning signals has increased significantly. (Case 2, Respondent 342)

On the event of disasters, people may not take appropriate action and ignore warning signals for several reasons. The most common reasons are cultural, economic, and the lack of understanding of the meaning of the official signals as expressed by the respondents indicating the problems or issues. False disaster warnings cause doubts and make it difficult for fishers to make appropriate response decisions. A 60 year old fisher from Chakaria described some of the practical barriers of disaster response in the following way.

> "Sometimes we hear the news about the official warning signals for cyclones and floods. On many occasions nothing happens and it turns out to be a false alarm. Then sometimes floods and cyclones happen without any prior official signal. It is always a difficult decision for us to leave our properties and go to cyclone shelters."(Case 13, Respondent 353)

Fishers do not understand the exact meaning of cyclone signals. The community tends to develop their own interpretation of warning signals.

> "We do not know what the official disaster signal really means. But when a signal is up to 10 we know it's something really dangerous." (Case 9, Respondent 349)

A boat owner expects that his boats will return with good catches and at least his costs will be covered from a voyage. The head maji (the boat captain) gets the highest salary among all crews, and if a boat returns empty he might lose his job and the crew will not get paid. Therefore, the captain may take considerable risks to ensure some income expedition. A retired fisher aged 70 years explains the case in the following way:

> Most of the boat owners do not go to deep sea for fishing. They recruit crews and provide all necessary inputs like fishing gear, food, oil and other necessary fishing materials. It takes 12- 20 days to complete a voyage. On average a voyage costs Taka 40,000 to 150,000 depending on the size of the boat, the number of crew and days at sea. The boat owner pays the highest salary to the head maji (boat captain). There is constant pressure from the boat owner not to come back empty handed from a voyage. The boat captain and crews are not paid if they return empty-handed. They also do not get full payment if a boat owner cannot make a profit from an expedition. Sometimes a captain and crew lose their jobs if they return without good catch for few times. To protect their reputation and job a captain may take considerable risks in the sea. (Case 19, Respondent 359)

Sometimes women do not go to cyclone shelters because of safety concerns. A 30 year old woman explained security issues of woman in a cyclone shelters in the following way:

> A 30 year old wife of a 40 year old fisher explained, "As a woman I am scared of being molested in a cyclone shelter. How can women live together with strangers in a cyclone shelter? It is not safe for the women. Moreover, cyclone shelters are overcrowded and there are no latrine facilities (unhygienic)." (Case 27, Respondent 373)

Another fisher thought that it was not religiously acceptable to mix women with man in a cyclone shelter.

> A 35 year old fisher stated, "Some people don't leave their houses during a cyclone. They think it is not religiously acceptable to stay together (men and women) in a cyclone shelter." His 22 year old wife added, "How can I leave property and take refuge in a shelter when my husband's life is in danger at sea?" (Case 31, Respondent 371)

Fisher communities develop a range of strategies and livelihood choices in order to deal with various annual stresses. These strategies include various methods of income generation, protection of properties, food storage, and savings.

The community perceives that family ties and social networks are an important coping strategy. During a crisis, fishers first seek a loan from relatives, and usually prefer to sail with relatives and also with fishers from the same community whom they know and can trust, and who will not leave them in the case of a mishap. It was observed that trust and royalty is crucial in the community as it is not uncommon to hear stories about when a fellow fisher risks his own life to save his mates from pirates, strong waves or from any sort of untoward incidence.

Beliefs and rituals are an important part of the fishers' community to cope with risks associated with various disasters. Traditional Hindu fishers perform various rituals and worship the Sea Goddess (Samudra Dabi) in a way that is different from other Hindu casts. They believe this particular Goddess has total power over the sea and can protect fishers from various calamities. Muslim fishers perform a special prayer and wear a bracelet (tabiz) in the hope to get favour from the Almighty. It was observed that the belief system is crucial in the community and is a source of mental strength to continue in the risky fishing profession.

Fishers mostly think that it is possible to minimise disaster impacts by taking action at a personal, community and government level. Fishers believe that they are doing everything they can possibly do at the individual and community level to protect themselves from various disasters. The motivation behind the action against disasters is to survive and thrive after they occur.

The jeleparas are densely populated and dwelling conditions of the fishers are poor. Most of the fishers live in thatched houses and the quality of construction of most of the houses is not good enough to protect the inhabitants from cyclones, floods and rain. Among the fishers, those who can afford to do so are trying to raise plinth height above the flood level, and some of them construct concrete and a semi-concrete houses. In order to protect houses from cyclones, floods and erosion they plant trees surrounding their houses and also preserve dry foods in the case of an emergency.

It was observed that a good number of fishers that were interviewed are homeless as some of them lost their land due to coastal and river erosion. These ultra-poor families construct shelters on the government owned forest or on the flood embankments. However, not many fishers admit that they live on government lands or illegally occupied lands.

> A 30 year old fisher who is a father of two children said that he used to have our own house with a decent life and lost everything to river erosion. They had been living on the embankment for the last one year. (Case 23, Respondent 363)

It was reported that in the sea, winds are stronger and waves are bigger than before and in response fishers were strengthening boats and nets mostly by using locally available technology.

> Traditional boat building methods are not working anymore. In the last 5-10 years all the boat owners have strengthen their boats and fishing nets. These days most of the boats are stronger than before. (Case 9, Respondent 349)

Fishers expressed their deep dissatisfaction over boat safety arrangements during fishing voyages at sea. Generally, fishers sail without the minimum safety equipment like life jackets, compass and a communication systems. Boat owners are supposed to provide all the required equipment for safety. Unfortunately, most of the boats are

without safety equipment and my field observation confirmed this fact. However, boat owners did provide some plastic cans and rafts made with bamboo sticks as safety equipment that was found in most of the boats. The lack of monitoring, policy and law enforcement by the government are encouraging boat owners not to comply with laws and policies. Apparently, fishers seemed to be the ones more concerned regarding safety arrangements on boats.

> A 30 year old fisher said, "If we ask for life jacket owners reply that we should bring our own. We won't be fishers if we can afford to buy a life jacket?" He also explained that there is no mobile network when we go out deep-sea fishing for 15-20 days. If the engine fails, we have to wait for another boat to pull us to shore. If a cyclone develops during our voyage sometimes we get the information from another boat. We stay in the sea if the signal is five to six. If the signal is more than six, the head fisher makes the decision whether to return or to stay at sea. (Case 2, Respondent 342)

Fishers think their capacity to take action against various disasters are limited. They perceived that the government's role is critical for disaster management and recovery. Most of the fishers were critical of the government for the way in which natural disasters were handled. Corruption, poor planning, a lack of trust, lack of communication and funding are impeding the government response to disaster management. Poor maintenance and the faulty design of dams were perceived to be the reason for increased flooding in the area. According to a community leader:

> Embankments are easily washed away by cyclone and surges because their poor construction. Sometime a breached portion of the embankment remained without repair for years. Every year it gets wider. Consequently our areas easily get flooded.… This newly constructed road works as a dam. If the river overflows, it will create severe waterlogging on the other side.… Monsoon water cannot pass through due to a faulty drainage system. As a result frequency of flood is increasing in this area." He further continued, "… look at the hill how indiscriminatingly people are chopping down trees and settling down on the hill. Deforestation, stripping off vegetation, and unplanned human settlement are making the soft soil hill vulnerable to landslide especially during the monsoon. In this area landslides and flash floods are increasing because of these practices. (Case 18, Respondent 358)

Another fisher explained reasons for unplanned dwellings built over the hill are the reason for flash flooding.

> Shelter scarcity is severe for the large population living in this area. Due to frequent floods, some like us had to move houses up on to the hill. Now we are in constant danger of becoming victims of landslides. A few years ago 2 people from the same family perished in a landslide. (Case 13, Respondent 355)

To cope with recurring income losses fishers are increasing putting pressure on fisheries resources. Fishers are sailing more frequently than before, and some are involved in illegal fishing practices, such as poisoning fish and catching undersized species.

7.4 Impacts of various climatic events on the fish catch

In a group discussion, respondents were asked to explain what they perceived were the main impacts of climatic changes on the fish catch and Table 7.1 summarises their perceptions.

Table 7.1: Impacts of various climatic events on the fish catch

Events	Impacts on fish catch Positive/Negative	Description
Cyclones		
Before cyclone	Negative	In stormy weather, it is difficult to catch fish. Fish moved into deep sea
Post cyclone	Immediate –Positive	After cyclone, when water is settled down, fishes were more visible. Possibilities of high fish catch
	Mid & Long term- Unknown	Long-term impacts of cyclone were unknown. For few years some species get abundant, some get lost.
Strong sea wave	Negative	Fishes were more visible. Fishers get less fish as it is difficult to set net.
Rain fall	Positive	Fishers catch more fish at the time of rainfall
Strong wind	Negative	Difficult to set net and fishers loose net. As a result, they get less fish
Hotter summer	Both positive and negative	Hot and humid conditions were generally good for fishing
Colder winter	Negative	Fishers need to sail to deeper waters for fishing
Earthquake	Negative	Always negative. Almost no catch after earthquake

Source: Field visit (2013)

Extreme weather events like cyclones effect fishing operations in a number of ways and the impacts depends on various factors. According to respondents, generally whenever a cyclone forms in the sea fishing becomes difficult because of strong winds and waves. Cyclones can increase the mortality of various fish species, and

generally, after a super cyclone, the sea returns to its normal state in a day or two. At this stage, fishes become abundant and the possibility of getting a good catch increases. However, mid-term and long-term effects of cyclones were difficult to understand. After a cyclone, the structure of fish assemblages and habitat change significantly. Probably in the most cases the diversity of species declines after every super cyclone, which could be short-term or permanent.

Fishers prefer hot, humid and rainfall conditions for fishing. The monsoon is the peak-fishing season for the small-scale fishers. During the monsoon fishers can catch fish relatively easily and need not to go into the deep sea for fishing. However, fishers were concerned about the declining stocks and the consecutive poor fishing seasons.

In summary, any change in climate can affect fishers in multiple ways. Fishers indicated changes in water temperature, precipitation, wave action, wind velocity, and disasters (such as cyclones, storm surges) which can have short-term and long-term impacts on the distribution and abundance of various fish species. However, the net effects of climate change was difficult to measure just through observations and experiences.

7.5 Climate change information and response strategy

7.5.1 Observations and indigenous knowledge

Apart from formal disaster forecasting, people can predict disasters by observing natural signs (Pareek and Trivedi, 2011, McAdoo et al., 2009). Indigenous knowledge has an important role for community disaster risk reduction (Kelman et al., 2012). For centuries, traditional indigenous knowledge has helped coastal communities in Bangladesh to predict disasters and to increase resilience (Howell, 2003). However, indigenous knowledge is not formally recognised by the policy makers in Bangladesh (Paul and Routray, 2013).

Most of the fishers have a long family history of living in coastal areas. It was learnt that through oral family history, folklores, poetry, songs and by sharing life experiences the community kept records of major and regular climatic events.

Knowledge, skills and experiences are also passed down from elders to the younger generation through oral conversations and on-the-job training.

> According to a 25 year old fisher from Chakaria, "I learn all the fishing skills and knowledge from my father. From my young age, I used to go fishing with my father. Later, I have learned a lot about fishing from the head fisherman." (Case 22, Respondent 362)

It was observed that for lifestyle and professional reasons, fishing community members are experienced and closely observe the environment and climate as various ecological and climatic conditions directly affect fishing activity. Sunshine, rain, wind, temperature and tides are some of the important factors for fishing. Most of the survey respondents indicated that they have observed or heard about changing historical climatic trends in the last 10 to15 years. Respondents observed that heat during summer has increased and patterns of rainfall have changed, and winter has become shorter. Respondents have experienced extreme cold for a couple of days for the last few years and it has become drier, while rainfall has also decreased dramatically. Severe cold in winter has negative effects on fishing activities and fishers' everyday lives, especially for the elderly and children. Fishers frequently fall sick in winter and fishing boats have to go into the deeper sea for fishing which increases the costs of fishing. Respondents also reported that the frequency of cyclones on land had been stable (normal) in the last five to seven years, while storms at sea had increased significantly. More fishers said that are being struck by thunderbolts and also reported that in last few decades the fish catch had declined significantly. However, this decline was not linear, and some years are better than others are. Most importantly, the community seems quite anxious about the continuous decline in fish stock at sea and in the estuaries.

It was observed that in the study areas recurrent natural disasters have an improvising effect for most of the respondents. It was observed that the fishers living in the study areas were well aware of the "regular" disaster threats and they took precautions to cope with these threats in a "normal year". To protect their properties from cyclone and erosion fishers plant trees surrounding their homes and grow vegetables in their gardens to add some nutritious food to their regular diet and to ensure food safety

during crisis periods. During a food-crisis, the bread earner and children get preference to foods, while women get the least. Another dominant strategy to cope with such crises are withdrawing children from school and engaging them in fishing knowing that their wages are far less than adults. During such crisis fishers sell labour in advance and take loans from the local moneylenders with high interest rates.

Fishers learn indigenous knowledge through experiences and from ancestors and use that knowledge to predict an impending disaster and to take appropriate response actions. During the field visit, it was observed that the majority of fishers, especially the older ones, have a very good idea about seasonal weather patterns. Fishers think, to some extent, they can predict the type and severity of a natural disturbance through indigenous knowledge.

> A 70 year old head fisherman and owner of three trawlers said his father predicted the 1971 cyclone by observing the movements and behaviour of animals. He said, "Noticing the continuous cry of dogs my father predicted a cyclone in 1971. At that time there was no radio, no flag and no warning from the loud speaker. There was no way but to depend on natural signs of the calamity." The respondent himself can predict cyclones by observing nature. He said, before a cyclone "the wind blows violently. The sea becomes rough and constantly makes a sharp noise. The sky and the sea become cloudy and smoky. All these indicate a strong approaching cyclone." His 66 year old brother added that before a cyclone "sea water becomes warm." Another 70 year old fisher added that "continuous crying of dogs, an increase in flies and mosquitoes, movement of ants to the trees are signs of disasters. A sharp observer can read these signs a week before a disaster." He added how his traditional knowledge had helped him to protect his family from a flood. "It was stormy. The atmosphere warmed up alarmingly. Dogs and cows were wailing without a break. We felt a flood or cyclone is about to hit us. I packed some dry food, home utensils and some valuable belongings in a sack and put them beneath the soil. Within 24 hours water started overflowing the river bank (river Matamuhuri)". A 30 year old fisher added that his mom claimed that "the movement of ants to higher places predicts floods. Before a cyclone the weather becomes hot and humid." (Case 13, Respondent 354, 355, 356 and 357)

Traditional knowledge is also important for navigation and for locating fishing points, as most of the fishing boats do not have basic navigation tools. It was observed that most of the boats don't even carry maps and compasses for navigation. The head fisher depends on his senses and mental images for navigation and for deep-sea fishing, generally, the entire boat depends on the navigation skills of the head fisher. He has in his mind's eye the map of the sea and he uses such a conceptual compass whose points are typically delineated according to the rising and setting of the key star

and constellations, and wind directions. A 60 year old experienced fisher shared some of his knowledge and experience of the sea in the following way:

> "We know the direction of the wind by watching the direction of the clouds. Speed of cloud movement indicates the speed of the wind. Ripples on the sea indicate the direction of the wind. Wind and swell conditions are very important for fishing. They also observe ocean swell, the state of the sea, cloud formations, and animal behaviour to understand the current and approaching weather. For example, the formation, colour, height and shapes of cloud can give an indication of an approaching storm, also when birds fly towards land in large numbers can indicates an approaching storm. The height of the swell depends on the speed and duration of the wind. A strong wind and wave makes it difficult for fishers to set nets in the deep sea." (Case 13, Respondent 353)

Histories of the local environment and disasters have been passed from one generation to another through various songs, poems, proverbs, and parables that have played an important role in understanding fishers traditions, culture and customs. "What shall I say about our life…(there is) tiger on the land, crocodile in the water"- a 25 year old fisher related while describing how they are affected by disasters both on land and sea. Another fisher shared a story from his grandfather. To make the long story short, the moral is if someone heard an approaching super cyclone they must store dry foods and safe drinking water by digging ground or placing them in a higher place.

The role of an informal social network in the fisher community is crucial to get disaster information and to deal with various high-risk events both on land and at sea. During the 1991 cyclone, a large number of deep-sea fishers died and went missing as most boats were unaware of that it was coming and consequently the death toll was high. These days most fishers carry mobile phones while sailing for 12-20 days into the deep sea which helps them to stay updated with the weather reports from friends, family and colleagues, whenever they are under network. According to fishers, they can usually get the mobile network for the first 4 to 5 days and in the last couple of days of sailing time. In the deep sea if a boat master recognises an approaching cyclone he passes this information to all the boats they meet on the way back to shore. In addition, fishers rescue other fishers if they find them in a distressful situation in the middle of the sea and generally they do not mind taking considerable risks to rescue other distressed fishers.

When fishers migrate from one place to another they rely on the local residents and community leader to obtain information on local disaster risks and possible strategies to deal with them. From a political perspective, for the newly migrated families communicating with influential locals is important to establish themselves in the new environment and society.

Table 7.2 summarises some of the natural signs before floods and cyclones. Most of these indicators are based on the changing characteristics of sea/river, weather patterns and animal behaviour before a disaster. The majority of these natural indicators were noted from a retired fisher from Chakaria. Occasionally some of the indicators were discussed with other fishers to get their opinions. It is important to note that sometimes fishers have contradicting opinions on indicators, for example, fishers have different opinions regarding changes in wind direction before a cyclone. Further research is needed to find out some of the most reliable indicators which are likely to be found among the locals.

Table 7.2: Natural signs before floods and cyclones

Sea/river	Strong waves Changes in "sea/river sounds" River and sea water becomes hot Smoky and cloudy mist in the sea A strong specific type of noise (garam garam) in the sea
Weather	Gloomy and overcast sky Formation of black clouds Hot and humid weather Spells of rain Strong winds blow from the south A strong smell in the wind
Animal behaviour	Cattle become restless Cattle and dogs continuously wail at night Ants move with their eggs towards high land and trees An increase in the number of flies and mosquitoes Cockroaches become disoriented and fly a lot Fish jump in the sea, river and ponds Crabs come towards houses and land

Source: Field visit (2013)

7.5.2 Formal sources

The Bangladesh Meteorological Department (BMD) is the authority responsible for monitoring, issuing and disseminating warning signals for all meteorological extreme events in Bangladesh. This organisation also provides warning information to public media for dissemination (BMD, 2015). Bangladesh Cyclone Preparedness Program (CPP) developed by the government of Bangladesh with the help of United Nation (UN), Red Cross and Bangladesh Red Crescent Society, is responsible for disseminating warning information to the coastal population. The CPP uses 42,000 volunteers to disseminate warning information to the population at risk (Habib et al., 2012). After formation of a cyclone in the bay, the BMD issues special bulletins at regular intervals until landfall. The CPP control room provides updated information to its volunteers through radio communications. Then volunteers disseminate warning information to the population by bicycle, walking using megaphones, sirens, lights and flags (Paul, 2009).

Most of the fishers had learnt how to respond to disasters through personal, family and community experiences. Respondents also think that formal sources of information are crucial at the time of disasters. A boat owner from Chakaria described how during the event of a cyclone most of the fishers follow the media reports and government announcements very carefully. They also followed announcements from the Red Crescent volunteers, based on these official announcements fishers make their decisions about how to respond. For example, if the cyclone-warning signal is less than four, most of the time boats are not instructed to come back to shore. If the signal is between seven and ten boat owners mostly depend on the judgement of the head fishers (captain) as to whether they stay at sea or come back to shore. If the signal is more than ten all the fishing boats must come back. A 60 year old experienced fisher explained the issues related to cyclone signal in the following way:

> "We expect to get accurate and on time information regarding cyclone and storm surges. Based on the warning signal we make a response strategy both for the fishers and for our family. Besides the strength, it is important for us to know the time of the day when the cyclone would hit the land. Damage would be much higher if a cyclone hits land during high tide and in the middle of the night like in 1991." (Case 13, Respondent 353)

According to a village leader, on several occasions the government authority did not issue any warning signals of an approaching cyclone. However, in the past the media was not popular and mobile phones were not available like they are today. Compared to the cyclone warning system of a few decades ago, fishers now get the information on time when a cyclone is generated in the bay and approaches land. The local Government is proactive in informing and encouraging people to take necessary precautions. Beside the government agencies, Red Crescent volunteers warn the coastal communities through microphones. They also inform people regarding evacuation and relief plans after disasters, and provide first aid to the injured and get the severely injured to emergency medical support.

Another fisher pointed out that while there are arrangements from the government to provide information for the people who are on land at the time of disasters, there is no formal way of getting disaster information to boats that have gone out deep-sea fishing. Even today there is no radio and mobile network coverage out in the deep sea areas. These fishers have to rely on traditional and informal sources to get information on cyclonic events. Consequently, a large number of fishers become the victims of cyclones. An interviewee related how his best mate went missing in the bay in 2007 when more than twenty fishers were drowned and four boats were sank during the storm. Only seven bodies were retrieved from the rough sea by the fishing boats that managed to return to shore. Survivors said they saw several bodies floating away but they could not reach them due to strong winds and high waves.

An experienced fisher claimed that sometimes boat captains ignore cyclone signals and most of the boats do not carry basic safety equipment.

> A 50 year old community leader argued that the fishing boats often ignored the warnings from officials and a good number of boats do not carry radio or mobile phones to monitor the latest weather bulletins. He added that these days a good portion of the coastal area is under mobile and radio coverage and weather bulletins are aired every few hours. However, some boats even ignore the warning due to economic reasons. Sometimes a captain of the boat does not want to return to shore without any catch as boat owners do not like to see their boats returning empty. Generally, if a boat owner cannot make a profit, fishers are not paid for that voyage. (Case 9, Respondent 349)

7.6 Responsibility and trust

A 40 year old fisher said,

> "If Mother (nature) abandons fishers, the government and the people do not care for us…we get something when there is any leftover (in terms of aid and development plan)." (Case 3, Respondent 343)

In the fishing community there is a sense of extreme dissatisfaction, social exclusion, alienation and a lack of trust in institutions. This includes local government, national government, Non- government Organisations (NGOs), and the so-called "rich and influential" people in the local community.

> According to a community leader from Chakaria, "it may not be possible to have total control over natural disasters. However, lots of disasters could be prevented and the damage minimised if the authorities work responsibly with vision and planning". Fishers believe to some extent that local government is responsible for disasters like frequent flooding, and landslides by not maintaining and constructing dams with proper planning. Government authorities were described as being corrupt, politically motivated, inefficient, shortsighted and insensitive to the fishers' community. (Case 18, Respondent 358)

One experienced fisher from Chakaria expressed his dissatisfaction over development issues in the flood plain and the lack of forward thinking by the government. Like these research findings, Mahmud and Prowse (2012) also indicated that the wide spread corruption of government agencies in pre and post disaster intervention.

> "Look at these shrimp farms. Long ago, this area used to be a mangrove forest. The forest used to protect us from cyclones. Moreover, the mangrove forest is a good breeding ground for fishes. As the government gives permission for shrimp farming, gradually people cleared the forest. In our area the frequency of floods and cyclones have increased due to short sighted government policy." (Case 18, Respondent 358)

Another interviewee pointed out that government inaction and poor response causes extensive damage. He also claimed that the government only responds when something becomes catastrophic.

> "A flood control dam in our area has been damaged for several years. A sluice gate of the dam was destroyed, several cracks had developed in the dam. The cracks are getting bigger every year. We complained to the chairman (local government official) several times. Every time he told us there is no funds for maintenance. In the last monsoon each fisher family donated Taka 500. With that fund, we put some sand bags in the cracks. Nevertheless, that was not enough. A strong cyclone and tide surge can badly damage

> the dam and flood the whole area. Then the government has to spend millions to repair the dam" (Case 10, Respondent 350)

There was a widespread perception among the fishing community that they were ignored by the authorities because they are poor, illiterate and 'fisher'.

> An older community leader claimed that government officers do not listen to the illiterate fishers and probably they have no any idea about "the people of water".

> Another 70 year old retired fisher said that the fishers' voices are largely unheard because they do not have any influential community leaders/representatives at the local or national level. What is even more hurtful is that the fisher families who have left the fishing profession for some reason do not like to reveal their past. This retired fisher also expressed, "A non-fisher will never understand our relationship with water." Fishers frequently claim that non-fishers will never understand the life of a fisher because of cultural differences. (Case 19, Respondent 359)

It was evident that fishers were doing everything they could possibly do to adapt to changing climate and disasters. A sense of ignorance, lack of trust of the authorities as well as threats to life and livelihoods had motivated fishers to take the best possible effective actions to respond and adapt. The persistence of individuals and community efforts of the fishers to adapt to the changing environment and disasters are quite impressive.

> According to 40 year old retired and injured fisher from Chittagong, "We cannot rely on the authority for everything. Cyclones and floods threaten our lives and livelihoods. Therefore, as individuals and a community we have to work responsibly. We have to look after ourselves". He also report that during and after disasters like floods and cyclones, community members help each other to find safe shelters and to store food. After floods, the community often cooks in a common kitchen and distributes food among the families. Adult members of the community actively participate in search and rescue operations during and after disasters. (Case 20, Respondent 360)

It was observed that respondents were well aware of the limited choice of response strategy. Poverty is one of the key factors limiting disaster response options for the fishers. On several occasions it was observed that respondents failed to take appropriate response action due to resource limitations.

> According to a 45 year old fisher from Chakaria, "I need to raise house plinths above flood level. How can I afford to do that? Every day I struggle to earn enough money to feed my family and I am in debt." (Case 8, Respondent 348)

> Another 40 year old fisher from Chittagong claimed that he had no money to strengthen fishing boats and nets as this was expensive. (Case 3, Respondent 343)

> A 43 year old fisher from Charakia also reported that he had to shift to embankments 2 to 3 times a year because of annual floods. However, he could not afford to buy a house on higher land. (Case 5, Respondent 345)

The government and various NGOs generally start relief operations immediately after disasters. They can be divided into two categories: first, intervention for short-term and immediate recovery and second, intervention for medium and long-term recovery. All the interviewees expressed a strong dissatisfaction against widespread corruption amongst authorities involved in relief operations.

> A 65 year old community leader stated, "the relief comes to us (meaning the ultra-poor), but it is distributed among the rich." He continued, "Relief is a profitable business for the (local) chairman. He keeps some for his consumption and the rest he sells in the market." In addition, interviewees complained relief operations were mostly delayed and supply never met the demand. "Sometimes fights break out in the food distribution centres when authorities inform people that there is no more rice when people are starving and had been waiting for the whole day" (Case 18, Respondent 358)

The Government issues a relief card for the disaster victims to support immediate and long-term food and rehabilitation needs. The size of the household and damages incurred by the household in the disaster are some of the main criteria for allocating cards. Fishers complained that rich and influential families got more relief cards compared to the ultra-poor, notably fishers. Moreover, in most of cases fishers have to bribe the mediators to put their name on the list to get a relief card. If fishers don't pay the bribe their name might not be listed. Fishers expressed their deep dissatisfaction regarding the amount of relief they received. Relief is always far less than what is requirement.

> A 35 year old fisher reported, "In 2007 our whole area was flooded. We lost our shelters. There was no work, no food. Government allocated 15 kg rice for a month for my four-member family and the relief was not sufficient…Moreover, at the distribution point we received less rice than we were entitled to. With that relief somehow we were meant to survive." (Case 21, Respondent 361)

> A 25 year old net mender from Chittagong reported that people who work for the chairman always get some benefits in terms of (relief) cards and foods (rice). Union chairman and his associates are mostly corrupt. The chairman prefers his associates and (political) party men first. (Case 22, Respondent 362)

7.7 Conclusion

Cyclones, storms and tidal surges, floods, river erosions and heavy rainfall are some of the recurrent natural phenomenon of the study areas. Disaster shocks are numerous, severe and widespread. One might think fishers are the helpless victims of various hazards as they accept them as an *Act of God*, *Punishment of God* and *can't do anything against nature*. However, when an event does occur fishers do not sit idle at home and pray to God to rescue them from disasters, nor wait for the government to distribute relief after disasters. Rather they undertake several measures to rescue themselves from disasters and to survive despite the lack of help.

The faith systems of fishers can be seen as a self-help strategy to avoid desperation, feeling lost and alone. By referring to God as the one who decides on everything, fishers express the belief that disasters are a test of faith and God will be on the side of whoever keeps the faith till the end. This faith is a survival strategy that provides the mental strength for fishers to continue with the risky fishing profession.

To cope with various shocks fishers take a good number of pre and post disaster strategies that are practical and effective, especially in a 'normal disaster year'. Fishers believe the ownership of assets and social networks are key to guard against shocks and to differentiate them to cope with, and negotiate the impacts of these events.

Fishers also think various human activities, e.g. unplanned development, population growth and deforestation are the reasons for disasters. They believe through proper planning and support it is possible to reduce disaster impacts significantly by avoiding some detrimental activities.

Fishers think that these days forecasting systems have been improved significantly in terms of identifying, monitoring and disseminating information among the inhabitants. However, it is difficult to understand and differentiate between warning signals. In many cases, the community had developed its unique way to explain the signal. For example, up to a warning signal seven they stay at sea, while if the signal

is ten or more, fishers think it is too dangerous and generally come back to shore. Presently, broadcasting media, Red Crescent volunteers and word of mouth from relatives and neighbours, are some of the main sources of early warning information.

After receiving the official warning most of the fishers take measures to protect their lives and properties. Fishers put dry food, drinking water and other valuables in a safe place. They either bury valuable things and/or put them on higher ground.

Fishers think that they receive almost no support from the government to help them to recover after various shocks and disasters. Most of the respondents expressed strong dissatisfaction by accusing the government and the society for abandoning the fishers' community from every aspect of development. Fishers believe that the government never considers their needs and demands for policy development to overcome disasters and climate change adaptation.

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

Climate change is considered as one of the major development challenges for Bangladesh (Agrawala et al., 2003, Yu, 2010). The adverse impacts of climate change include social, cultural, political, psychological, ecological and economical aspects (GOB, 2009). In such a dynamic situation, one of the major policy challenges is to know the perceptions of the local community who live in the high-risk areas and are exposed to climate change related impacts. This study has argued that the implementation of effective adaptation policy is important for Bangladesh, and therefore understanding the perceptions of local communities is an essential factor in any effective and acceptable adaptation policy (Stringer et al., 2009). This research provides an in-depth understanding of the small-scale marine fishers' perceptions of, and responses to, climate change and discusses the policy implications of risk perception research. Furthermore, this study documents fisher's personal observations and experiences of the local environmental and climatic stresses, and also discusses relationships between climate change, experiences and observations. Details on how people are affected and behave in response to the unpredictable nature of climate change, are some of the findings, along with the limitations of current adaptation programs in Bangladesh, specifically in the small-scale fishing community. The study found that given the vulnerability and limited development, an understanding of community perceptions of climate change should be considered as an integral part for the development of location and community based adaptation policy.

This chapter summarises the key research findings and assesses the extent to which research objectives have been achieved. It concludes with policy recommendations for policy planners and suggests areas for future research.

8.2 Major findings

8.2.1 Community understanding and knowledge about climate change

This research examined community understanding, knowledge, concerns and attitudes to climate change and disasters. The majority of respondents were poor with little education whose livelihood was based mainly on marine resources. Nevertheless, they had clear perceptions about changes in the key climatic variables, such as temperature, rainfall and seasonal patterns. They reported that summer had become longer, temperature had increased in summer, and winter had become shorter and drier with intense cold waves for 1 or 2 weeks, and there had been an increase in extreme rainfall events in the monsoon and summer. According to fishers, some of the most serious environmental and climatic threats are floods, cyclones and storm surges, lightening, sea level rise and erosion, changing seasonal patterns, earthquakes and salinity intrusion. Respondents in Chakaria living in high- risk disaster prone low-lying areas were more strongly concerned about impacts associated with climate change than those in Chittagong. Fishers reported that rough waves and stronger winds were becoming common phenomenon at sea. In the last 5 to10 years, the frequency of storms that cross the danger level 3 had increased at sea which forced the fishers to frequently abandon fishing trips or risk their lives and livelihoods. Fishers experienced increase in intensity and frequency of disasters at sea and predicted more in future. This study shows that awareness of the impacts of climate change was high among the small-scale fishing community in Bangladesh and the majority of these perceptions were in line with the impacts of climate change stated in the IPCC fifth assessment report (IPCC, 2014, p. 6). An overwhelming number of respondents believed that climate change is happening now or it will happen in the next five to ten years and most are worried about it. Respondents also linked future threats of climate change to current disasters. Moreover, local perceptions about climate change variability and threats were consistent with scientific evidence regarding impacts of climate change in coastal Bangladesh.

This study found that fishers mostly unaware about the causes and physical process of climate change largely, and this differed from the scientific explanations. Fishers

knowledge about the causes of climate change were influenced by faith, tradition and culture, it was found that religious faith played a significant role in shaping community perceptions of climate change. Both Hindu and Muslim fishers believed disasters are a test of faith and ultimately God will protect the faithful. However, the perceived role of God in influencing the weather and causing disasters was common among coastal fishers irrespective of religious faith. Belief in a higher spiritual being is an important factor for fishers who believe that humans have no role in influencing the climate or weather. The study further explored the meaning, motivation and reasons for this belief and found that Hindu fishers explained that disasters were increasing because the sea deities were angry because humans are committing sins and destroying nature like never before. Muslim fishers thought that climate change was the will of God and He can do whatever He likes. Fourteen percent of respondents thought disasters are punishment by God. Deep-sea fishers are one of the most vulnerable to climate change, and one fifth of respondents in Chittagong, who were mostly deep-sea fishers, thought that climate change was a punishment by God. Some respondents also related climate change to local environmental issues, such as deforestation and pollution. However, only a small fraction of respondents thought that climate change was happening because of the actions of other countries. To explain change in future climate, fishers frequently referred to traditions, disaster events and the community rebuilding efforts. According to fishers' traditional beliefs and observations, whenever land is eroded on one side of river, new land emerges on the other side. Therefore, they can always move to the new land. The results indicated that local experiences, traditions, faith, values, and the type of disasters are powerful indicators of fishers' understanding of climate change and the future state of the environment.

This study found that fishers perceptions about climate change risk and response decisions were influenced by geo-physical, socio-economic and local infrastructure. Results show that respondents in Chakaria were more concerned about sea level rise, floods and cyclones than in Chittagong. Perceptions about climate change were influenced by local infrastructure facilities as well, and it was observed that this was better in Chittagong than in Chakaria. Results show that respondents in Chakaria were

more concerned about rainfall, floods and sea level rise. In the interviews, respondents from Chakaria mentioned that high water levels put tremendous pressure on the dams and caused the frequent failure of the flood management system. As a result, the incidence of floods, water logging and salinity intrusion had increased, and they blamed mismanagement of the government authorities for the frequent failure of dams. It was observed that the flood management system was better in Chittagong than in Chakaria, and respondents there had different views about sea level rise. They reported that new islands were emerging near the shoreline in Chittagong, and it is clear that further investigation is needed here. Brammer (2014) pointed out that coastal areas of Bangladesh are not uniform nor static but more dynamic and diverse than is generally recognised. This has led to serious misconceptions about the potential impacts of sea level rise on Bangladesh. The author suggested that it is important to identify location specific adaptation and mitigation measures to counter probable impacts of sea level rise in different coastal areas of Bangladesh. Deb (2009, p. 271) argued that in coastal Bangladesh the impacts of climate related events differ between locations, development history and social groups. Moreover, the study findings indicated that environmental concerns were closely related to local experiences that pose a direct threat to individuals. Results of this study also indicated that respondents' level of concern were related to the local impacts of climate change, and respondents in Chakaria were more concerned compared to those in Chittagong.

The majority of respondents perceived that they had a moderate knowledge about the local environment, although a third of respondents aged over 40 years thought that they had good knowledge about local climate. Results generally indicated that older respondents were more likely to have better knowledge about environment and climatic changes than their younger counterparts. It was also observed that most of the boat captains and boat owners were older and because of professional reasons, aged fishers were concerned about various impacts associated with climate change.

In-depth interviews indicated that while faith is an important motivating factor/encouragement for fishers to continue with the risky profession, it was also associated with the notion that God alone has the authority and power to change the climate. Therefore, humans have no role in causing climate change. However, there is

a positive side to this perception. Schmuck (2000) argued that this conception of rural people in Bangladesh is a self-help strategy to overcome distresses related to disasters, and helps them to rebuild their lives without wasting time and energy asking questions about why disasters happen. It can be concluded that fishers' conceptual understanding of climate change is different from the experts.

The study found that some of the threats associated with climate change are community specific, such as decreased fish stock, changes in fishing points and increased storms at sea. The survey also found that regular and continuous threats of climate change were equally threating and damaging to lives and livelihoods for the fishing community, as was the case when extreme disaster events occur. Some fish species are sensitive to rainfall and temperature, and the community believed that fishes were changing their migration patterns, and traditional fishing points were changing. This has made fishing extremely risky and in some instances an unprofitable profession.

Short-term and long-term impacts of climatic changes on fisheries are difficult to evaluate, as some of the impacts are understandable and some are unknown. Fishers reported that when a cyclone forms, the sea conditions become unfavourable for fishing, while after a cyclone conditions return to normal and the probability of getting a good catch increased significantly. Generally, after a super cyclone, some new fish species become available and others get lost. This change of species composition could be permanent or temporary. Respondents mentioned that warm and overcast conditions were good for fishing, while strong winds associated with strong waves and extreme cold were mostly negative for fishing activities.

Most of the respondents from Chittagong and Chakaria agreed that adaptation to climate change is possible through proper planning and support, and the majority recognised that the government, individuals and community were all responsible for making adaptations to climate change. However, one third of respondents also believed God was responsible for protecting the community against climate change, more so in Chittagong than in Chakaria. Some 95 percent of respondents in Chittagong were either deep sea or near shore fishers and they mentioned that it

depended on luck or God for survival from an impending cyclone. The relationship between climate change perceptions, intentions and real actions are very complex. However, survey results found that during disasters fishers just do not sit ideally believing God would protect them.

The fishing community widely uses traditional knowledge and strategies to predict and to cope with climate change and disasters, given that traditional knowledge is widely acceptable and respectable in the community. In interviews fishers reported that traditional local knowledge can significantly reduce community vulnerability to disasters and they were resilient to regular disasters. They believed that local and traditional knowledge of disaster management is cost effective and ecological friendly. Traditional knowledge was seen to help fishers in fishing activities and to understand the local environment, trends and patterns of disasters and to prepare an appropriate response strategy. Fishers argued that traditional response strategies were tested to overcome local disasters and to address community needs. Traditional knowledge was also found to be the key source of information related to the local ecology, fish habitats and hydrological cycle. Fishers can also predict weather and disasters by observing wave movements, the flow of wind and clouds, tide levels and animal behaviour.

All most all of the respondents spoke in local dialects and it was observed that there were no common phrases that described the concept of climate change and adaptation. Generally, the community was a keen observer of short and long-term changes in weather, temperature, rainfall, seasonal trends and disasters. Fishers kept these records through word of mouth, songs and poems that are passed down from one generation to another. They also use words that are close to weather to describe trends in climate. It was observed that most of the published documents and communique on climate change were in the formal Bengali language, which is difficult to understand for fishing communities where illiteracy is quite high.

Individual and community perceptions of climate change are contextual and influenced by environmental, socio-economic and political factors. Perceptions of climate change are also influenced by ethics and morals. It was observed that

generally fishers have pro-environmental attitudes and community supported policies to preserve the environment.

In summary, the determinants that shape fishers perception about climate change and response decisions were tradition, faith, observations, local infrastructure, geo-physical location, culture, disaster experiences, age and income. Table 8.1 summarises the dimensions of community perceptions of climate change.

Table 8.1: Summary of themes in community perceptions of climate change

Dimensions of community understanding of climate change	**Argument source**
Climate change is a natural process, *Act of God*, Coastal areas would never be inundated and become inhabitable.	Faith, Traditional knowledge, values, culture and customs.
Strong belief in community adaptation capacity. Humans can always adapt to changing environment.	Faith, observation, disaster experiences and tradition.
Climate change is linked to local environmental issues.	Geographic location, deforestation, unplanned development, mismanagement in disaster management.
High awareness of climate change. Changing climate and disasters are a threat to social, economic, health and psychological wellbeing of fishers.	Disaster experiences and high dependency on natural resources. Fishers are keen observers of environment.
Difficult to understand short and medium term changes of sea level rise at a local level.	Dynamic coastal environment and frequently changing coastline.
Fishers frequently share personal and family experiences of environment and disasters with community members. The government and media are key sources of secondary information regarding environment and climate.	Faith, Traditional values, Culture and customs. Difficult to understand disaster signals, no mobile and radio network in the deep sea.
Perceptions on climatic changes : Changes in historical rainfall and temperature patterns, Longer summers, shorter winters with extreme cold waves, Drier winter, a round the year rainfall, and rough sea.	Observation and experiences,
Some climatic phenomenon are good for fishing. Humid, overcast and drizzling conditions are good for fishing.	Observation and experiences,
Difficult to measure overall impacts of climate change on fishing. According to fishers' reasons for the decline in fish stocks are climate change, overfishing and sea pollution.	Environmental, social and economic issues are interlinked.
Terminology	In the local dialect, there is no specific term for the global warming or climate change.

8.2.2 Adaptation to climate change

This study found that respondents perceptions and attitudes were influenced by local disasters and its impacts, institutional factors, infrastructure, income and investment, individual and community costs and benefits. Some of the adaptation preferences mentioned by respondents were infrastructure development, financial support, safety and security, improved housing, on board communication and safety equipment, reinforcement of fishing boats and nets, and the inclusion of community representatives in the local disaster management committee, which varies across locations. For example, the majority of respondents from Chakaria were concerned about infrastructure development compared to one quarter of the fishers from Chittagong. It was observed that infrastructure in Chittagong was better and results indicated that respondent's adaptation perceptions were influenced by the local availability. Fishers' adaptation priorities indicated that fishers prefer intervention to reduce immediate, short-term and long-term vulnerability to climate change, with some of these adaptation priorities community specific. Respondents indicated that they need access to formal credit channels and fast and easy loans to rebuild their lives after a disaster. The results showed that sixty percent of respondents were indebted. In the interviews fishers explained that they generally borrow money to overcome disasters, in periods of unemployment, as well as for family and professional reasons. Fishers get fast cash loans from various informal sources, e.g. relatives, colleagues and moneylenders. If they have to take large amounts of money for a longer period, the only source is the local moneylenders, who generally charge exorbitantly high interest rates. This informal credit is also subject to awful terms and conditions. To get fast cash, fishers also leased out resources or sell their labour in advance. Most fishers do not have access to any formal credit sources mainly because of their lifestyle and poor socio-economic conditions. Islam et al. (2014) found that access to formal credit is one of the important economic barriers of climate change adaptation for fishing communities in Bangladesh.

Some of the most common adaptation practices in the community were migration, borrowing money to support family; to strengthen fishing boats and nets, and home improvements. Migration is one of the commonly used strategies for adaptation in the

fishing community. Fishers migrate to reduce exposure to climatic shocks and stress, as well as to get access to better health, water and income sources. In the study areas, it was found that significant migration happened after previous major climatic shocks, e.g. 1991 cyclone and 1998 floods. The study also found the widespread practice of child labour in fishing communities, with one in ten fishers starting in the fishing profession at ages less than 14 years. Widespread poverty and traditional norms in the community are the reason for child labour, and it is a common practice to teach children fishing at a very early age. Sometimes fathers take children out fishing to save money by not hiring labour. In-depth interviews showed that after disasters when there are severe food crises children are forced or encouraged to work to earn some extra income for the family. It can be concluded that fishers' adaptation to climate change is influenced largely by immediate needs and poor resources.

Coastal afforestation is considered to be one of the top most important projects for adaptation in Bangladesh (UNDP, 2013). However, this study found that coastal afforestation was not on the top five most important lists of the priorities for adaptation of the fishing communities. Overall, only sixteen percent of respondents mentioned coastal afforestation as an important adaptation priority.

Barriers to adaptation

The study explored key environmental, social, economic, technological, institutional and psychological barriers for adaptation. Impending factors for adaptation are both natural, psychological and anthropogenic. Some of the adaptation barriers are:

- Geo-physical characteristics of coastal Bangladesh,
- Low income and credit inaccessibility of the population,
- Poorly constructed boats and lack of on boat safety equipment,
- Poor law and order situations,
- Lack of information on climate change,
- Over population and poor education.

Because of its location and geo-physical characteristics, the coastal zone of Bangladesh is prone to cyclones and storm surges (Shamsuddoha and Chowdhury, 2007). Experts predict that the intensity and frequency of disasters will increase due to

climate change (Ali, 1999, Wernberg et al., 2011, Roy, 2011, Dasgupta et al., 2014b). Geographical limitations can constrain adaptation. A cyclone exposes fishers to various risks, for example, increased injury and mortality, damage to fishing assets and non-completion of fishing trips. Sometimes the boat captains do not receive any information of an impending cyclone due to the lack of radio/mobile signal coverage. Inaccurate and the misinterpretation of cyclone signals can also reduce the capacity to take proper precautions. Traditional boats have not been strong enough to sustain strong winds and waves. In addition, boat owners put pressure on the boat captains to continue fishing during storms and overcast situations. This highlights the fact that natural barriers to adaptation are linked with technological, institutional, economic and cultural barriers.

Lack of access to credit and the poor enforcement of regulations are leading to maladaptation. Due to limited accessibility to credit with unfavourable conditions and no significant support from the government, fishers do not invest much on safety and the better quality construction of fishing boats. As the government does not do much to enforce fishing laws, boat owners frequently violate regulations by not providing safety equipment on the boat. The boat owners and to some extent fishers focus on short-term financial gain rather than their long-term vulnerability reduction. Moreover, individual adaptation by fishers to climate change is constrained by social norms, institutional processes and economics.

In many cases, it was found that climate change has made an impact on infrastructure and put its operation and reliability at risk. Some of the main threats to infrastructure, include frequent damage and destruction of embankments caused by extreme events, like the increased intensity and frequency of floods and cyclones, as well as the increased erosion and infiltration of saline water. Fishers expressed their concern about unplanned and faulty design of infrastructure, poor maintenance of embankments and sluice gates, poor drainage systems and unplanned private and public developments (discussed in chapter 7).

According to fishers from the study areas, every year a good number of houses are flooded in the coastal region, and some are flooded two to three times a year. During

floods fishers take shelter on the government lands and embankments, however, the rate of erosion in some parts of Chakaria is increasing dramatically. Fishers' thought it was beyond their capacity to protect their dwellings from regular flooding and erosion. Sometimes fishers stopped spending money for adaptation when they perceived the risk was impossible to avoid. Moreover, frequent disasters can limit the ability of fishers to respond.

Fishers repeatedly echoed their concern about sea safety measures that are frequently ignored by vessel owners and government officials. There are some laws and regulations to ensure safety of the small-scale marine fishers. In practice, fishers' safety related laws are frequently violated because the government fails to monitor and enforce the laws at the local level. In addition, boat owners are not interested in abiding with safety regulations for fishers due to extra costs. Rising piracy was another key issue that threaten lives and livelihoods of the fishers, and at the time of the field visit, it was observed that community members were strongly concerned about piracy.

When disasters like erosion, cyclones, storm surges and floods strike the community fishers move to safe shelters. If the condition permits, afterwards fishers generally move back to their dwelling place. However, on some occasions fishers are forced to migrate permanently to other areas as they have no choice. Some of the fishers reported a good number of fishers migrated to Chittagong and Chakaria after the 1991, 2007 and 2009 cyclones, and 1998 floods. Another key migration reason of fishers was the loss of homeland due to erosion, intrusion of saline water and the increased frequency of seasonal floods. When fishers are displaced they move to government land, embankments or illegally occupied lands. These migrants often are subjected to social exclusion and discrimination. Displacement already causes some tensions and conflicts within the community, because fishers residing lower down the hill believed that the incidence of landslides were increasing due to the increasing number of people living in the upper hills. Disasters in any form tend to create some displaced persons and migrants.

The fishing community is facing multiple independent and connected natural, psychological and anthropogenic challenges for adaptation. Some of the adaptation barriers are reinforced by others. Therefore, no single adaptation policy could overcome all these barriers. This study highlights the importance of location specific adaptation policies and argues for the combination of complimentary policies to address all the adaptation challenges, and that the effective combination of planned and autonomous adaptation to reduce community vulnerabilities to the impacts associated with climate change.

8.2.3 Differences in scientific and community conception of climate change

Understanding the causes and consequences of climate change is critically important for making response decisions (Schneider, 2001, Schneider, 2002). A study by Nursey-Bray et al. (2012) reported that Tasmanian Rock Lobster fishers reported that they have observed major changes in the marine environment and yet they expressed doubts about whether climate change was a real process. The study argued that fishers' perceptions of climate change risks might create a barrier for adaptation actions. Dessai et al. (2004) suggest that a robust adaptation policy must appreciate both scientific risk analysis that is performed by experts and individual and collective perception of insecurity that is either experienced or perceived.

Table 8.2 shows differences in the community and experts' conception of climate change. The majority of fishers perceived that future environmental and climatic scenario will be somewhat similar to the present and past. The fishing communities conception about climate change is not consistent with that of scientists. The majority of the respondents believed climate change is a natural process or it is an *Act of God*. Fishers understanding of environment and climate change were influenced by indigenous knowledge, experiences, faith, custom and tradition, and risk assessment were mainly qualitative. Experts' sources of information on climate change are various climatic models and systematic data analysis and mainly quantitative. It was found that community risk management was influenced by socio-economic contexts, location, experiences, customs and external support especially from the government,

whereas experts' policies were influenced by development goals and financial capacity.

Table 8.2: Experts and community understandings of climate change and knowledge gaps

Experts and policy makers	Community	Knowledge gap
Concept of climate change Climate change is a physical process. GHG concentration is rising atmospheric mean temperature are the key reasons for climate change. Human activities are the key drivers of climate change. (Stocker et al., 2014, p. 121)	Fishers understanding of climate change are not consistent with scientific conceptions. Most fishers believe change of climate is a natural process. They link causes of climate change with supernatural power, sins, environmental degradation. Few believe it is impossible to say (Chapter 5 and 7).	Experts' have a specific understanding of the physical process of climate change. The community mostly believe climate change is a natural process.
Key source of knowledge Experts' climate change knowledge emerges from various climatic models and systematic data analysis (Stocker et al., 2014, p. 144).	Fishers' understanding of climate change is influenced by indigenous knowledge, narratives, experiences, culture and customs, faith, institutions, external sources like the government agencies(Chapter 5 and 7).	Science is the key source of experts' knowledge of climate change. Fishers' perception of climate change is influenced by social, cultural and experiential factors are
Risks of climate change Risks are assessed at global, regional, national and local level. Climate change risks include gradual increase of frequency and intensity of disasters, sea level rise, and seasonal fluctuations that pose significant threats to people, resources and ecosystem (Barros et al., 2015, p. 538, 664). Precise methods are applied to measure risks (Stocker et al., 2014, p. 121).	Risks are assessed mainly at local, personal, professional, and communal level. Risks are measured mainly in qualitative terms (Chapter 7).	The process of risk assessment differ significantly between experts' and the community. Experts' knowledge of risk of precise and focus on short term and long term impacts. Experts' are more concern of ecological and socio-economic impacts of climate change. Community is more concern of immediate personal, communal and local impacts of climate change.
Risk management Experts' knowledge of climate change risk is precise. Risk management policies are complementary with development goals and economic analysis (GOB, 2009).	Risk management is influenced by socio-economic contexts, location, experiences, customs and external supports especially from the government (Chapter 5,6 and 7).	Experts' cost-benefit analysis for adaptation policy preference might not always address critical community needs.
Coastal Bangladesh is one of the most vulnerable in the world to the impacts climate change (Maplecroft, 2014). Managing risks of climate change is critical to achieve long-term development goals for Bangladesh (World Bank, 2010).	Fishers thought future environmental scenario will be kind of similar to the present and past conditions. Fishing communities living in coastal areas of Bangladesh for centuries. Adapting to changing climate is a common practice for the community (Chapter 7).	Fishers and experts perceptions of climate change differ in terms of in future scenarios of disasters and climate change.

8.3 Recommendations

The preceding discussion explores a number of challenges for policy makers in engaging the public and implementing effective and acceptable adaptation policies. This section proposes a number of strategies to meet the challenges.

8.3.1 Challenges of community perception research

This research strongly supports mixed methods for data collection and analysis considering socio-economic, cultural dynamics, professional and geographical dimensions of the community. In this case, the respondents are mostly illiterate, and live in remote areas where postal services and internet services are not up-to-date. Moreover, respondents mostly speak in local dialects that are very different from the formal Bengali language in which most of the climate change and disaster information are published.

8.3.2 Communication and community engagement

Results of this study indicate that community perceptions of climate change risk are contextual, multidimensional, and do not always complement concepts of science. Typically, at the individual and community level, risk is assessed by a combination of qualitative and quantitative approaches. Lorenzoni et al. (2005) argued that scientific communities which rely on systematic risk assessment is important, but not sufficient to develop a long-term policy. Climate change policy decisions need to include other considerations, such as value judgements, and societal and individual perceptions of the risks of climate change.

Community involvement for risk mapping can be cost-effective and practical ways to gain insights to identify local threats and develop customise adaptation policies that prioritise local needs. However, policy makers have to be aware that the involvement of the community for risk assessment has some advantages and disadvantages (Quinn et al., 2003, Hossain and Roy, 2013). This study found that community risk assessment was influenced by the experience, faith, socio-economic and political status of fishers. Threats of climatic risk may differ from one community to another.

For example, fishers do not mind if the number of days with low to medium rainfall increases overtime and if winters become a bit warmer, as these scenarios are favourable for fishing activities. However, these scenarios may not be favourable for agriculture.

The small-scale fishing communities who have lived in coastal Bangladesh for centuries, have a rich knowledge of the eco-system, climatic system, environment and disasters. They are excellent observers and interpreters of changing climate over time. Fishers' collective knowledge of land, water, sky and climate at the local level can offer valuable insights into changing climatic and disaster patterns over time. Indigenous knowledge can enrich scientific data as information on change of climate over time is critical for verifying climate models and climate change scenarios. Understanding local knowledge, culture and customs can provide an important foundation for the development of community based adaptation policies. Bangladesh has limited resources for adaptation. Therefore, the involvement of community representatives in adaptation policy development would help to find the most cost effective and acceptable adaptation programs.

The small-scale fisher community in coastal Bangladesh entirely depends on natural resources for their livelihoods. The community is very much concerned about degradation of the ecosystem, increasing extreme climatic events and the depletion of fishing stocks. Most fishers' are unaware of future impacts of climate change and disasters scenarios predicted by experts. However, fishers believe various disasters are increasing at an alarming rate, historical climatic trends are changing and disasters are becoming difficult to predict. Fishers also believe they can adapt to the changing climate as they have done for hundreds of years. There is a sense of proudness, complacency and arrogance in fishers' perceptions of future adaptation. Fishers are completely unaware of experts' predictions on climate change, and their knowledge about the causes of climate change is not consistent with the experts. This lack of awareness to climate change could be a barrier to the effective implementation of adaptation policies. More accurate knowledge of climate change is an essential step to motivate the community to take practical steps for climate change adaptation and to

support adaptation programs and policies (Buys et al., 2012). Increased awareness of climate changes should also help the fishers to avoid maladaptation practices.

The language of the communication materials should be carefully selected. The survey findings and in-depth interviews show that the community think any changes in climate are an *Act of God* and a natural process. For fishers who have lived in coastal areas for centuries, tradition and faith play an important role in shaping their perceptions of climate change. To make an impact in the community the awareness campaign must be respectful of tradition, culture, vales and faith. Local language lacks terms for the key concepts of climate change and adaptation. This is an obvious and important barrier to communication about climate change. An effort should be made by policy makers to develop terminologies of key concepts that relate to climate change in everyday language.

The fishing community feels that the government and the policy makers have overlooked them for ages, they have received limited support and services from the government. Fishers pointed out that the community voices are mostly unheard at the local and national level because of poor literacy, low socio-economic status and that there are no renowned influential leaders in the community. A community leader explained how he has been lobbying government for years to get a representative post for the fishing community in the Disaster Management Committee at the union level. The inclusion of a fishing community representative in the disaster management committee could help the policy makers in the following ways:

- To understand local contextual factors in terms of environment, social, cultural and politics,
- Proper identification and assessment of local risks,
- Prioritise adaptation policies according to local needs,
- Motivate and inform community members regarding policies for adaptation and
- Develop adaptation policies that are effective and address local needs.

8.4 Future research

Based on the findings from this research this section describes areas in which future research might be directed.

1. This research describes climate change perceptions, adaptation and policy implications for small-scale marine fishers from two communities in southeast coast of Bangladesh and highlights the importance of location specific adaptation policies. Replication of this research to different communities and locations should provide an in-depth understanding and response to climate change and its validity.

2. This research found that the conceptual understanding of climate change among the community was poor. There is no proper phrase in everyday Bengali language and in local dialects that can explain the conceptual meaning of the English "climate change" term. Future research should focus developing terminology of climate change that is easily understandable in the Bengali everyday language.

It was found that fishers' associate climate change with weather, disasters and changing patterns of various climatic trends. Fishers do not believe that sea levels will rise in the future and that the coastal areas would become inhabitable. Faith, traditional knowledge and experience all play important roles in understanding the environment and interpret environmental changes in local communities. Further research is needed to investigate the best way to communicate climate change information.

3. This study has documented fishers' adaptation practices and policy preferences, and there is a need to investigate how fishers' preferences and adaptation practices can be incorporated into formal adaptation policies.

4. This research has shown that a number of fishers have migrated into the study area for various reasons. Some fishers have migrated temporarily for economic reasons and others permanently. A good number of migrants live on government lands, forestland, on embankments and some on illegally occupied lands. It was observed that a number of fishers in Chakaria took shelter on the embankments and were displaced due to the increased frequency of floods and erosion. Of most importantce, a good number of people in the study areas were landless and homeless. Future research should investigate adaptation policies and programs required for settlement

of the displaced population and needs to document carefully environmental migrants and their future.

8.5 Conclusion

This study investigated contextual determinants and dimensions of artisanal marine fishers' perceptions of, and adaptation to, climate change and recommended strategies for adaptation policy for them. The study found that the concern about climate change is high in artisanal fishing communities in Bangladesh. Nine out of ten respondents were worried about threats associated with climate change and observed changed in climatic pattern. Relatively younger fishers were more worried about climate change but older one had a better understanding of local environment and climatic changes, such as changes in temperature, seasonal and rainfall pattern. Fishers claimed that because of climate change the sea had become rougher and more dangerous for fishing, storms were not following the historical trends, stronger winds and waves had become common phenomenon at sea, and therefore, fishing had become a more unprofitable and risky profession. Most of these fishers' observation of changed climatic patterns matches with the key scientific predictions of climate change in Bangladesh. However, fishers knowledge about reasons for climate change differ from experts. This study found that six in ten fishers believe that climate change is a natural process or it is an *Act of God*.

Community culture, experience and world views influence fishers knowledge about climate change. Some of the respondents relate the cause of climate change to local environmental issues, such as deforestation and pollution. The majority of fishers recognised individual, community and government responsibilities to protect the community from the effects of climate change.

This study argues that community vulnerability of climate change can vary considerably depending on facilities in specific locations. Results show that respondents in Chakaria were more concerned about sea level rise, erosion, floods and cyclones than in Chittagong. It was observed that road communication, electricity and mobile phone communication in Chittagong were better than Chakaria. Monthly

average incomes of fishers in Chittagong were also higher than in Chakaria. Results indicated that lower income and poor infrastructural facilities increase community vulnerability to climate change.

It was found that traditional knowledge and practices were widely used in the fishing community to predict and to cope with climate change and disasters. Traditional knowledge was seen to help fishers in everyday fishing activities and to understand the local environment and climatic changes. In addition, fishers get information on the environment and climate from various other secondary sources, such as media, government agencies, NGOs, voluntary organisations, friends and colleagues. It was observed that fishers do not interpret the exact meaning of the disaster early warning signals and the community had developed their own interpretation of the signals to make response decisions. For example, when the cyclone warning signal crosses level 10 they must come back to shore for safe shelters. Fishers also claimed that occasionally the early warning signal appeared to be wrong, the cyclone appeared much more rapidly. Respondents also mentioned that sea going fishers were one of the most vulnerable as there were no mobile phone coverage and radio networks far out to sea.

The majority of fishers agreed that adaptation to climate change is possible through proper planning and support. Respondents mentioned adaptation preferences, such as infrastructure development, financial support, improved safety and security, and the inclusion of a community representative on the local disaster management committee. Fishers claimed these steps would increase their adaptation capacity. Results also indicated that the preferences for adaptation depends very much on location, such as fishers in Chakaria were more concerned about community development compared to those in Chittagong. Adaptation priorities are also community specific. These survey results indicated that migration and sending children to work were widespread adaptation practices in the fishing communities. This study also explored key environmental, social, economic, technological, institutional and psychological barriers for adaptation. One or a combination of these variables constrains the response decisions of fishers.

This study found that natural resource dependent fishing communities are extensively impacted by climate change. Some changes are gradual (such as rainfall, temperature) and some shocks happen suddenly (e.g. floods and cyclones). A diminished eco-system, and loss of fishers profits and outcomes, have a profound negative impact on the socio-economic, cultural system and human psychology of the fishing community. Considering the range of impacts related to climate change and non-climatic variables, an effective adaptation policy should be locally customised and address community specific needs, especially in poor vulnerable communities. A combined adaptation approach for the artisanal fishing community is recommended that should include an information campaign to increase awareness, financial incentives to support rebuilding processes after disasters, access to a formal credit system, improve disaster warning and management systems and the proper implementation of the legal system.

APPENDICES

Appendix 1: Ethical approval

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
RESEARCH ETHICS AND COMPLIANCE UNIT

BEVERLEY DOBBS
EXECUTIVE OFFICER
LOW RISK HUMAN RESEARCH ETHICS REVIEW GROUP (FACULTY OF HUMANITIES AND SOCIAL SCIENCES AND FACULTY OF THE PROFESSIONS)
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26 April 2012

Dr M Nursey-Bray
School of Department of Geography, Environment and Population

Dear Dr Nursey-Bray

ETHICS APPROVAL No: **HP-2012-011**
PROJECT TITLE: **Climate change vulnerabilities, risk perception and implications of adaptation of marine fishermen from south eastern part of coastal Bangladesh**

I write to advise you that the Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions) has approved the above project. The ethics expiry date for this project is **30 April 2015**.

Ethics approval is granted for three years subject to satisfactory annual progress and completion reporting. The form titled *Project Status Report* is to be used when reporting annual progress and project completion and can be downloaded at http://www.adelaide.edu.au/ethics/human/guidelines/reporting. On expiry, ethics approval may be extended for a further period.

Participants in the study are to be given a copy of the Information Sheet and the signed Consent Form to retain. It is also a condition of approval that you **immediately report** anything which might warrant review of ethical approval including:

- serious or unexpected adverse effects on participants,
- previously unforseen events which might affect continued ethical acceptability of the project,
- proposed changes to the protocol; and
- the project is discontinued before the expected date of completion.

Please refer to the following ethics approval document for any additional conditions that may apply to this project.

Yours sincerely

ASSOCIATE PROFESSOR PAUL BABIE
Convenor
Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

THE UNIVERSITY of ADELAIDE

RESEARCH BRANCH
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Applicant: Dr M Nursey-Bray

School: Department of Geography, Environment and Population

Application/RM No: 13303

Project Title: **Climate change vulnerabilities, risk perception and implications of adaptation of marine fishermen from south eastern part of coastal Bangladesh**

Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

ETHICS APPROVAL No: HP-2012-011

APPROVED for the period until: 30 April 2015

This study is to be conducted by Zaheed Hasan, PhD Candidate.

ASSOCIATE PROFESSOR PAUL BABIE
Convenor
Low Risk Human Research Ethics Review Group (Faculty of Humanities and Social Sciences and Faculty of the Professions)

Appendix 2: Survey questionnaire

ARTISAN FISHERS' PERCEPTIONS OF AND ADAPTATION TO CLIMATE CHANGE IN THE SOUTHEAST COAST OF BANGLADESH

Survey questionnaire for artisanal fishers in the southeast coast of Bangladesh

The University of Adelaide,
Department of Geography, Environment and Population,
Adelaide, South Australia-5005,
Australia.

Location

Area..... Upazilla (subdistrict).....

Village..... District.....

Section 1: Fishing profession

1. Category of fisher (Please check all that apply)
   - o Sea going
   - o Fishing at river, estuary, creeks, canals
   - o Aqua- culture
   - o Other, please specify……

2. Role in fishery (Please check all that apply)
   - o Fisherman/Labour
   - o Head fisherman
   - o Trader
   - o Investor/money lender
   - o Other, please specify...

3. Ownership
   - o Number of boat(s) ☐
   - o Number of fishing net ☐
   - o None

4. Please state years of involvement with fishery ☐

5. Please indicate your seasonal involvement with fishery
   - o Summer
   - o Winter
   - o Rainy
   - o All of the above

6. According to your opinion, what are three most important challenges of fishing sector today?

   1)……
   2)……
   3)…….

Section 2: Perceptions of environment and climate change

7. How do you rate your knowledge on local climate?

○Excellent	○ Moderate	○ Poor

8. Considering the last 5 to 10 years, please indicate your level of agreement with the following statements:

	Strongly agree	**Agree**	**Ambivalent**	**Disagree**	**Strongly disagree**
Frequency of extreme climatic events like floods, cyclone is increasing					
Sea level is rising					
Rainfall pattern is changing					
Average temperature is increasing					

Additional comments: ……..

9. Do you expect climate change to disrupt following elements (Please indicate your level of concern)

	Strongly concerned	**Very concerned**	**Not concerned or concerned**	**Not concerned**	**Strongly not concerned**	**Don't know**
Fish stock						
Fishing points						
Rough sea						
Soil salinity						
Salinity of sea water						
Shoreline erosion						
Profitability in fisheries						
Professional risks						
Fish marketing						
Drinking water						
*Food security						

*Food security = Earn enough money to buy rice for two meals per day for family

10. According to you, what will be the most serious climate change threat for the fishing community in the next 10-15 years?
    .....

11. Do you think you will be affected by climate change?
    - o Never
    - o Now
    - o In 5 to 10 years
    - o In 15 to 20 years
    - o >20 years

12. Are you worried about climate change?
    - Very worried
    - Worried
    - Not worried

13. What you think about the reasons for climate change? (Please tick all that apply)

Authorities	**Tick**
Act of God/Natural process	
Punishment of God	
Result of sins	
Other countries	
Impossible to say	
Pollution	
Deforestation	
Other(s), please specify	

14. According to your opinion, who is/are responsible for managing risks associated with climate change? (Please mention all that apply)

Authorities	**Tick**
Government	
Local community	
Self-responsibility	
Red Cross	
NOGs	
God	
Scientists	
Captain of the boat	
Other(s) (please mention)	

15. What is/are the trusted source(es) of information about climate change? (Please mention all that apply)

Source	**Tick**
Government	
Friends and family	
NGOs	
Media (Radio, TV, Newspaper and Magazine)	
Red cross	
Others, please specify	

Section 3: Adaptation perceptions

16. According to you, what is/are the important needs for fishers to cope up with climate change impacts?

……..

17. Could you please indicate your degree of agreement with the following statements

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**	**Don't know**
I believe adaptation to climate change is possible through proper planning and support						
It would be easier to respond to climate change if there were financial incentives						
I would like to get more information on climate change adaptation to response appropriately						
I believe change of fishing profession is a way to climate change adaptation						

18. Do you have any other comments concerning extreme climatic events like floods and cyclones, its impacts and response to it?

.....
.....

Section 4: Demographic information

This section assesses the participant's basic demographic information

19. Gender
    - o Male
    - o Female

20. Gender of the household head
    - o Male
    - o Female

21. How long have you been living in this area?.....

22. Total number of household members.....

23. Number of bread earner in the household including you.....

24. Age.....

25. a) Are you a permanent residence of this village?
    - Yes (go to next question)
    - No (Please answer 28B)

b) What is the main reason(s) for migration.....

26. What is your highest level of education
    - No formal education
    - Primary school
    - High school
    - Tertiary
    - Others

27. Marital status
    - Single
    - Married
    - Divorced
    - Widowed

28. Do you have children?
    - Yes
    - No

29. Religious faith
    - Muslim
    - Hindu
    - Christian
    - Atheist
    - Don't want to disclose

30. Media access at home (Please check all that applicable)
    - TV
    - Radio
    - Newspaper
    - Magazine
    - No media access

31. Tenure status
    - Own house
    - Rented house
    - Homeless
    - Others...

32. Does the household own cultivable land?
    - Yes
    - No

33. Average monthly income (in Taka).....

34. What are the main sources of income?
    - Fishing
    - Agriculture
    - Day labourer
    - Others...

35. a) Does your household have savings?
    - Yes
    - No

b) What is the purpose of saving.....

36. a) Do you or any member of your family have loan?

- o Yes
- o No

b) If yes, what is the total loan amount (in Taka).....

c) Sources of loan

- Bank
- NGO
- Local money lender
- Other, please specify.....

d) What was the purpose of the loan? .....

Thank you very much for your participation

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