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**CLIMATE CHANGE AND PREPAREDNESS
AT THE VILLAGE LEVEL
IN COASTAL AREAS OF BANGLADESH**

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Authors

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Abstract

This study assessed people's perception of climate change and their preparedness at the village level to cope with the disaster in coastal areas of Bangladesh. Data were collected from stratified randomly selected 500 landless, small, medium & large landowners in purposively selected 10 coastal villages of 5 districts.

It is revealed that majority of the people understand the past and future climate change impacts on their livelihoods and habitats while don't have the apprehension confidently of Sea Level Rise (SLR) in future. They are not prepared at the village level to cope with the climate change impacts. The common interventions mentioned by both people's bottom-up and government's top-down prescriptions for coping with climate change impacts are "heights and sluice gates of existing barrages/polders should be increased and new long barrages with adequate heights and sluice gates should be constructed"; "number and size of cyclone shelter centers should be increased"; "various measures including use of cement-blocks should be increased for protecting riverbanks from erosion"; "salinity tolerant rice varieties and fish species should be innovated and replicated in the coastal area"; "pure drinking-water sources should be installed in the coastal belt"; and "forestation along the coastal belt should be accelerated". The unique interventions mentioned by people's bottom-up prescription for coping with climate change impacts are "high lands may be created to be used by people in various purposes during emergency"; "canals of limited use to people should be closed at their ends"; "coastal area friendly industrialization should be patronized"; "professional skill development training should be strengthened"; "non-farming income generating opportunity should be increased"; "hospitals should be established in the coastal belt"; and "educational institutions should be established on sufficiently raised lands".

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Therefore, the study principally recommends, as alternative to constructing thousands of new cyclone shelter centers, long barrage and polders, to establish cluster villages of multistoried buildings surrounded by deep green belt of trees along the coastal belt for a reasonable number of landless and small landowners on land raised up to the estimated safe level by gathering soil from silted riverbed and seabed. Medium and large landowners should be motivated by GOs and NGOs to construct multistoried buildings by use of the long-term loan with low interest rate and installment from commercial banks, GOs and NGOs. This intervention is to safe the coastal people's habitats and to discourage their migration during SLR, cyclones, floods, and tidal surges due to climate change.

1. Introduction

The coastal area was selected for this study because people in coastal areas and islands are likely to be the worst victims of climate change, particularly Sea Level Rise (SLR) due to acceleration of global warming by human activities. Bangladesh is considered by the global expert community as one of the worst climate change victims on the earth. Climate change is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (Disaster Management Bureau, GoB, 2010: pp.100).

There are many top-down prescriptions of interventions for coping with climate change impacts, but bottom-up prescriptions by people concerned in this regard seem scanty. Top-down prescriptions refer to those given by national and international experts of government, UN bodies, development partners and academicians. Interventions common to top-down and bottom-up prescriptions and unique interventions of bottom-up prescriptions are likely to meet actual aspirations of the coastal people.

Bangladesh is in South Asia having common border with India in the east, west and north and with Myanmar in the northeast corner. The Bay of Bengal covers the whole south side of the country. The Himalayas of Nepal is standing very near in the north of Bangladesh. The Bay of Bengal and the Himalayas are the dominant players in Bangladesh climate.

The population and geographical area of Bangladesh is over 150 million and about 144,000 km² respectively. If the city countries are not taken into account, Bangladesh is the most densely populated country in the world with more than 1000 persons per km² (Lonnqvist, Linda, *et.al*, 2010: pp.5). In the name of Division, Bangladesh has 7 regions (Dhaka, Chittagong, Rajshahi, Khulna, Sylhet, Barisal and Rangpur). There are 64 districts, 482 *Upazilas* (sub-district), 4,498 *Unions* (the lowest administrative unit) and 68,000 villages (*Gram*) in Bangladesh. On average each district has population and area of 1.9 million persons and 2,250 km² respectively. Each *upazila* has average population and area of 250,000 persons and 300 km² respectively. Each *union* has average population and area of 27,000 persons and 30 km² respectively. Each village has average population and area of 1,600 persons and 2 km² respectively (GoB, 2010:pp.31).

Bangladesh is an active mega delta with the average elevation of 4 to 5 meters above sea level. Over 310 rivers, many of which are originated from other countries, form a network and spread over whole Bangladesh through their numerous tributaries and distributaries and finally flow into the Bay of Bengal. The Padma (called the Ganges in India), the Jamuna (the Brahmaputra) and the Meghna rivers are occupying only 7% of river basin but receiving water like a funnel from 57 international rivers and end journey to the Bay of Bengal which drain out not only about 1,205 billion m³ water but also carry enormous quantities of silt from Nepal, India, Tibet and China –around two billion tons a year (BCCSAP, 2008: pp.6).

Coastal areas in Bangladesh are on the ‘front line’ of climate change, directly affected by cyclones, storm surges, SLR, drainage congestion, etc. At least 1.4 million hectare of the coastal and offshore areas of Bangladesh, inhabited by about 15% of the population is directly affected by the intrusion of saline water into the surface (Bangladesh Summery Report, 1994). Saline water from the Bay of Bengal already penetrates into around 100 km inland during the dry season, and climate change is likely to exacerbate this situation further. If the sea level rises up to 1 m, around 29,846 km² coastal areas would suffer from inundation and stagnation of saline water and consequently Bangladesh may lose up to 17% of its landmass and up to 30 million people could become climatic refugees. The livelihood of coastal people will be affected to a great extent if the sea level rises up to the predicted level in future. Twenty million people, engaged in salt production, shrimp culture, fish culture, agriculture and similar primary sectors would be directly affected. A lot of people will lose their habitation and productive farmland. All these issues are in the process of scientific assessment, academic discussion and coming out as the most critical global problems.

According to a report in April 2011 by Bangladesh Ministry of Environment and Forests, titled “Impact of Climate Change on Bangladesh and Responses”, around 65% landmass of Kutubdia, Bhola and Sandip islands had already been eroded during the last 100 years. If the sea level rises further, 72 islands and the entire coastal area would be hit hard resulting in billions dollar of losses in GDP, economic downturn, ecological damage and livelihood options.

Therefore, any literature related to Bangladesh’s climate change always gives a terrifying future picture to be faced in the country as consequence of global warming and climate change–SLR, recurrent cyclone, storm surges with more intensity, increased intensity of cyclone in speed & frequency, recurrent severe flooding, water logging, permanent inundation, salinity intrusion, disrupted river flows, river bank erosion, increased temperature, irregular weather patterns, increase in frequency & intensity of drought, disruption in seasons’ characteristics, environmental degradation, ecological imbalance, increase of vector borne diseases, loss of biodiversity, increase in inland population density due to migration, social unrest, etc.

Though floods and cyclones with varying intensity are common in Bangladesh every year, the gradually increasing trend in the number of deadly natural disasters during the last 150 years may be seen in Table 1.

United Nation’s responses to climate change in Bangladesh

There is now clear scientific evidence that the gradual increase in concentration of greenhouse gases in the atmosphere is causing global warming. Sea level rise (SLR) is among the most profound impacts of climate change. Thermal expansion of ocean water and melting of Arctic-ice due to higher ambient temperatures would lead to a rise in the average sea level by about 50 cm before the end of the current century (Warrick, *et al.* 1996). Therefore, World Meteorological Organization (WMO) and United Nations Environment Program (UNEP) jointly

Table 1 Deadly natural disaster in Bangladesh during last 150 years at 50 years interval (frequency)

| Year | Flood | Cyclone | Drought | Tornado |
|-----------|-------|---------|---------|---------|
| 1861-1910 | 4 | 5 | 2 | NA |
| 1911-1960 | 3 | 11 | 3 | NA |
| 1961-2010 | 5 | 24 | 8 | 11 |

Source: Chowdhury, Aparup (2008), Disaster Management Programs of Non-government Organizations (NGOs) in Bangladesh: An Empirical Study on Performance and Pitfall, pp: 64-67 and 79 (Unpublished Ph.D. Thesis);

GoB (2010), National Plan for Disaster Management 2010-15, Disaster Management Bureau, Dhaka, Bangladesh, pp: 12

established the Intergovernmental Panel on Climate Change (IPCC) to look after the global issue of climate change (Bangladesh Summery Report, 1994) in 1988 in response to growing national and international concerns regarding threats due to climate change.

Bangladesh is currently ranked as one of the most climate-vulnerable country in the world. IPCC in its Fourth Assessment Report in 2007 described following changes in climate trends, variability, and extreme events (Disaster Management Bureau, GoB, 2010: pp.23).

- The average temperature has registered an increasing trend of about 1°C in May and 0.5°C in November during 14 years period from 1975 to 1988 in Bangladesh.
- In the country, the annual rainfall shows an increasing trend. Decadal rain anomalies are above long-term averages since 1960s.
- Serious floods have recurrently taken place during 2002, 2003, and 2004.
- Frequency of monsoon depressions and cyclones formation in the Bay of Bengal has increased.
- Salt water from the Bay of Bengal is reported to have penetrated 100 km or more inland along tributary channels during the dry season.
- The precipitation has declined and drought has resulted in the drying up of wetlands and severe degradation of ecosystems.
- The production of rice and wheat might drop by 8% and 32% respectively by the year 2050.
- With a meter rise in sea level the Sundarbans (the largest mangrove forest in the world; a habitat of rich bio-diversity; probable UNESCO World Heritage Site; and home of the Royal Bengal Tiger) is likely to be disappeared permanently –no longer providing a shield for the rest of Bangladesh against cyclones, storm surges and tidal surges.
- Approximately 1,000 km² of farmland and sea product culturing areas are likely to become salt marsh.
- Bangladesh's population is expected to increase by 130 million over the next 50 years, which will further exacerbate climate change impacts.

Bangladesh Government's responses to climate change in the country

International scientific and negotiating communities well recognized the vulnerability of Bangladesh to adverse impacts of climate change. A joint study of the government of Bangladesh, UNDP, and Bangladesh Center for Advanced Studies (BCAS) in 2009 revealed major vulnerability contexts of Bangladesh to climate change, which are a) SLR and salinity intrusion; b) increase of drought; c) erratic behavior of rainfall and temperature; d) changes in nature of cyclone and storm charges; e) **increase of** frequency and intensity of flood. The study identified that water resources, agriculture, human settlement, health; biodiversity (particularly in the Sundarbans) and infrastructure are the major impacted sectors. Coastal areas and islands are the most vulnerable region of the country due to their low lying topography, geographical location, concentration of poor communities and exposure to SLR, salinity intrusion, cyclone and storm surges, coastal inundation, and drainage congestion.

Bangladesh government has approved Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009 and National Adaptation Program of Action (NAPA) which put thrust on six major aspects: (1) food security, social protection and health, (2) comprehensive disaster management, (3) infrastructure development, (4) research and knowledge management, (5) mitigation and low carbon development, and (6) capacity building and institutional strengthening. Most notable and multi sector disaster management program of the government included flood protection and improvement of drainage; dredging of major rivers; building of coastal embankment; construction of cyclone shelters; reclamation of land with silt excavated; and creation of green belts.

Bangladesh government created a National Climate Change Trust Fund of US \$ 200 million for 2009-10 and 2010-11 to support initiatives of government and NGOs. Forty nine government projects have so far been finally approved for implementation while 53 NGO projects have been given approval on principle. A Climate Change Unit has been established in the Ministry of Environment and Forests to deal with climate change issues and activities of climate change trust fund. Another fund in the name of "Bangladesh Climate Change Resilience Fund" has been also established by the contributions of development partners –ADB, UNDP, SIDA, CIDA, CARE International, USAID, World Bank, JICA and OXFAM (UK). Bangladesh has started dialogue with neighbor countries for cooperation and collaboration to manage climate change impacts through formulation and implementation of regional action plans. The country is also in the front line of climate change negotiations at the international level.

Several studies were conducted in Bangladesh to assess climate change impacts on different sectors. But what the coastal people themselves are thinking about climate change issues, what the preparedness situation is at the village level to face the apprehended problems and what livelihoods and habitats will be in hazardous situation are not yet definitely known. Not much information is available about the preparedness of coastal people to cope with climate change. All those need to be studied in depth for equipping people on how to cope with climate change

and selecting appropriate development interventions matching with people's aspirations by the government and development partners.

2. Objectives

In the above background, the specific objectives were to study

- (1) Coastal people's perception of climate change;
- (2) Their perception of climate change impacts on livelihoods and habitats;
- (3) Preparedness at the village level to coping with climate change;
- (4) People's bottom-up prescription, its commonality with top-down government prescription for coping with climate.
- (5) Policy recommendations for coping with climate change, putting a special emphasis on SLR.

3. Methods

Selection of study areas

Twelve coastal districts of Bangladesh formed three distinct coastal regions -namely, southwestern, central and southeastern coastal zones. As representative of all zones, out of the total 12 coastal districts of the country, 5 were selected purposively considering more proximity to the Bay of Bengal and historic deadly cyclones, tidal surges, floods and salinity intrusion. The cyclone in Noakhali, Laxmipur and Bhola districts on November 12, 1970 was one of the deadliest natural disasters in the recent history. The exact death toll would never be known, but it was estimated that 300,000 to 500,000 people and millions of livestock and poultry lost their lives in one night due to very high tidal insurgence (Kabir, *et.al*, 2007). Recently, the super-Cyclone Sidr in 2007 and Cyclone Aila in May 2009 killed 15,000 and 1000 people respectively. An estimated 40,000 people were displaced and sought refuge on embankments and roadsides (Lonnqvist, Linda, *et.al*, 2010: pp.5). Simply, those three incidences give a taste of what is likely to come as climate change impacts in the country. Five study districts Cox's Bazar, Noakhali, Laxmipur, Bhola and Satkhira are shown in Figure 1. From those five study districts, 10 villages of 10 *Unions* (the lowest administrative unit) under 7 *Upazilas* (Sub-districts) were also selected purposively on the same arguments. Names of these study villages, *Unions*, *Upazilas* and Districts are shown in Table 2.

Selection of sample households

Stratified sampling was adopted in selecting households of this study for the rational representation of all socio-economic strata. Bangladesh Bureau of Statistics (BBS) considers that land ownership is a basic factor of socio-economic stratification as anthropologically that determines socio-economic status of rural society in the country. Therefore, all households of each study village were stratified into 4 strata: landless, small, medium, and

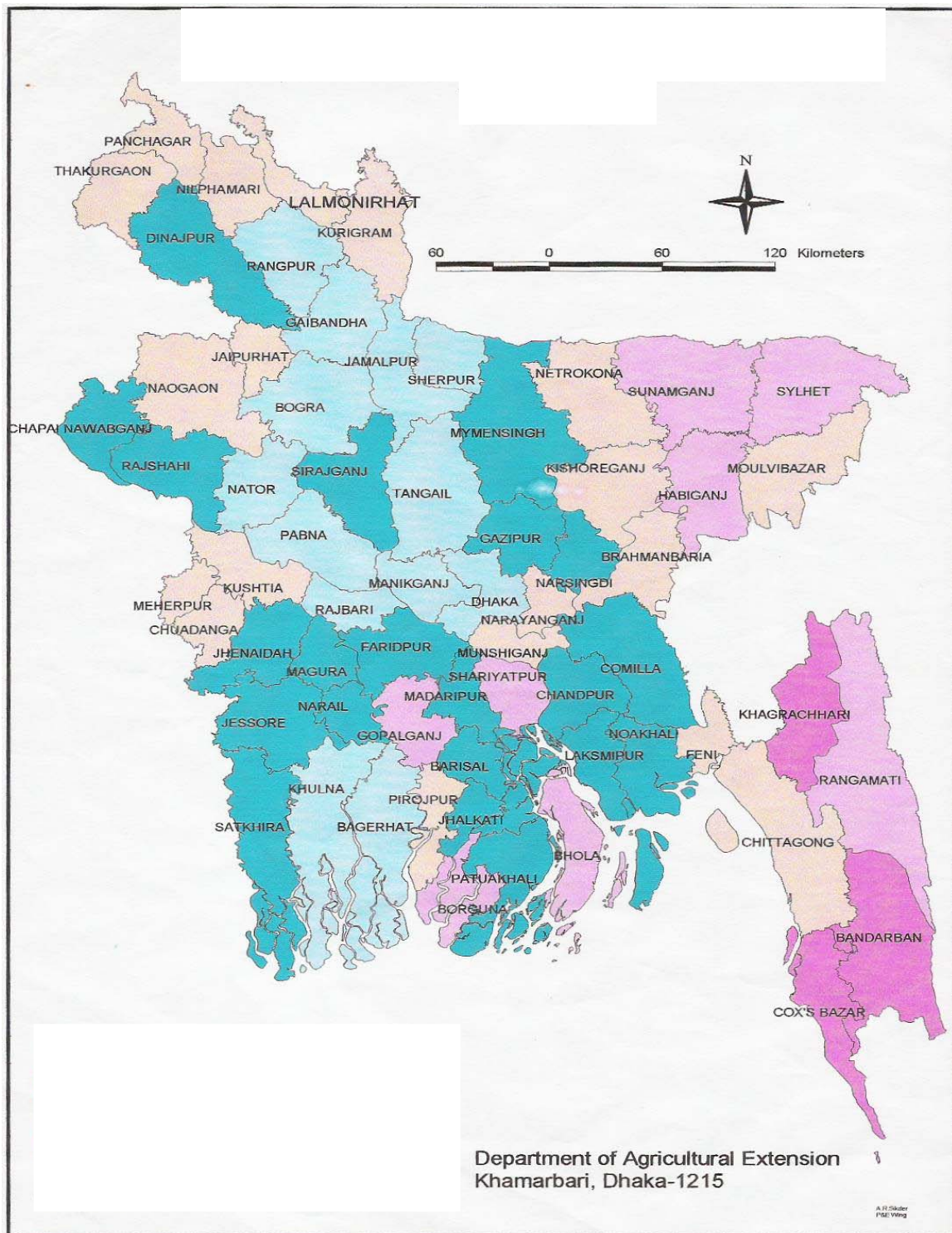


Figure 1 Map of Bangladesh

Table 2 Study Areas

| Study Villages | Unions | Upazilas | Districts |
|----------------------------------|-----------------------------------|-----------------------------------|-------------|
| Hatkhola para, Charpara | Khurushkul, Moheshkhali | Cox's Bazar Sadar, Moheshkhali | Cox's Bazar |
| Char Lotia, Purba Rasulpur | Char Iswar, Hiruni | Hatia | Noakhali |
| Hajipara, Char Gozaria | Char Alekzander, Char Abdullah | Ramgoti | Laxmipur |
| Paschem Char Sultani, Medua | Rajapur, Medua | Bhola Sadar, Doulatkhan | Bhola |
| Purbo Ashashuni, Uttar Bordul | Ashashuni, Bordul | Ashashuni | Satkhira |
| 10 | 10 | 7 | 5 |

large landowner. It was a plan to select 10 households from each stratum and in addition 10 households from various professionals to make a list of 50 sample households from each study village. But, this could not be maintained because of non-existence of that number of medium and large landowners in reality in a study village. Majority of them were landless and small landowners. Therefore, the distribution of respondents' households according to their land ownership strata is shown in Table 3.

Table 3 Sample households by land ownership stratum

| Stratum (in acre) | Cox's Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total (%) |
|----------------------------|-------------|----------|----------|-------|----------|-----------|
| Landless class (0.00-0.49) | 64 | 22 | 42 | 28 | 33 | 189 (38) |
| Small class (0.50-2.49) | 30 | 51 | 39 | 46 | 28 | 194 (39) |
| Medium class (2.50-7.49) | 5 | 23 | 18 | 23 | 24 | 93 (18) |
| Large class (7.50 -) | 1 | 4 | 1 | 3 | 15 | 24 (5) |
| Total | 100 | 100 | 100 | 100 | 100 | 500 (100) |

Source: Field survey, 2010

Data collection

An elderly person of each sample household was interviewed with the aid of a pre-structured questionnaire. Four research staff of Bangladesh Academy for Rural Development (BARD) visited door to door to collect data under close supervision and strict quality control by researchers. Information was also collected through Focus Group Discussion (FGD), personal visits and observation. Besides, some data were collected through in-depth review of secondary materials.

Data processing

Data were processed using SPSS program in computer. Major analytical tools were frequency tables, arithmetic mean and percentage.

Limitation

The study could not incorporate equal representation of samples from all the three distinct coastal zones of

Bangladesh. Selection of at least 12 study villages from 12 coastal districts could make the study more representative of the coastal area of Bangladesh.

4. Research Findings

4.1 Perception on climate change during last 25 years (1985-2010)

Coastal people perceive climate as situation of temperature, rainfall, wind, cyclone, tidal water level, salinity and behavior of sea and rivers in the area. Due to local factors, among the 5 coastal districts, people differently perceive those elements as climate change. A comparative picture of people's perceived climate change is shown in Table 4.

The highest proportion (73%) of coastal people perceived that number of cyclones in the area increased during 1985-2010 (the last 25 years) followed by low rain in the suitable time for farming (71%), and tidal water level increased by 2/3 feet (67%) than before. Twenty three percent to 37% of them perceived that salinity in water and soil in the area also increased during the same period. Even 30% people perceived that temperature of weather in the area increased during the same period than before. They observed continuous erosion of riverbank and char (new land formed by silt) in many places as the hard reality in their lives.

Table 4 Perceptions of climate change during 1985 – 2010 (%)

| Item | Cox's Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total |
|------|-------------|----------|----------|-------|----------|-------|
| 1 | 18 | 38 | 34 | 22 | 41 | 30 |
| 2 | 75 | 61 | 57 | 73 | 71 | 67 |
| 3 | 59 | 21 | 36 | 52 | 65 | 47 |
| 4 | 54 | 59 | 87 | 78 | 86 | 73 |
| 5 | 11 | 20 | 15 | 25 | 25 | 19 |
| 6 | 75 | 68 | 53 | 65 | 95 | 71 |
| 7 | 31 | 22 | 24 | 34 | 73 | 37 |
| 8 | 17 | 14 | 12 | 5 | 65 | 23 |
| 9 | 41 | 43 | 86 | 73 | 9 | 50 |
| 10 | 52 | 28 | 24 | 20 | 61 | 37 |
| 11 | 11 | 20 | 23 | 17 | 12 | 17 |

Note 1) Items define climate changes as follows:

- 1: Temperature increased than before
- 2: Tidal water level increased by 2-3 feet approximately than before
- 3: Cyclones came with higher speed than before
- 4: Number of cyclones increased than before
- 5: Rains more in the unsuitable time for farming than before
- 6: Rains less in the suitable time for farming than before
- 7: Salinity in water increased than before
- 8: Salinity in soil increased than before
- 9: River bank erosion increased than before
- 10: Depth of river/canal decreased than before
- 11: Char area increased than before

Note 2): Multiple responses

Source: Field survey, 2010

SLR: Coastal people were found to have understanding on tide, tidal boor, tidal surge and even tsunami but majority of them could not confidently apprehend SLR in future.

Flood: Many people were found to consider climate change as the main cause of flood. But, normal flooding is a useful yearly phenomenon for fish production and alluvial soil deposition on sub-merged farmland. Frequency of flood might have increased due to climate change but manmade factors like poorly planned construction of barrages, polders, roads, bridges, culverts, etc and their inefficient maintenance aggravated the frequency and intensity of flooding by unnecessary obstructions to natural water drainage in many cases (Lonnqvist, Linda, *et.al*, 2010: pp.14).

Embankments and polders are the principal physical infrastructure for river and flood management in Bangladesh. The then undivided Pakistan Government established polders for the first time in 1960 in coastal areas of present Bangladesh with support of Dutch Government. Polders are earthen embankments along rivers. In view of the subject specialists like Professor Dr. Dilip Kumar Datta, Head of the Environmental Science Department at Khulna University of Bangladesh and his colleagues, structural river management was an inappropriate response to the active delta like Bangladesh. For an example, the structural management was removed from the Mississippi in the USA in 1950s and thus improved the health of the river (Lonnqvist, Linda, *et.al*, 2010: pp.14). But Bangladesh continued implementation of that inappropriate strategy since 1960.

Consequently, around two billion tons of silt with about 1,205 billion m³ water carried by the river network of Bangladesh per year even from Nepal, India, Tibet and China deposited and raised the river beds remarkably in many polder areas higher than the level of land inside polders and water draining out time through those rivers increased remarkably which caused a rise of river water beyond the danger level in many cases and breached polders/embankments and resulted to flood. Due to those polders/embankments the silt could not be spread over large land areas like before 1960 in the form of agriculturally beneficial alluvial soil deposition on large land areas. Rather those silts deposited on the riverbed and might contributed to the formation of 72 coastal islands which again might be the obstructions to draining out water through rivers to the Bay of Bengal.

Therefore, it may be said that not only climate change, manmade factors were also responsible for the increase in frequency and intensity of flooding in Bangladesh. Even those embankments and polders created water logging in many areas, for which people had to migrate due to losses of their agricultural livelihoods and habitats -Bill Dakatia is one of such examples.

Salinity intrusion: Climate change might have increased the salinity intrusion in the coastal area of Bangladesh, but manmade factors like Bagda shrimp culture by saline water in farmland in Satkhira and Cox's Bazaar and salt production on farmland by sundry method in Cox's Bazar aggravated the salinity intrusion problem.

Nevertheless, it may be said that although they were poor literate and not subject specialists, coastal people were aware of the past climate change in the area through living in the situation by generations. All those changes in climate had profound impacts on coastal farming, livelihoods, habitats, resources and thus on their lives.

4.2 Perception of climate change impacts on cropping during last 25 years (1985-2010)

There are three farming seasons in Bangladesh -*Rabi*, *Kharip-1* and *Kharip-2*. *Rabi* season is usually October 16 to March 15 while *Kharip-1* season March 16 to June 30 and *Kharip-2* season July 1 to October 15. Rain fed rice cultivation is the dominant tradition in the coastal area. Coastal people also produce such vegetables as potato, melon, spices, pulses and oil seeds in various seasons. Changes in cropping are shown in Table 5.

As shown in Table 5, only 3%-26% households in Cox's Bazar were producers in *Rabi* 1985. The proportion showed a decrease in *Rabi* during 1985-2010, except High Yielding Variety (HYV) rice, mainly due to climate change and some other reasons. Their involvement in HYV rice production in *Rabi* showed an increasing trend (3%-8%) during 1985-2010, which may not be remarkable considering coverage and proportion of producers.

Table 5 Change in cropping during 1985-2010 in Cox's Bazar (%)

| Crop | <i>Rabi</i> | | <i>Kharip-1</i> | | <i>Kharip-2</i> | |
|---------------------------|-------------|------|-----------------|------|-----------------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Vegetables, potato, melon | 22 | 13 | 10 | 1 | - | - |
| Spice | 26 | 20 | - | 1 | - | - |
| Pulse | 17 | 12 | - | 0 | - | - |
| Oil seed | 3 | 0 | 10 | 0 | - | - |
| LV rice | 0 | 0 | 0 | 0 | 29 | 15 |
| HYV rice | 3 | 8 | 8 | 0 | 9 | 20 |

Note: There were multiple crop cultivators

Source: Field survey, 2010

Similarly, a few households were producers in *Kharip-1* 1985 and even those households gave up in 2010, resulting to almost no cropping in *Kharip-1* 2010 in two study villages of Cox's Bazar. Local Variety (LV) rice cultivation was traditionally dominant in *Kharip-2*, although the proportion was not remarkable and even showed a decrease during 1985-2010. But, HYV rice cultivation in *Kharip-2* showed an increase, although the proportion was not remarkable.

Therefore, it may be said that cropping decreased during 1985-2010 in the coastal area of Cox's Bazar.

As shown in Table 6, 18%-60% households were producers of vegetables such as potato, melon, spices, pulses and oil seeds in Noakhali in *Rabi* 1985 which may be considered remarkable in proportion. Even the proportion showed an increase in *Rabi* during 1985-2010 except pulses. Due to salinity, they could not produce rice in *Rabi* during 1985-2010.

Table 6 Change in cropping during 1985-2010 in Noakhali (%)

| Crop | <i>Rabi</i> | | <i>Kharip-1</i> | | <i>Kharip-2</i> | |
|---------------------------|-------------|------|-----------------|------|-----------------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Vegetables, potato, melon | 18 | 41 | 1 | 2 | - | - |
| Spice | 60 | 63 | - | - | - | - |
| Pulse | 57 | 29 | - | - | - | - |
| Oil seed | 50 | 58 | - | - | - | - |
| LV rice | 0 | 2 | 53 | 50 | 65 | 64 |
| HYV rice | 1 | 1 | 5 | 25 | 2 | 10 |

Note: There were multiple crop cultivators

Source: Field survey, 2010

Similarly, a remarkable proportion of households were producers (mostly LV rice) in *Kharip-1* and *Kharip-2* during 1985-2010 in Noakhali. Except rice, almost no other crops or vegetables were found in *Kharip-1* and *Kharip-2* during 1985- 2010. Local Variety (LV) rice cultivation was traditionally dominant in *Kharip-1* and *Kharip-2*. HYV rice producers showed an increase in *Kharip-1* and *Kharip-2*, although the proportion was not remarkable during 1985-2010.

Therefore, it may be said that farming, in which majority of households were involved, has been a bit developed during 1985-2010 in the coastal area of Noakhali.

Table 7 Change in cropping during 1985-2010 in Laxmipur (%)

| Crop | <i>Rabi</i> | | <i>Kharip-1</i> | | <i>Kharip-2</i> | |
|---------------------------|-------------|------|-----------------|------|-----------------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Vegetables, potato, melon | 25 | 7 | 0 | 1 | - | - |
| Spice | 69 | 47 | 1 | - | - | - |
| Pulse | 55 | 25 | - | - | - | - |
| Oil seed | 49 | 59 | 1 | - | - | - |
| LV rice | 0 | 0 | 28 | 17 | 70 | 62 |
| HYV rice | 0 | 0 | 11 | 4 | 0 | 1 |

Note: There were multiple crop cultivators

Source: Field survey, 2010

As shown in Table 7, 25%-69% households in Laxmipur were producers of vegetables, potato, melon, spices, pulses and oil seeds in *Rabi* 1985 which may be considered remarkable in proportion. But the proportion showed a decrease in *Rabi* during 1985-2010, except oil seeds, due to popularization of soybean cultivation. Due to salinity, they could not produce rice in *Rabi* during 1985-2010.

Not-remarkable proportion of households in Laxmipur was producers (mostly LV rice) in *Kharip-1* during 1985-2010. Except rice farmers, almost no other households were found in *Kharip-1* and *Kharip-2* during 1985-2010. On the other hand, the proportion of LV rice producers was dominant (70%) in *Kharip-2*, although showed a slight decrease during 1985-2010. The proportion of HYV rice producers was not remarkable during 1985-2010.

Therefore, it may be said that farming has been less developed during 1985-2010, although majority of households were involved in farming in the coastal area of Laximpur.

As shown in Table 8, 12%-68% households in Bhola were producers of vegetables such as potato, melon, spices, pulses and oil seeds in *Rabi* 1985 which may be remarkable in the proportion. But, the proportion showed a decrease in *Rabi* during 1985-2010 except HYV rice. Due to low level of salinity, HYV rice cultivation showed an increase in *Rabi* during 1985-2010.

Table 8 Change in cropping during 1985-2010 in Bhola (%)

| Crop | <i>Rabi</i> | | <i>Kharip – 1</i> | | <i>Kharip – 2</i> | |
|---------------------------|-------------|------|-------------------|------|-------------------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Vegetables, potato, melon | 29 | 25 | 16 | 19 | - | - |
| Spice | 60 | 58 | - | - | - | - |
| Pulse | 68 | 33 | - | - | - | - |
| Oil seed | 42 | 34 | - | 1 | - | - |
| LV rice | 12 | 11 | 41 | 24 | 74 | 73 |
| HYV rice | 22 | 58 | 0 | 1 | 0 | 1 |

Note: There were multiple crop cultivators
Source: Field survey, 2010

Not-remarkable proportion of households in Bhola were involved in producing vegetables such as potato, melon, etc even in *Kharip-1* 1985 with a slight decrease up to 2010. Forty one percent households were producers of LV rice in *Kharip-1* in 1985 with a decrease up to 2010. Except LV rice farmer, almost no other households were found in *Kharip-2* during 1985- 2010. The proportion of HYV rice producers in *Kharip-1* and *Kharip-2* was negligible during 1985-2010.

Therefore, it may be said that majority of households in the coastal area of Bhola were involved in farming but farming has been less developed during 1985-2010, except HYV rice cultivation with an increase.

Table 9 Change in cropping during 1985-2010 in Satkhira (%)

| Crop | <i>Rabi</i> | | <i>Kharip-1</i> | | <i>Kharip-2</i> | |
|---------------------------|-------------|------|-----------------|------|-----------------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Vegetables, potato, melon | 22 | 5 | - | 3 | - | - |
| Spice | 17 | 3 | - | - | - | - |
| Pulse | 13 | 0 | - | - | - | - |
| Oil seed | 3 | 0 | - | - | - | - |
| Shrimp | 0 | 0 | NA | 39 | - | - |
| LV rice | 0 | 1 | 0 | 0 | 63 | 0 |
| HYV rice | 0 | 27 | 0 | 0 | 5 | 34 |

Note: There were multiple crop cultivators
Source: Field survey, 2010

As shown in Table 9, only 3%-22% households in Satkhira were vegetable producers in *Rabi* 1985. Even mainly due to climate change and for some other reasons, the proportion showed a decrease in *Rabi* during 1985-2010, except High Yielding Variety (HYV) rice. HYV rice cultivation in *Rabi* showed an increase (0%→27%) during 1985-2010, which may not be remarkable.

No household was involved in farming in *Kharip-1* 1985, while 39 % households were involved in shrimp culture in *Kharip-1* 2010. They had to give up farming during 1985-2010 due to the rapid irrational replication of shrimp culture in rice fields by the people belonging to local power structure, resulting to almost no farming in *Kharip-1* 2010. Local Variety (LV) rice cultivation was dominant in *Kharip-2* 1985 but declined to nearly nil by 2010. On the other hand, HYV rice cultivation in *Kharip-2* showed a remarkable increase during 1985-2010.

Therefore, it may be said that majority of households were not involved in farming which kept on decreasing during 1985-2010 in the costal area of Satkhira.

All those findings imply that cropping patterns in the coastal area of Bangladesh have been changed remarkably and cropping intensity has decreased gradually due to climate change mainly among other reasons during the last 25 years. But, there were variations in those changes among the 5 districts because of local factors. On the basis of above-mentioned findings, it may be said that people in the coastal area of Bangladesh are quite aware of the past impacts of climate change on farming due to living in the situation by generations.

4.3 Perception of climate change impacts on livelihoods during last 25 years (1985-2010)

Traditionally major sources of livelihoods in the coastal area of Bangladesh were found to be farming, fishing, fish trade, unskilled labor, skilled labor, job inside Bangladesh, and small trade. Shrimp culture and job in abroad appeared as new sources of livelihood in the coastal area. As shown in Table 10, the proportion of households with farming as major source of livelihood demonstrated a decrease during 1985-2010 in all the study villages. It also showed a decrease in case of fishing due to super saturation of people in that sector except in Noakhali and Laxmipur where there was little increase. They said that due to more ecological change in other areas, Noakhali and Laxmipur were good for fishing those days. Fish trade showed an increase in all study villages except the stagnancy in Noakhali and Laxmipur. Skilled labour showed an increase in all the study villages and unskilled labour also showed an increase in Noakhali, Laxmipur and Bhola but a decrease in Cox's Bazar and Satkhira due to decrease in job opportunity in farming.

Job inside Bangladesh showed an increase in all study villages except Laxmipur. Although young Bangladeshis suffer from going abroad phobia for work these days, a few persons only in Cox's Bazar and Noakhali were found to do job in abroad. It was due to inaccessibility of coastal young persons because of their financial poverty, poor literacy, poor skill, poor linkage agencies, and remoteness from related facilities. Small trade increased remarkably during 1985-2010 in all the study villages. Shrimp culture in farmland as a new profitable business expanded remarkably in Satkhira only among the 5 study districts during 1985-2010 by the well off people instead of the traditional farming. Landless and small landowners could not do shrimp culture due

to lack of resource endowments, knowledge, skill and local power relations and gradually most of them became workless.

Table 10 Major livelihoods in 1985 and 2010 (%)

| Livelihood | Cox's Bazar | | Noakhali | | Laxmipur | | Bhola | | Satkhira | |
|-----------------------|-------------|------|----------|------|----------|------|-------|------|----------|------|
| | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 | 1985 | 2010 |
| Farming | 41 | 32 | 94 | 71 | 74 | 55 | 94 | 73 | 79 | 56 |
| Fishing | 59 | 33 | 33 | 42 | 26 | 41 | 64 | 54 | 8 | 3 |
| Fish trade | 13 | 16 | 2 | 2 | 5 | 5 | 7 | 18 | 3 | 4 |
| Unskilled labour | 29 | 20 | 17 | 30 | 8 | 23 | 18 | 25 | 31 | 25 |
| Skilled labour | 12 | 17 | 2 | 7 | 14 | 19 | 8 | 12 | 7 | 11 |
| Job in Bangladesh | 2 | 12 | 2 | 10 | 1 | 1 | 4 | 16 | 14 | 17 |
| Job in abroad | 0 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Small Trade | 15 | 24 | 7 | 18 | 19 | 29 | 15 | 21 | 37 | 32 |
| Shrimp & fish culture | - | - | - | - | - | - | - | - | 1 | 21 |
| Others | 6 | 9 | 3 | 11 | 0 | 1 | 2 | 5 | 2 | 4 |

Note: People had multiple livelihoods

Source: Field survey, 2010

Therefore, it may be said that people in the coastal area are quite aware of the past climate change impacts on their livelihoods through observing the changing situation by generations. Consequently, they started to leave farming for available non-farming jobs successively. There were variations in findings among the 5 districts due to local factors.

Table 11 presents an overall picture of climate change impacts on livelihoods in all the study villages. As shown in Table 11, people's involvement in farming and fishing decreased remarkably during 1985-2010. That was mainly due to climate change impacts and super saturation of people's involvement in fishing. Therefore, they changed their traditional professions gradually during 1985-2010. Their involvement in fish trade, unskilled and skilled labor, job inside and outside Bangladesh, small trade, shrimp & fish culture, and other works increased remarkably during 1985-2010. All those findings imply the shift of people from farming to non-farming jobs

Table 11 Climate change impacts on livelihoods in all study villages

| Livelihood | 1985 (persons) | 2010 (persons) | Change (%) |
|-----------------------|----------------|----------------|------------|
| Farming | 382 | 287 | -25 |
| Fishing | 190 | 173 | -10 |
| Fish trade | 30 | 45 | +50 |
| Unskilled labour | 103 | 123 | +19 |
| Skilled labour | 44 | 66 | +50 |
| Job in Bangladesh | 23 | 56 | +145 |
| Job in abroad | 0 | 7 | +700 |
| Small Trade | 93 | 124 | +33 |
| Shrimp & fish culture | 1 | 21 | +2000 |
| Others | 13 | 30 | +131 |

Note: People had multiple livelihoods

Source: Field survey, 2010

during the last 25 years with variations among the 5 districts due to local factors.

4.4 Apprehensions of climate change during next 25 years (2011-35)

People in the coastal area apprehended that more changes would be occurring in the climate during the next 25 years. There were remarkable variations in proportions of apprehended climate change events among the 5 study districts during the next 25 years due to differences in local factors. As shown in Table 12, majority (81%) of the households apprehended that “tidal water level would be increasing more than in 2010” followed by “raining in suitable time for farming would be decreasing less than in 2010” (53%) and “river bank erosion would be increasing more than in 2010” (53%). Fifty percent and 49% households respectively apprehended that “number of cyclones would be increasing more than in 2010” and “speed of cyclones would be increasing more than in 2010”.

Considerable proportion of households apprehended that salinity in water and soil would be increasing more

Table 12 Apprehensions of climate change during 2011-35 (%)

| Item | Cox's- Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total |
|------|--------------|----------|----------|-------|----------|-------|
| 1 | 16 | 20 | 21 | 17 | 23 | 19 |
| 2 | 84 | 79 | 65 | 89 | 90 | 81 |
| 3 | 57 | 38 | 28 | 28 | 26 | 35 |
| 4 | 56 | 40 | 49 | 48 | 54 | 49 |
| 5 | 36 | 33 | 81 | 52 | 49 | 50 |
| 6 | 20 | 27 | 23 | 21 | 21 | 22 |
| 7 | 54 | 61 | 41 | 52 | 55 | 53 |
| 8 | 30 | 36 | 33 | 32 | 45 | 35 |
| 9 | 35 | 27 | 37 | 37 | 78 | 43 |
| 10 | 36 | 42 | 83 | 82 | 23 | 53 |
| 11 | 33 | 19 | 23 | 15 | 26 | 23 |
| 12 | 36 | 31 | 32 | 23 | 35 | 31 |
| 13 | 5 | 22 | 9 | 15 | 14 | 13 |

Note 1) Items define climate changes as follows:

- 1:Temperature of weather will be increasing more than 2010.
- 2:Tidal water level will be increasing more than 2010.
- 3:Permanent water logging will be occurring in more areas than 2010.
- 4:Speed of cyclones will be increasing more than 2010.
- 5:Number of cyclones will be increasing more than 2010.
- 6:Raining in unsuitable time for farming will be increasing more than 2010.
- 7:Raining in suitable time for farming will be decreasing more than 2010.
- 8:Salinity in water will be increasing more than 2010.
- 9:Salinity in soil will be increasing more than 2010.
- 10:River bank erosion will be increasing more than 2010.
- 11:Depth of river / canal will be decreasing more than 2010.
- 12:Char area will be increasing more than 2010.
- 13:Only God knows what will be happening in future.

Note 2) Multiple responses

Source: Field survey, 2010

than in 2010. Thirty five percent households apprehended that “permanent water logging would be occurring in more areas than in 2010”. Only 19% households apprehended that “temperature of weather would be increasing more than in 2010”, which implied that majority of people in the coastal area had low understanding on technical aspects of increase in temperature in weather. Table 12 indicated that due to living in the coastal area and observing the relationship of their lives with climate by generations, people in the coastal area were aware of future changes in the climate.

4.5 Apprehensions of impact of tidal inundation/saline water stagnation due to SLR on habitats during next 25 years (2011-35)

As majority of the households could not confidently apprehend SLR in future, we asked them if the sea level rises in their area by 2/3 feet during the next 25 years, what will be happening to livelihoods and habitats? They rightly apprehended that there would be permanent inundation and stagnation of saline water on farmland and on many homesteads, which would result to adverse impacts on their food, fuel, farming, poultry, fishery, livestock, transport, communication, education, public health and social cooperation. Their apprehended impacts on livelihoods and habitats are shown in Table 13.

Forty four percent households apprehended that there would be food deficit during 2011-35 (the next 25 years) but according to 37% households, food deficit would turn to food insecurity during the next 25 years. Remarkably 40% households did not think about possibility of future food problem in the coastal area and may be they were either ignorant or remarkably well off compared to their neighbors.

Thirty six percent households apprehended that there would be fuel deficit during the next 25 years but according to 38% households the fuel deficit would turn to fuel crisis during the next 25 years. Remarkably 44% households did not think about possibility of future fuel problem, and may be either they were ignorant or remarkably well off compared to their neighbors.

It is very important to mention that most (97%) of the households apprehended that farming would be decreasing due to saline water stagnation, wet land, and salinity in soil and water during the next 25 years. All (100%) households apprehended that fish culture would be decreasing during the next 25 years for the same reasons. Remarkably 78% households apprehended that livestock and poultry rearing have decreased during the next 25 years due to fodder crisis, epidemics and ecological degradation.

Remarkable proportion (76%) of the households apprehended that road transport and communication would be breaking down and transport and communication through waterways would be increasing under risk as opined by 62% households. Remarkably 80% households apprehended that their educational institutions would become unable of operation due to disruption of communication and saline water inundation during the next 25 years.

Table 13 Apprehensions of impact of tidal inundation/saline water stagnation on habitats during 2011-35 (%)

| Item | Cox's Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total |
|---------------------------------------|-------------|----------|----------|-------|----------|-------|
| Food: | | | | | | |
| 1 | 21 | 45 | 40 | 46 | 46 | 40 |
| 2 | 55 | 39 | 36 | 38 | 53 | 44 |
| 3 | 36 | 38 | 34 | 42 | 35 | 37 |
| 4 | 2 | 11 | 7 | 7 | 0 | 5 |
| Fuel: | | | | | | |
| 5 | 29 | 50 | 46 | 50 | 47 | 44 |
| 6 | 43 | 34 | 19 | 37 | 49 | 36 |
| 7 | 42 | 32 | 38 | 39 | 38 | 38 |
| Farming: | | | | | | |
| 8 | 88 | 100 | 99 | 100 | 100 | 97 |
| 9 | 68 | 44 | 35 | 35 | 23 | 41 |
| Livestock, Poultry and Fishery | | | | | | |
| 10 | 52 | 45 | 39 | 44 | 34 | 43 |
| 11 | 38 | 31 | 30 | 11 | 30 | 28 |
| 12 | 86 | 70 | 79 | 90 | 67 | 78 |
| 13 | 99 | 100 | 100 | 100 | 100 | 100 |
| Transport and Communication: | | | | | | |
| 14 | 84 | 49 | 80 | 75 | 92 | 76 |
| 15 | 41 | 25 | 29 | 38 | 44 | 35 |
| 16 | 82 | 77 | 45 | 79 | 26 | 62 |
| Education: | | | | | | |
| 17 | 93 | 52 | 95 | 88 | 72 | 80 |
| 18 | 26 | 40 | 42 | 34 | 5 | 29 |
| 19 | 92 | 43 | 78 | 82 | 32 | 65 |
| 20 | 30 | 45 | 18 | 41 | 53 | 37 |
| Public Health: | | | | | | |
| 21 | 83 | 72 | 73 | 77 | 73 | 76 |
| 22 | 39 | 32 | 28 | 26 | 30 | 31 |
| 23 | 100 | 100 | 100 | 100 | 100 | 100 |
| 24 | 100 | 100 | 100 | 100 | 100 | 100 |
| Others: | | | | | | |
| 25 | 100 | 99 | 100 | 100 | 100 | 100 |
| 26 | 100 | 100 | 100 | 100 | 100 | 100 |

Note 1) Items define impacts on habitats as follows:

<Food>

- 1: Do not think about food of future.
- 2: Food deficit will be occurring.
- 3: Food insecurity will be increasing.
- 4: God will be giving us food.

<Fuel>

- 5: Do not think about fuel of future.
- 6: Fuel deficit will be occurring.
- 7: Fuel crisis will be increasing.

<Farming>

- 8: Farming will be decreasing due to water stagnation and wet land
- 9: Salinity in soil will be increasing

<Livestock, poultry and fishery>

- 10: Fodder crisis of livestock and poultry will be occurring
- 11: Epidemics of livestock and poultry will break out.
- 12: Livestock and poultry rearing will be decreasing
- 13: Fish culture will be decreasing

<Transport and communication >

- 14: Road transport and communication will be breaking down

- 15:Water transport and communication will be increasing
- 16:Risk in transport and communication will be increasing
- <Education>
 - 17:Educational institutions will become unable of operation
 - 18:Do not know how to continue children’s education
 - 19:Children’s education will be stopping
 - 20:Children should be sent to other areas for education
- <Public health>
 - 21:Drinking water crisis will be increasing
 - 22:Diarrhea will be breaking out due to drinking impure water.
 - 23:People’s toilet will be becoming unusable.
 - 24:Dysentery and other diseases will be breaking out as epidemics
- <Others>
 - 25:Stagnant dirty water removal will be becoming difficult
 - 26:Social cooperation will be breaking down

Note 2) Multiple responses
Source: Field survey, 2010

“Children’s education would be stopping during 2011-35” was apprehended by 60% households. According to 37% households, children should be sent to other areas for education during 2011-35. Twenty nine percent households did not know how to continue children’s education rather they seemed panic about education of their children during 2011-35.

Regarding public health, majority (76%) of households apprehended that in a situation of saline water inundation and stagnation during the next 25 years, drinking water crisis would be increasing more than in 2010 and diarrhea would be breaking out due to drinking of impure water. All (100%) households apprehended that toilets would not remain usable due to saline water inundation and stagnation. Stagnant dirty water removal would become difficult. Dysentery and other diseases would be breaking out as epidemics.

Bangladesh has a remarkable tradition of helping poor neighbors and relatives during natural disasters. But, all (100%) households apprehended that such tradition of social cooperation would be broken down during 2011-35 due to saline water inundation and stagnation, because irrespective of rich and poor everybody would be affected similarly by that disaster.

Above-mentioned all apprehensions implied that people in the coastal area had adequate awareness of the probable impacts of climate change on their habitats during the next 25 years (2011-35), which would become more miserable gradually. There are variations in apprehension among the 5 districts due to local factors.

4.6 Apprehensions of climate change impacts on livelihoods during next 25 years (2011-2035)

As shown in Table 14, people in the coastal area apprehended that their involvement in farming, fishing and fish trade would be decreasing in all study villages remarkably during 2011-35 due to increase in saline water inundation and stagnation, salinity in soil, cyclone, flood etc compared to those in 2010. Their involvement in job

inside Bangladesh would be increasing and more people would be going to abroad for work during 2011-2035 because of lack of job opportunity throughout the coastal area.

Table 14 Apprehensions of climate change impacts on their livelihoods during 2011-35 (%)

| Item | Cox's Bazar | | Noakhali | | Laxmipur | | Bhola | | Satkhira | |
|------|-------------|---------|----------|---------|----------|---------|-------|---------|----------|---------|
| | 2010 | 2011-35 | 2010 | 2011-35 | 2010 | 2011-35 | 2010 | 2011-35 | 2010 | 2011-35 |
| 1 | 32 | 14 | 71 | 46 | 55 | 34 | 73 | 33 | 56 | 31 |
| 2 | 33 | 25 | 42 | 30 | 41 | 26 | 54 | 13 | 3 | 1 |
| 3 | 16 | 11 | 2 | 1 | 5 | 1 | 18 | 8 | 4 | 1 |
| 4 | 12 | 43 | 10 | 35 | 1 | 4 | 16 | 34 | 17 | 44 |
| 5 | 6 | 23 | 1 | 0 | 0 | 0 | 0 | 4 | 0 | 3 |
| 6 | 20 | 27 | 30 | 15 | 23 | 13 | 25 | 7 | 25 | 10 |
| 7 | 17 | 14 | 7 | 4 | 19 | 9 | 12 | 1 | 11 | 7 |
| 8 | 24 | 47 | 18 | 29 | 29 | 33 | 21 | 26 | 32 | 54 |
| 9 | - | - | - | - | - | - | - | - | 21 | 28 |
| 10 | - | 28 | - | 7 | - | 25 | - | 8 | - | 2 |
| 11 | - | 8 | - | 43 | - | 29 | - | 64 | - | 39 |

Note 1) Items define livelihoods as follows:

- 1:Farming
- 2:Fishing
- 3:Fish trade
- 4:Job in Bangladesh
- 5:Job in abroad
- 6:Unskilled labour
- 7:Skilled labour
- 8:Small Trade
- 9:Small Trade
- 10:Shrimp culture
- 11:Migration to other areas
- 12:God will provide livelihood

Note 2) People would have multiple sources of livelihoods

Source: Field survey, 2010

They opined that the proportions of unskilled and skilled labor would be decreasing during next 25 years (2011-2035) due to lack of job opportunity in the coastal area except Cox's Bazar, may be because of probable job opportunity in the expanding tourism there. Proportion of small trade would be increasing remarkably due to decrease of other job opportunity in all study villages, resulting to a state of super saturation of people in small trade. If majority of the coastal people migrate in future, small trade would not be able to make profits due to lack of customers. Involvement in shrimp culture would be increasing more only in Satkhira during the next 25 years. Some households opined to migrate to other areas in search of any job opportunity. Even remarkable proportion of households opined that God would be providing them with livelihoods in future.

As shown in Table 15, they apprehended that for livelihoods households involved in farming, fishing, fish trade, unskilled labor and skilled labor would decrease in a range of 41% to 51% during the next 25 years (2011-2035). Such changes would obviously increase poverty, food deficit, food insecurity and even food crisis. Consequently the pressure on already super saturated job market and small trade would be increased tremendously in a range of 52% to 329%. Some households would increase the environment unfriendly shrimp culture during

the next 25 years. Fourteen percent households expressed their intension of aimless migration during the next 25 years, although many more would become bound to be migrated due to climate change impacts, more particularly due to SLR. Even 37% households opined that God would be providing them with livelihoods and shelter in future. All these findings imply people's propensity for leaving farming during the next 25 years.

Table 15 Apprehensions of possible impacts of climate change on livelihoods during 2011-35(%)

| Livelihood | 2010 (persons) | 2011-35 (persons) | Change (%) |
|-----------------------------|----------------|-------------------|------------|
| Farming | 287 | 158 | - 45 |
| Fishing | 173 | 95 | - 45 |
| Fish trade | 45 | 22 | - 51 |
| Unskilled labour | 123 | 72 | - 41 |
| Skilled labour | 66 | 35 | - 47 |
| Job in Bangladesh | 56 | 160 | 186 |
| Job in abroad | 7 | 30 | 329 |
| Small trade | 124 | 189 | 52 |
| Shrimp culture | 21 | 28 | 33 |
| Migration to other areas | - | 70 (14%) | - |
| God will provide livelihood | - | 183 (37%) | - |

Note: People would have multiple sources of livelihoods

Source: Field survey, 2010

4.7 Coping strategies with apprehended impacts of climate change during next 25 years (2011-35)

As shown in Table 16, the highest proportion (47%) of households considered that migration to other areas in Bangladesh might be a coping strategy due to adverse impacts of climate change. Thirty seven percent households opined that they might be going to other areas in the country in search of jobs. Some households expressed their intention to educate their children for jobs at home or in abroad. All those

Table 16 Assumed coping strategies with climate change during 2011-35 (%)

| Item | Cox's Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total |
|------|-------------|----------|----------|-------|----------|-------|
| 1 | 38 | 41 | 55 | 52 | 50 | 47 |
| 2 | 48 | 41 | 52 | 33 | 10 | 37 |
| 3 | 43 | 30 | 4 | 30 | 31 | 28 |
| 4 | 19 | 2 | 0 | 4 | 2 | 5 |
| 5 | 42 | 34 | 39 | 40 | 39 | 39 |
| 6 | 23 | 42 | 19 | 28 | 14 | 25 |
| 7 | 33 | 3 | 12 | 5 | 0 | 11 |

Note 1) Items define coping strategies as follows:

- 1:Migration to other areas of Bangladesh
- 2:Searching work in other areas within Bangladesh
- 3:Educating children to get jobs
- 4:Working in abroad
- 5:Engagement in non-farm jobs due to decrease of arable land
- 6:Receiving government services and supports
- 7:Doing other works instead of fishing due to super saturation of fishermen in common water bodies

Note 2) Multiple responses

Source: Field survey, 2010

implied that opinions on ways to cope with climate change impacts were largely biased to migration to other areas in the country and to change their traditional livelihood pattern. Implementation of such intensions would be contributing a lot to the increase of slums in the already super saturated big cities of Bangladesh with a large number of slums.

Thirty nine percent households opined that they would engage themselves in non-farm jobs due to decrease of arable land. Remarkable 25% households would be looking for government supports and services. Some households opined that they would be doing other jobs instead of fishing due to super saturation of fishermen in common water bodies. All those would be contributing to super saturation in non-farm sector of the coastal area and increase of pressure on non-farm sector of the country. All these findings imply people's propensity for migration to other areas during the next 25 years.

4.8 Bottom-up prescription to government for coping with gradual increase of inundation/stagnation of saline water during 2011-35 due to SLR

As shown in Table 17, people perceived essential interventions by the government were for improvement of infrastructure, economy, public health, education and forestation. For infrastructure, most (95%) of households opined, "Heights and sluice gates of existing barrages/polders should be increased and new long barrages with adequate heights and sluice gates should be constructed". This was followed by "Number and size of cyclone shelter centers should be increased" (93%). Majority (74%) of households opined "Various measures including use of cement-blocks should be increased for protecting riverbanks from erosion". Even remarkable 31% households opined "High lands may be created to be used by people in various purposes during emergency".

For economy, 33% households opined "Salinity tolerant rice varieties and fish species should be innovated and replicated in the coastal area". This was followed by "Coastal area friendly industrialization should be patronized" (27%). They also opined for strengthening professional skill development training and increase of non-farm income generating opportunities.

For public health, they (44%) opined "Pure drinking-water sources should be installed in the coastal belt". Twenty eight percent households opined "Hospitals should be established in the coastal belt". They (16%) opined "Educational institutions should be established on sufficiently raised lands". Remarkable proportion (55%) of households opined "Deep forestation along the coastal belt should be accelerated".

Above opinions of households in the coastal area substantiated that they were very much aware of climate change impacts in the area but they have very limited capacity to cope with such a mega problem. Official interventions are inevitable to cope with climate change impacts.

Table 17 Bottom-up prescription to government for coping with gradual increase of inundation/stagnation of saline water during 2011-35 (%)

| Item | Cox's Bazar | Noakhali | Laxmipur | Bhola | Satkhira | Total |
|------------------------|-------------|----------|----------|-------|----------|-------|
| Infrastructure: | | | | | | |
| 1 | 99 | 87 | 99 | 92 | 99 | 95 |
| 2 | 100 | 75 | 92 | 100 | 99 | 93 |
| 3 | 64 | 80 | 79 | 98 | 49 | 74 |
| 4 | 14 | 16 | 35 | 78 | 13 | 31 |
| 5 | 13 | 14 | 10 | 25 | 26 | 18 |
| Economic: | | | | | | |
| 6 | 31 | 33 | 34 | 29 | 37 | 33 |
| 7 | 37 | 24 | 23 | 28 | 23 | 27 |
| 8 | 36 | 15 | 33 | 19 | 22 | 25 |
| 9 | 14 | 19 | 27 | 16 | 12 | 18 |
| Public health: | | | | | | |
| 10 | 89 | 36 | 38 | 20 | 37 | 44 |
| 11 | 29 | 29 | 45 | 18 | 21 | 28 |
| Education: | | | | | | |
| 12 | 11 | 15 | 20 | 22 | 10 | 16 |
| Forestation: | | | | | | |
| 13 | 73 | 46 | 47 | 21 | 86 | 55 |

Note 1) Items define prescriptions as follows:

<Infrastructure>

- 1: Heights and sluice gates of existing barrages / polders should be increased and new long barrages with adequate heights and sluice gates should be constructed.
- 2: Number and size of cyclone shelter centers should be increased
- 3: Various measures including use of cement-blocks should be increased for protecting riverbanks from erosion.
- 4: High lands may be created to be used by people in various purposes during emergency
- 5: Canals of limited use to people should be closed at their ends.

<Economic>

- 6: Salinity tolerant rice varieties and fish species should be innovated and replicated in the coastal area.
- 7: Coastal area friendly industrialization should be patronized.
- 8: Professional skill development training should be given to people
- 9: More opportunities of non-farm employment should be created for people to buy food and fuel

<Public health>

- 10: Pure drinking-water sources should be installed in the coastal belt
- 11: Hospitals should be established in the coastal belt.

<Education>

- 12: Educational institutions should be established on sufficiently raised lands.

<Forestation>

- 13: Deep forestation along the coastal belt should be accelerated

Note 2) Multiple responses

Source: Field survey, 2010

Cyclone shelter centers: There are 2,500 cyclone shelter centers constructed by the government and development partners and a few by NGOs along the coastal belt against the necessity of several thousands more. Those are of

inadequate in number, low capacity, poor construction in some cases, poor maintenance, rapidly inaccessible due to distant location from many villages, the least scope to bring their bulk stock of agricultural products, the least accommodation for livestock & poultry, inadequate sanitation, etc. For security of properties many people have tendency of not leaving home for cyclone shelters until the climax of disaster comes, which makes their lives at a stake. Therefore, the construction of more cyclone shelter centers along the coastal belt may not be a very useful solution to the problem always to all people.

5. Summary and Conclusions

5.1 Summary

The coastal people of Bangladesh expressed their perception that during the last 25 years (1985-2010) seasonal temperature increased particularly in winter and summer; tidal water level increased gradually which inundated more and more land day by day; frequency and intensity of cyclones increased and came with more speed; it did not rain in the proper times but rained in the improper times for farming; riverbank erosion, char area, salinity in water and soil increased; and depth of rivers and canals became less than before 25 years. They also expressed their perception that during the next 25 years (2011-35) the similar trend in climate change would be continued, in addition permanent saline water logging would occur in more areas than in 2010 and in the coastal area people's lives would become more miserable gradually.

People in the coastal area reported their understanding that during the last 25 years due to climate change their involvement decreased in farming but increased in the non-farm sector remarkably; fishing in natural common water bodies remained almost similar; un-skilled & skilled labor, small trade and job inside and outside Bangladesh increased remarkably. Thus, they were quite aware of the past climate change impacts on their livelihoods through observing the changing situation by generations. Consequently, they started to leave farming for available non-farm jobs successively.

According to their views on impacts of SLR and consequent tidal inundation and stagnation of saline water on farmland and homesteads during the next 25 years, food and fuel problems would aggravate and turn to crisis; involvement in farming, fish culture, fishing, fish trade, unskilled labor, skilled labor would decrease drastically; stagnant water removal would become very difficult; transport communication would become more difficult and risky; children's education and educational institution operation would be at a stake; diarrhea, dysentery and many other diseases would break out as epidemics; livestock and poultry rearing would decrease due to scarcity of pasture land; drinking water crisis would aggravate; and social cooperation among people would break down in the coastal area.

People in the coastal area would change their professions due to decrease of employment opportunities in agriculture, forestry and fishery sectors. Their involvement in small trade and job inside and outside Bangladesh would increase remarkably. In feasible areas they would accelerate shrimp culture. All information above-mentioned implied that they had an adequate awareness of climate change impacts on their livelihoods and habitats during the next 25 years.

Except community-based cyclone warning and preparedness system, people in the coastal area did not have mentionable village community level preparedness to cope with climate change impacts. Rather the highest proportion of them considered that migration to other areas in Bangladesh in search of jobs might be a coping strategy with climate change impacts. Some of them expressed their intention to educate their children to get jobs at home and abroad. The highest proportion of them was biased to changing their traditional livelihood pattern. Many of them opined that they would engage themselves in non-farm jobs due to decrease of arable land. They would be looking for government supports and services. Some of them opined that they would be doing other jobs instead of fishing due to super saturation of fishermen in common water bodies.

All those information implied that people's opinions on coping with climate change impacts were largely biased to migration to other areas in the country and to changing their traditional professions and livelihood pattern. Implementation of such intensions would be contributing a lot to the increase of slums in already super saturated big cities in Bangladesh with a large number of slums.

People in the coastal area have made a bottom-up prescription of interventions parallel to the top-down prescription for coping with climate change. There are commonality and uniqueness between bottom-up and top-down prescriptions for coping with climate change.

5.2 Conclusions

On the basis of findings, the conclusions are as follows.

- (1) Majority is aware of the past and future climate change but can not confidently apprehend SLR in future.
- (2) Majority can perceive the past and future climate change impacts on livelihoods and habitats.
- (3) They are not adequately prepared at the village level to cope with future changes in climate.
- (4) Common interventions as mentioned in both bottom-up (people) and top-down (government) prescriptions for coping with climate change are “Heights and sluice gates of existing barrages/polders should be increased and new long barrages with adequate heights and sluice gates should be constructed”; “Number and size of cyclone shelter centers should be increased”; “Various measures including use of cement-blocks should be increased for protecting riverbanks from erosion”; “Salinity tolerant rice varieties and fish species should be innovated and

replicated in the coastal area”; “Pure drinking-water sources should be installed in the coastal belt”; and “Forestation along the coastal belt should be accelerated”.

(5) Unique interventions as mentioned in bottom-up prescription for coping with climate change impacts are “High lands may be created to be used by people in various purposes during emergency”; “Canals of limited use to people should be closed at their ends”; “Coastal area friendly industrialization should be patronized”; “Professional skill development training should be strengthened”; “Non-farm income generating opportunity should be increased”; “Hospitals should be established in the coastal belt”; and “Educational institutions should be established on sufficiently raised lands”.

6. Policy recommendations to Bangladesh government, development partners, practitioners and academicians

On the basis of findings, the policy recommendations are as follows.

- (1) As an alternative of constructing thousands of new cyclone shelter centers, new long barrage and new polders, establish cluster villages of multistoried buildings surrounded by deep green belt of trees along the coastal area on land raised up to the estimated safe level by gathering soil from silted riverbed. Cluster villages may be established first as an action research model to be replicated through piloting step by step.
- (2) Ensure proper maintenance of the existing embankments, polders and internal canals. Increase height, breadth, sluice gate, flashing gate and pumping station of the existing embankments and polders wherever necessary.
- (3) Organize more programs to increase village community-level awareness on climate change impacts and preparedness for coping.
- (4) Innovate and replicate salinity-tolerant farming, fishery and forestry rapidly.
- (5) Provide skill development training to people on scientific techniques of fishing boat making, fishing net knitting, fishing, fish preservation, fish processing and marketing supported by low cost adequate loan in cash and kind.

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