Climate Change Induced Disaster: Adaptation and Management Strategies in Coastal Areas of Bangladesh

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Abstract

The aim of this research is to analyze the current situation of climate change induced disaster into the exposed coastal areas of Bangladesh. The study area is Moheswaripur union under Koyra upazila in Khulna district. This study was conducted to find out the various local natural disasters, problems faced by people and adaptation strategies to cope with disaster. Both quantitative (household survey) and qualitative tools (focus group discussions, in-depth interviews and community consultations) were used to explore how disaster affects on coastal livelihood. The study provides a baseline on evaluation of the present adaptation practices by the affected communities at south-west coastal belt of the country. The most important adaptation option of the farmers are to cultivate the saline tolerant rice cultivars such as BRRI 47 and BINA 8. This study concludes with some guidelines and mitigation strategies for reducing adverse impacts of natural disaster in those particular areas

Keywords: *Climate Change, Natural Disaster, Coastal Livelihood, Adaptation Practices, Mitigation Strategies.*

1 Introduction

According to the Third Assessment Report of Intergovernmental Panel on Climate Change (IPCC), South Asia is the most vulnerable region of the world to climate change impacts (McCarthy *et al*., 2001). The international community also recognizes that Bangladesh ranks high in the list of most vulnerable countries on earth. In 2007, IPCC estimated that climate change would cause 0.6 meter or more of global sea level rise by 2100. The analysis of National Adaptation Plan of Action (NAPA) demonstrated 0.14 meter, 0.32 meter and 0.894 meter rises in the sea level of the coastal zone of Bangladesh by the year of 2030, 2050 and 2100 respectively. The assessments of World Bank (2000) projection show that last half of the present century (from 2050 to 2100) sea level will rise 0.75 meter. The rise in sea level has been predicted to reach 1.5 meter as in extreme scenario. Recent studies of IPCC suggested that the delta and island nations are at high risk of being the victim of sea level rise due to the ocean volume and thermal expansion. Assessments made from physical models used in Department of Environment (DoE) of Bangladesh and relevant organizations have shown an increment in the sea level which are summarized for the year of 2050 in **Table 1**.

Table 1. Rise in Sea Level by the year 2100 in the Bay of Bengal by different organizations

Organization	Region studied	Year of estimation	Estimated rise in sea level (m)	The year to experience the extremity
World Bank	Bay of Bengal in Bangladesh	2000	0.25	2050
Woods Hole Oceanographic Institute	Bay of Bengal in Bangladesh	1986	0.13	2050
World Bank	Bay of Bengal in Bangladesh	2000	0.10	2020
DoE	Bay of Bengal in Bangladesh	1993	0.3-1.5	2050
NAPA	Coast of Bangladesh	2006	0.14	2030
NAPA	Coast of Bangladesh	2006	0.32	2050

Moheswaripur Union under Koyra upazila under Khulna district was selected because of the people are suffering from climate change induced disaster. Two villages namely Gilabari and Moheswaripur under the union were selected as case study for the research. Location of study area in context of Bangladesh has been shown in **Figure 1**.

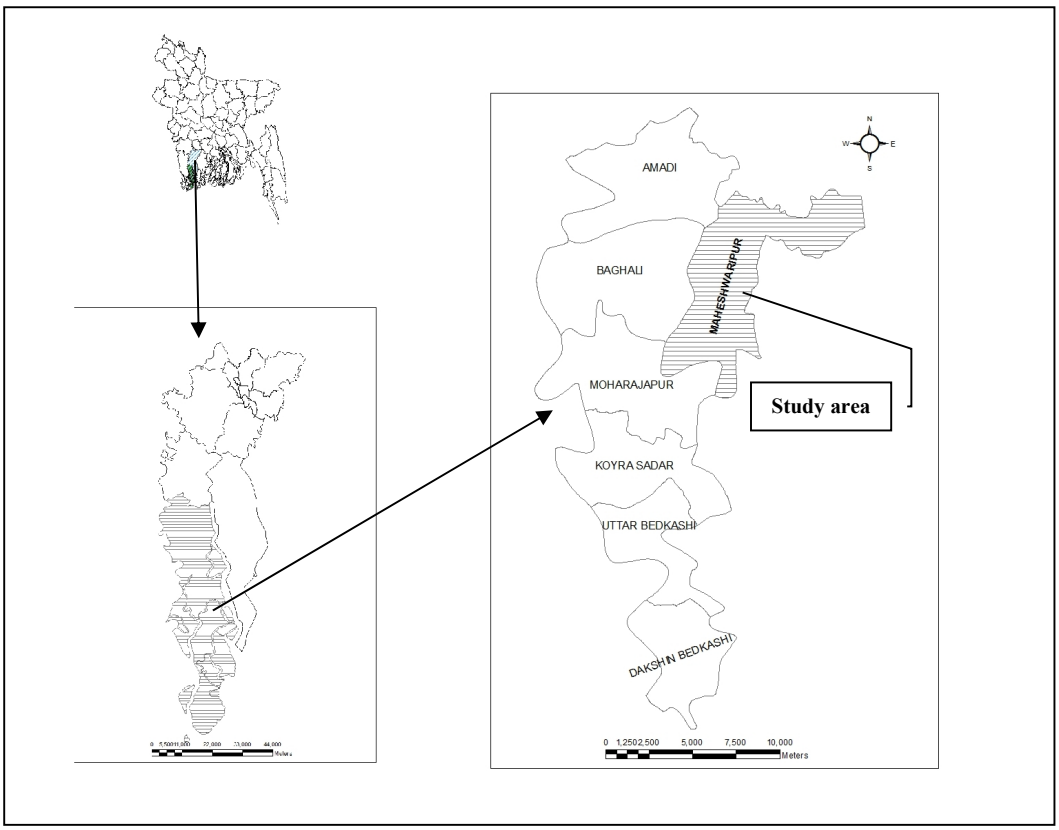


Figure 1. Map showing location of study area (Moheswaripur Union) in context of Bangladesh

2 Study Methodology

To get idea about the existing condition of the area, a reconnaissance survey was conducted during the initial stage of the study. It was also helpful in selecting study area, sampling procedure and questionnaire formulation**.** This research is founded upon both quantitative and qualitative data collection methods. After selecting study area, data were collected from 100 respondents randomly through questionnaire survey. The total number of respondents for sample survey in each village was 50. One Focus Group Discussion (FGD) was conducted in each of the study villages. Each FGD comprised 10 to 14 respondents (male and female). The FGDs were conducted with farmers only. In some cases, the local elites or some knowledgeable persons were present in the group discussion. The Key Informants Interview (KII) and the people for indepth interviews were also carried out with Engineers, Executive persons of Government and Non-Government organizations. In order to get insight into the problem as well as understanding of the study area, an attempt was made to review the available secondary sources of information. This included reviewing secondary documents most of which are published in journals, conferences and from various organizations. All the data are interpreted to get the better results of the study. The data sheets were rigorously edited and checked for completeness and consistency. The quantitative data were analyzed through statistical analysis using SPSS software.

3 Study Area

Koyra is one of the Upzailas of Khulna district in the south-west, which is at high risk due to the threats of climate change. The study area (Moheswaripur union under Koyra Upazila) constitutes of 10 villages namely Gilabari, Hodda, Baniakhali, Bhagba, Satalia, Moheswaripur, Chowkuni, Baburabad, Tetultalar Char and Kaliapur. Due to the two erosion-prone rivers, one is the Shakbaria River, at the flank of Sundarban, on its East, and the other, the Kapatakkha River, on its West, river bank erosion has become the union's daily feature. The depressing scenario of salinity is clearly visible in every house in this greenless union. The poor people of this union passes their days by coping with disasters and adversity like cyclone in 1988, floods and riverbank erosion

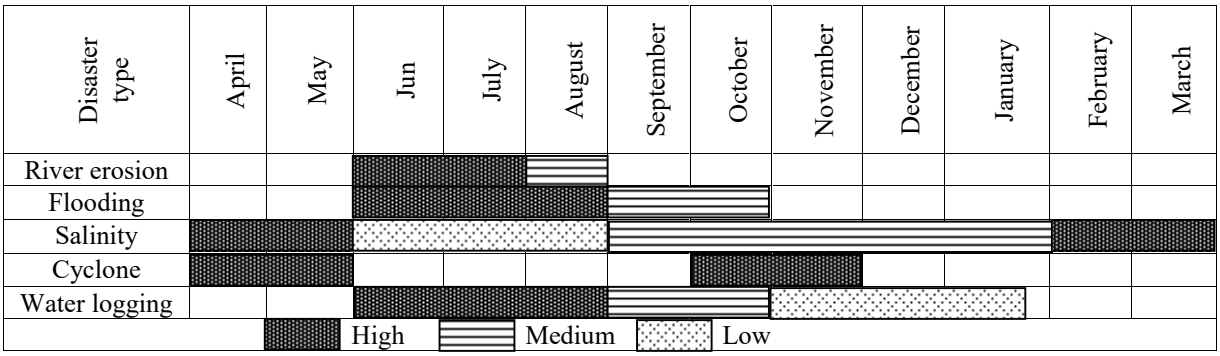
in 1991, 2002, and 2004, Sidr in 2007, Aila in 2009, and tidal surge in 2010. According to Bangladesh Bureau of Statistics (2011) total population of the study union is 30,449. A large greenery of the union had been damaged during cyclone Aila in 2009. Agriculture is the main source of livelihood in the study villages. Among the households the farmers grow cereal crop Aman over the years. Boro was cultivated ten years before. Due to high level of salinity, local people started to use their cultivatable lands as shrimp farming.

4 Study Findings and Analysis

4.1 Climate Change Induced Disaster in the Study Area

Disaster becomes a common phenomenon of the life of people of the study area. Major disasters of Koyra Upazial in Khulna district are salinity intrusion, cyclone, river bank erosion and water logging. Seasonal disaster calendar is presented in the following **Table 2**.

Table 2. Seasonal disaster calendar of the study area



Source: Household Survey, 2016

From the study it is revealed that the most common disaster is sea water intrusion, but from the beginning of settlement the catastrophic disaster identified as cyclone and storm surge. According to the respondents the ranking of disaster in the study villages is shown in **Table 3** below.

Table 3. Ranking of Disaster according to the respondents of study villages

Disaster type	**Percentage of Disaster**	
	Gilabari village	**Moheswaripur village**
Salinity Intrusion	30	35
Cyclone	25	20
Storm surge	10	8
Flood	10	8
River Erosion	20	24
Water logging	5	10

Source: Household Survey, 2016

The effects of natural disasters are loss of life, damage to physical properties and thoroughly affect the total community livelihood. The problems in various sectors due to local disaster are given below (**Table 4**). The study results show that agriculture is one of the most vulnerable systems to be affected due to climate change induced disaster.

Table 4. Problems faced due to disaster in the study villages

Sector	**List of Problems**	**Percentage**
Water	Salinity intrusion	100
	Lack of fresh drinking water	
Sanitation	Hygienic problem	25
Health	Skin disease	28
	Diarrhoea	

Sector	List of Problems	Percentage
Agriculture	Rice production reduction	88
	Decreasing agricultural land	
Fishing	Due to extensive shrimp cultivation	55
	Virus affected	
Forestry	Decreasing plantation	30
	Sea water into the homestead garden	
	Unfavorable condition	

Source: Household Survey, 2016

4.2 Impacts on Coastal Livelihood

During Cyclones Sidr and Aila in 2007 and 2009 respectively, sea water was driven into ponds and rivers in Khulna, Bagerhat and Satkhira districts of southern Bangladesh to raise levels of salinity in the soil and in underground aquifers. Farmers now have to dig wells at least 500 ft deep to get water that is safe for irrigation. Groundwater was available at 200 ft to 250 ft 10 years before. Over the last 25 years, sea water from the Bay of Bengal has pushed 40 km inland throughout underground aquifers, replacing fresh water. Topsoil salinity in cropped lands came down to 4.0 dS/m or less at least one month earlier than fallow lands (SRDI, 2010).

The respondents were asked about the causes of salinity increasing day by day. They mentioned two rivers Kapatakkha and Shipsha flow into the Bay of Bengal. The tidal surge bears the salt water from the sea that makes the water and soil into saline. It is anticipated that withdrawal of river water from upstream, irregular rainfall, introduction of brackish water for shrimp cultivation, faulty management of sluice gates and polders are also the causes of sea water intrusion in the study area.

Table 5. Soil Salinity in the study area (Koyra, Khulna)

Name of Upazila	Total area (ha)	Uncultivated area (ha)	Cultivated area (ha)	Total saline area (ha)	Salinity Class and area (ha)				
					S1 2.0-4.0 dS/m	S2 4.1-8.0 dS/m	S3 8.1-12.0 dS/m	S4 12.1-16.0 dS/m	S5 >16.0 dS/m
Koyra	26323	4910	21413	21410	240	1310	5250	7250	7360
S1= No Saline; S2= Very Slightly Saline; S3= Slightly Saline; S4= Strongly Saline; S5= Very Strongly Saline									
Source: Soil Resource Development Institute, 2012									

From **Table 6,** annual loss from agricultural land was Tk.3000/bigha at Gilabari, whereas Tk.25000/bigha at Moheswaripur in 2010. According to the respondents the loss from agricultural fields increases over the years. The farmers used to cultivate the main rice crop (Aman) during June-December of the year. They also cultivate some rice and vegetables during December-May. Harvesting of rice and vegetables during November/December helps them to avoid food crisis but they can continue with the food stock until June/July. The household survey data demonstrates that salinity caused by extreme events (e.g cyclone and storm surge) has not only engulfed new farm lands but also intensified during the last decade and particularly over the past

Table 6.Annual loss (Tk/bigha) from agricultural fields

Year	Tk/bigha	
	Gilabari village	Moheshwaripur village
2016	4800	5000
2013	4000	3500
2010	3000	2500

Source: Household Survey, 2016

Table 7. Reasons for decreasing rice production (% households)

Reasons for decreasing rice production	Percentage
Saline irrigation water	30
High cost of production	5
Reduced soil fertility due to salinity	18
Natural disaster	20
Loss of seedbed	27
Total	100

Source: Household Survey, 2016

five years. With regard to the trend in rice productivity a large majority of the farmers reported that it has declined for all three rice crops over the last decade. It is worthy to note that fall in productivity of Boro, cultivated during the dry season when salinity level reaches its peak, is higher than Aus and Aman crop. The reasons for decreasing rice production have been found mostly for saline irrigation water (30%), reduction of soil fertility. The other reasons for less rice production have been presented in **Table 7.**

According to **Table 8**, the study reveals that most of the households collect water from Pond Sand Filter (PSF) (20%) for drinking. Many households collect water directly from pond and drink without filtration as confirmed during the FGDs and interviews. Some of the households use rainwater, deep tube-well or shallow tube-well.

Table 8.Sources of drinking water in the study villages

Sources of drinking water	Percentage
Tube well	3
Pond Sand Filter (PSF)	20
Rainwater	17
PSF + Rainwater	25
Pond	25
Desalination Plant	10
Total	100

Source: Household Survey, 2016

Institutions play a leading role in supplying drinking water in the study area. Various local and international NGOs such as Rupantar, Sushilan, Uttaran, JJS, Caritas, Brac, Concern, UNICEF, UNDP and government organization such as Department of Public Health and Engineeinrg (DPHE) are involved in supplying drinking water in the study areas. Among them, UNICEF and DPHE carried out the introduction of PSF along the coastal belt. The survey result shows that PSFs are used to get drinking water with assistance of DPHE and UNICEF in severe drinking water scarcity areas. Local people use rainwater harvesting technology by conserving rainwater during the rainy season and using it for drinking purposes with help for various NGOs.

4.3 Adaptation and Management Practices due to Disasters

It was found that many of the male members of the household temporarily migrate to work and earn more either in the nearest district or in Dhaka, the capital city. During FGDs, it was informed that many of the people have changed their livelihoods from rice cultivation to small trade, rickshaw/van pulling, etc. Some households have migrated permanently after selling their households assets. Although the local people are adapting various practices in association with government fund, donor agencies against climate change impacts but all of them are not successful. According to the villagers the present coping measurement to deal with disaster is given in **Table 9** below.

Table 9. Percentage of Coping Measurement to deal with disasters

Disaster type	Coping measures	Percentage	
		Gilabari village	Moheshwaripur village
River erosion	Embankment by Govt. and community	58	83
Flooding	- Shifting another place - Changing occupation	53	43
Salinity	- Using water of desalination plant - Pond Sand Filter (PSF) - Pond Water	98	95
Cyclone	Go to cyclone shelter	83	73
Water logging	No step	40	33

Source: Household Survey, 2016

The farmers and communities are trying to adapt the changing conditions with assistance from the relevant government organizations and NGOs/civil society forums. The government is mainly providing the infrastructural and technological coping/adaptation options in both rice production and drinking water facilities. A number of rice tolerant varieties have been introduced to adapt to the adverse impacts of salinity. Many of the households are getting positive results especially from BINA 8 and BRRI 47 rice varieties. Some of the current adaptation options to address salinity intrusion in the study villages are listed below:

- Saline tolerant rice variety (BRRI 23 can resist up to 4 dS/m, BRRI 47 and BINA 8 can resist up to 12 dS/m)
- Excavation and re-excavation of canals and ponds around the rice fields for washing and irrigating the rice fields to reduce salinity
- Preservation of rainwater in above mentioned ponds and canals for the use of irrigation in lean period
- Some farmers put Gypsum and Sugar solution (or solid form of sugar) to reduce salinity in the rice seedbed
- Frequent tillage of the rice fields also helps in reduction of salinity during cultivation
- Farmers put additional cow-dung and bio-fertilizer

Respondents were asked about their expectations for support from the government and NGOs to reduce their vulnerabiltiy to drinking water scarcity. The recommendations are summarized below:

- Installation of rainwater harvesting system at the family level. The government should take proper initiatives in consultaion with community members and local NGOs to make the projects sustainable.
- Installation of rainwater harvesting systems in all government and nongovernment offices, schools and colleges. The government should include the activity during policy formulation at both national and local levels with the bilateral agreement of the Union Parishad and NGOs that are working in the study areas.
- Installation of solar-powered deep tubewells with overhead tanks that supply piped water to the community since piped water is the topmost desired option among the local people.
- Community based pond sand filters with proper governmental monitoring and maintenance. Pond sand filter are simple, easy to use and effective technique in the south-western region of Bangladesh.

5 Conclusion

From the above findings and discussion, the study can be concluded as follows:

- The most severe disasters of the study area are identified
- Due to climate change, livelihood patterns of the coastal communities in the study area are changing
- People are internally displaced, forced to leave coastal areas due mainly to deterioration in livelihood opportunities
- The study suggests that policy makers, donor agencies, government officials and the communities of the area should work together to exercise more sustainable adaptation and management practices.

6 References

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