Report on

Climate change impacts on wetland ecosystem in exposed coastal zone of Bangladesh: Necessity of IWRM for sustainable management

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1. Introduction

Bangladesh has long been recognized as being very vulnerable to both environmental degradation and climate change impacts (GoB, 2005). Increasing changes in climate variability and extreme events pushes the country more towards vulnerability. This vulnerability is compounded by low economic strength, inadequate infrastructure, low level of social development, lack of institutional capacity, improper management practices, and a higher dependency on the natural resource base which makes coping strategies difficult to implement.

Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000 m and that the ocean has been absorbing more than 80% of the heat added to the climate system (IPCC, 2007). Such warming causes seawater to expand, contributing to sea level rise (SLR). Mountain glaciers and snow cover have declined on average in both hemispheres. Widespread decreases in glaciers and ice caps have contributed to sea level rise (ice caps do not include contributions from the Greenland and Antarctic Ice Sheets). However, global average sea level rose at an average rate of 1.8 [1.3 to 2.3] mm per year over 1961 to 2003 (IPCC, 2007).

Changes of climate may directly and indirectly cause decreased water availability and deteriorate water quality, decreases in reliability of hydropower and biomass production, adverse impacts on fisheries biology and aquatic ecosystem, increase incidences of water borne diseases (diarrhea, cholera, dysentery etc), reduction of agriculture crops, increase morbidity and mortality, increase demand and consumption on water due to increase of temperature, increased pressure on groundwater etc. Ultimately, the most vulnerable population would be the poor of the country. And perhaps, the women and children would be the most vulnerable group.

It has been predicted that "climate change impacts will be differently distributed among different regions, generations, age classes, income groups, occupations and genders" (IPCC 2001). The IPCC also notes: "the impacts of climate change will fall disproportionately upon developing countries and the poor persons within all countries, and thereby exacerbate inequities in health status and access to adequate food, clean water, and other resources. It became an unkind or terrible reality for the communities of Bangladesh to face extreme climatic events e.g. recent prolonged and devastating floods (1998, 2004, 2007); Cyclone Sidr (2007), Cyclone Bijli (Mid April 2009), Cyclone Aila (24th May 2009), droughts, extreme heat waves (e.g., over 42°c temperature in the first week of May 2009) etc. It was also predicted that the sea level is likely to rise 30 and 50 cm by 2030 and 2050 respectively. It has been revealed that by the year 2030, an additional 14.3% of the country would become extremely vulnerable to floods, while the existing flood prone areas will face higher levels of flooding. Analysis of past floods suggests that about 26% of the country is subject to annual flooding and an additional 42% is at risk of floods with varied intensity (IPCC, 2002, WG II). However, Climate change may have adverse impacts on natural resources in different degrees in different ecosystems (terrestrial and

aquatic). Wetlands may be one of the most vulnerable resources to the adversities of climate change in the country.

In fact, the impacts of climate change on the wetlands of developing countries like Bangladesh may be comparatively higher may be due to many reasons. A number of climate induced anomalies including serious and recurrent floods due to glacier melt and increased rainfall intensity, increased intensity and frequency of Cyclone, projected sea level rise (SLR), salinity intrusion, temperature and rainfall variation etc may affect wetlands and connected livelihoods in many ways. Millions of people in coastal region of Bangladesh are already suffering from saline intrusions. More than 90% small ponds of the Cyclone Sidr affected districts were contaminated. A recent study shows that climate change will adversely affect the wetlands of Bangladesh but it doesn't mention how the impacts will be occurred. It is necessary to understand the impacts of climate change and climate variability on wetlands of the country especially in the exposed coastal zone and explore the necessity of IWRM aspects as a tool for sustainable management. The findings would ultimately help the policy makers and water managers to take initiatives on sustainable wetland resources management in the country.

1.1. Objectives:

The research investigated climate change risks for the wetlands in Bangladesh and explored measures for sustainable management of this vital ecosystem. The specific objectives were:

a) To identify the climate change hazards/indicators that affect wetlands in Bangladesh
b) To determine the pathways how this event adversely affect wetlands ecosystem at the community in the exposed coastal zone and other ecosystem e.g hilly area, haor area, flood plain area etc
c) To identify the consequences of climate change and climate variability issues on wetland ecosystem in the study areas
d) To identify measures for sustainable wetland resources management

METHODOLOGY

The major steps were followed in con ducting the study:

1.2.1. Reconnaissance survey: A reconnaissance survey was carried out to identify the study areas in the affected wetland areas of the country. A small team consisting of three members visited four potential sites. Three sites (most adversely affected) have been finally selected to meet the objective of the study.

1.2.2. Discussion and consultation with relevant stakeholders

At the beginning of the study the BCAS study team held discussions and consultation with relevant stakeholders especially with Bangladesh Water Development Board (BWDB), Local Government Engineering Department (LGED), Department of Environment and local civil society organizations and community based

organizations. This was practically useful for planning and methodological development of the case study.

1.2.3. Selection of the Study Area

Identifying most affected wetland areas; three locations (Satkhira, Rangamati and Sunamgaj) were selected for the study. The study covered two villages of one upazilla of the respective district/location.

1.2.4. Collection and Review of Secondary Data/Information

A number of wetland related documents were collected from concerned local, national, and international sources. These were collected and reviewed to meet the study objective. However, the major sources for secondary documents include DoE, BWDB, and Wetland International etc. Some of the international peer reviewed journals were also reviewed.

1.2.5. Development of Data Collection Tools

Questionnaire for sample survey and checklist for FGDs and In-depth interviews were separately developed to collect the primary data/information from the study sites. A number of issues including sources of water for drinking and other domestic purposes, status of pond water, seasonal variation in terms quality and quantity of water, perception on current and future climate induced hazards, potential measures for sustainable management of the resources. Details of these data collection tools are given in **annex-1.**

1.2.6. Primary Data Collection

The following steps were followed accordingly to collect primary data from the study sites:

a. Recruitment and training of the field staff for primary data collection

A field team comprising one field supervisor and two field investigators were deployed in each of the three study locations for primary data collection. A two-day long training programme was organized for the field staff at BCAS headquarters before going to fields. The training was conducted by the experts of the study team to explain the objectives and field research methodologies including interviews and FGDs. The survey questionnaires, checklists and related issues for FGDs were discussed in detail during the training. The training exercise was fruitful in gathering field data/information by the field staff. The fieldwork was monitored by the experts of BCAS.

b. Quality control of data and information

Data were examined by field supervisor once and the investigators were apprised of whichever existing deficiencies to reform it. In this strain quality of data was assured in every step of the survey.

c. *Methods of primary data Collection*

Multiple methods were used to collect the primary data. These are as follows:

- Sample survey
- Focus Group Discussion (FGD)
- In-depth interview

The sample survey was designed to gather information and data in a more structured format, the FGDs and interviews were focused on open ended opinions and views of the target study groups.

✓ **Sample Survey**

The sample survey was targeted to the households of two villages from each of the three study sites. The total respondent for sample survey in each village was 50. Thus 300 respondents were surveyed in six villages of three locations. The households in each village were randomly selected. The head of the family/household was given priority to respond to the questions. In absence of the head, other senior informed person of the family/household was requested to respond. However, in many cases either elder male or female responded in presence of all members of the family.

✓ **Focus Group Discussion (FGD)**

Two FGDs were conducted in each study locations. One was with households (male and female together) and the other was with wetland related professionals. Each FGD was comprised with 10 to 14 respondents. One of the field investigators presented the issue from the FGD checklist and the other two members of the team recorded the responses of the participants on specific issue.

✓ **In-depth Interview**

Five in-depth interviews were taken from each of the study sites. Senior and knowledgeable persons in the village and community leaders, key person of the BWDB were interviewed.

1.2.7. Data Analysis

Data processing involved editing, coding, entering of figures and generating statistical tables required for analysis. SPSS software package was used for data analysis. Tables and Graphs were also worked as useful tools for further analysis. Qualitative information through FGDs and sample survey were also analyzed.

1.2.8. Draft Report

The core research team broadly analyzed the data/information and developed the draft report on the study. This draft report was presented to experts and relevant stakeholders in national consultation meeting to finalize.

Workshop (National level): The findings of the research have been shared at the national level to validate and get feedback from the relevant stakeholders and experts to prepare the final report.

3. FINDINGS OF THE STUDY

Occupation of household respondents

This shows that the livelihood patterns of people of these three study areas are not similar, possibly because of different topography and ecological system. However, most of the household members were found to be involved with a number of occupations including agriculture, daily labor, business, fishing or fisheries cultivation and others which include household work, service in government and non-government organizations, boatmen etc. It appears that about 44 % households are involved with fisheries related activities in Rangamati while the highest occupation was daily labor (50%) in Sunamganj and "others" in Satkhira. It shows that 34 % respondents work on agriculture aspects in Sunamganj followed by 9 % in Rangamati. Many people were found to have business category in the occupation, especially in Satkhira (24 %). Please see the table below for details.

Table 1. Occupation of the household respondents

Main Occupations	Percentage of the respondents		
	Rangamati	Sunamganj	Satkhira
Agriculture	9.2	34.4	5.0
Daily labor	18.5	50.0	21.9
Business	8.1	5.6	23.6
Fishing/Fish cultivation	43.9	7.7	21.8
Others (HH work, teaching, service etc)	20.3	2.3	27.7
Total	**100.0**	**100.0**	**100.0**

Literacy of household respondents

It shows that most of the respondents in Haor (Sunamganj) and coastal area (Satkhira) were illiterate. Household member's education was found better in Satkhira or coastal area. The education status of the other two study areas was very poor. Please see details in the table 2.

Table 2: Educational Status of Respondents

Educational Status	Percentage of the respondents		
	Rangamati	Sunamganj	Satkhira
Illiterate	50.7	11.3	40.3
Can sign only	25.3	28.3	-
Primary	13.8	30.2	24.4

Secondary	8.0	28.3	13.4
SSC	1.1	1.9	10.9
HSC and above	1.1	0.0	11.0
Total	**100.0**	**100.0**	**100.0**

Perception of Respondents on Climate Change

In response to a question on perception of the respondents or the households on climate change in the study areas, a set of climate induced elements were mentioned. These mainly include temperature variation, erratic behavior of rainfall, cyclone and storm surge, salinity intrusion, frequent flood, seasonal variation etc. However, mentioned hazards varied from one area to another area. Most of these hazards were mentioned in Satkhira. About 34 % respondents in Satkhira mentioned that they suffer from erratic behavior of rainfall which includes late rain, excessive rain in short period of time. It shows that the rainfall problems remain a challenge in all the study areas, highest in Rangamati (48.9 %). Please find details in Table 3.

Table **Perception of Respondents on Climate Change in study area**

Climate Change Related Hazard	Percentage of respondents		
	Rangamati	Sunamganj	Satkhira
High temperature in Summer than before	21.7	20.9	10.2
Long time summer without rain	16.3	7.3	2.8
Short term winter with less cold	11.7	8.7	11.8
Long cold winter	1.4	0.4	-
Erratic rainfall	48.9	30.4	33.4
Frequent cyclone and storm surge	-	-	26.5
Salinity intrusion	-	32.1	10.3
Frequent flood	-	32.1	4.7
Others	-	-	0.3
Total	**100.0**	**100.0**	**100.0**

Perception on the impacts of climate change on the local wetlands (pond, haor and lake ecosystem)

It appears that most of the respondents mentioned that the local wetlands are affected by climate induced hazards. In Satkhira, 64 % respondents clearly stated that climate change is responsible for deteriorating the water quality in the local small isolated wetland ecosystem. Similar opinions were recorded from Rangamati (54 %) and Sunamganj (49 %). The respondents said that Cyclone and storm surge, lack of rainfall, tidal flood and temperature variation would affect the pond while frequent flood and excessive rainfall were mentioned in Sunamganj for the same problem.

Table 4. Percentage Distribution of Households on the impacts of climate change on the local wetlands

Study Area	Yes	No	Don't know	Total
Rangamati (Lake)	54.0	6.9	39.1	**100.0**
Sunamganj (Haor)	48.9	35.6	15.5	**100.0**
Satkhira (Pond)	63.9	20.1	16.0	**100.0**

Sources of drinking water in the study area

The following table shows that a large portion of the households still depend on the small water bodies (pond, lake) for the drinking water. More than 30 % people in Satkhira use pond water for drinking while 29.8 % people drink lake water. But it was mentioned in both FGD and I-depth interview that people filter this water by different processes before they drink at home. On the other hand, all households in Sunamganj (Haor area) were found to have tube-well as the source of drinking water. But it was also found that most of the in each of the study areas use the water of these local small wetlands for other domestic purposes such as cooking, washing, bathing etc. Please see the table below for details.

Table 5. Percentage Distribution of Households by Sources of Drinking Water

Source of Drinking Water	Study Area		
	Rangamati (Lake)	Sunamganj (Haor)	Satkhira (Pond)
Tube well	55.0	100.0	0.8
Kaptai lake	29.8	-	-
PSF	-	-	21.9
Rain water	8.4	-	42.7
Pond	-	-	34.6
Dug well	6.8	-	-
Total	**100.0**	**100.0**	**100.0**

Use wetlands for Irrigation and agriculture purposes

It appears that many of the households use water of the wetlands for irrigation and agriculture practices. It was found that 1about 75 % people in Sunamganj use lake water for irrigation purposes while more than one-fourth people does the same in Rangamati. At least 10% households in Sathkhira use pond water for home gardening and small agriculture practices.

Fig.1. Percentage distribution of households according to Use wetlands for Irrigation and agriculture purposes

Percentage distribution of households according to Use wetlands for Irrigation and agriculture purposes
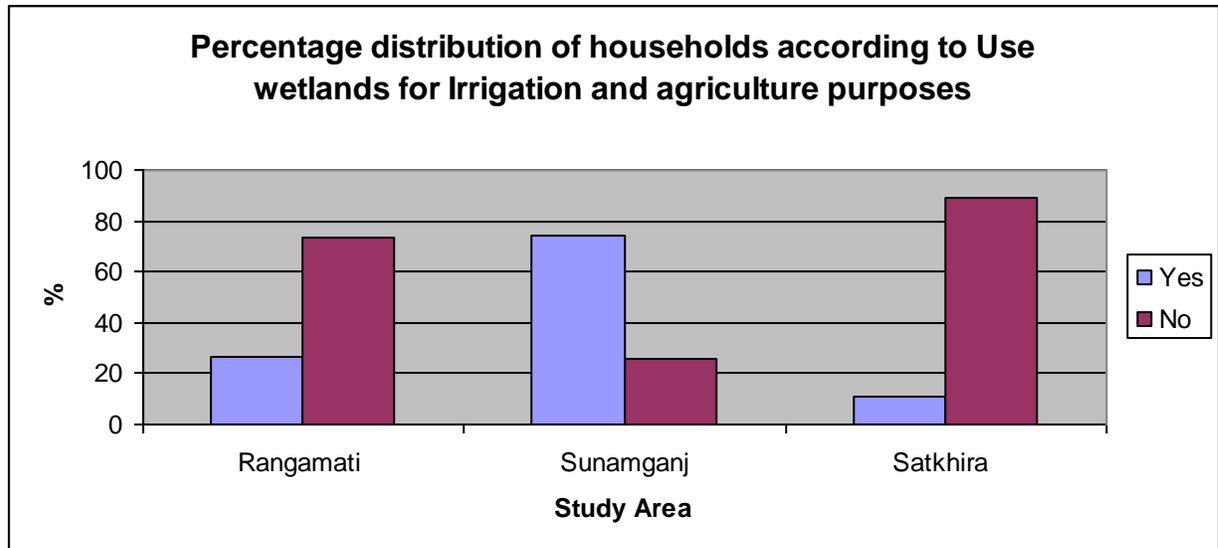
Climate Change impacts on local wetland ecosystem

A set of climate related problems were identified in all the study areas. Some of the problems including access to safe water supply and sanitation, health problems and damage of fisheries resources were common in the study sites. Many of the households were found to be in fear of experiencing frequent flood and cyclone and storm surge especially in Sunamganj and Satkhira. More than 50 % people mentioned that water borne diseases are becoming very common in Satkhira followed by Rangamati (40 %). Diarrhea, dysentery, cholera, skin diseases are dominant in Satkhira and Sunamganj. A number of key problems are given below

- ✓ Decrease water level especially during pre-monsoon (March-April-May)
- ✓ Increase salinity in both surface and ground water resources
- ✓ Sub merge of water bodies due to cyclone and storm surge
- ✓ Inundation of crops due to flash flood
- ✓ Overflow of the wetlands
- ✓ Damage fish and fisheries resources
- ✓ Damage crops- crops go under water due to flood and tidal surge
- ✓ Cultivation/crop production problem
- ✓ Contamination of pond and lake water with flood water
- ✓ Health problems during and after flood
- ✓ Lack of access to safe water during hazard period
- ✓ Sanitation crisis in all the study areas

The study team also looked at the recent experiences of climate induced hazards in coastal region (Satkhira). In response to a question on sources of water during most recent "cyclone Aila" it appears that most of the people use pond water for washing, bathing and sanitation. It is to be noted that most of the ponds in the study areas were submerged by the Aila hit. People had no option other than using the saline and contaminated water for the mentioned purposes. Please see the details in table below

Table 6. Water Sources of households during Last Cyclone (Aila) in Different Purposes

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Source of water	Purpose of water during "Cyclone Aila"				
	Drinking	Cooking	Washing	Bathing	Sanitation
Rain water	22.5	20.4	2.3	1.6	-
Pond	4.0	4.8	67.2	62.8	76.3
Tube well	1.2	1.2	6.3	7.9	5.3
Aid water	63.6	64.6	2.3	-	-
River	-	-	21.9	26.9	17.5
Others	8.7	9.0	-	0.8	0.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Conclusion and Recommendation

Adaptation to climate change is particularly important for a vulnerable community in climate prone areas in Bangladesh. Many people of Bangladesh partially dependent on small isolated wetlands for safe drinking water and sanitation, home gardening, small scale agriculture practices, fisheries, and livestock especially in coastal, haor and hilly areas. But the findings in related to adaptation activities in any mentioned sector is very inadequate. People simply depend on aid water during disaster period. However, some of the following measures were identified during survey, FGD and in-depth interview in the study areas.

Short-term:
- Mass Awareness and Advocacy programmes in the study areas on climate change and associated impacts on wetlands
- Training on climate change issues for people at all levels
- Protection of the wetlands from inundation
- Rain water harvesting
- Enforcement of wetland protection act

Long-term:
- Excavation and re-excavation of the wetlands to conserve water
- Protection of the wetlands
- Community led management of the wetlands
- Development of policy for management of wetlands

Financial Statement

The budget for conducting the case study was 19000 USD. The total expenditure for conducting the case study was bit less than agreed budget. However, expenditure was 18,830 USD. Please see below for details.

Activity – 3   **Case Studies**

SI. No.	Description of Activities	Total (US$)	Total Budget BDT	Actual Expenses (BDT)	Actual Expenses (US$)
1.	**Description of Coordination and Management** - Coordination - Monitoring	2,000	137,000	137,000	2,000
2.	**Logistics** - Stationery - Phone/Fax/Postal service - Photocopy/printing etc	2,000	137,000	136,675	1,995
3.	**Primary and secondary data Collection** **-** Field investigator (3X4X1month) - local transport - Snacks/DSA for FGD participants	6,500	445,250	445,528	6,504
4.	**Travel and Conveyance** - Experts travel from Dhaka to three study locations	1,500	102,750	102,740	1,500
5.	**Consultation workshop**				
	Pen, pencil/pad/paper, plastic folders/bags etc	2,000	137,000	137,890	2,013
	Venue rent, lunch, tea break	2,500	171,250	171,250	2,500
	Conveyance for the participants and honorarium for designated discussant	900	61,650	56,000	818
	Workshop logistics (Phone, fax, courier service, workshop banner, flip charts etc)	1,000	68,500	61,700	901
	Workshop associates	600	41,100	41,100	600.0
	Grand Total	**19000**	**1,301,500**	**1,289,883**	**18830**