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Community Based Risk Assessment and Adaptation to Climate Change in the Coastal Wetlands of Bangladesh: A Case Study from *Chenchuri Beel*, Narail , Bangladesh

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***Abstract*— This paper presents community based framework to assess the risk and the adaptation practice as response to climate change. *Chenchuri Beel* (Wetland) was selected as the study area and historical change-chronology was constructed using statistical analysis of community perception. The community's experience suggests risks are shifting along with prolongation of hydro-meteorological events and its irregularity is threatening adaptation capacities as it is affecting the sensitivity and production of the ecosystem of the region. Communities are increasingly depending on the non-agricultural activities while the required time to be spent for earning livelihoods is increasing rapidly. People are migrating from their nature based occupation as their alternative livelihood. And in such cases, local adaptation practices are almost absent in the region while only alternatives are applying more incentive in compensating. Government and researchers need to understand the nature of community adaptation and perception of climate change if we want to stride forward to negotiate climate change in the country.**

INTRODUCTION

Global climate changes are expected to affect coastal communities around the world [4]-[8] and Bangladesh already has been affected severely [1]. Wetland system of Bangladesh is being affected by the odds of climate change [10] along with other Ramser Sites of Bangladesh and threatened to be lost due to high salinity and permanent inundation as per projected sea level rise by 2100 [11].

Bangladesh is at great risk under global climate change [13]. So the risk assessment and adaptation process is needed for achieving the sustainable development, as it introduce an additional layer of complexity and uncertainty into management planning [6]. Moreover wetland system has immense importance on the livelihood of the people not only in Bangladesh but also around the world as it cover 6% of the world's land surface and contain about 12% of the global carbon pool, playing an important role in the global carbon cycle [5].

The initial approach to adaptation was dominated by the top-down approach derived from the original characterization of the issue as a global environmental pollution problem. The best-known formulation is to be found in the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations [2].

Some of the methods can be adapted for use in determining community-based adaptation to climate change and Community Based Risk Assessment which has received increased attention in the scientific and policy debate, and is seen as complementary to mitigation [13]. As all the communities are not same and different communities can have differential risks [7] which are scale depended, we need tools like Community Based Risk assessment for planning our adaptation strategy. All of such related studies have been termed as the classical or first generation of impact and adaptation studies [9].

Drawing from the literatures on recent climate change impacts and vulnerability, the purpose of this paper is twofold; first, it provides an evidence of changes through the risk assessment and responses in this area that are identified as adaptation practice, and second, the vulnerability assessment provides information on the susceptibilities resulting from climate change and available adaptation options [3].

SELECTION OF THE STUDY AREA

The *Chenchury Beel*[1] is in *Narail*, a southern District of Bangladesh with an area of 317.64 sq km. River dominant area nourishes the wetland seasonally. The average annual rainfall of the *beel* area is over 1,000 mm.

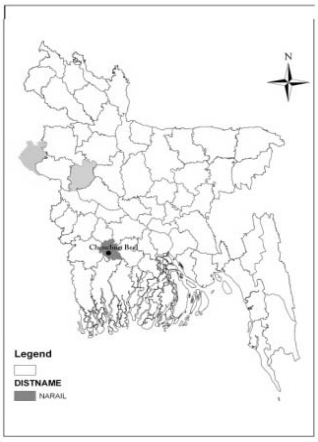

Fig 1: Study area

The land elevation of most part is as low as 2-3 meters from MSL. Major resources of this *beel* include fisheries and crop production while framing, fishing and aquaculture including shrimp *gher*[2] farming are the main occupation types.

DATA COLLECTION AND ANALYSIS

In the study, risk was analyzed and the community level adaptation practices were investigated using statistical analyses of community perception. A historical change-chronology was constructed using the FGDs and Questionnaire survey along with some other tools like problem census, Seasonal calendar, livelihoods mapping, problem matrix and problem scoring to identify and

[1] *The various permanent and seasonal freshwater lakes and marshes of the flood plains are known as haors, baors and beels*
[2] *shimp farm known as shrimp gher.*

prioritize the risks faced by the community. The time frame covered was last 2 decades (1990-2010). The number of total respondents was 500 who were selected by random sampling method. The survey result was checked against the reports of FGDs for validation analysis.

Result And Discussion

The study reveals that the community perceptions of common risks around the year are mostly related to hydro-meteorological phenomena. The community's experience over last two decades suggests the main risks persisting are that of the shifting of period of occurrences of hydro-meteorological events over the year which are, at the same time, expanding by length. This means communities are facing variable risk events for longer and unusual time which is ultimately threatening their adaptation capacities. The concepts of risk events suggest that, most of the threats are posed by rising of temperature. For example, Fig.2 and Fig.3 shows that early season drought, mid season drought, salinity and water scarcity are affecting the livelihoods of the wetland community as the consequence of elevated temperature. Temperature was observed to rise in all seasons especially from march to September and even in winter season. Before 90s the period of March to May and the month of August was the period of early season and mid season which now has extended from March to

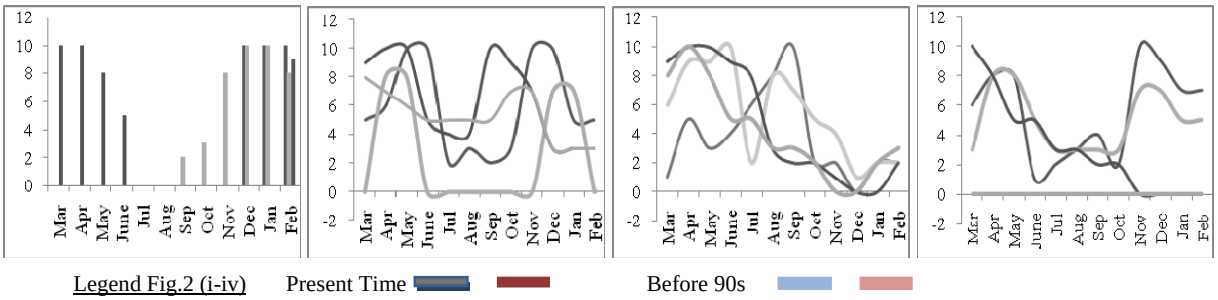

Fig 2: Seasonal Calendar and Livelihood Activities; from left i. Rainfall (Blue bars) and Temperature (Brick bars); ii. Labor Demand (Blue Bar) and Food Availability (Brick bars) iii. Fog (Blue bars) and Salinity (Brick bars iv. Hours to work (Blue bars) and Migration (Brick bars).

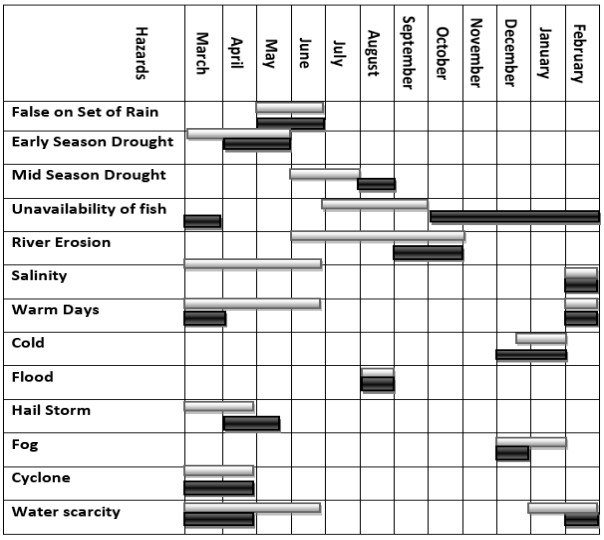

Fig 3. Seasonal Calender >Present Before 90s

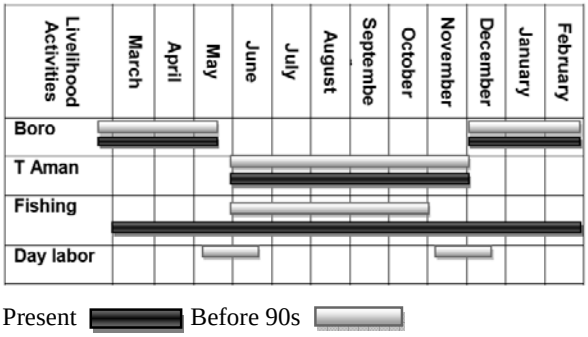

Fig 4. Seasonal Calendar and livelihood Activites

In Fig 3 & 4 March to February has been arranged sequentially as per the Bengali month. March denotes the month Chaitra and then Boishakh, Joistha, Ashar, Srabon, Vadro, Ashin, kartik, Agrahon, Poush, Magh, respectively to Falgun (February).

August.The rising of salinity has been observed to be is very much parallel to drought. Variation of temperature over time has also affected the sensitivity and production of the ecosystem of the region. The season of 'unavailability of fish' has shifted period along with drought conditions. Salinity also increases in the region with the seasonality of extension of summer heat and resulting water scarcity of the river.

The study area is consisted with several *beels* (wetlands) and the surrounded big two big rivers *chitra* and *Nabaganga*. Water availability in these determines the agriculture and, fishery i.e., the livelihood of the communities in the wetland. Salinity was rare before the 90s, which is affecting the community severely now-a-days. Communities reported that with the rise of temperature they are facing more salinity problems in the area, which are almost parallel with drought conditions and has been extended up to at least two folds over last 30 years. Severity and frequency of river erosion has also been extended. Hail storm has been observed to be increased and while severity of cyclone and flood is reported as negligible in the area. Fog has been observed to be increased (Fig 2 [iii] & Fig 3) than that of the past while the winter is shortening over time but getting warmer day by day. Seasonal rainfall has been gone under substantial changes in terms of shifting of peak season, amount of rainfall, no rainfall days etc. erratic rainfall recently. Rainfall intensity has increased (Fig 2[1]and Fig 3) but the peak rainfall season has shifted and it

is now-a-days very harmful for the agriculture. The amount of rain is increasing in summer while decreasing monsoon and the winter is getting drier. From Fig.4 it reveals that cultivation time of local varieties of rice namely *boro* and *aman*[3] has not changed. but farmers reported that their production cost have been raised substantially due to extended length of fog, unusual summer heat, irregular rainfall and extensive salinity. The length of fishing season has been shortening since the 90s. Due to water scarcity and salinity during the breeding season, fish population in the region has also declined. Table 1 indicates that livelihood activities round the year are changing in the region. Communities are increasingly depending on the non-agricultural activities like day laborer, rickshaw (manual three wheeler) pulling, small business etc. Farmers in the region reported that the production of local *aman* and *aus*[3] paddy has reduced up to 50 percent for last 5 years. Cost of chemical fertile and groundwater irrigation has increased manifolds over last 15 years where these costs were somewhat near to the zero‘ even in 90s.

Table 1: Historical trend of sources of livelihoods

Source of livelihoods	**Time land Mark**	**Time land Mark**	**Time land Mark**
	After 2000	*90s*	*Before 90s*
Paddy	+++	++++	+++++
Fish	+++	++++	++++
Gardening	+	+++	
Cattle	+++	++++	++++
Tree Product	++	+++	+++
Van/ Rickshaw Puller	++++	++	
Stationary Shop	+++	+	+
Labor	+++	+	+
Small Business	++++	++	++

From the trend of livelihood activities analysis (Table 2.) suggest the sources of livelihoods and alternative livelihoods are declining in communities while the required time to be spend against any source of livelihoods are increasing rapidly. For example, for a season of winter paddy cultivation required about 10 hours a day for the entire season now-a-days while it was less than 5 hours even in the nineties. The pattern of labour demand and seasonal migration has also changed in the region over time. In the past, ‘day labor’, as a source of livelihood was absent but now these days this is very much common because people are migrating from its traditional occupation such as fishery and agriculture because of high cost and low production. The problem matrix (Table 3) prepared by the communities suggests that climatic events such as rainfall, temperature, drought, salinity are affecting the livelihood. Also, the Table 2 of ‘Trends of livelihood’ constructed by the communities reports that, that agriculture and direct nature based sources of livelihoods are declining over time while new kind of jobs, of which most of were absent in past, like glossary shop, day labor etc are increasing. This indicates natural productivity is falling sharply responding to the environmental changes that are occurring in the region.

Table 2. Trends of Source of Livelihood Activities

Livelihood activity	**In Past**	**Present**	**Future**
House Hold as maid	rare	common	Increase
Paddy husking	common	increase	Decrease
Boiling paddy	common	Increase	Decrease
Day Labor	rare	Increase	Increase
Rickshaw puller	Common	Increase	Increase
Agriculture	Common	Increase	Decrease
Fishery	common	Decrease	Decrease
Shrimp Cultivation	rare	Increase	Increase

Table 3. Problem Matrix

Problem	**intensity x frequency**	**Score**	**Rank**
Rainfall	4 x2	8	4
Drought	5 x3	15	2
Lack of fish	4 x2	8	4
Fog	2 x2	4	5
Salinity	4 x2	8	4
Temperature	5 x5	25	1
Hail Storm	2 x2	4	5
Flood	0	0	8
Cyclone	1 x1	1	7
River Bank erosion	1 x2	2	6
Lack of Irrigation water	4 x3	12	3
Drinking water	0	0	8

(Score = $\sum$ $intensity_i$ x $frequency_i$ / N , i = 1, 2, 3,… N)

Table 3 shows that communities have identified some physical and meteorological causes behind such changes. According to the community conceived knowledge of hydro meteorological phenomena like the temperature, rainfall, lack of water etc are the main cause of local environmental problems that are affecting their livelihoods. Trends of livelihoods and climate change impact shows that dependency of the communities on paddy, fishery and livestock has been reduced with the course of time.

The problem matrix, seasonal calendar and the case studies developed by the communities suggest the climate change might have triggered the changes of livelihoods pattern in the region through the influences of the hydo-meteorological events. People are migrating into small business, stationary shops, rickshaw puller, and day labor as their alternative livelihood and the rate of these changes have gained pace in the recent years. And in such cases, local adaptation practices are almost absent in the region except applying more incentive in compensating such as rising cost of production of paddy by applying manifold chemical fertilizer and pesticide, expensive diesel driven ground water irrigation, biodiversity destroying shrimp culture etc. Table 4 states the local adaptation practice which is almost compensation based adaptation practice. Community is depended on foreign seeds instead of local variety which were almost no cost cultivation. Cultivation of local varieties like *Jute, Aman, Aus, Til*[3] in a pair was traditional pattern which is seems to be rare. Shrimp cultivation is getting popular for increasing the salinity which could alter the livelihood and act as trigger in changing the livelihood and act as trigger in changing the environment of the area and similar experience have already by the southern community of Bangladesh.

Increasing trend of temperature, erratic pattern of rainfall creating the pressure on ground water resource as

the community is depended on it. Depth of pipes in installing the tube wells is increasing (80-100ft to150-200 ft) along with use of boring is now regular to cope with water scarcity under the vulnerability of Climate Change.

Table 4: Adaptation Practice (*[3] Aus and Aman are local rice variety , Jute and Til are crop variety)*

Current Risk and Trend	Anticipated Impact	Adaptation Practice
Salinity *Trend* Increasing	Agricultural and fish production is hampering, fish eggs dying. Rice production becoming difficult. Threatening the food security.	Using more fertilizer, change of occupation, Dependency of foreign seed and foreign variety instead of local variety increased. Shrimp cultivation introducing along with cultivating only rice (IRRI) where there was tradition to cultivate *aus, aman , jute , til* [3]in a pair.
Erratic Rainfall *Trend* Increasing	Decrease in Agricultural production, specially hampering *aus* and *aman*, *til* and *jute* during the panicle and spikelet initiation time, Upper land crops is dying for lack of water, production cost increased.	Cultivating hybrid instead of local variety, Dependency on fertilizer and Boring for irrigation.
Temperature *Trend* Increasing	Weather is getting warmer and seems to be intolerable, Dependency on fertilizer and ground water instead of rain water which used to nourish the soil naturally. Aus production is becoming rare along with farmers are struggling with other local crops variety. Salinity increasing due to the warm weather which making the water to more evaporate.	Cultivating hybrid instead of local variety, Dependency on fertilizer and Boring for irrigation. Local peoples used to install tube wells in 80-100 ft depth before but now these days the depth is 150-200 ft.
Flood *Trend* Decreasing	Losing the fertility of soil for lack of sediment	Dependent on Fertilizer

CONCLUSION

The scenario is alarming because it suggests the lack of application of indigenous knowledge and local knowledge, short of local innovation initiatives, lack of adaptation capacities, absence of knowledge sharing and lack of understanding. These ultimately set these communities to severe vulnerability under the future climate change. Immediate attention, therefore, is to be put by the government on the issues and there are further researches to be undertaken to understand the nature of community adaptation and perception of climate change in the wetlands of Bangladesh if we want to stride forward to negotiate climate change in the country.

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