



# Community Vulnerability and Adaptation to the Impact of Climate Change in the Coastal Areas of Bangladesh

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## Authors' contributions

This work was carried out in collaboration between all authors. Authors KSR and MNI design the study and wrote the protocol. Authors DMNA and SBR wrote the first draft of the manuscript. Authors SBR and PKH managed the literature search and analysis of the study. Authors DMNA, KSR and MNI managed the experimental process and finalize the manuscript. All authors read and approved the final manuscript.

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## ABSTRACT

**Aims:** Inhabitants of the Sundarbans impact zone are frequently affected by natural hazards such as salinity, cyclones, tidal surge, water logging, etc. In addition, limited asset, livelihood options, low agricultural production and inadequate access to productive resources and services are increasing the vulnerability of communities in the coastal region. This paper presents the climate change trends and possible impact of climate change and climatic vulnerabilities. It also presents the adaptive capacity of the climate change affected communities of the south-western part of Bangladesh.

**Study Design:** It is a qualitative and quantitative research based on primary and secondary data.

**Place and Duration of Study:** Sutarkhali union, Dacope, Khulna, Bangladesh, between January to August 2014.

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**Methodology:** Participatory and qualitative research methods, including focus group discussion (FGD) for climate vulnerability and capacity analysis (CVCA) and the individual household survey were applied among different vulnerable livelihood groups of the study area.

**Results:** The result of the study shows that the changing pattern of climate drastically influenced the livelihood of community, natural resource degradation and increasing social inequalities. In this study, the positive role of government programs such as cash for work, test relief, vulnerable group feeding, vulnerable group development and the active role of NGOs through training on different income generating activities, cash support, commodity support, disaster related training for reducing effect of past disaster and the vulnerability of the existing climate change effect were found.

**Conclusion:** Climate change has become a supplementary burden to the community who are already vulnerable and struggling with poverty.

*Keywords: Vulnerability; capacity analysis; adaptation; livelihood and Sundarbans impact zone.*

## 1. INTRODUCTION

The scientist has used the term climate change for any changes in the climate which arises naturally or by human activities. The Intergovernmental Panel on Climate Change [1] defined climate change as “*A change in the state of the climate that can be identified by changes in the mean and / or the variability of its properties and that persists for an extended period, typically decades or longer*”. United Nations Framework Convention on Climate Change (UNFCCC) defined climate change as “*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*” [2]. Several scientific evidence was expressed in the literatures about climate change and its probable impact on global poor communities in the near future [3,4,5]. Ongoing poverty, lack of social safety nets, lack access to education and health care are the general reasons of increasing poor’s vulnerability to natural climate change [3]. Among the world countries, temperate and tropical Asian countries are likely to have more exposure to extreme natural events [1].

Regarding the climate change aspect, Bangladesh is one of the most vulnerable countries in the tropical Asia due to the fragile economy and environmental conditions while its contribution to emission is negligible. In addition, Bangladesh is at the mouth of the funnel made by the Indian Ocean and most of the natural calamities come from Indian Ocean strike directly in this country. Sapir et al. [6] reported that minimum 174 natural disasters affected Bangladesh from the year of 1974 to 2003 as a result of climate change. Moreover, the observed adverse effects of climate change, especially high temperature, extreme rainfall, river bank

erosion, sea level rise, salinity intrusion, floods, cyclones and storm surge in Bangladesh became severe in the last decade. Most of the climate change impacts, including tidal surge, tropical cyclones, monsoon rainfall, floods, salinity intrusion, riverbank erosion in Bangladesh rises from the Southern part, i.e., from the Bay of Bengal and the adjoining North Indian Ocean [6]. Its extreme, devastating impacts are faced by the people of the southwestern coastal region adjacent to Sundarbans and made the southwestern a hotspot of climate change. A vast network of river channels, enormous discharge of water, heavily laden with sediments, large number of islands between channels, shallow northern Bay of Bengal and funneling to the coastal area of Bangladesh, strong tidal and wind action is the main cause of vulnerability of coastal areas of Bangladesh [7]. Thus, natural hazards are impacted crop failure, food and livelihood insecurity, water scarcity and most of all added to income insecurity. However, the people of the coast are living in isolation and tend to political-economic marginalized more than population elsewhere [8].

The communities of southwestern Bangladesh are beyond their capacity to understand the causes of climate change. They only realize something unusual, abnormal and negative is happening as there are severe changes in the local livelihoods [9] as well as in every sector of their life. Being aware of the present and future challenges due to climate change in the socioeconomic development, local communities do not wait for external help to develop coping mechanisms for survival. These communities have lived in the same territory from generation to generation and as a result, have been able autonomously or assisted to survive and even cope with environmental changes. But many studies explore that because of the extreme

poverty the adaptive capacity of rural people of southwestern Bangladesh is decreased severely [10].

So, there is not adequate knowledge about how the climate hazards are impacting the livelihood resources, how the climate change is impacting on different livelihood groups and how the poor people of south-western region is responding to the natural hazards. The analysis of differential impacts of climate change is important for the existence of the local poor community of that region. This paper aims to answer the following questions: what is the trend of climate change, what is the impact on livelihood, who is vulnerable to impact and why, what are the existing local and institutional coping mechanisms. The materials of the study are current climate change data and interview with local people, stakeholders from the southwestern region, particularly Sutarkhali union, Dacope upazila, Khulna, Bangladesh. By examination of directional change in the current climate impact and responses and identifying the future adaptive capacity and constraints of the communities, this study distinguishes the community's ability to cope with future likely climate change impacts. Thus, the objectives of this study were to investigate the climatic hazard caused by the effect of climate change and its impact on rural livelihoods and the adaptive strategy of the local community.

## 2. RESEARCH METHODOLOGY

The qualitative research methods consisting of focus group discussion (FGD), community risk assessment and individual household survey were applied in a participatory way to satisfy the objectives of this research. Moreover, the secondary information was collected and analyzed to validate the changes. A set of questionnaire has been used to collect quantitative and qualitative data from the study area. The main target group for household survey was the vulnerable households in the study area. Vulnerable households were marked by focus group discussion (FGD) with local communities. To understand the background and context of the study area review of the secondary information is important. Secondary information on socioeconomic, geographic, weather and climatic condition were collected from different government and non-government offices, e.g. union parishad, union and upazila land office, Bangladesh Bureau of Statistics (BBS), Department of Agricultural Extension (DAE), Soil

Resources Development Institute (SRDI), Bangladesh Meteorological Department (BMD), Food and Agricultural Organization (FAO), Standing Order of Disaster (SOD) etc. This collected primary and secondary data and information used to review and analyze at the beginning and at the various stages of the study. In addition, based on the availability meteorological information on temperature and rainfall of the last 60 years was collected from the Bangladesh Meteorological Department. The meteorological data (1950-2010) was analyzed to understand the climatic variation. The objective wise research methods are discussed in the following two subsections.

### 2.1 Analysis of Climate Vulnerability and Rural Livelihood in a Participatory Way

The participatory vulnerability assessment method was applied for the climate vulnerability and rural livelihood. The assessment method was climate vulnerability and capacity analysis (CVCA) used by CARE International [11] for livelihood system assessment, vulnerable group profiling and livelihood adaptation study. CVCA is a proficient process of better understanding about implementation of climate hazards on people's livelihood; analyze the hazard and poverty of the area and interaction between them. The strength of CVCA is its simplicity of understanding and adoption by the local people. Also the community can easily triangulate and validate the visual information obtained from diagram and map [12]. The methodology comprised several participatory tools including hazard mapping, seasonal calendars, historical timeline of livelihood activities, vulnerability matrix and stakeholder analysis.

### 2.2 Analysis and Understanding of the Adaptation Practices to Reduce Vulnerabilities

Total seven FGD was conducted with local people in the study area. First one was with all classes of people to identify the professional groups and other 6 were with six different professional groups (*Mowali*, *golpata* collector, crab collector, farmer, fisherman and vulnerable women) to understand the vulnerabilities and adaptation practices of the community. Also, through the FGDs, identification of the climatic hazards and ranking, vulnerable livelihood group, vulnerable places were done in the study area, i.e., the Sutarkhali union of Dacope upazila under

Khulna district. Hazard calendar explaining the month wise intensity of hazards and livelihood calendar were also prepared for the study area. Moreover, the sector wise vulnerability was measured by FGD.

To understand the adaptation practices, a survey was conducted with the 70 individual households within the communities which were farmers, fishermen, mowalies and golpata collectors. The major criteria considered for the household survey were adaptation practices including cropping pattern, home state gardening, livestock rearing, early warning response, the role of different social organizations and support received from different NGOs and government programs for reducing vulnerabilities.

### 3. RESULTS AND DISCUSSION

#### 3.1 Climate Change Trend in Bangladesh

Climate change has added new dimensions to risk and vulnerabilities associate to the communities regarding the natural hazards, especially in the coastal region. The coastal area of Bangladesh is about 710 km long and extends along the Bay of Bengal. It is divided into three sub regions named western (Khulna, Pirojpur and Patuakhali), central (Barishal, Borguna and Nohakhali) and eastern (Chittagong) region. Combination of frequent natural hazards and high vulnerability may result from the expected climate change impacts like increasing the temperature and sea level rise; bear the risk of inundation of the major part of the land mass

along the coastline of Bangladesh. Moreover, due to the climate change the frequency of natural hazards such as storms, high rainfall, floods, droughts, salinity, soil degradation and river bank erosion increased in the last 30 years. These natural hazards become a direct threat to the livelihoods, lives and properties of coastal communities [13].

#### 3.2 Temperature and Rainfall Trends

##### 3.2.1 Increasing temperature

From the meteorological information, the temperature records for last 60 years (1950-2010) available from the Bangladesh Meteorological Department showed mean maximum and mean minimum temperature had increased to a rate of 1.03°C per 100 years. The average temperature shows an increasing trend and the data are highly inconsistent. It is also become evident that the rate of change has more accelerated in the last 30 years. Annual mean maximum and minimum temperature showed in Figs. 1 and 2 respectively, which describe a positive increase with a rate of 2.05°C, 1.2°C and 1.64°C per 100 years. It has clearly found that maximum temperature has been increased dramatically over the last 30 year period. These statistical changes have been shared with local communities during the focus group discussion. From the discussion it has been identified that the elevation of temperature has a clear impact on decreasing of irrigation and drinking water sources.

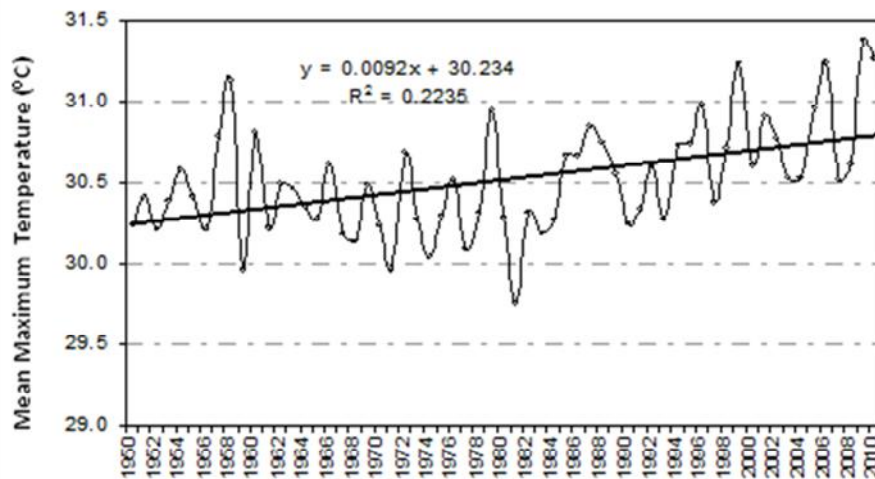
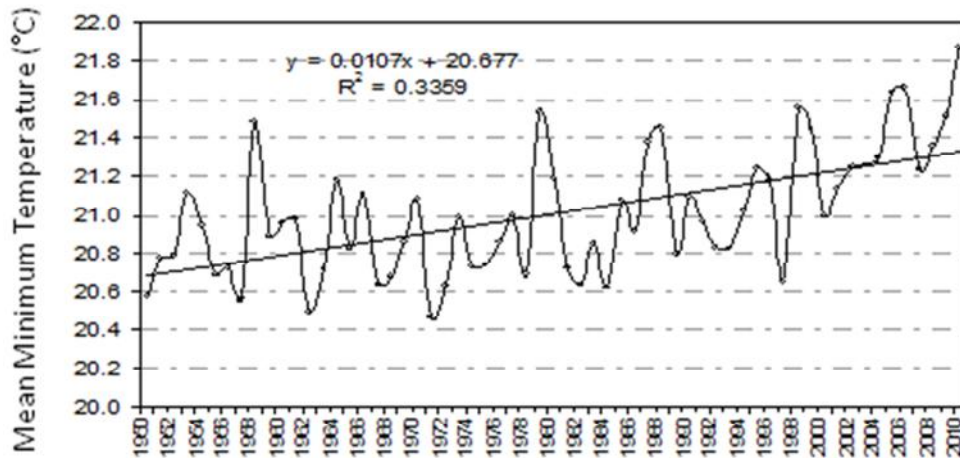


Fig. 1. Variation of annual mean maximum temperature of Bangladesh during 1950-2010  
Data source: Bangladesh metrological department

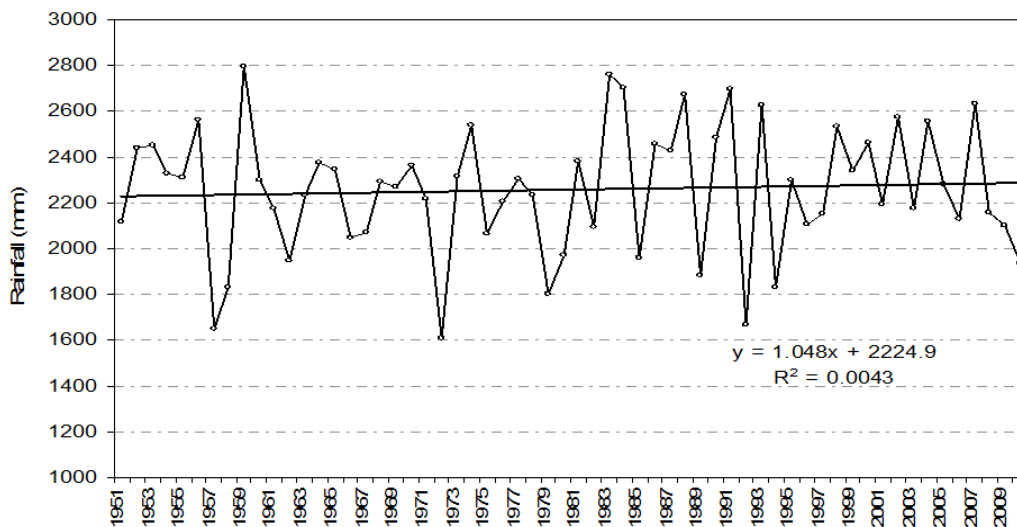
**3.2.2 Irregular and low precipitation**

Variation of precipitation pattern has noticeably changed over the last 60 years (Figs. 3, 4 and 5). Fig. 3 showed that the mean annual rainfall was decreasing from last several years. Also Fig. 4 indicating increasing trend of rainfall during pre-monsoon season but Fig. 5 Indicating decreasing trend of rainfall during monsoon. According to the collected information from Bangladesh Metrological Department (BMD), heavy rainfall frequency during pre-monsoon season have increased in March (+0.0048 mm/year) and April (+0.0061 mm/year) but significant increasing trend (0.0258 mm/year) is observed in May. Heavy rainfall during pre-monsoon season has

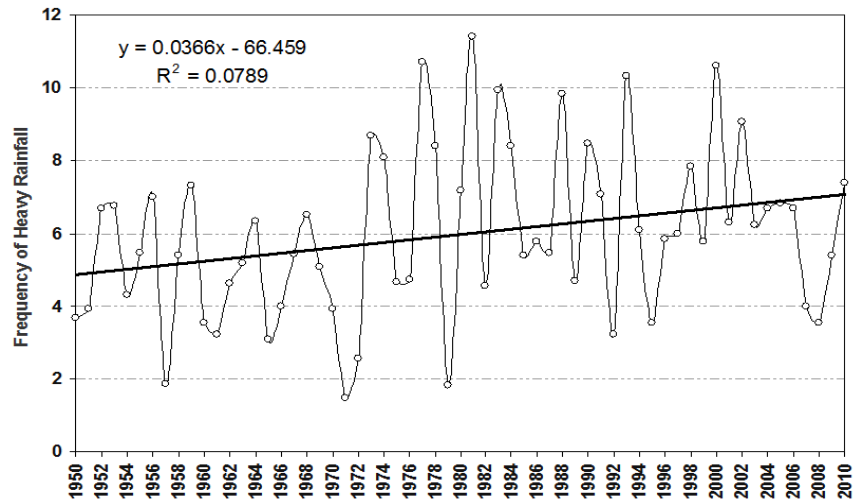
increased the trend (+0.0258 mm/year). On the other hand, during the monsoon frequency of heavy rainfall increasing in June (+0.0006 mm/year), July (+0.0161/year) and September (+0.0081 mm/year) but decreasing in August (-0.0025 mm/year). Heavy rainfall during monsoon season shows increased trend (+0.0053 mm/year). These evidences are expressing the extreme weather change of the coastal region. The rainfall pattern during the agricultural period was also shared with local people during FGD and they identify the inconsistency of rainfall pattern and existence of extreme weather adversely affects the livelihood of coastal people.



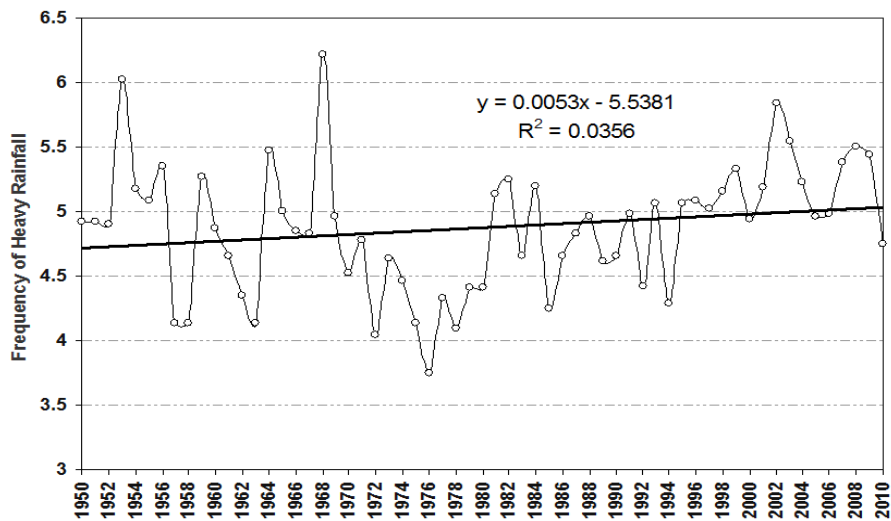
**Fig. 2. Variation of annual mean minimum temperature of Bangladesh during 1950-2010**  
Data source: Bangladesh metrological department



**Fig. 3. Average rainfall of Bangladesh during last 60 years (1950-2010)**  
Data source: Bangladesh metrological department



**Fig. 4. Variation of heavy rainfall of Bangladesh during pre- monsoon (1950-2010)**  
 Data source: Bangladesh metrological department



**Fig. 5. Variation of heavy rainfall of Bangladesh during monsoon (1950-2010)**  
 Data source: Bangladesh metrological department

### 3.3 Major Hazards Associated to Livelihood Resources

A vulnerability table was prepared as part of the CVC analysis of the study area (Table 1). Considering the accelerating intensity and frequency, the community identified the salinity, cyclone, riverbank erosion, storm surge, heavy rainfall, water logging and drought as major hazards of the study area. Agriculture, fisheries, livestock rearing, forestry and non timber forest products (NTFPs) collection were prioritized as major livelihood resources. Considering the significant effect on the livelihood resources each hazard was scored against livelihood resources.

Community people estimated that the agricultural sector was at risk and in the near future will be threatened by almost all major risks like salinity, cyclones, floods and storm surges. Other sectors like fisheries will also continue to be affected severely by various risks like cyclone, storm surge, excess rainfall, etc., which lead to wash out the fishponds and sanctuaries and to an increase in disease infestation and, resulting in decreased fish production. Most of the risks and their increased trend were thought to render livestock in fodder crises, disease infestation and more death in near future. Among other risks, flood and cyclone were considered most critical for the loss of the livestock. In the study area,

nursery seedling and saplings were estimated to be affected by the current risks threatening to damage the whole nursery enterprise in the area. The communities also thought that the salinity, both in soil and water will continue to increase in the coming years and will have a profound impact on not only agriculture and fishery but also the livelihood of the different Sundarbans dependent communities living around the Sundarbans.

### 3.4 Hazards Classification and Ranking

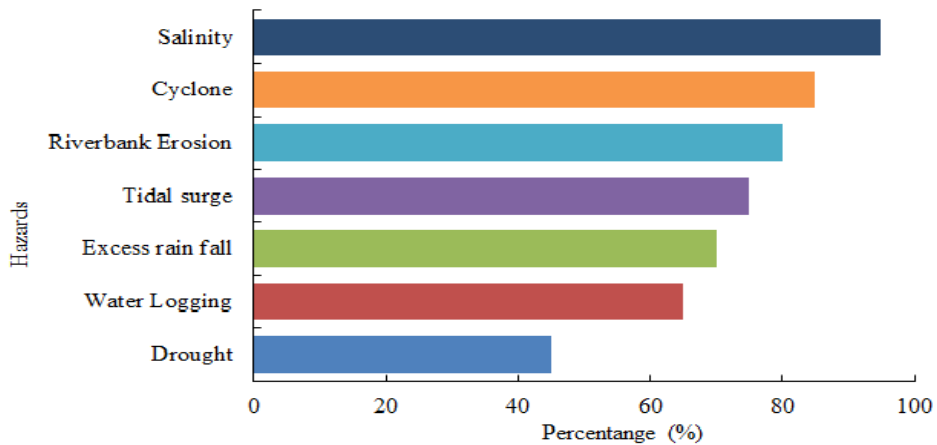
Hazard is an event or incident that has potentiality to damage. The communities in the study area are suffering from adverse impacts of climatic incidents or more specifically natural hazards. These hazards affect the communities in many ways, including the livelihood, assets, crops, etc. The local hazards in the study area were identified through using focus group

discussion, mapping and calendar as tools. Finally, the hazards were ranked by the participants, based on the frequency, intensity and severity through percentages of responses from FGD participants (Fig. 6). There were some differences in responses among the participants regarding the frequency, intensity and severity of the hazards, particularly among the different livelihood groups. However, salinity was ranked as top of hazard list as 94% of the respondents ranked it number one hazard for this area, causing huge damage to the crops, soil, water and the entire environment of the area. Along with salinity, the other major hazards were identified according to the respondent perception, including cyclone and riverbank erosion, tidal surge, excess rainfall, water logging and droughts. As the study area was within the Sundarbans impact zone, sometimes forest dependent community thinks that tiger attack within and outside the forest is a hazard.

**Table 1. Hazards and the impact on various sectors**

Hazards	Vulnerable sector						
	Agriculture/crop production	Fisheries	Livestock rearing	Forestry	Mowals	Goalpata collector.	Vulnerable women
Salinity	√	√	√	√	x	x	√
Cyclone	√	√	√	√	√	√	√
Riverbank Erosion	√	√	√	√	x	√	√
Storm Surge	√	√	√	√	√	√	√
Excessive rainfall	√	√	√	x	√	x	√
Water logging	√	x	√	√	x	√	√
Drought	√	√	√	√	x	x	x

Source: Field survey in the study site, 2014



**Fig. 6. Hazards based on their frequency, intensity and severity**

Source: Field survey 2014



### 3.5 Frequency and Intensity of the Risks

From Table 2, different types of natural risks affect the study area at different times of the year. The severity of most of these risks varies by season. The hazard calendar shows the seasonality of the main hazards in the study area. It has prepared based on bangle months because community people traditionally count Bengali month in relation to hazards and their regular activities.

### 3.6 Resource Degradation

FGD and hazard map was indicated increasing rate of salinity which cause decreasing of drinking and irrigation water source. Communities claimed that during the dry season the salinity of water, especially that of river, canal and ponds increase. It was also claimed that the increasing salinity affected the trees of Sundarbans and collection of non-timber forest products (NTFPs). Among all other hazards cyclone does severe resource destruction in a short time during summer, pre monsoon and monsoon period. River bank erosion also caused severe infrastructure destruction. Another strong reason of resource destruction was excess rainfall and water logging. The Sundarbans dependent communities claimed that the major sources of income were decreasing every year proportionally with resource degradation.

### 3.7 A Variability of Vulnerability Based on Assets

During preparation of hazard map, the area was identified through people's perception which was vulnerable to different natural hazards such as salinity, drought, riverbank erosion, water logging and cyclone, affected areas and vulnerable households. From the individual household survey it was find that the poor households remain unproductive throughout the year due to water logging and salinity. Also the poorest households reported no access to formal financial institution due to lack of security. The climate vulnerability was measured according to social dignity, such as rural agriculture and land ownership. Similarly households, with better education and financial assets had more capacity to reduce vulnerabilities. In the southwestern region of Bangladesh almost all livelihood groups including fishermen, farmers, golpata and honey collector etc. were affected by different types of natural hazards. The vulnerability of these livelihood groups associate to different risks depended on various physical and socioeconomic factors including vulnerable physical assets i.e., cultivable land, irrigation facilities, agriculture/ fishing equipment, livestock, housing conditions, orchard/ homestead garden etc. and vulnerable human resources i.e., literacy, education, knowledge and skills, availability of health facilities, overall health of the family etc.

**Table 2. Hazard calendar according to intensity of hazards**

Hazards	Baishakh (Apr-May)	Jaista (May-June)	Ashar (June-July)	Srabon (July-Aug)	Vadra (Aug-Sep)	Ashwin (Sep-Oct)	Kartick (Oct-Nov)	Agrahayan (Nov-Dec)	Poush (Dec-Jan)	Magh (Jan-Feb)	Falgun (Feb-Mar)	Chaitra (Mar-Apr)
Salinity	H	H	M	L	N	N	N	N	L	L	M	H
Cyclone	H	H	M	M	N	H	H	N	N	N	L	M
Riverbank erosion	L	L	H	H	H	M	M	L	L	L	L	L
Tidal surge	H	H	H	H	H	M	M	N	N	N	N	L
Excess rainfall	N	N	H	H	H	M	L	N	N	N	N	N
Water logging	N	N	H	H	H	H	H	M	N	N	N	N
Drought	H	H	N	N	N	N	N	H	H	H	H	H

Source: Field survey, 2014

Where, H-High effect, L-Low effect, M-Medium effect, N-No effects



### **3.8 Vulnerability of Different Livelihood Groups**

#### **3.8.1 Vulnerability of fisherman**

Fisherman community was the majority livelihood group in the study area. The result of climate change and their impact mainly increased the salinity, scarcity of fish, tidal surge, siltation, flood and inundation as well water pollution was negatively affected the livelihood sector. Increasing salinity and lack of fresh water in pond and canals fresh water fish were disappearing. As a result the income became decreased of this livelihood group. In addition, regular cyclones and tidal surges decreased the fish resources and species.

#### **3.8.2 Vulnerability of farmers**

According to the focus group discussion, agricultural sector was highly vulnerable due to the climate change. Yield of most of the crops was negatively impacted by a rise in temperature, erratic rainfall, flooding, droughts, salinity, etc. The current trend showed a drier region become drier in winter season and the yield of crops might drastically reduce up to 50%. As a result, farmers become more vulnerable to the changing climate in the study area. The farmers become laborers or to migrate to urban areas. Many farmers initiated shrimp cultivation on their lands instead of rice cultivation due to salinity and flooding.

#### **3.8.3 Vulnerability of honey collector (Mowals)**

The *Mowals* are one of the indigenous communities who depend on Sundarbans fully for their livelihood. Poverty and uncertainty is everywhere in the mowal's community. Therefore, throughout the year mowals are going to the Sundarbans to collect honey, catching fish and crabs, collect leaves and others available resources. Only around three months of the year this *mowal* groups remains busy in honey collection and rest of the year doing other informal work. Natural hazards including cyclones, flood, and tidal surge are very common almost every year in the Sundarbans impact zone which reduces the availability of the resources. As a result, the communities like *Mowals* who are totally dependent on Sundarbans suffer severely. In the previous years, due to the disasters number of trees uprooted and damaged, and a number of

animals and insects died. All these facts negatively affect the livelihood of mowals community.

#### **3.8.4 Gender vulnerability**

Although climatic risks are affecting both male and female populations in the study area, women are facing more severe problems due to a number of reasons. In Bangladesh, especially in the coastal area women are generally more vulnerable than men to all kinds of climate change impacts due to gender inequalities in various social, economic and political institutions. In addition, the social customs prevailing in the region have further increased their vulnerability.

### **3.9 Adaptive Capacity**

#### **3.9.1 Adaptation and adaptive capacity**

Coastal communities have been found resourceful in adaptation to climate change, but a wealthy community is more resistant than others and has the capacity to take advantage of change and stressful condition. On the other hand small landowner and other poor and disadvantage groups have limited capacity to adopt with water logging condition, salinity and other natural disasters due to lack of land ownership, insufficient capital etc. As a result the poorest part of the community has to adopt alternate livelihood strategies to cope with the existing climate change impacts. These strategies were mainly reactive and autonomous, mostly short-term tactical and were largely undertaken by individual or household level. Some people depend on loan in the form of money or food, others sell their land, livestock or other assets to adopt the measures. The coastal communities are feeling about the long term and sustainable adaptive measures to cope with the climate change impacts.

#### **3.9.2 Adaptation to future climate change**

Adaptation to climate change is necessary for the coastal communities as it is affecting the existence of human being. But beyond the predictability of changes in climate, planning for promoting adaptation is necessary due to four additional reasons, including (i) increasing knowledge about the future impact of climate change [1] (ii) existing experience of historical forms of adaptation [14] (iii) ecological effects of unplanned adaptation [15] and (iv) potentially greater costs of adaptation especially for the poor population.

For the effective risk reduction and promotion of culture of climate resilience the key step is the ability to measure vulnerability. Measuring vulnerability has become a crucial task with the increasing frequency of natural hazards and counting environmental degradation [16]. Adaptive capacity, in turn, relates to the preconditions that enable actions and adjustments in response to change [17]. The elements that increase the adaptive capacity of socio-ecological systems include traditional knowledge and institutions that store collective memory and promote social cohesion within communities [18]. From previous research, disturbance is considered as systematic dimension of environment to which communities have historically established adaptive capacities by enforcing locally developed practices to cope with frequent shocks [19].

Over time resilience socio-ecological system is able to adapt to climate change and reform society after disturbance by maintaining the ecological structure and function and related ecosystem services [20]. When resilience is lost due to cumulative change or unexpected shocks, socio-ecological systems can reach critical thresholds, resulting in loss of ecosystem-services, social crisis and collapse [19].

### **3.9.3 Adaptation measure adopted by the community**

During the dry season, the salinity of the water increases and then only different variety of *robi* crops are cultivated by the community. According to survey about 7% farmers of the study area cultivating saline tolerant and high yielding rice i.e., BRRI 47 for coping with salinity during *robi* season. As a coping mechanism around 71% people of the study area practices homestead gardening for nutritional value, utilization of fallow land and economic values. Moreover, through these practices generating additional income for the households by selling the surplus quantity of vegetables. Thus, raises savings of the households which may help the household during disaster period or any emergency needs.

About 65% people of the study area rear different livestock's specially cow, goat, hen, duck and poultry. Vulnerable women's mainly practice duck and hen in very small quantity. After meeting the demands of the household, it also generates additional income for the households by selling the products. Sometimes the poor people migrate to divisional cities of Bangladesh

and also to India as different types of occupation including daily labour may be available for managing the livelihood. It was also observed that few people had migrated in recent years with entire family.

Peoples from the different portion of the community lives in different types of house. Most of the houses are *kaccha* i.e. made of *golpata* with mud walls and very little amount of house is semi *pacca* i.e., made of brick wall and tin shed. Mainly the community around the Sundarbans depends on the resources of Sundarbans for house construction, especially *golpata* for shed, different timbers like *Sundari*, *Bine*, *keora* as pole and beam of the houses. Therefore, most of the houses are vulnerable to different natural calamities like cyclone, storm, tidal surge, heavy rain, etc. In the year of 2007 during the cyclone *Aila*, almost 95% of the households are destroyed. But currently the communities in the study area are more conscious the house construction. The people who have some ability try to construct brick house with tin sheds and others uses silver cable or roof to tighten the house, shed and pillars as adaptation measure to the disaster period. Moreover, to avoid inundation during tidal surge community people raised the basement or plinth of houses.

### **3.9.4 Role of social organizations and government**

Bangladesh government's different department and different national, international and local NGOs are playing a vital role in awareness rising in the field of climate change adaptation in collaboration with different international donor agencies with the help of the local government. The government launched some programs, including vulnerable group feeding (VGF), vulnerable group development (VGD), Test relief (TR), Food for work, old age allowance, allowance for widow, 100, 60 and 40 days employment generation for the poorer to reduce the effects of natural hazards. . NGOs are also contributing in cooperation with the district, upazila and Union Disaster Management Committee for promoting disaster resilience in the coastal communities. NGOs are mobilizing communities for taking appropriate preparedness measures and also providing support in capacity building through meetings, awareness campaign, training to the volunteers of cyclone preparedness programs and early warning materials. Some NGOs formed community based organization (CBO), self help group (SHG) etc.

for different income generating activities and also provided cash and asset support to cope with natural calamities and hazards. Different NGOs and some government divisions like agriculture, livestock, fishery, forestry and youth development department, provided different necessary training on saline and flood tolerant rice varieties, high yielding crop production, crab fattening, duck and poultry rearing, fish cultivation, goat, cow and pig rearing, homestead gardening and different non-agricultural income generating activities such as tailoring, handicrafts, small scale enterprise development etc. to the different livelihood groups to improve their life skill and knowledge.

#### **4. CONCLUSION AND RECOMMENDATIONS**

The objectives of the study were to understand the trend of climate change, their effect on people's livelihood, people's vulnerability towards climate change and their adaptation. From the study it was concluded that the study area was extremely vulnerable due to climatic hazards. Former experience of respondents and meteorological data analysis revealed that climatic hazards negatively affected the livelihood and available resources of the community. The people of study area became more vulnerable to climatic hazards due to geographical location, limited livelihood options, poor asset base, limited access to services, and lack of knowledge about the available technology. However, people stand back and appear to be struggling to adapt with and sustain. Therefore, following specific conclusions can be drawn from the above presented results and discussion:

1. Different natural hazards in the study area were identified and their negative effects on different sectors like agriculture, fisheries, education, livestock, forestry, infrastructure and health were evaluated through focus group discussion and meteorological data analysis.
2. Hazard calendar and natural hazards ranking were done through Focus group discussion and meteorological data analysis where salinity proved to be more hazardous and ranked top followed by cyclone, riverbank erosion, tidal surge, heavy rainfall, water logging and drought.
3. Opinion from respondents and meteorological historical data it was clear that different climatic hazards strike the

poor people's livelihood and degrade resources i.e. large fisherman community faces acute declination of fresh water fish, farmers face a reduction of crops, disasters causing threat to mowals, women became more vulnerable for social inequalities.

4. With limited capacity peoples in the study area struggling with adverse weather, limited asset, poor livelihood opportunities, low agricultural production. Common practices for adaptation of community people were diversified crop selection, especially saline and flood tolerant crops, homestead gardening, livestock rearing, raising basement of the houses, etc. Further research is needed in this area about suitable crop diversification and nature resource consumption to understand and adopt better technology, methods and services.
5. According to this study the recommendation for adaptation of community people are: involvement of vulnerable community in different government scheme like vulnerable group feeding, vulnerable group development, cash for work, etc. Also Access to small loan, introduction of modern technology and saline tolerant crops is needed to ensure livelihood security.

Finally, raising consciousness of the communities about the rights, ensure ownership, access and control over assets such as forest, land and river by training and awareness based programs through different government institutions and NGOs would be appear effective adaptation measures for vulnerable communities.

#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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