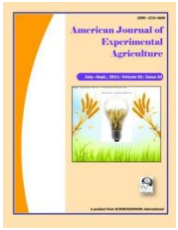

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# Impact of Climate Change on Food Security in South-West Coastal Region of Bangladesh

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors MAR and AA designed the study, performed the statistical analysis, wrote the protocol, and prepared the first draft of the manuscript in collaboration with author MAF. The mastermind behind all the statistical analyses and literature searches was author MLH. All authors read and approved the final manuscript.*

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## ABSTRACT

The study was carried out during March to April 2010 to identify the impacts of climate change on food security in context of southwest coastal region of Bangladesh and to

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address appropriate strategies to overcome it. Multistage sampling technique was adopted to select the households. Four villages of 3 unions of Dacope upazila were selected purposively from 9 upazilas of Khulna district. Twenty households were taken from each selected village. The heads of households were taken as the respondents to carry out the survey. Collected data were analyzed to identify percentage, mean, standard deviation, standard error of mean using statistical software SPSS 16. The study demonstrated the sources of income in two time periods: 2010 and 2003. In 2003, 62.5% of the respondents were engaged in agriculture, followed by 22.5% in fisheries, and 5% in small business. There happened a drastic change in income sources due to compulsion by climate change. In 2010, share of agriculture was drastically declined to 47%, whereas, fisheries increased to 27% and similarly, share of small business and day laborer increased to 7% and 5% respectively. Study revealed that cyclone resulting 89% respondents to shortage of drinking water, followed by 75%, 65%, 50%, and 42% to food shortage, property loss, homeless, and decreased production respectively. Most of the respondents were unable to fulfill their daily needs as there was a gulf of differences between the income and expenditure of the people of the study area reflecting the extent of misery of coastal lives. Alternative livelihood adaptation practices such as cultivation of vegetables on floating bed, multi cropping, salt tolerant crop or cultivation of beans, gourds and other vegetables on embankment's surrounding should be adapted.

*Keywords: Adaptation; Bangladesh; climate change; food security; impact.*

## ABBREVIATIONS

*AR4- Fourth Assessment Report; BDT- Bangladeshi Taka; GDP- Gross Domestic Product; IPCC- Intergovernmental Panel on Climate Change; LDC- Least Developing Country; SD- Standard Deviation; SPSS- Statistical Package for Social Science; UNDP- United Nations Development Programme.*

## 1. INTRODUCTION

Global warming and climate change are unequivocal and agreed by all scientists around the world. Observing the global average air and ocean temperatures, physical and biological systems scientists agree that the world climate is gradually changing day by day [1]. Experts and officials from across the world collectively endorsed the latest findings of the Inter-Governmental Panel on Climate Change (IPCC) through its fourth Assessment Report (AR4) that the average temperature might increase up to about 5.5 degree Celsius with respect to current mean values by 2100 in Asia [2]. Bangladesh, a South Asian Least Developing Country (LDC), has recently been reported as in the worst position of long-term climate risk [3]. The geographical location and geo-morphological condition made Bangladesh one of the most vulnerable to climate change [4]. United Nations Development Programme (UNDP) has identified Bangladesh to be the most vulnerable country in terms of cyclone and the sixth most vulnerable country in terms of floods [5]. The intensity of vulnerability is further enhanced by climate change. A number of major studies in the past investigated the causes of vulnerability of Bangladesh due to climate change [6,7]. Historically, the country has been subjected to a variety of water-related hazards, mostly in the forms of flood, cyclone, storms surge, river bank erosion, drought, and salinity intrusion [8,9]. A large number of recent analyses suggest that such hydrological hazardous events are likely to be aggravated due to climate change [6,10,11]. Agriculture is important for food security in two ways: it produces the food people eat; and (perhaps even more important) it provides the primary source of livelihood for 36

percent of the world's total workforce. In the heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50 percent, and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture [12]. If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased. Ensuring food security has been one of the major goals of Bangladesh since its independence in 1971 when most of the people were living under the poverty line [13]. Scientists throughout the world are paying much effort to explore the relationship between irreversible climate change and its impact on food production and therefore, food security. However, with improvement of calculation models they have found tacit relationship between climate change and food security. The unprecedented impacts of climate change along with other environmental and geomorphologic changes make more concerns over food security especially, for the poor and marginal population [14,15,16]. In Bangladesh, the major impacts of the climatic issues are the hotter summer, irregular monsoon with untimely rainfall, increased river flow with inundation during monsoon, heavy rainfall over short period causing water logging, increased frequency, intensity & recurrence of flood, very scarce rainfall in dry period, drought in summer, very short acute cold spell and salinity intrusion along the coastal region all of which cause agricultural production to a significant extent. The occurrence of SIDR on 15 November 2007 and AILA on 25 May 2009 are the recent cyclonic catastrophes which have permanently altered the agricultural production to downward trend in the southern region of Bangladesh as a result of climate change. Thus, crop production in Bangladesh seems to be vulnerable under climate change scenarios resulting the country's food security at risk. Bangladesh has an area of 14.43 million hectares (ha) of land of which 3.75 million ha (26%) covers housing, water bodies, roads etc and forest covers 2.25 million ha (15.6%). Agriculture remains the most important sector of Bangladeshi economy, contributing 19.6% to the national GDP and providing employment for 66% of the population [17]. Southwest coastal region has shaken by the recent devastated cyclone SIDR and AILA, which affected millions of people, and destroyed their land, house and ways of living. Besides, see level rise flooded many areas by saline water which is the obstacle to crop production. This paper examines the climate change and its impacts on food security in context of southwest coastal region of Bangladesh. It intends to identify the impacts of climate change on food security in particular and to address appropriate strategies to overcome it.

## 2. METHODOLOGY

The study was conducted in 2010 based on questionnaire, in which people were asked about status of 2010 and 2003 to compare the positive or negative change in society, income, expenditure, education, food production and so on. A multistage sampling technique was used to identify the households. Firstly, Dacope upazila (sub-district) was selected purposively from 9 upazilas of Khulna district (Fig. 1). Three unions (unit of upazila) (Bajua, Kamarkhola, and Saherabad) out of 9 were taken purposively. Four villages (Chunkuri, Kamarkhola, Jaliakhali and Poddarganj) from 3 unions were identified deliberately to carry out the survey. Eighty households (20 from each village) were selected who were the victims of climate change and recent disasters. The heads of households were taken as the respondents. An interview schedule containing both closed and open-ended questions was used to collect data from the respondents. The schedule was pre-tested; necessary correction and modification were made before it was run for final data collection. Data were collected through face-to-face interview during March to April 2010. Collected data have been analyzed to identify percentage, mean, standard deviation, and standard error of mean using statistical software SPSS 16.

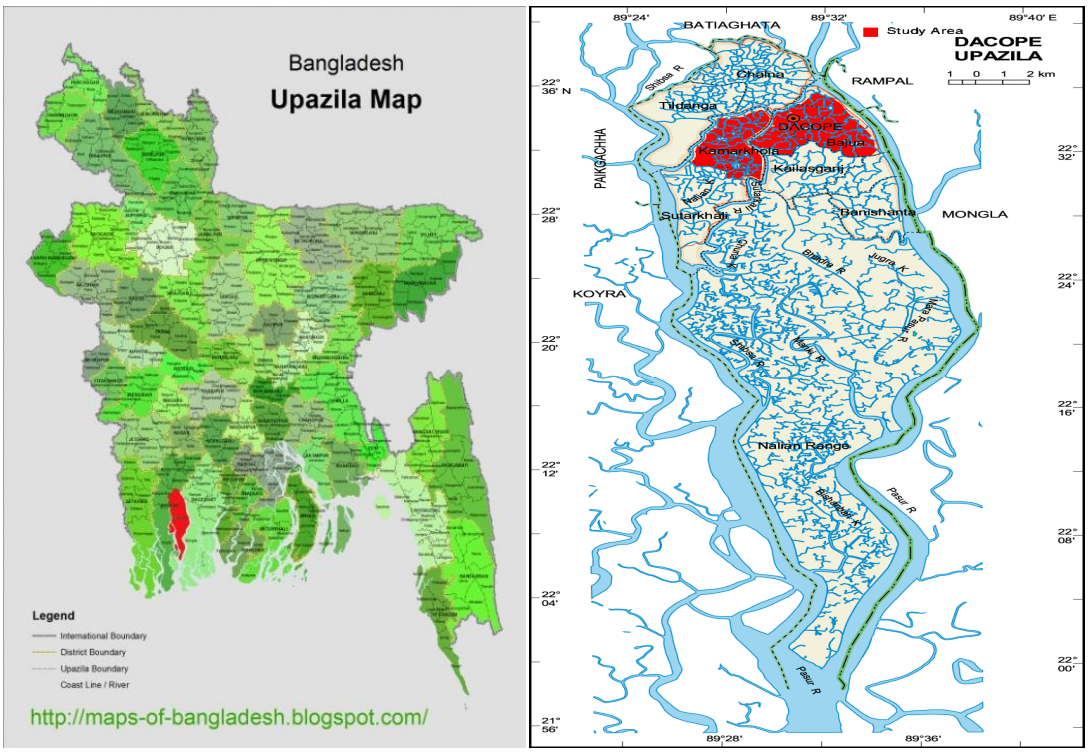


**Fig. 1. Study area map (Red marked portion is the study area)**

## 3. RESULTS AND DISCUSSION

### 3.1 Socioeconomic Chrematistics of the Climate Victims

Characteristics of individuals largely influence their behaviors. The characteristics investigated include age, education, occupational status, income, and expenditure.

Age Distribution: Most of the respondents (37.5%) belonged to 46 to 60 years age group, 30% belonged to 31 to 45 years age group, while, 20% had the age between 15 to 30 years and only 12.5% were found above 60 years (Table 1).

Educational Status: Educational status is one of the most important indicators of social development and standard of living. Fifty (50) percent of the respondents were found illiterate, 30% had only primary education, while 12.5% and 7.5% had secondary and tertiary education respectively (Table 1). Thus, the people of this region are having lower literacy rate than national average of 55%.

Occupational Status: Occupation is one of the important means to earn living. Most of the respondents directly or indirectly rely upon agriculture and fisheries. Fifty (50) percent of the respondents were involved in agriculture, 20% in shrimp farming. Besides, 12.5% of the respondents were found with business, 7.5% day laborer, 10% various services like teaching, NGOs and other professions (Table 1).

Income status: Most of the respondents fall under low income group with little income per month. Study reveals that 37.5% had income below BDT 1500; followed by 30% BDT 1500 to 2000, 17.5% BDT 2000-3000, and only 15% had monthly income above BDT 3000 (Table 1).

Expenditure status: Expenditure is the most important and logistic indicator to show the dynamics of food security. The people of the study area do not fulfill their livelihood due to high expenditure and low income. It was evident that the most of the families (47.5%) possessed expenditure range between BDT 2001 to 3000 and followed by 15% respondents whose family expenditure lies between BDT 1001-2000 and BDT 4001-5000. Very few respondents (7.5%) are in income range above BDT 5000. Thus, there is a gulf of differences between the income and expenditure of the people of the study area reflecting the extent of misery of coastal lives (Table 1).

**Table 1. Socioeconomic Chrematistics of the Climate Victims**

| Characteristics | Categories (Score) | Distribution of respondents | | | |
|---|---|---|---|---|---|
| | | Number | (%) | Mean | SD |
| Age (Year) | Young (15-30) | 16 | 20.00 | 43.18 | 12.25 |
| | Mid age (31-45) | 24 | 30.00 | | |
| | Old (46-60) | 30 | 37.50 | | |
| | Above 60 | 10 | 12.50 | | |
| Educational status | Illiterate | 40 | 50.00 | 0.78 | 0.94 |
| | Primary Education | 24 | 30.00 | | |
| | Secondary | 10 | 12.50 | | |
| | Above | 6 | 7.50 | | |
| Occupational status | Farmer | 40 | 50.00 | - | - |
| | Shrimp farming | 16 | 20.00 | | |
| | Small business | 10 | 12.50 | | |
| | Day laborer | 6 | 7.50 | | |
| | Others | 8 | 10.00 | | |
| Income (BDT/month) | < 1500 | 30 | 37.50 | 1705.00 | 886.63 |
| | 1501-2000 | 24 | 30.00 | | |
| | 2001-3000 | 14 | 17.50 | | |
| | 3000 above | 12 | 15.00 | | |
| Expenditure (BDT/month) | 0-1000 | 2 | 2.50 | 2995.00 | 1136.78 |
| | 1001-2000 | 12 | 15.00 | | |
| | 2001-3000 | 38 | 47.50 | | |
| | 3001-4000 | 10 | 12.50 | | |
| | 4001-5000 | 12 | 15.00 | | |
| | above 5000 | 6 | 7.50 | | |

*Source: Field Survey, March 2010*

## 3.2 Dynamics of Income Source

Dynamics of income source indicates the lives and food security in coastal area. In 2003, most of the people were well-off and their main earning sources were agriculture and fisheries. Recent AILA and SIDR devastated their crop land, fishing gher, so many people are compelled to change their earning sources. Table 2 shows the dynamics of income sources of respondents. It demonstrates the sources of income in two time periods: 2010 and 2003. In 2003, 62.5% of the respondents were engaged in agriculture, while 22.5% in fisheries, and

5% in small business. There happened a drastic revision in income sources due to compulsion by climate change. SIDR and AILA significantly caused change in income sources. Due to disasters many agricultural land have become unusable due to salinity intrusion, and people are compelled to go for shrimp farming on those land. Besides, many people having no options opted for small business and day laborer. Thus, in 2010 share of agriculture has drastically declined to 47%, that of fisheries has increased to 27% and similarly the share of small business and day laborer have increased to 7% and 5 % respectively (Table 2).

**Table 2. Dynamics of sources of income**

| Source of income | | | | | |
|---|---|---|---|---|---|
| **In 2010** | **Respondent** | | **In 2003** | **Respondent** | |
| | **Number** | **%** | | **Number** | **%** |
| Agriculture | 38 | 47.00 | Agriculture | 50 | 62.50 |
| Fisheries | 22 | 27.00 | Fisheries | 18 | 22.50 |
| Small business | 6 | 7.00 | Small business | 4 | 5.00 |
| Day laborer | 6 | 7.00 | Day laborer | 4 | 5.00 |
| Sundarbans | 4 | 5.00 | Sundarbans | 2 | 2.50 |
| Others | 4 | 5.00 | Others | 2 | 2.50 |
| Total | 80 | 100.00 | | 80 | 100.00 |

*Source: Field Survey, March 2010*

## 3.3 Daily Menu of Food Items

Food is main basic need of human being. As the inhabitants in coastal region are mostly poor, the food items taken by them are not rich enough. They can't fulfill their minimum food requirements for human body. Table 3 reveals the food items of different categories taken by the costal people. All respondents consume rice, 75% take vegetable and fish, 37.5% consumes wheat, 25% take milk, and very few respondents can afford meat and fruit in their regular food menu.

**Table 3. Daily Food Items of the Respondents**

| **Menu of food** | **Respondents** | |
|---|---|---|
| | **Number** | **%** |
| Rice | 80 | 100.00 |
| Wheat | 30 | 37.50 |
| Fish | 60 | 75.00 |
| Milk | 20 | 25.00 |
| Meat | 4 | 5.00 |
| Vegetable | 60 | 75.00 |
| Fruits | 6 | 8.00 |

*Source: Field Survey, March 2010 (Multiple Response)*

## 3.4 Dynamics of Food Takings

Dynamics of daily food taking is a crucial issue of the AILA and SIDR affected areas. Many people of this area cannot afford three times food in a day. They do not get meal properly or even passing a day without meal. Table 4 demonstrates the dynamics of foods takings of the

respondents of the study area. In 2010, half of the respondents (50%) take meal twice per day, while it was only 30% in 2003. In 2003, 63% respondents used to take three times meal per day but in 2010, the figure was only 30%. It was also found that in 2010, 20% of the respondents take meal once a day which was not seen in 2003. In 2010, no respondent was found taking meal more than three times while, 7.5% respondents were used to take more than three times meal a day in 2003. Thus, climate changes deteriorated the food taking ability of coastal inhabitants.

**Table 4. Dynamics of Daily Food Takings**

| Number of meal | Food takings in 2010 | | Food takings in 2003 | |
|---|---|---|---|---|
| | Number | % | Number | % |
| One time | 16 | 20.00 | 0 | 0.00 |
| Two times | 40 | 50.00 | 24 | 30.00 |
| Three times | 24 | 30.00 | 50 | 62.50 |
| More | 0 | 0.00 | 6 | 7.50 |
| Total | 80 | 100 | 80 | 100.00 |

*Sources: Field Survey, March 2010*

## 3.5 Sources of Drinking Water Used by the Respondents

Water is one of the most important elements to sustain lives on the earth. Due to extreme salinity in ground water, it is totally undrinkable. So, the coastal people use rain and pond water to drink. However, the water crisis is deteriorating due to adverse effect of climate change. Multiple responses were found regarding the source of drinking water. Table 5 reveals that in 2010 majority (80%) of the respondents used pond water as the main sources of drinking water, whereas, the figure was 75% in 2003. In 2010, 50% respondents relied upon stored rain water as the chief sources of drinking water, whereas, in 2003 the figure was 45%. Sixty two and half (62.5%) percent respondents were used to drink deep tube-well water in 2003, but in 2010, only 12.5% respondents have access to tube-well water (Table 5).

**Table 5. Sources of Drinking Water of the Respondents**

| Sources | Year | | | |
|---|---|---|---|---|
| | 2010 | | 2003 | |
| | Number | % | Number | % |
| Rain Water | 40 | 50.00 | 36 | 45.00 |
| Pond Water | 70 | 80.00 | 60 | 75.00 |
| Deep Tube-well | 10 | 12.50 | 50 | 62.50 |
| Others Sources | 10 | 12.50 | 6 | 7.50 |

*Sources: Field survey, March 2010 (Multiple Response)*

## 3.6. Dynamics of Land Use Pattern

Table 6 depicts that in 2010 on average 8 katha land is used for dwelling purposes, while in 2003, 15 katha land was used for the same purpose. On the other hand, in 2010 on average 45 katha land is used for cultivation purposes, whereas, in 2003 on average 60 katha land was used for the same purpose. Similarly, average land size for shop and bazaar also declined over the years, while average size of uncultivable land is dramatically increased during the same period.

**Table 6. Dynamics of land use pattern**

| Land use purpose | Average land holding (Katha) | |
|---|---|---|
| | In 2010 | In 2003 |
| Dwellings | 8 | 15.00 |
| Cultivable land | 45 | 60.00 |
| Uncultivable land | 20 | 5.00 |
| Shop, bazaar etc. | 1.5 | 2.40 |

*Sources: Field Survey, March 2010*
*Note: 60.61 Katha = 1 Acre*

## 3.7 Causes of Declining the Land Property

Table 7 reveals that 80% of the respondents perceived that river erosion was the main cause of damage the land property, followed by 75% perceived salinity intrusion, 50% and 37.5% argued that cyclone, and land fragmentation respectively as the causes of declining land property.

**Table 7. Causes of declining land property**

| Causes | Respondents | |
|---|---|---|
| | Number | % |
| River erosion | 64 | 80.00 |
| Salinity intrusion | 60 | 75.00 |
| Cyclone | 40 | 50.00 |
| Land fragmentation | 30 | 37.50 |

Sources: Field survey, March 2010 (Multiple Response)

## 3.8 Climatic Impact on Agriculture and Food Security

Climate change has become a burning issue throughout the world, and the southwest coastal region of Bangladesh being the adversely affected, the socio-economic condition of this area got altered. Many crop lands, shrimp firms, trees are being overwhelmed by the devastation of cyclone, flood, and salinity intrusion. Therefore, it has brought a curse for the people of this area, and affected people's income, expenditure and food security.

## 3.9 Changing the Income Pattern

The main source of income of southwestern coastal people is agriculture. Due to climate change and its impact their income sources also changed significantly. AILA and SIDR have changed the income level ferociously. Study reveals that there is a huge difference between incomes in 2003 and in 2010, and the people of the southwest coastal region are severely affected by the climate change manifested by SIDR and AILA, and their food security is at risk (Table 8). Roy and Sultana 2009 [18] report that due to flood caused by tropical cyclone, SIDR (2007) & Aila (2009) average income has dropped about 44% and debt increased 40% in the affected households in Satkhira and Khulna Districts of Bangladesh.

**Table 8. Test of significance of the differences of between income before and after natural disaster**

| Test for equality of means between series | | | | |
|---|---|---|---|---|
| **Method** | **Value** | **Level of significance** | | **Test** |
| Z-test | 3.23 | 0.05 | | Two Tailed |
| **Category statistics** | | | | |
| **Variables** | **Sample Size** | **Mean** | **Std. Deviation** | **Std. Error Mean** |
| Income in 2003 | 80 | 5105.00 | 1858.44 | 293.84 |
| Income in 2010 | 80 | 1705.00 | 886.63 | 140.19 |

Author's calculation

## 3.10 Changing Expenditure Pattern

Due to climate change expenditure pattern is changing over the years. Table 9 demonstrates the expenditure before and after SIDR and Aila. It is evident that the mean expenditure before SIDR and Aila was BDT 4,272.5, while after the disasters present mean expenditure was BDT 2,995.0. Thus, it is clear that due to climate change expenditure pattern of the respondents was deteriorated over the years (Table 9).

**Table 9. Changing expenditure pattern**

| Expenditure | Before SIDR and Aila | | | | After SIDR and Aila | | | |
|---|---|---|---|---|---|---|---|---|
| | **Number** | **%** | **Mean** | **SD** | **Number** | **%** | **Mean** | **SD** |
| 0- 1000 | 0 | 0.00 | | | 2 | 2.00 | | |
| 1001-2000 | 8 | 10.00 | | | 12 | 15.00 | | |
| 2001-3000 | 14 | 17.50 | | | 38 | 48.00 | | |
| 3001-4000 | 12 | 15.00 | 4272.50 | 1688.11 | 10 | 12.50 | 2995.00 | 1136.78 |
| 4001-5000 | 30 | 37.50 | | | 12 | 15.00 | | |
| Above-5000 | 16 | 20.00 | | | 6 | 7.50 | | |
| Total | 80 | 100.00 | | | 80 | 100.00 | | |

*Source: Field Survey, March 2010*

## 3.11 Vulnerability Effect on the Study Areas

Households suffer not only from natural disasters but also from a broad range of other factors. Livelihoods are vulnerable when they are unable to cope with respond to risk, stress, and shock. Based on field survey, the vulnerability context is identified in the study area that creates several threats on their lives, property, settlements and livelihood patterns. The effect for the vulnerability contexts of the study were assessed as a percentage of population affected by the problem. Table 10 brings out that cyclone resulted 50% respondents to homeless, 75% to food shortage, 65% to property loss, 15% to diseases, 89% to shortage of drinking water, 42% to decreased production, 59% to reduced income, 70% to sanitation problem, 55% to damaging homes, and 88% to damaging communication. Thus, cyclone had severe impacts on the livelihood of people of the study area. In the same fashion, tidal surge, floods, river erosion, heavy rainfall, and salinity intrusion all had more or less similar impacts on the people of the study area (Table 10). The respondents were mainly dependent on pond and rain water. Due to lack of portable water 81% of the respondents face water crises, and 44% of them had water-borne diseases. Thus, safe portable water supply is inevitable for ensuring better health of the coastal inhabitants.

**Table 10. Effects of climate change on the study area**

| Vulnerability contexts | Homeless | Food Shortage | Property Loss | Diseases | Shortage of Drinking Water | Decrease of Production | Reduce Income | Sanitation Problem | Snake Attack | Home Damage | Damage Communication System |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % | % |
| Cyclone | 50 | 75 | 65 | 15 | 89 | 42 | 59 | 70 | 6 | 55 | 88 |
| Tidal surge | 29 | 24 | 47 | 12 | 51 | 42 | 33 | 55 | 7 | 77 | 61 |
| Floods | 47 | 47 | 35 | 35 | 35 | 59 | 29 | 59 | 29 | 29 | 29 |
| River erosion | 31 | 0 | 35 | 0 | 0 | 21 | 11 | 3 | 0 | 47 | 36 |
| Heavy rainfall | 4 | 29 | 11 | 2 | 0 | 24 | 18 | 4 | 0 | 4 | 47 |
| Salinity intrusion | 0 | 35 | 12 | 0 | 24 | 47 | 29 | 0 | 0 | 0 | 0 |
| Portable water Crisis | 0 | 0 | 0 | 44 | 81 | 0 | 0 | 0 | 0 | 0 | 0 |

*Source: Field Survey, March 2010 (Multiple Responses)*

## 3.12 Vulnerability Ranking of Declining Agricultural Production

Food production is hampered when farmers are unable to cope with and respond to risk, stress and shock. Table 11 indicates that 100% respondents viewed that salinity intrusion and river erosion occurring throughout the year, were the major climatic problem. All (100%) respondents perceived that salinity intrusion was the major cause of declining food production, and put in high rank. While 93% respondents viewed river erosion as a high and 37.5% as a medium problem responsible for declining food production. However, 100% respondents claimed cyclone as the high degree of climatic problem which occurred 2~3 times per year. Recent cyclone SIDR and AILA carried out devastating impacts on the study area that might make its ranking high. Ninety (90) percent and 62.5% of the respondents perceived cyclone as a high and medium problem responsible for declining food production. Similarly, floods, tidal surge, and heavy rainfall had more or less similar impacts on the food production in the study area (Table 11). Thus, it is evident that climate change has been causing significant impact on the food production of the study area.

## 3.13 Dynamics of Agricultural Production

Agricultural production was reduced tremendously due to frequent natural disasters and climate change over the years. Table 12 depicts data on the production of major crops in the study year. It is evident that production of all major crops including vegetables are drastically declined due to climatic reason, while only production of water melon has got some positive growth as it grows well in saline soils and water (Table 12).

**Table 11. Average frequency of climatic problems and ranking in declining food production**

| Climatic problem | Respondents | | Average frequency | Ranking in declining food production | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number | % | | Highly | | Medium | | Low | |
| | | | | Number | % | Number | % | Number | % |
| Salinity intrusion | 80 | 100.00 | Throughout the year | 80 | 100.00 | 0 | 0.00 | 0 | 0.00 |
| River erosion | 80 | 100.00 | Throughout the year | 74 | 93.00 | 30 | 37.50 | 0 | 0.00 |
| Cyclone | 80 | 100.00 | 2~3 times | 72 | 90.00 | 50 | 62.50 | 0 | 0.00 |
| Floods | 60 | 75.00 | 1~2 times | 68 | 80.00 | 44 | 60.00 | 58 | 72.50 |
| Tidal surge | 24 | 30.00 | 1~2times | 40 | 50.00 | 30 | 37.50 | 20 | 25.00 |
| Heavy rainfall | 30 | 37.50 | 2~5 times | 40 | 50.00 | 44 | 55.00 | 32 | 40.00 |

*Source: Field Survey, March 2010 (Multiple Responses)*

**Table 12. Yearly Agricultural Production (Kg/Bigha)**

| Crops | Year | |
|---|---|---|
| | 2003 | 2010 |
| Rice | 700-900 | 200-300 |
| Wheat | 200-250 | 90-120 |
| Water melon | 200-320 | 350-600 |
| Brinjal | 160-200 | Negligible quantity |
| Aurum | 400-500 | |
| Vegetable varieties (Cabbage, cauli-flower, beans) | 300-400 | |

*Source: Field Survey, March 2010*

## 3.14 Loss of Average Food Production due to Climate Change

Climate change exerts detrimental effects on agricultural production in southwest coastal region of Bangladesh due to adverse effects of sea level rise, chronic salinity intrusion, cyclone, tidal surge and other disasters. So, food production is decreasing day by day. Table 13 shows yearly loss of average food production due to climate change. Most of the respondents (30%) claimed that loss of food production was around BDT 2001-3000, 25% respondents argued that their losses confined around BDT 3001-4000, 20% respondents claimed that their loss of food production was around BDT 4001-5000. On the other hand, very few respondents (5%, 7.5% and 5%) claimed that their loss of food production was around BDT 5001-6000, BDT 6001-7000, and BDT 70001-8000 respectively. However, the mean loss of food production was BDT 3755 per year.

**Table 13. Average Loss of Food Production Due to Climate Change**

| Average loss (BDT) | Respondents | % | Mean | SD |
|---|---|---|---|---|
| 0-1000 | 1 | 2.50 | | |
| 1001-2000 | 2 | 5.00 | | |
| 2001-3000 | 12 | 30.00 | | |
| 3001-4000 | 10 | 25.00 | | |
| 4001-5000 | 8 | 20.00 | 3755.00 | 1568.00 |
| 5001-6000 | 2 | 5.00 | | |
| 6001-7000 | 3 | 7.50 | | |
| 7001-8000 | 2 | 5.00 | | |
| Total | 40 | 100 | | |

*Source: Field Survey, March 2010*

## 3.15 Price Trends of Rice

Climate change is taking place severely for last few years and its adverse affects is increasing the price of basic commodities, as their productions are declining over the years. Since the most of the coastal people are poor, they are happy if they get their daily necessities cheaper. Table 14 shows that price of rice has been increasing over the years at very faster rate. In the year 2007, when SIDR hit this area, price of rice increased by 45%, although it came down by the next year, but again it increased in the following year when another cyclone Aila took place. Thus, the price of rice has had increasing trend over the years because of adverse impact of climate change and a severe food insecurity is taking place in southwest coastal area of Bangladesh.

**Table 14. Price trends of rice (BDT/50Kg)**

| Year | Avg. rice price | Change rate (%) |
|---|---|---|
| 2000 | 500 | - |
| 2001 | 510 | 2.00 |
| 2002 | 540 | 5.80 |
| 2003 | 550 | 2.00 |
| 2004 | 660 | 20.00 |
| 2005 | 800 | 21.21 |
| 2006 | 820 | 2.50 |
| 2007 | 1190 | 45.00 |
| 2008 | 875 | -26.24 |
| 2009 | 1010 | 15.45 |

*Source: Field Survey, March 2010*

## 4. CONCLUSION AND RECOMMENDATION

Most of the respondents in the study area were found illiterate and poor. They were directly or indirectly relied upon agriculture and fisheries. They were unable to fulfill their daily needs as there is a gulf of differences between the income and expenditure of the people reflecting the extent of misery of coastal lives. The crisis of drinking water was emerged due to adverse effect of climate change, and majority of the respondents utilized pond water and rain water as the main sources of drinking water. Agricultural land is also shrinking due to river bank erosion, prolonged water logging and salinity intrusion. Major disasters led the respondents to be homeless, caused severe food shortage, property loss, outbreak of diseases, shortage of drinking water, decrease in production, reduction of income, sanitation problem, damage of homes, and communication system. Present study reveals that salinity intrusion, river bank erosion, cyclone, floods, tidal surge, and heavy rainfall have been causing significant declining impact on food production of coastal areas of Bangladesh and also is in agreement with Litchfield [19]. Considering climate change adaptation and disaster risk reduction following recommendations have been suggested as coping mechanism in southwest coastal region of Bangladesh. Farmers should be given access to subsidized inputs and loans. Rehabilitation should include different measures for income and employment generating activities for the climate victims. Flood forecasting and early warning system should be made effective, and crop calendars should be kept up-to-date along with special methods to be used to grow seasonal crops after disaster. Saline tolerant and heat resistant, less water-requiring and short rotation multi crops should be invented for the coastal areas. Alternative livelihood adaptation practice for coastal people such as cultivation of vegetables on floating bed or cultivation of beans, gourds and other vegetables on embankment's surrounding should be adapted. Coconut tree can be the effective alternative means of food security because coconut is very much nutrient food and adaptive in this saline prone area. Besides, it is possible to add value through its multiple usages.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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# APPENDIX

## Questionnaire

### A) Identification of the Respondents

Name: Date:
Village: Union: Upazila: Dacope District: Khulna

a. Personal information:

| Sl. no | Identification | Answer |
|---|---|---|
| 1 | Age (in year) | |
| 2 | Education | |
| 3 | Occupation | |
| 4 | Income (monthly) | |

### B) Socio Economic Impact of Climate Change

a. Do you have any idea that climate is changing? Yes/ No
If yes, then specify Know well/ Know/ slightly know

b. Sources of income before and after natural calamity (Aila and SIDR)

| Income source | In 2003 | | In 2010 | | Differences |
|---|---|---|---|---|---|
| | Amount | BDT | Amount | BDT | |
| Agriculture | | | | | |
| Vegetables crop | | | | | |
| Livestock | | | | | |
| Fisheries | | | | | |
| Service | | | | | |
| Business | | | | | |
| Day laborers | | | | | |
| Tress | | | | | |
| Forest (Sundarbans) | | | | | |

c. What were your previous earning sources of income?
Fishery/ Gher/ Day labor/ Business/ Farming/ Any jobs/ Others

d. Expenditure pattern of the family after and before natural calamity (SIRD and Aila)

| Sources of expenditure | After natural calamity BDT | Before natural calamity BDT |
|---|---|---|
| Food | | |
| Clothing | | |
| Housing | | |
| Medical | | |
| Education | | |
| Social activates | | |
| Others | | |

e. Economic losses after climatic change

| S.N | Losses | Amount/Number | BDT |
|---|---|---|---|
| 1 | House | | |
| 2 | Gher | | |
| 3 | Livestock | | |
| 4 | Poultry | | |
| 5 | Cattle | | |
| 6 | Land crop | | |
| 7 | Others | | |

f. Sources of feedback taking after climatic change

| Reliefs/ helping materials | Relief provider | | Amount/ number (BDT/unit) |
|---|---|---|---|
| | Person | Agency | |
| Housing | | | |
| Clothing | | | |
| Flooding | | | |
| Agriculture assistance | | | |

g. Do you feel secured in food production? Yes/No

h. How many times do you have meals a day in 2010?
One time two times three time more

i. How many times did you have meal in 2003?
One time two times three time more

j. Do you want to change your food pattern? Yes /No, if yes then why...

k. Food taking amount in 2003 and in 2010

| List of foods | In 2003 | | In 2010 | |
|---|---|---|---|---|
| | Daily amount | Price | Daily amount | Price |
| Rice | | | | |
| Wheat | | | | |
| Fish | | | | |
| Meat | | | | |
| Milk | | | | |
| Egg | | | | |
| Vegetables | | | | |
| Fruit | | | | |
| Drinkable water | | | | |
| Others | | | | |

l. Dynamics of land use pattern of the respondent

| Type of land | Present amount of average land (Katha)/respondent | Amount of average land ten years ago (Katha)/respondent |
|---|---|---|
| Dwellings | | |
| Cultivable land | | |
| Uncultivable | | |
| Shop, market etc. | | |

m. Causes of declining the land property

| Causes | Answer of the espondent |
|---|---|
| Cyclone | |
| River erosion | |
| Salinity intrusion | |
| Land fragmentation | |

n. Do you think food production is declining? Yes/No
If yes then…… severely More severely medium

o. Causes of lowering the food production

Cyclone Water logging,
River erosion Shrimp cultivation
Salinity intrusion, Lack of land,
Lack of finance Others

**C) Sector Wise Losses after Climatic Change in the Area**

a) What type of natural disaster effect your food production most?

b) Losses of agriculture production

| Name of crop | Amount of land | | Expected production | | Actual production | | Projected market price | Amount of loss |
|---|---|---|---|---|---|---|---|---|
| | Local unit | ha | Kg | Ton | Kg | Ton | | |
| | | | | | | | | |

c) Losses of vegetables

| Name of crop | Amount of land | | Expected production | | Actual production | | Projected market price | Amount of loss |
|---|---|---|---|---|---|---|---|---|
| | Local unit | ha | Kg | Ton | Kg | Ton | | |
| | | | | | | | | |

d) Losses of livestock

| Name of livestock | Number | | Losses by Aila and Sidr | Number |
|---|---|---|---|---|
| | In 2003 | In 2010 | | |
| Cow | | | | |
| Buffalo | | | | |
| Goat | | | | |
| Ramp | | | | |
| Duck | | | | |
| Cock | | | | |
| Others | | | | |

e) Losses of fisheries

| Sources of fish | Cost of cultivable fish (BDT) | Expected income of cultivable fish | Price or amount of present fish | Final result |
|---|---|---|---|---|
| Gher | | | | |
| Pond | | | | |
| Others | | | | |

**D) Effects of Disaster**

a) Effects during the disaster

| Problems | Weight of disaster | | | |
|---|---|---|---|---|
| | Highly severe | Severe | Less severe | No severe |
| Heavy water tide | | | | |
| Loss of housing | | | | |
| Scarcity of water | | | | |
| Effects on livestock | | | | |
| Damage of trees | | | | |
| Lack of proper alarming | | | | |
| Lack of communication and transportation | | | | |
| Lack of security | | | | |

b) Post disaster effects

| Problems | Weight of disaster | | | |
|---|---|---|---|---|
| | Highly severe | Severe | Less severe | Rank |
| Water logging | | | | |
| Lack of portable water | | | | |
| Lack of relief | | | | |
| Lack of clothing | | | | |
| Lack of housing | | | | |
| Diseases | | | | |
| Lack of medicine | | | | |
| Employment | | | | |
| Robbery | | | | |
| Presence of snake | | | | |
| Damage of school and colleges | | | | |
| Lack of foods of livestock | | | | |

c) What your perception about the above problems?
d) Do you feel that you are a victim of climate change? Yes/No
e) Causes of feel victim of climate change

| Causes | Answers |
|---|---|
| Cyclone | |
| River erosion | |
| Flood | |
| Salinity intrusion | |
| Others | |

f) How we can adopt the various disasters? Specify?



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