

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

Md Abdur Rahman¹, Md. Lokman Hossain^{2*}, Muhammad Abul Foysal³,
Ashik Rubaiyat⁴, Asma Akter⁵

¹Research Assistant, Shushilan, Dhaka, Bangladesh

²Project Coordinator, Building a Disaster Resilient Bangladesh, DIPECHO-VII, Khulna, Bangladesh

³Assistant Fund Raising Officer, Shushilan, Dhaka, Bangladesh

⁴Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, Bangladesh

⁵Consortium Monitoring Associate, Oxfam GB, Dhaka, Bangladesh

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 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 have been 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 the 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 or cultivation of beans, gourds and other vegetables on embankment's surrounding should be adapted.

Keywords: Adaptation, Bangladesh, Climate Change, Food Security, Impact

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 Intergovernmental 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 Program (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

* Tel.: +880 1710 161588

E-mail address: lokmanbbd@gmail.com

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 of land of which 3.75 million hectares (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, sea 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 (Figure 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, standard error of mean using statistical software SPSS 16.

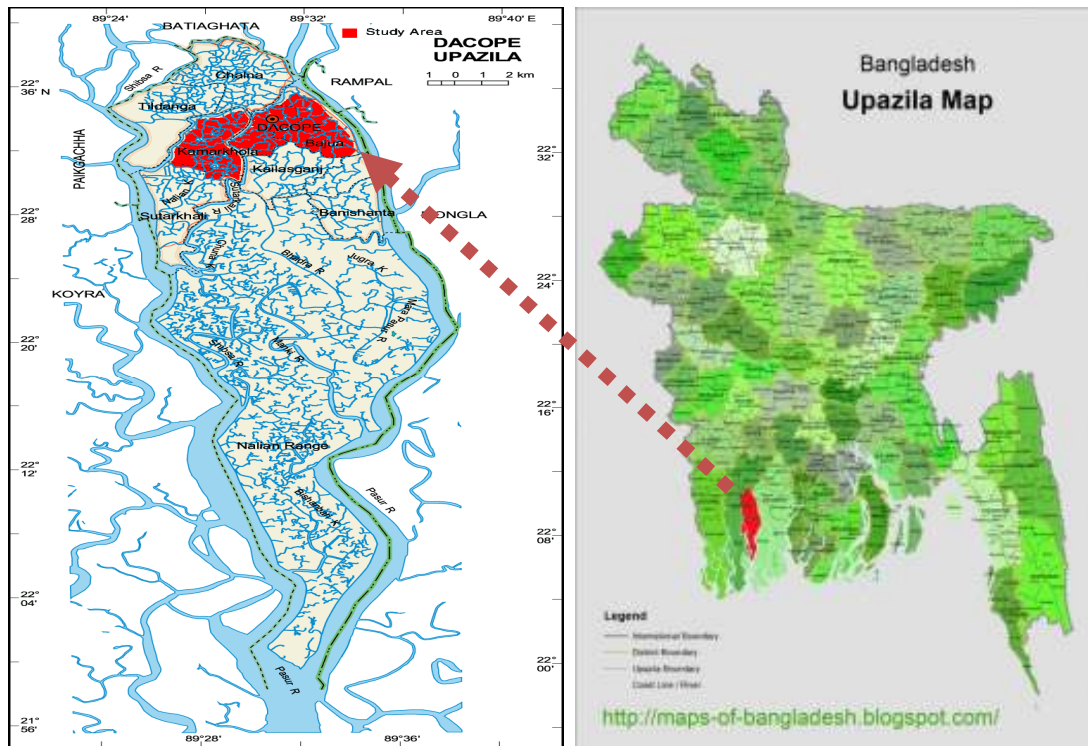


Figure 1: Study area map (Red marked portion is the study area)

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics 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. 50% 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. 50% 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 portions of the respondents (7.5%) are in income range above 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	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 Number	%	In 2003	Respondent Number	%
Agriculture	38	47	Agriculture	50	62.50
Fisheries	22	27	Fisheries	18	22.50
Small business	6	7	Small business	4	5.00
Day laborer	6	7	Day laborer	4	5.00
Sundarbans	4	5	Sundarbans	2	2.50
Others	4	5	Others	2	2.50
Total	80	100		80	100.00

Source: Field Survey, March 2010

133 3.3 Daily Menu of Food Items

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

140 **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)

141 3.4 Dynamics of Food Takings

142 Dynamics of daily food taking is a crucial issue of the AILA and SIDR affected areas. Many
 143 people of this area cannot afford three times food in a day. They do not get meal properly or
 144 even passing a day without meal. Table 4 demonstrates the dynamics of foods takings of the
 145 respondents of the study area. In 2010 half of the respondents (50%) take meal twice per
 146 day, while it was only 30% in 2003. In 2003, 63% respondents used to take three times meal
 147 per day but in 2010 the figure was only 30%. It was also found that in 2010 20% of the
 148 respondents take meal once a day which was not seen in 2003. In 2010, no respondent was
 149 found taking meal more than three times while, 7.5% respondents were used to take more
 150 than three times meal a day in 2003. Thus, climate changes deteriorated the food taking
 151 ability of coastal inhabitants.

152 **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

153 3.5 Sources of Drinking Water Used by the Respondents

Water is one of the most important elements to sustain on the earth. Life is impossible without water. 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 majority (80%) of the respondents use pond water as the main sources of drinking water, the figure was 75% in 2003. In 2010, 50% respondents relied upon stored rain water as the chief sources of drinking water which used 45% in 2003. 62.5% 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	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 farms, 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. 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 4272.5, while after the disasters present mean expenditure was BDT 2995.0. 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	Std. Deviation	Number	%	Mean	Std. Deviation
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. 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.

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)

235 3.13 Dynamics of Agricultural Production

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

241 **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	300-400	
Cabbage, cauli-flower, beans		

Source: Field Survey, March 2010

242 3.14 Loss of Average Food Production due to Climate Change

243 Climate change mostly effected the agricultural production in southwest coastal region of
 244 Bangladesh due to adverse effects of sea level rise, chronic salinity intrusion, cyclone, tidal
 245 surge and other disasters. So, food production is decreasing day by day. Table 13 shows
 246 yearly loss of average food production due to climate change. Most of the respondents
 247 (30%) claimed that loss of food production was around BDT 2001-3000, 25% respondents
 248 argued that their losses confined around BDT 3001-4000, 20% respondents claimed that
 249 their loss of food production was around BDT 4001-5000. On the other hand very few
 250 respondents (5%, 7.5% and 5%) claimed that their loss of food production was around BDT
 251 5001-.6000, BDT 6001-7000, and BDT 70001-8000 respectively. However, the mean loss of
 252 food production was BDT 3755 per year.

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

Average loss (BDT)	Respondents	%	Mean	Std. Deviation
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

254 3.15 Price Trends of Rice

The climate is taking place severely for last few years and its adverse affects are falling on 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. Therefore, 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, out break 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 the 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 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.

292 **COMPETING INTERESTS**

293 Authors have declared that no competing interests exist.

294 **REFERENCES**

- 295 1. IPCC, Climate change: The physical science basic', *Contribution of Working Group 1 to*
296 *the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*,
297 Switzerland. 2007.
- 298 2. Cruz, R.V.H., Harasawa, M.Lal, S.Wu, Y.Anokhin, B.Punsalmaa, Y.Honda, M.Jafari, C.Li
299 and N.Huu Ninh, Asia. In M.L.Parry, O.F. Canziani, J.P.Palutikof, P.J.Van Der Linden
300 and C.E. Hanson, (eds.). *Climate Change 2007: Impacts, Adaptation and Vulnerability*.
301 Contribution of Working Group 11 to the Fourth Assessment Report of the
302 IPPC,Cambridge University Press,Cambrize, UK. 2007.
- 303 3. GERMANWATCH Global Climate Risk Index 2010. IN HARMELING, S. (Ed.) *Briefing*
304 *paper*. Bonn, Germanwatch. 2010.
- 305 4. Sharmin Z. and M.S. Islam. Consequences of Climate Change and Gender Vulnerability:
306 Bangladesh Perspective. *Bangladesh Development Research Center*. 2013.
- 307 5. Siddique. T., Abrar, C.R., Alamgir, M., and Ali, S.M. Climate Change & Community
308 Adaptation: Case Study from Bangladesh. Dhaka, Bangladesh. 2010.
- 309 6. Huq,S.,Ahmed,A.U. and Koudstaal,R. 'Vulnerability of Bangladesh to climate change
310 and sea level rise', in T.E. Downing (eds), *Climate Change and World Food Security*,
311 Springer Verlag, Berlin. 1996.
- 312 7. Warrick, R.A.and Ahmad, Q.K. (eds), The Implications of Climate and Sea-Level Change
313 for Bangladesh, *Kluwer Academic Publishers*, Dordrecht, Boston, London. 1996.
- 314 8. Ahmed, A.U., and Mirza, M.M.Q., 'Review of the causes and dimensions of floods with
315 particular reference to flood'98: National perspectives', in Ahmed, Q.K et al., (eds)
316 Perspectives of flood 1998, *The University Press Limited*, Dhaka. 2000.
- 317 9. Karim, Z., Hussain, S.G., and Ahmed, M. Salinity Problems and Crop Intensification in
318 the Coastal Regions of Bangladesh, *Bangladesh Agricultural Research Council*,
319 (BARC), Dhaka. 1990.
- 320 10. Ahmed, A.U. Adaptation options for managing water related extreme events under
321 climate change regime: Bangladesh perspectives', in Mirza, M.M.Q., and Ahmed, Q.K.,
322 (eds), *Climate Change and Water Resources in South Asia*, Belkima Press, Leiden.
323 2005.
- 324 11. Reazuddin, M., Asaduzzaman, M., and Ahmed, A.U., (eds), *Global climate change:*
325 *Bangladesh episode*, Department of Environment, Government of People's Republic of
326 Bangladesh. 1997.
- 327 12. ILO. Chapter 4. Employment by sector. In *Key indicators of the labour market (KILM)*, 5th
328 *edition*. 2007.
329 Available at: www.ilo.org/public/english/employment/strat/kilm/download/kilm04.pdf.
- 330 13. International Fund for Agricultural Development (IFAD). Enabling poor rural people to
331 overcome poverty in Bangladesh. 2012. pp7, Rome, Italy.
332 <http://www.ifad.org/operations/projects/regions/PI/factsheets/bd.pdf>.
- 333 14. Gregory, P.J., Ingram, J. S. I. Global change and food and forest production: future
334 scientific challenges. *Agric. Ecosyst. Environ.* 2000, 82:3–14.
- 335 15. Parry, M. et al. Millions at risk: defining critical climate change threats and targets.
336 *Global Environ. Change* 2001,11, 181–183.
- 337 16. Rosegrant, M. W. & Cline, S. A. Global food security: challenges and policies. *Science*
338 2003,302, 1917–1919.
- 339 17. Bangladesh Bureau of Statistic, 2003.
- 340 18. Roy, K., and Sultana, U.T. Climate Change Disasters & Rural Poverty: Case of Coastal
341 Bangladesh, Paper Presented in *3rd International Conference on Bangladesh*
342 *Environment (BAPA-BEN)*. 2009.

343 19. Litchfield W.A. Climate Change Induced Extreme Weather Events & Sea Level Rise in
 344 Bangladesh Leading to Migration and Conflict, ICE case studies, Number 229. 2010.
 345

APPENDIX

Questionnaire

A) Identification of the Respondents

Name:

Date:

Village: Union: Upazila: Dacope

District: Khulna

a. Personal information:

S.N	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 respondent
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?