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Climate Change Adaptation: The Bangladesh Experience

Dr. Ben Groom

Author

Dr. Ben Groom

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606-607, Fortune Centre, Block 6, P.E.C.H.S., Shahrah-e-Faisal, Karachi

Tel: 021-34544791-2, Fax: 021-34544790, www.wwfpak.org/ccap

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List of Acronyms

1.	BARC	Bangladesh Agricultural Council
2.	BARI	Bangladesh Agricultural Institute
3.	BCAS	Bangladesh Centre for Advanced Studies
4.	BCCSAP	Bangladesh Climate Change Strategy and Action Plan
5.	BCRF	Bangladesh Climate Resilience Fund
6.	BIDS	Bangladesh Institute of Development
7.	BMD	Bangladesh Meteorological Department
8.	BRRI	Bangladesh Rice research Institute
9.	CANSA	Climate Action Network- South Asia
10.	CBA	Community Based Adaptation
11.	CCU	Climate Change Unit
13.	CTF	Climate Trust Fund
14.	DOE	Department of Environment
15.	EIA	Environmental Impact Assessment
16.	FFWC	Flood Forecasting and Warning Centre
17.	GAR	Global Assessment Report
18.	GDP	Gross Domestic Product
19.	GoB	Government of Bangladesh
20.	IFPRI	International Food and Policy Research Institute
21.	IOM	International Organization for Migration
22.	IPCC	Intergovernmental Panel on Climate Change
23.	ITDG	Intermediate Technology Development
24.	LACC	Livelihood Adaptation to Climate Change
25.	MDF	Millennium Development Goals
26.	MoEF	Ministry of Environment and Forest
27.	NAP	National Agriculture Policy
28.	NAPA	National Adaptation Programme of Action
29.	NEMAP	The National Environmental Management Action Plan
30.	NfoP	National Forest Policy
40.	NLUP	National Land Use Policy
41.	NWP	National Water Management

42.	PRS	Poverty Reduction Strategy
43.	RVCC	Reducing Vulnerability to Climate Change
44.	SFYP	Sixth Five Year Plan
45.	UNDP	United Nations Development Programme
46.	UNEP	United Nations Environmental Programme
47.	UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

The purpose of this paper is to provide an overview of adaptation to climate change and its impact in Bangladesh. The combination of being located at the confluence of three major rivers, and being extremely low lying makes Bangladesh vulnerable to natural hazards, such as typhoons and flooding. On the one hand this means that the government and citizens of Bangladesh has a long history of preparing for, adapting to and recovering from natural disasters. On the other hand, it is well known that the prospect and occurrence of such disasters is an important barrier to development and the improvement of well-being (E.g. Carter et al 2009).

The prevailing view with respect to climate change is that the frequency and severity of extreme weather events in South East Asia is only going to increase in the future. Such increased variability comes on top of less sudden but changing climatic trends: decreasing rainfall, increasing temperature. Given the lack of consensus globally on mitigation of climate change, and the inertia inherent in the climate system, it is now widely accepted that adaptation is a crucial component to the climate change response, particularly in vulnerable countries such as Bangladesh.

What to expect in the study:

In this report we firstly provide a summary of the chief concerns surrounding climate change and the role of adaptation in responding to climatic change. Adaptation is defined and some key adaptation strategies observed from around the world are discussed. The impact on agriculture is emphasized. The report then turns to the situation in Bangladesh and two different features of adaptation are discussed: 'Planned' adaptation and 'Autonomous' adaptation.

The section on planned adaptation provides a summary of the national plans, government institutions, climate change funds and specific adaptation projects that currently exist in Bangladesh. A detailed list of government ministries and the national policies with regard to climate change is provided and discussed, including the role of non-governmental organisations and climate adaptation funds. Autonomous adaptation, essentially adaptation at the micro (e.g. household) level, is then discussed in the Bangladesh context. A range of possible adaptation options are considered which then lead to a more detailed focus on agriculture and food security. The paper concludes with a discussion of existing policy recommendations.

2. Climate Change and Adaptation: Background

2.1 Adaptation: Definition

The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The goal of an adaptation measure should be to increase the capacity of a system to survive external shocks or change. The IPCC (2007) also defines adaptation as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or, exploits beneficial opportunities. The IFPRI (2007) defines adaptation as the process of improving society's ability to cope with changes in climatic conditions across time scales, from short term (e.g. seasonal to annual) to the long term (e.g. decades to centuries).

2.2 Climate Change: the view from the IPCC report

In the past two centuries, the world has witnessed an evolution of the scientific discovery of climate change. At the outset of the process, this discovery was criticized heavily and trust in it was lacking. But gradually climate science evolved in details with meticulous and convincing calculations. The history of the scientific discovery of climate change started in the early 19th century with the identification of greenhouse effect. Scientists put their arguments in the late 19th century with the claim that human emissions of greenhouse gases could impact climate, though the details of the calculations were still speculated upon. The calculation of the warming effect of carbon dioxide emissions took convincing shape in the 1950s and 1960s. Then, scientific opinion increasingly supported the warming viewpoint during the 1970s. During the 1980s, persuasive calculation methods for climate change led to a consensus that human activity was in the process of warming the climate, leading to the foundation of the modern period of global warming science (Christina Hutchins 2011). The elaboration of the scientific process behind climate change is not an exact purview of the research. Rather, the research will define climate change as statistical properties of the climate change variables like rainfall, temperature, precipitation etc.

IPCC[1] provides a good number of climate change evidences through publishing assessment reports and updates. The latest published report of IPCC (2007) on climate change gave discernible and statistically proved climate changed evidences. Three panels of the Figure 1 represents that world has witnessed cognizable changes in terms of temperature, sea level and snow cover in the northern hemisphere.

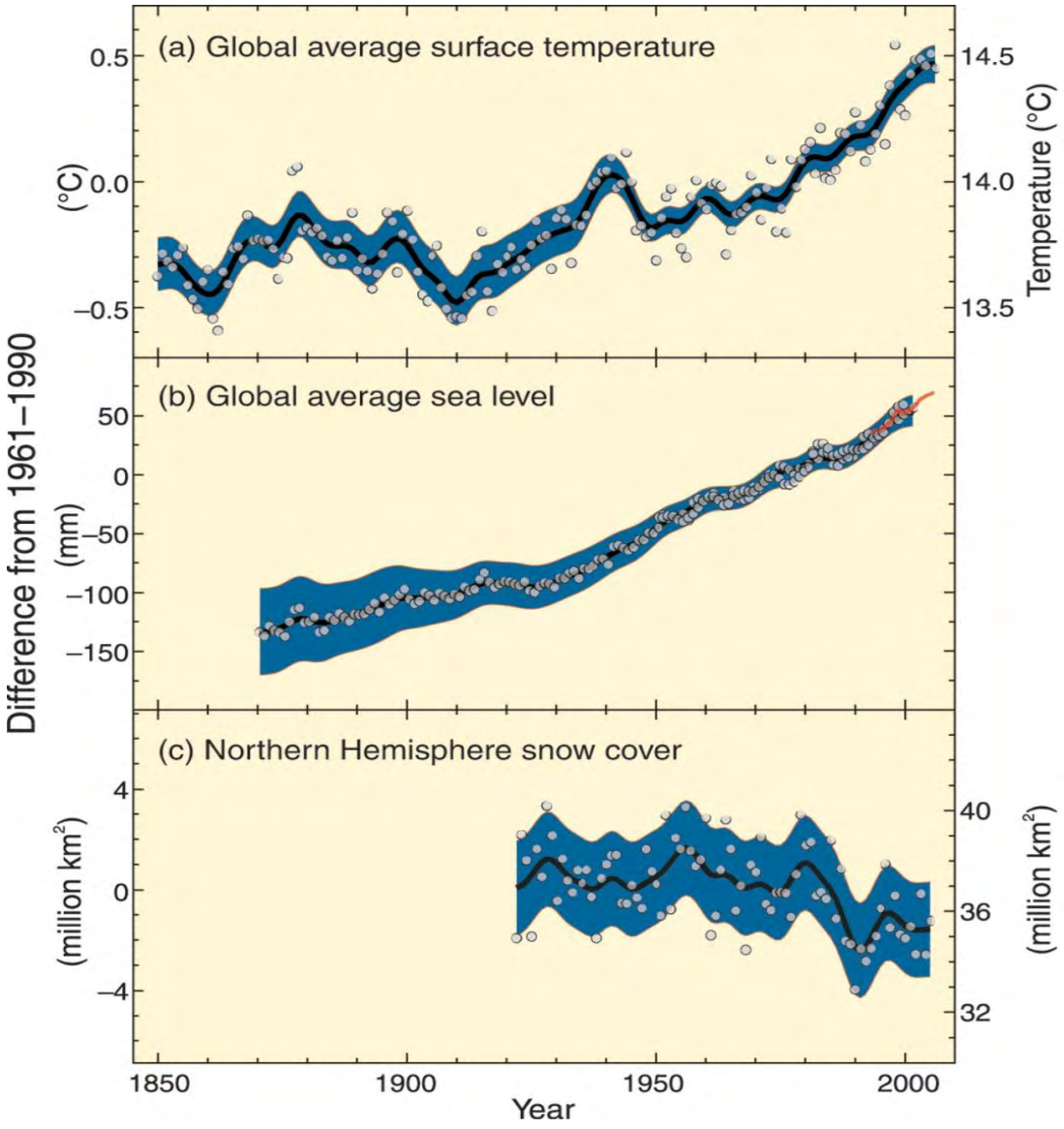
[1] The Intergovernmental Panel on Climate Change (IPCC) which was established by the United Nations Environmental Programme (UNEP) and the World Metrological Orgnization to provide a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts is the leading international scientific body for the assessment of climate change. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.

Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000). The linear warming trend over the 50 years from 1956 to 2005 (0.13 [0.10 to 0.16]°C per decade) is nearly twice that for the 100 years from 1906 to 2005.

Figure 1 presents that increases in sea level are consistent with warming. Global average sea level rose at an average rate of 1.8 [1.3 to 2.3]mm per year over 1961 to 2003 and at an average rate of about 3.1 [2.4 to 3.8]mm per year from 1993 to 2003. Since 1993 thermal expansion of the oceans has contributed about 57% of the sum of the estimated individual contributions to the sea level rise, with decreases in glaciers and ice caps contributing about 28% and losses from the polar ice sheets contributing the remainder. From 1993 to 2003 the sum of these climate contributions is consistent within uncertainties with the total sea level rise that is directly observed.

Figure 1 also shows that observed decreases in snow and ice extent are also consistent with warming. Satellite data since 1978 exhibits that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3]% per decade, with larger decreases in summer of 7.4 [5.0 to 9.8]% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres. The maximum areal extent of seasonally frozen ground has decreased by about 7% in the Northern Hemisphere since 1900, with decreases in spring of up to 15%. Temperatures at the top of the permafrost layer have generally increased since the 1980s in the Arctic by up to 3°C.

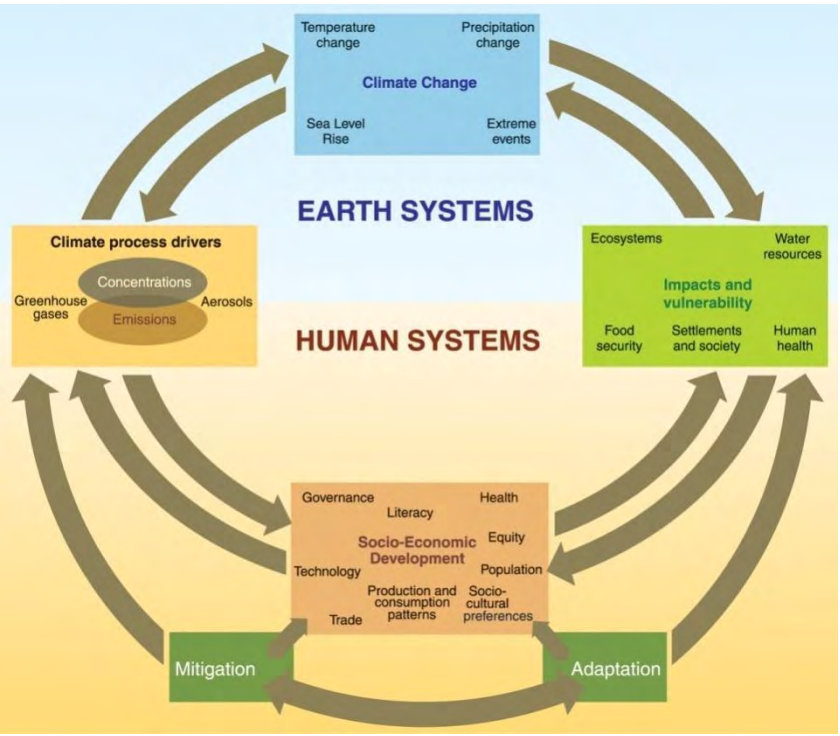
Figure 1: Changes in temperature, sea level and Northern Hemisphere snow cover



The temperature increase is widespread over the globe and is greater at higher northern latitudes. Average Arctic temperatures have increased at almost twice the global average rate in the past 100 years. Land regions have warmed faster than the oceans. Observations since 1961 show that the average temperature of the global ocean has increased to depths of at least 3000m and that the ocean has been taking up over 80% of the heat being added to the climate system. New analyses of balloon-borne and satellite measurements of lower- and mid-tropospheric temperature show warming rates similar to those observed in surface temperature.

IPCC (2007) has presented the following diagram linking the earth systems and human systems of climate change. The diagram also delineates that mitigation works through climate process drivers to climate change while adaptation works through impacts and vulnerability to climate change.

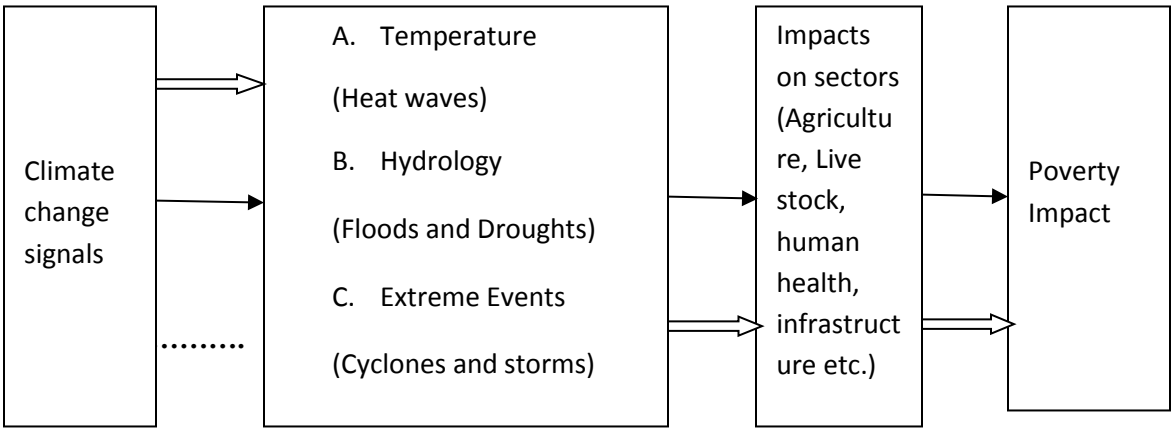
Fig 2: Interaction between Earth and Human Systems in Climate Change



Source: IPCC Fourth Assessment Report, Climate Change 2007 (AR4)

Fig 3 presents the strength of the channels of climate signals and their impact on poverty. Here narrow arrows represent weaker relationship while wide arrow refers strong relationship. Fig 3 shows that climate change signals appear more prominently in temperature compared to extreme events like cyclones and storms. But the impacts of extreme events are more compared to temperature effects and these impacts occur in different sectors such as agriculture, live stock, human health, infrastructure etc. All these impacts have poverty implication to different extent.

Fig 3: Strength of Relationship of Climatic Signal and their Impacts on Poverty



Source: Huq et al., 2006

2.3 Climate Change Vulnerabilities

Climate change is an environmental issue which has significant implication on poverty and inequality. The pattern and behavior of climate including variability and extreme events play a significant role in freshwater availability, agricultural productivity, function of natural eco system and biodiversity, human health and livelihood of the people (Policy Study on The Probable Impacts of Climate Change on Poverty and Economic Growth and The options of Coping with Adverse Effects of Climate Change in Bangladesh, 2009). These characteristics of climate either create favourable conditions for a system to function better or impose risks on a system or increase its vulnerability. Therefore, economic growth and the performance of a nation or society depend on, to a large extent, the behavior of climate.

A good number of papers (Skoufias et.al., 2011, Thurlow et. al., 2009, Jacoby et.al., 2011) have recognized climate change as one of the emerging issues of pro-poor growth, poverty and inequality. Poor people are generally the most vulnerable to the climate change as they live in disaster prone and remote areas where they have little capacity to adapt to the shocks. They are also more dependent on ecosystem services and products for their livelihood. Any impact that climate change has on natural system therefore threatens employment and income generation. Moreover, livelihood, food intake, health and education are also affected by the climate change. Empirical evidence using cross country data suggests that climate change will slow the pace of global poverty reduction, but the expected poverty impact will be relatively modest and far from reversing the major decline in poverty that is expected to occur over the next 40 years as a result of continued economic growth (Skoufias et.al., 2011). A study on Zambia by using dynamic computational general equilibrium model found that if rainfall declines by 15%, climate change

enhances the negative effects of climate variability by a factor of 1.5 and pushes an additional 30,000 people below the poverty line over a 10-year period (Thurlow et. al., 2009). The welfare cost of climate change fall disproportionately on the poor —which is true in urban as well as rural areas (Jacoby et.al., 2011).

Indeed, it is widely agreed that developing countries are more vulnerable to climate change than developed countries mostly because of their proportionately larger agricultural sectors, with food security affected adversely. William Cline, whose earlier models of climate change from 1992 were more or less in line with the Stern Review, has a recent study of the estimated impact of climate change on agriculture by country (Cline 2007) . The findings of this study are as follows in (Cline 2008).

- Warming will decrease production by accelerating growth speed and reducing their water consumption;
- Evaporation from topsoil will increase, as does transpiration, again inducing moisture loss or evapotranspiration;
- This is partially countered by the increase in rainfall anticipated due to climate change;
- On the positive side, CO2 can help agriculture via carbon fertilization which aids agriculture for so- called C3 crops (wheat, rice and soy) but not C4 crops (sugarcane and maize).

Table 1: Climate Change Vulnerable Sectors

No	Affected Sectors	No	Affected Sectors
1	Crop production	8	Drinking Water
2	Fisheries	9	Industry
3	Livestock	10	Food Security
4	Health and sanitation	11	Water Development
5	Education	12	Energy security
6	Housing	13	Fiscal Management
7	Road Communication	14	Governance

Using the output of a number of climate models which estimate the relationship between CO2 emissions and surface and ocean temperatures into an agronomic model of agricultural production, Cline has estimated the change in production for 116 regions of the world. Around $5^{o}C$ temperature increase in the business as usual scenario is predicted in the model., Table (1) shows some details of the results of the model, measured in the percentage change to agriculture that are likely to take place, and the expected cost of climate change on agriculture with and without 'carbon fertilization' (CF).

Table 2: The Costs of Agriculture as a Consequence of Climate Change

	Land Area	Farm Area
Base Levels		
Temperature	**13.15**	**16.20**
Precepitation	**2.20**	**2.44**
By 2080s		
Temperature	**18.10**	**20.63**
Precepitation	**2.33**	**2.51**
(Percentage change in agriculture output potential)		
	Without CF	**With CF**
World		
Output-weighted	**-16**	**-3**
Population-weighted	**-18**	**-6**
Median by Country	**-24**	**-12**
Industrial Countries	**-6**	**-8**
Developing Countries	**-21**	**-9**
Median	**-26**	**-15**
Africa	**-28**	**-17**
Asia	**-19**	**-7**
Middle-east and North America	**-21**	**-9**
Latin America	**-24**	**-13**

Source: Cline 2007

Table 2 shows that the percentage change in the agricultural output potential due to climate change is higher for Annex II countries. Table 1 represents the estimates derived from 'crop models' using data on climate change, land quality, fertilizer into an agronomic model to predict the changes. Other models statistically infer the value of climate and so on in agriculture and make predictions in the basis of observed relationships. These are the so called 'Ricardian' models which look at the determinants of land rents and yields. In both cases the impact on crop yields is strongly negative, and only partially offset by Carbon Fertilization. Developing countries face 10-15% reductions overall, compared to around 5% gains in developed countries with. Africa, Latin America and South Asia suffer the worst reductions in the order of 20%. Cline (2007) also finds that the equatorial countries suffer the most from climate change, since these areas are projected to increase in temperature more than others. Some areas will gain if carbon fertilization is considered. Those areas which benefit are generally in the upper latitudes. Other countries which benefit have higher elevations, such as the Tibetan 12on-agr. In Africa, Ethiopia and South Africa appear to suffer most (25+%), while Nigeria has lower losses. In South Asia, India appears to be most vulnerable, with 30-40% losses predicted.

2.4 Adaptation Strategies in Agriculture

There are a number of strategies which are considered as a means to adaptation to climate change in agriculture. Bradshaw et al.(2004) has mentioned a number of adaptation strategies, which include the following: crop diversification, mixed crop livestock farming systems, using different crop varieties, changing planting and harvesting dates, drought-resistant varieties and high-yield water sensitive crops. Di Falco et al (2011a) has identified a set of strategies (e.g., changing crop varieties, adoption of soil and water conservation strategies) for climate change adaptation in Nile basin area. Wang et al (2008) has referred adjusting irrigation practices, crop varieties and livestock species to both temperature and precipitation levels as adaptation strategies.

Among all the adaptation strategies in agriculture, a number of recent literature examined crop choices as an adaptation strategy in agriculture. Seo et al (2007) has shown that Latin American farmers adapt to climate by changing crops. Taking 2000 farmers from 8 latin American countries, the paper shows that both temperature and precipitation affects the crop choice of the Latin American farmers. It also shows that predictions in the impact of climate change must reflect not only changes in yields or net revenues but also crop switching. Wang et al (2008) has recognized switching crop choice as a way of adaptation to climate change in China. This paper taking 8,405 farmers in 28 provinces in China finds that Chinese farmers are more likely to irrigate in case of lower temperatures and less precipitation. Oil crops, maize, and especially cotton and wheat are the chosen crops of the farmers in warmer places and they choose to produce vegetables, potatoes, sugar, and especially rice and soybeans to lesser extent. Farmers of the wetter locations choose soybeans, oil crops, sugar, vegetables, cotton, and especially rice while they choose potatoes, wheat, and especially maize less to produce. The paper also shows that future climate scenarios will cause farmers in China to reduce irrigation and shift toward oil crops, wheat, and especially cotton moving away from potatoes, rice, vegetables, and soybeans. Another finding of the paper is that adaptation will likely vary to a great extent from region to region. Kurukulasurya et al (2008) using a sample of over 5000 farmers across 11 countries in Africa find that farmers shift the crops to match the change in climate.

Di Falco et al (2011a) have examined the driving forces behind farm households' decisions to adapt to climate change, and the impact of adaptation on farm households' food productivity in the Nile basin of Ethiopia. They investigate how farm households' decision to adapt, through implementing a set of strategies (e.g., changing crop varieties, adoption of soil and water conservation strategies) in response

to long run changes in key climatic variables such as temperature and rainfall, affects food crop productivity in Ethiopia. The major findings of this research are- (a) there are significant and non-negligible differences in food productivity between the farm households that adapted and those that did not adapt to climate change, (b) adaptation to climate change increases food productivity, (c) the impact of adaptation on productivity is smaller for the farm households that actually did adapt than for the farm households that did not adapt in the counterfactual case that they adapted. They also analyzed the drivers behind adaptation. Econometric results show that information on both farming practices (irrespective of its source) and climate change is crucial in affecting the probability of adaptation. It is found that farm households with access to credit are more likely to undertake strategies to tackle climate change.

Di Falco et al (2011b) investigates whether the set of strategies (e.g., change crops, soil and water conservation) implemented in the field by farm households in response to long-term changes in environmental conditions (e.g., temperature and rainfall) affect production risk exposure which is based on the survey undertaken in the Nile basin area of Ethiopia in 2005. The major findings of the research are- (a) climate change adaptation *reduces* downside risk exposure i.e. farm households that implemented climate change adaptation strategies get benefits in terms of decrease in the risk of crop failure, (b) farm households that did not adapt would benefit the most in terms of reduction in downside risk exposure from adaptation; there are significant differences in downside risk exposure between farm households that did and those that did not adapt to climate change, and (d) provision of information through radio, farmer-to-farmer extension, and extension officers is a key driver of adaptation. The analysis also shows that the quasi-option value, that is the value of waiting to gather more information, plays a significant role in farm households' decision on whether to adapt to climate change. Farmers that are better informed may value less the option to wait to adapt, and so are more likely to adapt than other farmers.

Table 3: List of Adaptation Strategies in Agriculture

No	Adaptation Strategy in Agriculture
1	Change crops/ crop switching/crop diversification
2	Soil conservation
3	Water conservation
4	Mixed crop livestock farming system
5	Mixed crop fish farming system
6	Changing planting and harvesting dates
7	Using drought-resistant varieties
8	Using high-yield water sensitive crops
9	Floating garden in the flooded area
10	Cage Fishing
11	Duck rearing in the flooded area

An overwhelming number of studies (Amthor, 2001; Cline, 1992; Fuhrer, 2003; Rosenzweig and Parry, 1994; Tol, 2002) have contributed to the assessment of climate change impacts in agriculture. Those studies mainly look into how temperature, carbon emission, sea level rise and such climatic variables impact on the crop yields. Mainly agronomic models have been used in these studies by setting a direct relationship between climatic variables and crop yields. Since these studies assume that farmers make no change in crop choice, the predicted net revenue losses in the crop yield caused from climatic variables are large. There are four competing strands of research into the economic impacts of climate change on agriculture: agronomic, panel data, agro-economic and Ricardian. The agronomic literature predicts large and dire yield losses (Rosenzweig & Parry, 1994) especially in many areas of Africa (Deressa et al., 2005; Gbetibouo & Hassan, 2005). Panel data studies examine weather surprises and also suggest climate change will be harmful, though their predictions are not as dire as those of the agronomic studies (Deschenes & Greenstone, 2007). Agro-economic models take farmers' yield losses as given, but predict that farmers can reduce the impact by switching crops (Adams et al., 1990). Finally, the Ricardian model captures the actual adaptations that farmers make and measures the final net impact (Mendelsohn et al., 1994; Mendelsohn & Dinar, 2003). The problem with the first two approaches is that they do not capture adaptation and so overestimate damages. The problem with the agro-economic approach is that the burden of capturing adaptation falls on the analyst. Finally, the problem with the traditional Ricardian approach is that it is a 'black box' so that the actual adaptations by farmers are not revealed. Kurukulasuriya and Mendelsohn (2008) developed structural Ricardian Model to overcome the shortcomings of the overstated four types of models.

3. Climate Change Adaptation: Bangladesh Experience

The economy of Bangladesh has been stepping into high growth era in the recent years after experiencing a dismal growth performance in the 1980s and 1990s. The average annual GDP growth rate was 3.2 % in the 1980s and 4.8 % in the 1990s while it jumps to above 6.0 % in the recent years. In spite of the global recession, Bangladesh has been maintaining relatively high growth due to its own economic resilience, especially in the export and remittance inflows during the recession. Bangladesh has achieved remarkable progress in achieving poverty reduction and the Millenium Development Goals (MDGs). Per capita GDP increased from USD 277.0 in 1992 to USD 755.0 in FY11. The national head count rate of poverty as measured by the upper poverty line has declined from 56.6 % in 1991 to 31.5 % in 2010. Headcount rates for urban and rural areas are 21.3 and 35.2 respectively in 2010. Although large difference still exists in

the incidence of poverty between rural and urban areas, levels of poverty are falling faster in the rural areas. Income inequality in rural areas has improved, while it has deteriorated in urban areas.

Along with economic development, the economy of Bangladesh has acquired steady progress in the socio-economic development of the country. The net enrolment rate in primary education has increased from 60.5 % in 1991 to 95.6% in 2010. Gender parity in primary and secondary education has been achieved. Infant mortality has been halved from 92 per 1,000 live births in 1991 to 45 per 1,000 live births in 2009. The human development index in 1995 was 452, which increased to 543 in 2007. Bangladesh has earned the distinction of achieving a major decline in population growth rate and of graduating to the medium human development group of countries in the UNDP's ranking. Bangladesh has been awarded a UN award for its remarkable achievements in attaining the Millennium Development Goals (MDGs), particularly in reducing child mortality. Average life expectancy at birth has increased to 66.9 years in 2010. It is estimated that over 86.0% of the population has access to safe drinking water.

The population of Bangladesh is now approximately 150 million people and around 25% live in urban areas. The rural sector still accounts for the majority of the population — as well as the majority of the poor – with around 63% of the workforce engaged in agriculture. It still remains the biggest sector of the economy but represents a declining proportion of GDP. In 2003-04, contribution of broad agriculture (crop, forestry, fishery, livestock) to GDP was 23.94 which came down to around 20% in 2010

3.1 Visions and Development Plans of Bangladesh

Bangladesh has adopted a coordinated approach in its development planning process to achieve high growth in the medium and long term.

3.1.1 Vision 2021

The presented government in its election manifesto declared a set of development goals in the name 'Vision 2021' expressing the long-term objectives of the country. This vision has included the goals and objectives of both the economic and social sectors. According to the article 15 of the constitution of Bangladesh, the Government has taken the goals to provide food, clothing, shelter, education and health care to all citizens. The Government is aiming to reduce poverty and in the Millennium Development Goals declared by United Nations by 2015 or 2017 at the latest. A sustainable safety net will be established for the extreme poor until poverty is eliminated. There will be no food shortage and food self-sufficiency will be achieved through agriculture and rural development. Initiatives will be taken to increase the average life expectancy to seventy years, and to reduce child and maternal mortality rates. In case of education, the Government will make efforts to achieve the elimination of illiteracy by 2014, the

creation of a generation educated in science and technology and an improvement in the quality of education through ensuring higher salary for teachers.

3.1.2 The Perspective Plan

To achieve the goals of the vision-202, Bangladesh has stepped into a new era of development planning. The document titled *'Outline Perspective Plan (OPP) of Bangladesh 2010-2021: Making Vision 2021 A Reality'* outlines the long term goals and medium term objectives to make a more prosperous Bangladesh in the stipulated time period. The Perspective Plan presents both the future outlook of the country as well as a road map for reaching the destination. The overarching goal of this plan is welfare enhancement of the society by achieving a higher trajectory of inclusive growth. The targets of the key macroeconomic indicators are presented in Table 1.1 below.

Table 4: Targets of Key Macroeconomic Indicators in Perspective Plan

	Benchmark F09	**Target FY21**
Real GDP Growth (%)	5.9	10.0
As per cent of GDP		
Gross Investment (%)	24.2	37.5
Gross Domestic Savings (%)	24.0	30.0
Total Government Revenue (%)	10.4	17.1
Total Government Expenditure (%)	13.8	21.8
Export (Billion US$)	15.6	91.1
Import (Billion US$)	20.3	131.3
Remittance (Billion US$)	9.7	48.5
CPI Inflation (%)	6.7	7.9
Poverty (head count, %)	36.0	14.4

Source: Outline Perspective Plan (OPP) of Bangladesh 2010-2021

3.1.3 Sixth Five Year Plan (SFYP)

The goals of Vision 2021 and of the Perspective Plan 2010-2021 will be achieved through implemention of two medium- term plans. The time span of the first plan will be from FY11 to FY15. The SFYP document is divided into two parts. The first part (Part 1) will focus on the underlying strategies, policies and institutions for achieving the major targets of economic growth, employment, human development, poverty reduction, social protection and environmental management. Resource requirements and financing strategies are also discussed in this part. Part II of the SFYP will discuss detailed sectoral strategies, plans and programmes. One unique feature of the SFYP is that it will be a living document. Therefore, there will be scope for reviewing the resource requirements and allocations over the five year

period. The targets of the major macroeconomic indicators included in the SFYP document are presented in Table 5.

Table 5: Targets of Key Macroeconomic Indicators in SFYP

	Benchmark F09	Target FY15
Real GDP Growth (%)	5.9	8.0
As per cent of GDP		
Gross Investment (%)	24.2	32.5
Gross Domestic Savings (%)	24.0	30.0
Total Government Revenue (%)	10.4	14.6
Total Government Expenditure (%)	13.8	19.6
Export (Billion US$)	15.6	34.2
Import (Billion US$)	20.3	45.1
Remittance (Billion US$)	9.7	15.1
CPI Inflation (%)	6.7	5.5
Poverty (head count, %)	31.5 (2010)	22.0

Source: Sixth Five Year Plan (Second Revised Draft)

3.2 Climate Change Vulnerabilities in Bangladesh

Bangladesh is already vulnerable to many climate change related extreme events and natural disasters. It is expected that climate change will bring changes in characteristics of natural hazard and gradual changes phenomenon in the physical system. The fourth assessment report of the intergovernmental panel on climate change (IPCC) for South Asia predicts that monsoon rainfall will increase, resulting in higher flows during monsoon season in the river system. It has also predicted that sea level rise will be between 0.8 to 0.9 meters which will lead to salinity intrusion and coastal flooding. Rainfall is predicted to become higher and more erratic. Frequency and intensity of natural disasters are likely to increase especially in the northern and western part of the country. Several evidences of these phenomenon and its associated impacts in the agricultural system are already visible in Bangladesh. Erratic 18on-agri of rainfall and temperature, occurrence of extreme weather events and salinity intrusion are key indication of changes in the climatic system. Impacts of climatic change on production and human system are also being noticed in Bangladesh. Among the different production system agriculture will face significant adverse impacts of climate change due to change in hydrological regime. More water in monsoon causes floods and low water flow and erratic 18on-agri of rainfall will result in intense and frequent drought.

Sixth Five Year Plan (SFYP) has mentioned the following CC vulnerabilities of Bangladesh.

Increased Susceptibility to Natural Disasters: The changing pattern of climate variables increases hazard susceptibility in terms of flood, drought, storm surge and salinity intrusion in Bangladesh. It is apprehended that floods will be more intense and will submerge more areas and occasionally will perhaps prolong to devastate people's livelihoods, national economy and infrastructure. Different literature also indicates that the central western region will be hit hard due to exacerbated drought and marginal farmers would not be able to maintain livelihood thrusts by switching technologies to offset moisture stress. Simultaneously, increased salinity would tend to reduce crop suitability throughout the southwestern region and perhaps appear to be a deterring factor for industrial activities in the affected areas.

Coastal Impacts - Water Logging: A northward shift in isohaline lines would increase the alarming effect of water logging in the southwestern region. It has been reported that the sea surface temperatures along the northern Indian Ocean (i.e., Bay of Bengal) has gradually been up steadily. Though there is little evidence that the frequency of occurrences of cyclones along the Bay of Bengal has actually changed over the past five decades due to sea surface temperature increase. But there is clear evidence that in the recent years, new areas of the country have been experiencing very strong and devastating cyclones. A devastating event that Bangladesh has been experiencing in 2007 was the Aila affected areas in Satkhira, Khulna and Bagerhat district.

Coastal Impacts-Rough Seas and Cyclones: There is a strong correlation between increasing sea surface temperatures and the occurrence of too many rough sea events in the recent years. High wind actions have been causing economic damage to fisher folks by quickly damaging their traditional boats. High wind actions have been eroding sea-facing coastal islands; even embankments located far inland from the open sea. Sudden breaches in embankments have been destroying standing crops, inundating crop lands with saline water, thereby diminishing economic potential of the coastal lands, and forcing poor people to out-migrate from the affected areas by destroying their livelihoods. A potential implication would be that future storm surges might be even higher than those observed currently. About 1.2 million hectares of arable land are affected by varying degree of soil salinity, tidal flooding during wet season, direct inundation by saline water and upward and lateral movement of saline ground water during dry season. Inundation of brackish water for shrimp farming is key causes for secondary salinisation of coastal lands. The severity of salinity problem has increased over the years and expected in increase in the future due to sea level rise.

Increased Drought Posed Higher Risks: North-western region (Barind tract) of Bangladesh is normally drought prone. Droughts are associated with the late arrival or early withdrawal of monsoon rains and

also due to intermittent dry spells coinciding with critical stages of T. Aman rice. Droughts in May and June destroy broadcast *Aman, Aus* and jute. Inadequate rains in July delay transplantation of *Aman* in high Barind areas, while droughts in September and October 202 reduce yields of both broadcast and transplanted *Aman* and delay the sowing of pulses and potatoes. *Boro,* wheat and other crops grown in the dry season are also periodically affected by drought.

Box 2: Climate Change and Migration in Bangladesh

According to International Organization for Migration (IOM), Climate change is expected to affect the movement of people in at least four ways: 1) the intensification of natural disasters – both sudden and slow-onset - leading to increased displacement and migration; 2) the adverse consequences of increased warming, climate variability and of other effects of climate change for livelihoods, public health, food security and water availability; 3) rising sea levels that make coastal areas uninhabitable; and 4) competition over scarce natural resources potentially leading to growing tensions and even conflict and, in turn, displacement. The consequences of climate change (including its effects on migration) will be most severe for the developing world. Particular areas – including the Asian mega deltas - have been identified as 'hotspots' where greater exposure and sensitivity to climate change combine with limited adaptive capacity to suggest that impacts will be most significant.

Predicting the scale of impacts of climate change on migration remains an extremely difficult task. Existing estimates are based on long-term projections with a wide geographical scale and little recognition of the ability of individuals, communities and nations to implement both spontaneous and planned adaptations to reduce vulnerability to environmental change. There is a need for more localized, fine-grained projections, which take realistic account of the potential for adaptation and provide the data needed for planning over the short- and medium-term, as well as over longer term timeframes. Mainstreaming migration into development, climate change and environment policy to minimize the risks and maximize the benefits of human mobility should be acknowledged as a priority issue for policymakers as they seek to plan for environmental and climate related challenges in the future.

Critical Issues for Bangladesh

More than 50 million people still live under poverty in Bangladesh and many of them reside in remote and ecologically fragile parts of the country, such as flood plains and river islands (chars), or the coastal zones where cyclones are a major threat. The increasing trend in population growth means that, while disaster preparedness may have improved in many ways, an ever growing number of people are exposed to these environmental threats.

The country's environmentally susceptible regions are also facing the consequences of growing pressure on the environment as a result of rising demand for water, inadequate maintenance of existing embankments and other environmental protection measures, and rapid and often unmanaged urbanization and industrialization. These pressures risk creating new environmental problems, not least in the country's fast growing urban slums.

Climate change in Bangladesh is expected to aggravate many existing vulnerabilities, with increasingly frequent and severe floods, cyclones, storm surges and droughts forecast. Sustained and sustainable growth and development will be crucial in Bangladesh's long-term efforts to adapt to climate change, and within this framework, migration has an important role to play.

International migration is an important phenomenon, but far more people move within the borders of Bangladesh, both temporarily and permanently – and often with positive economic benefits for themselves, their destination area (urban or otherwise), as well as for family members who choose to remain in rural areas.

Environmental factors will be an increasingly important component of people's migration decisions over the course of the 21st century. While it remains crucial – morally and practically – to be aware of the long-term threat from climate change, the best way to prepare for the consequences of climate change in 2050 or 2100 is to improve the ability to deal effectively with Bangladesh's existing vulnerabilities now.

3.3 Riskiness of Bangladesh

Global Assessment Report 2009 (GAR 09) identified five categories of countries (very low, low, medium, high & very high) that share common characteristics in terms of their economic vulnerability and resilience to natural disaster loss and their development limitations, particularly their capacity to benefit from international trade. Bangladesh is in the 'high' category. GAR 09 observes that risk cannot be modeled deterministically due to the scarce nature of data on exposure of economic assets. Therefore in trying to understand the risk of any country, there is a tendency to use proxies. GAR 09 observes further that in addition to hazard severity and exposure, a range of other risk drivers related to economic and social development play a crucial role in configuration of disaster risk. Of these, Population density, Human Development index, income, literacy, poverty, inequality, access to technology and access to natural resource are considered relevant. The following table presents the proxy indicators for riskiness of Bangladesh.

Table 6: Proxy Indicators for Bangladesh

Demography	
Population[1] (millions)	164.4
Country Ranking	7
% Urban Population[2]	25
% below 15 years[3]	34.6
% 15 – 64 years[3]	61.4
% over 65 years[3]	4
% (15 – 49) Living with AIDS[4]	0.1
Economy	
GDP at purchasing power parity (PPP) Rank[5]	47
Gross Domestic Product (GDP) per Capita $[6]	1300
$ External Debt per $ GDP[7]	316.17
Sovereign Risk Rating[8]	-
Poverty & Disparity in Income	
% population below $1 income per day[4]	35.9
% population undernourished[4]	30.0
Gini Coefficient [9]	33.4
Human Development	
HDI [10]	0.543
HDI country rank	146
Ratio of Female to Male Youth Literacy [4]	0.9
Education Index[10]	0.530
Country Rank for Education Index[4]	163
Access to Technology	
ICT Development Index (IDI)[11]	1.26
IDI Country Rank	138
Telephones and cellular subscribers per 100 people[4]	2.6
Personal computers per 100 people[4]	1.2
Internet users per 100 people[4]	0.3
Ecosystems	
Land area covered by forest (%)[4]	6.7
Protected areas (%)[4]	1.3
Risk Rating	
Multiple Mortality Risk Class (0 – 10)	9
Economic Vulnerability	High

Source: Global Assessment Report 09

3.4 Climate Change in the Development Planning

3.4.1 3.4.1 Climate Change in Vision 2021

Vision 2021 has declared the following visions and measures:

All measures regarding environment will be taken to protect Bangladesh—including planned migration abroad—from the adverse effects of climate change and global warming. Facing natural calamities, planned reduction of air pollution, prevention of industry and transport related air pollution and disposal of waste in scientific manner will be ensured. Steps will be taken to make Bangladesh an ecologically attractive place through retention of forests and water bodies and prevention of river erosion.

Water Resources: The Government will take the initiative to formulate a comprehensive regional water policy along with India, Nepal and Bhutan for regional water security. In addition, in keeping with a comprehensive water police, measures will be taken for development of our water resources and their rational use.

Agriculture and Rural Development

The Main aim of the government is to ensure "food for all" by taking all possible measures and to make Bangladesh self-sufficient in food by 2013. Subsidy for agricultural inputs will be enhanced and availability of inputs will be made easier. The amount of agricultural loan will be increased and the lending procedure simplified. Incentives will be provided for development of rural warehousing. Fair price for all crops and agricultural products will be ensured. Efforts will be made to attain self-sufficiency in the production of fish, milk, egg, livestock and salt. Efforts will be directed to exporting surplus products after meeting domestic requirement. Other measures include:

i. Loan for share croppers will be made available, employment facilities for farm labourer will be created and they will be brought under rural rationing system.
ii. Appropriate measures to face the challenges of globalization will be taken, including developing commercial agriculture, use of genetic engineering methods and development of on-agricultural sector in villages. In order to increase agricultural production, special emphasis will be placed on modernization of agriculture, innovation of technology and expansion of facilities for research in agriculture.
iii. Village development will include provision of urban facilities and distribution of Khas land among landless farmers. Efforts will be taken to ensure that lease of khas ponds/haors is given to genuine fishermen. All land records will be computerized and a land reform commission will be formed to ensure increased production and social justice in the distribution of land and water bodies.
iv. Measures will be taken to reclaim land in the coastal areas.

Environment and Water Resources: An integrated policy and plan will be formulated to protect the country from the adverse effects of global warming; to create a pollution free environment and to save water resources. Projects will be undertaken for river dredging, water conservation, flood control, prevention of river erosion and protection of forestry. Attempts will also be made for restoring and

maintaining ecological balance. Initiatives will be taken to implement the Ganges barrage project to expand irrigation facilities, prevent salinity and to solve the problem of scarcity of sweet water in the Sundarban region.

3.4.2 Climate Change in Sixth Five Year Plan

The SFYP has documented a separate chapter on environmental management and climate change.

Environmental Management Objectives in the SFYP

While perceiving the long-run consequences of environmental degradation to the country's ecosystem and citizen's welfare, the Government has set a number of goals to attain a sustainable environment and to address the fallout of climate change. With a view of attaining these goals, the main objectives relating to environment and climate change under the SFYP can be described in the following manners:

- To promote appropriate environment management systems for mitigation and adaptation to climate change.
- To promote appropriate environment management systems for sustainable development.
- To preserve, protect and develop the natural resource base.
- To ensure conservation of biodiversity and its sustainable utilization.
- To ensure active participation of the poor, especially the women in environment management activities at all levels.
- To promote environment friendly activities in development of interventions.
- To monitor, control and prevent environmental pollution and degradation related to soil, water and air.
- To strengthen the capability of public and private sectors to manage environmental concerns.
- To initiate actions with regard to obligations under international treaties and conventions for minimizing adverse impact on global environment.
- To promote cooperation with regional and international institutions/organizations to address local, regional, and global environmental problems.
- To build capacity in the area of environmental health through both public and private sectors.
- To undertake research and development for innovating technology in national perspective and application of modern technology, information exchange and benefit sharing with other countries.
- To create public awareness, in order to participate in environment promotion activities.
- To undertake Environmental Assessment and environmental reporting.

- To promote 3R (Reduce, Reuse and Recycle) waste management strategy.
- To improve air quality through clean fuel and vehicle.
- To promote public-private partnership in environment management.
- To reduce dependency on fossil fuel by promoting solar/green energy.
- To improve air quality in major cities through monitoring and prevention measure.
- To establish Environment Management System (EMS) in Industries for pollution control.
- To mainstream poverty-environment-climate-disaster nexus in the development project design, budgetary process, project implementation and monitoring process.

Environmental Management Strategies in the SFYP

The significance of attaining a sustainable environment can hardly be over-emphasized. In this context, the Government is undertaking the following policies, strategies and programs during the SFYP:

- Environment committees at Division, District and Upazila levels will be activated with the participation of all stakeholders.
- National Environment Council headed by the Prime Minister and executive committee of National Environment Council headed by the Minister for Environment and Forests would be activated.
- Drafting of Environmental Impact Assessment (EIA) guidelines for all sectors under the Environment Conservation Act (ECA) 1995 will be formulated in order to ensure effective enforcement of EIA.
- Existing environmental laws and regulations will be amended to address new environmental issues.
- Department of Environment will be strengthened in the light of existing Environment Policy, Environmental Act, Rules and Environment Management Action Plan in order to coordinate, monitor and implement these activities.
- 'Polluters Pay Principle' will be followed in order to ensure strict compliance of environment legislation.
- Sectoral legislations are to be reviewed and redrafted in light of Bangladesh's commitments expressed through signing and ratifying of a number of International Conventions and Protocols on environment.
- Incentives, in the form of tax-rebate, tax-holiday etc. will be provided and incremental cost incurred by the Environment-friendly entrepreneurs will be met in various forms/sources.
- Environmental Impact Assessment will be made while processing each development project requiring approval of the Government.

- 'National Environment Fund' will be established in order to provide assistance to the victims of environment degradation caused by the natural disasters and anthropogenic activities.
- Enhance national capacity to mainstream poverty-environment-climate nexus in the development project design, budgetary process, project implementation and monitoring process.

Box 1: Investment in Climate Change Adaptation in Bangladesh

SFYP has mentioned that over the decades, the Government, with the support of development partners, has invested in:

- Flood management schemes to raise the agricultural productivity of many thousands of kilometers of low-lying rural areas and to protect them from extremely damaging severe floods.
- Flood protection and drainage schemes to protect urban areas from rainwater and river flooding during the monsoon season.
- Coastal embankment projects, involving over 6,000 km of embankments and polder schemes, designed to raise agricultural productivity in coastal areas by preventing tidal flooding and incursion of saline water.
- Over 2,000 cyclone shelters to provide refuges for communities from storm surges caused by tropical cyclones and 200 shelters from river floods.
- Comprehensive disaster management projects, involving community-based programs and early warning systems for floods and cyclones.
- Irrigation schemes to enable farmers to grow a dry season rice crop in areas subject to heavy monsoon flooding and in other parts of the country, including drought-prone areas.
- Agricultural research programs to develop saline, drought and flood-adapted high yielding varieties of rice and other crops, based on the traditional varieties evolved over centuries by Bangladeshi farmers.
- Coastal 'greenbelt' projects, involving mangrove planting along nearly 9,000 km of the shoreline.

3.5 Climate Change Adaptation in Bangladesh

Experience of Bangladesh in preparation of climate change strategies or policies are quite recent. Bangladesh did not have a climate change strategy or plan until recently, but rather a wide variety of measures implemented as part of key policies in Bangladesh to mitigate vulnerability to climate change (Tanner et al, 2007).

3.5.1 Planned Adaptation

A number of direct adaptation policies such as plans, policies, strategies and action plans undertaken by Bangladesh in the recent years have been presented in the following:

Table 5: List of Planned Adaptation Polcies in Bangladesh

Planned Adaptations
The National Adaptation Programme of Action 2005 (NAPA)
Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP)
Sectoral Adaptation Policies: National Water Policy 1999 National Water Management Plan 2001 National Environmental Management Action Plan (NEMAP) National Land Use Policy (NLUP) and the National Forest Policy (NfoP)

The National Adaptation Programme of Action 2005 (NAPA)

Following the broad guiding principles given by the LDC Expert Group (LEG), the Ministry of Environment and Forest (MoEF) prepared NAPA for Bangladesh in 2005. The NAPA was formulated as a response to the decision taken at the UNFCCC's Seventh Session Conference of Parties (COP7). The NAPA aimed to assemble the understanding of the current state of affairs from discussions with appropriate stakeholders from four sub-national workshops and one national workshop (MoEF, 2005). It recognizes the immediate and urgent needs of the country in regard to adaptation activities and has listed priority activities (BCAS, 2008). The NAPA was prepared keeping in mind the sustainable development goals and objectives of Bangladesh where the importance of addressing environmental issues and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution was recognized (BCAS, 2008).

The suggested future adaptation strategies mentioned in NAPA are:

- Reduction of climate change hazards through coastal afforestation with community participation.
- Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.
- Capacity building for integrating climate change in planning, designing of infrastructure, conflict management and land water zoning for water management institutions.

- Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.
- Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.
- Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).
- Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.
- Enhancing resilience of urban infrastructure and industries to impacts of climate change.
- Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.
- Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.
- Promoting adaptation to coastal crop agriculture to combat increased salinity.
- Adaptation to agriculture systems in areas prone to enhanced flash flooding in North East and Central Region.
- Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.
- Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh.
- Exploring options for insurance and other emergency preparedness measures to cope with enhanced climatic disasters.

Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP)

Bangladesh Climate Change Strategy and Action Plan (BCCSAP) is the most recent policy documents of the government aiming to address both adaptation and mitigation for the period of the decade- 2009 to 2018. It was prepared in 2009 focusing 10 years action measures to encounter the potential challenges and variable condition. BCCSAP identifies all the climate induced hazards including flood, drought, salinity intrusion, cyclone and storm surge variations in temperature and rainfall etc. and their associated impacts on different sectors. BCCSAP identifies a set of activities/measures under the following six major themes:

i. Food security, social protection and health
ii. Comprehensive Disaster Management
iii. Infrastructure
iv. Research and knowledge management

v. Mitigation and low carbon development and

vi. Capacity building and institutional strengthening

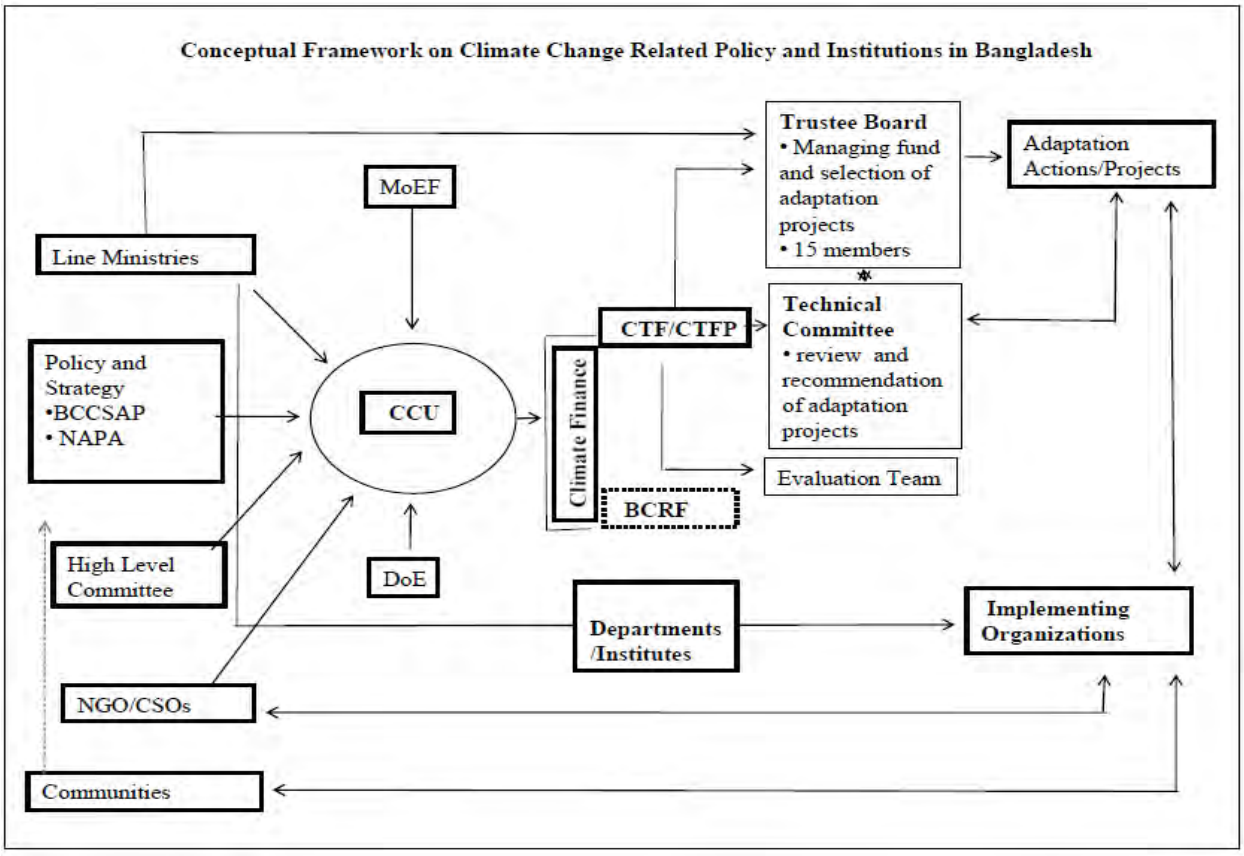
Sectoral Adaptation Policies

A number of sectoral policies and plans were developed by the Government of Bangladesh (GoB) since 1990s. Considering the fact that Bangladesh is highly susceptible to climate change, only one sectoral policy on the Coastal Zone, has considered climate change (BCAS, 2010). The National Water Policy (NWP) formulated in 1999, considered firstly short, medium and long term perspectives for water resources in Bangladesh. The NWP was followed by the National Water Management Plan (NWMP) in 2001. Though there is a huge effect of climate change on water resources in Bangladesh, the NWP does not mention the climate change issue at all. However, the NWMP identifies climate change as one of the future elements affecting supply and demand of water. The National Environmental Management Action Plan (NEMAP), which was published in 1995, does not illuminate climate change. Similar to NEMAP, the National Land Use Policy (NLUP) and the National Forest Policy (NFoP) does not make direct reference to climate change. Climate change was not also addressed in the Poverty Reduction Strategy (PRS) Papers until recently. The present PRS recognizes the threat of climate change and its adverse impacts on the development process. It understands the need for integration/mainstreaming of adaptation measures into other policy areas and the implementation of the adaptation projects identified in the NAPA (BCAS, 2010).

3.5.2 Institutional Mechanisms

The Figure 1 illustrates how the climate change institutional mechanism has been working in Bangladesh from policy formulation to implementation level. The MoEF is mainly responsible for the policy formulation on climate change and its adaptation while the Climate Change Unit (CCU) and Department of Environment (DOE) implement projects and programmes under NAPA and BCCSAP at the community level. Different line Ministries and their departments also contributed to the policy formulation and implementation level. Government has formed some high level committees to oversee the planning and implementation process of the adaptation actions in the country. Inter-ministerial committee on climate change headed by the state minister of MoEF and all party parliamentary committee on environment and climate Change headed by a member of the parliament are among the committees set up by the government in this purpose.

Figure 4: Climate change related policy mechanism in Bangladesh



Source: Huq and Rabbani, 2010

Table 6 : Climate Change Related Institutions and their Activities in Bangladesh

Name of the Institutions	Activities
Ministry of Environment and Forest Department of Environment Climate Change Cell	• Climate Change Focal Point • Responsible to comply under the decisions of the UNFCCC • Responsible for the preparation of national communication, formulation of national adaptation programme of action, providing approval for CDM projects, • Conducting international negotiations and • Facilitating mainstreaming at the sectoral level.
Ministry of Planning General Economic Division	• Preparing and coordinating overall midterm and perspective planning. • Supporting sectoral planning with guidance. • Enhancing institutional capacity of the GED to facilitate

	climate change in the planning perspective.
Ministry of Finance	• Responsible for Budget allocation • Setting Midterm Ministry Budget Framework (MTBF) where the key performance indicator of the MOEF has been set ans assessed against the budget allocation
Ministry of Health and Family Planning/ Directorate of Health	• Operating countrywide diseases surveillance, • Ensuring adequate availability of Ambulance, Medicine, Vaccine, Surgical Equipment etc. in the Upazila Health Centres of disaster prone areas.; • Educating people about health care through radio, television, newspaper and other media during floods and after cyclones; establish temporary hospitals and cyclone shelters to meet the emergency needs and • Ensuring active participation in the meeting of Inter-Ministerial Disaster Management.
Bangladesh Meteorological Department (BMD)	• Responsible for watching over weather conditions, and ensures improvement of cyclone forecast procedures and supply of information on regular basis. • Ensuring full time effectiveness of the quickest channel of communication for disseminating weather warnings to all concerned. • Preparation and submission of Special Weather Bulletin and broadcast/publicize the same through national news media such as the all stations of Radio and Television and in national newspapers
Ministry of Food and Disaster Management	• Dealing with natural disasters and ensure availability of food at country level. • Reviewing the Action Plan of the Ministry on disaster management every three months. • Responsible for the identification of the disaster prone Thanas and areas and the population likely to be affected by the disaster. • Update the list of foreign and private agencies willing to

	participate in the disaster preparedness, emergency response and rehabilitation programmes. • Arrange meetings of the National Disaster Management Council and Inter-Ministerial Disaster Management Coordination Committee to assess the disaster preparedness of different Ministries, agencies, departments, local governments, autonomous bodies, CPP, Red Crescent, NGOs, etc.
Ministry of Water Resources Bangladesh Water Development Board	• Flood Forecasting and Warning Centre (FFWC) of Bangladesh Water Development Board acting as Focal Point. • Responsible for the construction of embankments in disaster prone coasts and islands according to designs approved by the government; • Undertake operation of sluice gates and other water discharging devices in completed embankment areas; • Monitor continuously the condition of the embankment and repair the breaches and weak points in adequate manner and operate the Flood Forecasting and Warning.
The Ministry of Agriculture, Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Council (BARC) and Bangladesh Agricultural Research Institute (BARI)	• Responsible for carrying out research on the development of different crop varieties resilient to different climate stresses. • Keeping stocks of seeds, fertilizers and insecticides; • Training of various levels of officers for participation in different steps of cyclone preparedness activities; • Allocation of funds for the purchase and distribution of seeds and fertilizers; and the implementation of post disaster relief operations.
Ministry of Information	• Responsible for the popularization of the techniques for preparedness and survival during pre-disaster, disaster and post-disaster period including leaflets/booklets supplied by the Disaster Management Bureau and concerned Ministry through television, Radio and other publicity media.

	• Arranging wide publicity with the help of mass media about the cyclone and flood warning signals with necessary explanations; ensure strict performance of the allotted duties by Radio, Bangladesh Television, News Media, Press Information Department, Mass Communication Department and
Ministry of Local Government, Rural Development and Cooperatives, and its associated organizations are	• Responsible to encourage local government agencies for building roads, bridges and culverts for communication to cyclone shelters and growth centres; • Counsel people to keep the foundations of their residence above flood level; • Prepare maps showing population concentration and deep wells, protected pond and other sources of drinking water; • Ensure reserve stock of tube wells and spare parts; • Ensure availability of drinking water at times of need; • Ensure availability of repair workers for emergency repair of damaged tube wells in affected areas.
Bangladesh Institute of Development Studies (BIDS)	Research on climate change related issues along with economic development, population studies, human resources and social sciences related to planning.
Bangladesh Centre for Advanced Studies (BCAS)	An independent policy, research and implementation institute working on sustainable development (BCAS, 2002) and implementation of projects related to climate change and climate variability issues.

Source: Modified from Bangladesh Centre for Advanced Studies, 2010.

Climate Change Unit (CCU)

Climate Change Unit (CCU) has been formed by the government as a nodal point under the Ministry of Environment and Forests (MoEF) in June 2010 with the responsibility of managing the climate related funds of the government and providing technical and expertise support for the MOEF. The government has also taken initiatives for establishing the climate change unit in all relevant ministries to plan and implement the projects to address climate change. The CCU is also responsible for managing climate change related funds and establishing links among the sectoral agencies and prepared a common knowledge base for NGO efforts on climate change related issues.

3.5.3 Climate Change Related Funds

The GoB has created two funds to implement the plans and actions delineated in NAPA and BCCSAP which are as follows:

Climate Trust Fund (CTF)

The CCU is currently supporting adaptation actions under Climate Trust Fund (CTF) which is being guided by a Trusty Board and a Technical Committee. Mainly GoB is contributing to this fund. 40.23% of this fund has been allocated for the infrastructure projects in water management followed by 21.59% in environment forest sector. Climate Change Trust Act 2010 has been enacted to manage the BCRF through a high powered trustee board. This act has defined investment in four areas from this trust fund: adaptation, mitigation, technology transfer and action research.

Bangladesh Climate Resilience Fund (BCRF)

Bangladesh Climate Resilience Fund (BCRF) has also been created by the government for supporting actions to address climate change. Mainly international development partners of Bangladesh are contributing to create this fund.

3.5.4 Specific Adaptation Programmes

It is difficult for the central government and sectoral agencies to reach the rural poor community and build their capacity to adapt to the climate change events. Therefore, building capacity of people living in vulnerable area is essential and thus community based adaptation is considered as one of the most effective ways of reaching them and addressing community needs. Rahman et. al. 2007 has mentioned the following activities in adaptation to Climate Change in Bangladesh

Reducing Vulnerability to Climate Change (RVCC)

Reducing Vulnerability to Climate Change (RVCC) was the first project of its kind on Community Based Adaptation (CBA) to climate change implemented by CARE Bangladesh in the South western part of Bangladesh in association with 17 partner organizations. The project conducted participatory vulnerability and need assessments to deal with climate related problems which will be aggravated in the future due to climate change. The project put importance on diversification of livelihoods options of vulnerable communities, generated useful knowledge on how to communicate climate change (and adaptation) messages at the community level, and produced valuable knowledge and information about community-based adaptation to climate change. The project has enhanced awareness among the coastal communities and a number of organizations involved in promoting and implementing similar activities with coastal communities. One of the key lessons learnt during the project term is that activities focusing on livelihoods and disaster risk reduction help bring changes in coastal communities' life and quality of living.

Increase Resilience of Disaster Prone Communities in Gaibandha

Practical Action, former Intermediate Technology Development Group (ITDG) works in Gaibandha area where thousands of poor people live under continuous threat of homelessness, and loss of, their possessions and means of livelihoods, and risks of injury and death due to weather – related natural disasters – flooding, river bank erosion, storm, cyclone, drought, and cold wave. The project targeted to increase the resilience of 10,000 men, women, and children from vulnerable communities to cope with, and adapt to, the impacts of climate– induced hazards. The project also effectively brings, together issues of poverty reduction, environmental and natural resources management, disaster risk reduction and climate change.

The project has three main components:

- To strengthen the capacity of communities and government and non-government supporting institutions to prepare and respond effectively to future climate-induced emergencies
- To develop and promote practical (technology-based) interventions to strengthen people's livelihoods and natural resource assets
- To promote the engagement of vulnerable communities in decision making processes on climate-related adaptation strategies in order to influence policy change and increase self-sufficiency

Building Adaptation Strategy to Climate Change for Drought and Flood Prone Areas of Bangladesh

Bangladesh Lawyers Association and Bangladesh Centre for Advanced Studies (BCAS) are jointly documenting different practices to deal with climate variability and extreme events in flood and drought prone areas with financial support from Oxfam NOVIB, the Netherlands. Documentation of existing coping strategies and practices in relation with natural disasters particularly flood in one of the flood prone area in the central zone of Bangladesh and drought in one of the drought prone area of northwest district is one of the key objectives. The exiting strategies and practices will be categorized based on their innovativeness, effectiveness and outcome including negative and positive in relation to environment, socio-economic development, livelihoods opportunities etc. The wider dissemination of good practices among non-government organizations in the South Asian region including NOVIB partners and members of the Climate Action Network – South Asia (CANSA) through a regional workshop.

Livelihood Adaptation to Climate Change (LACC) in Drought Prone Areas

The project LACC is jointly implemented by the Food and Agriculture Organization (FAO) and the Department of Agriculture Extension (DAE), under Climate Change Cell, Department of Environment.

The project tried to address the needs of farmers and agricultural crops in drought prone and drought affected areas of Bangladesh with regard to risk management and adaptation in related livelihoods.

Adaptation Research of Climate Change Cell, Department of Environment

Climate Change Cell has undertaken the following research activities in different hot spots and relevant issues in Bangladesh with the support of some academic institutions, research organizations and NGOs;

- Adaptive Crop Agriculture including innovative Farming Practices in the Haor Basin
- Adaptive Crop Agriculture including innovative Farming Practices in the Coastal Zone of Bangladesh
- Climate Change and Health Impacts
- Crop Insurance as a Risk Management Strategy in Bangladesh
- Climate Change, Gender and vulnerable Groups in Bangladesh

3.5.5 Autonomous Adaptations

To define community-led adaptation strategies, Pender (2007) identifies the following adaptation strategies:

- Doing nothing: the least ideal strategy, obviously, but a common one, due to lack of adaptive capacity
- Sharing losses: whereby those affected do not bear the full cost of the effects of climate change; this may include insurance schemes as well as international aid
- Modifying threats: includes, for example, changing agricultural cropping patterns or building a breakwater on an island to safeguard industries
- Preventing effects: usually requires pre-planning and investments such as the building of large embankments to protect areas from flooding
- Changing use: a different use of resources such as growing shrimps in newly submerged areas
- Changing location: moving homes or businesses to safer areas
- Restoration: restoring an area damaged by the effects of climate change to its previous condition

Agriculture has been mentioned as a primary means by which the impacts of climate change are transmitted to the poor, and as a sector at the forefront of climate change mitigation efforts in developing countries (Hertel 2010). Agriculture in Bangladesh that is very dependent on nature, suffers from different types of extreme events of climate change almost every year. Therefore, individuals as well as the communities of Bangladesh have gradually been innovating different alternatives in broad agriculture and introducing them as a way of adaptation to climate change.

Crop Switching

There are a number of strategies which are considered as means to adaptation to climate change in agriculture. Bradshaw et al.(2004) has mentioned a number of adaptation strategies which are in the following: crop diversification, mixed crop livestock farming systems, using different crop varieties, changing planting and harvesting dates, drought-resistant varieties and high-yield water sensitive crops. Di Falco et al (2011) has identified a set of strategies (e.g., changing crop varieties, adoption of soil and water conservation strategies) for climate change adaptation in Nile basin area. Wang et al (2008) has referred adjusting irrigation practices, crop varieties and livestock species to both temperature and precipitation levels as adaptation strategies. Studies on crop choice as a way of adaptation to climate change in Bangladesh were almost non-existent in Bangladesh. A recent study (Monir, 2012) shows that farmers of Bangladesh are gradually switching from climate sensitive crops to climate insensitive crops. The study also shows that Aman rice which is very much dependent on rainfall for its production has been unpopular day by day while boro rice which is dependent on irrigation is becoming popular to farmers.

Integrated Farming

Integrated farming refers to a farming system where farms produce crops, fish and livestock in the same field in an integrated manner. Integrated rice-fish farming can play an important role in increasing food production as the integrated farming system is better than monoculture in terms of resource utilization, diversity, productivity, and both the quality and quantity of the food produced (Ahmed and Garnet, 2011). Using the Cobb-Douglas production function model in the survey data of Bangladesh, they have shown that the highest average annual productivity of rice per hectare was found in integrated farming (10,178 kg), followed by rice monoculture (9,691 kg) and alternate farming (4,986 kg). In a UNFCCC workshop on adaptation in 2004, a number of newly innovated adaptation strategies in agriculture sector of Bangladesh have been mentioned with pictorial definition (Ahmed, 2004). Integrated farming was one of the adaptation strategies as mentioned in the UNFCCC workshop.

Picture 1: Integrated Farming in Bangladesh

The Picture in the left panel shows, plain low lying agriculture that has been converted to an integrating farming land. Here fish and crops are cultivated together and the border of the farm has been turned into an embankment where different types of vegetables are cultivated. Just inside the embankment, a ditch is located where fish are cultivated. While in the middle of the farm, rice is cultivated.

Picture in the lower panel shows that farmers are fishing in an integrated farming system.

Floating Garden

Floating garden refers to a farming system where floating beds are prepared with water hyacinth and these beds are used as cultivating land. In the UNFCCC workshop on adaptation in 2004, floating garden has been highlighted as one of the adaptation strategies in the flooded areas of Bangladesh. Apparently, floating garden seems to be more expensive and cumbersome to develop. Studies on the efficiency of this farming system are almost non-existing so far.

Picture 2: Floating Garden in Bangladesh

	Picture 2(a): Preparing a floating garden with water hyacinth
	Picture 2(b): Vegetables growing on a floating garden

Cage Aquaculture

The above mentioned UNFCCC workshop also mentioned cage Aquaculture as an alternative way of fishing. The benefit of this system is that fishes will not disappear even flood or cyclone occurs. In the traditional aquaculture, when flood or cyclone occurs, usually the boundary of the lake or fishing farm becomes partly or wholly damaged hampering the cultivation of the fishes.

Picture 3: Cage Aquaculture in Bangladesh

Duck Rearing

In the submerged land area, spanning partly or a whole year, duck rearing can be a good way to use water logging productively. UNFCCC workshop in 2004 also mentioned Duck rearing as a way of adaptation to climate change in Bangladesh with the following picture.

Picture 4: Duck Rearing Water Logged Areas of Bangladesh

3.6 Policy Suggestions

3.6.1 Determination of Climate Sensitivity Crop Varieties

The present research has found that the probability of choosing different crops will change with future changes in temperature and rainfall in Bangladesh. This implies that farmers will be more willing to cultivate the climate change tolerant or insensitive crop varieties. This trend has already been observed in Bangladesh. For instance, in the case of rice production, farmers are gradually changing their position from the cultivation of the traditional rainfed 'Aman' variety to the irrigation dependent 'Boro' rice. Considering this change in trend, the government of Bangladesh should take measures to determine climate sensitive crops. It will help farmers to choose crop varieties with greater confidence and will allow them to generate more revenue from crop production. The crop production policy in the existing National Agricultural Policy (NAP) has emphasized crop diversification in favour of cash crops and crops suitable in the coastal and hilly areas. Among the different aspects, NAP has also addressed issues of environmental protection in agriculture emphasizing on crop rotation and salt tolerant seed varieties. This research intends to focus along with environmental protection; NAP should address climate change

adaptation issues in agriculture. Recent literature on climate adaptive agriculture in Bangladesh illustrates the alternative techniques of agriculture. These include, integrated farming, floating garden, among others. Literature also emphasizes the efficiency of these alternative forms of agricultural practices in Bangladesh. So the emphasis on such alternative farming as climate change adaptation needs to be highlighted in the NAP. Therefore, NAP should be developed from this point of view so that farmers can be fewer victims of aberrant behaviour of climate change events in future.

3.6.2 Promoting Food Security

Climate change events and natural catastrophes cause great stress to crop production in Bangladesh. According to the Bangladesh Agricultural Year Book 2010, 113465 metric tons of Aman rice and 369591 metric tons of Boro rice were lost due to floods, excessive rain fall and flash floods in 2008-09 and 2009-10 respectively. Crop switching as a climate change adaptation can be used to ensure food security in the country. Bangladesh is a highly populous country, which makes food security a particularly long standing challenge in the country. IPCC estimates that by 2050, rice production in Bangladesh could decline by 8% and wheat by 32%. In order to avoid this projected decline, climate change adaptation through crop switching can play an important role to ensure food security in the country. Table 2 presents the perception of present level of impacts of climate change on crop in the flood and flash flood affected areas. It is found that different types of climate change events are perceived to lead crop loss from 10% to 40%.

Table 7: Perception of Present Level of Impacts of Climate Change on Crop in the Flood and Flash Flood Affected Areas

Major Changes and Impacts	Crop loss/yield reduction (%)
Soil quality degradation by sand deposition due to bank erosion	10
Improve soil health by deposition of silts	20
Changes in flooding characteristics	30
Changes in cropping pattern with new varieties	15(increase)
Damage of Aus and Aman by riverine flood and river bank erosion	30
Damage of Boro rice by flash flood in basin areas	40
Delay sowing of pulses and vegetables	30
Increased water logged areas	20
River bank erosion causing decreased of cultivable land	20
Increasing incidence of pest and diseases	10

Source: Key experts interviews and workshop for MDG-GED project, 2008

3.6.3 Policy Differentiation in Different Agro-ecological Zones

Different land areas of the country are suitable for different crops. Bangladesh Statistical Yearbook 2010 has listed 30 different agro-ecological zones in Bangladesh. Presence of alluvium in the soil of the different ecological zones in the country varies from 2% to 98% and the clay level varies from 0 to 100 %. Therefore, crops adapting with climate change will differ from one agroecological zone to another. Therefore, NAP, NAPA, BCCSAP and the different sectoral policies should be differentiated for different ecological zones of the country.

3.6.4 Developing Seed and Fertilizer Distribution and Pricing Policy

Distribution mechanism of agricultural inputs, such as seed and fertilizer should be developed considering the suitable crops adapting climate change in different agro-ecological zones of the country. At present, public and private sectors as well as non-government organizations are involved with supplying seeds to the farmers. The Government should also give support as subsidies for fertilizer, diesel and irrigation. Climate change adaptation can be adopted in the subsidy policy in agriculture. Price mechanism of the agriculture inputs can be developed in such a way so that farmers are induced to climate change adaptation.

4.0 Conclusion

Planning, policy formulation and implementing adaptation strategies for climate change are still very nascent in Bangladesh. However, Bangladesh has made immense progress on this front in a relatively short period of time due to certain climatic realties that have been continually thrust upon them. For instance, in the last decade, both at the international and national level, Bangladesh has been regarded as a potential worst victim of climate change. In 2005 and in 2007, Bangladesh experienced two major catastrophies- ‘Aila’ and ‘Sidr’ which displaced millions of people in the southern part of the country. Moreover, issues such as water logging which started several years back continue to persist in some areas of the country. Thus in the wake of all these events, both the government as well as the Bangladeshi community are now well-aware of climate change triggered extreme events and their potential impacts and are now actively working towards offsetting these impacts. The Government has set up effective and

extensive institutional mechanisms and established dedicated funds from its own sources to take measures to adapt and mitigate climate change events.

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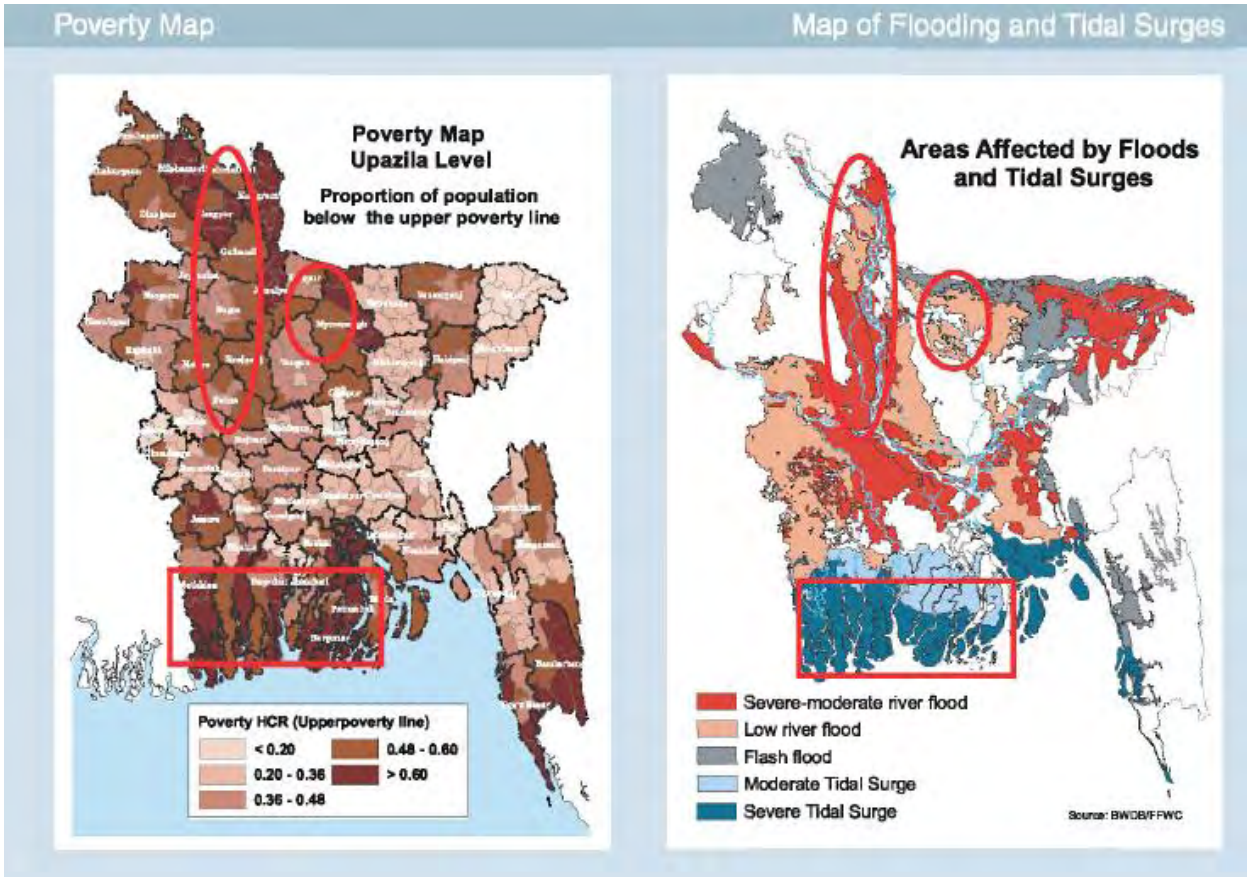
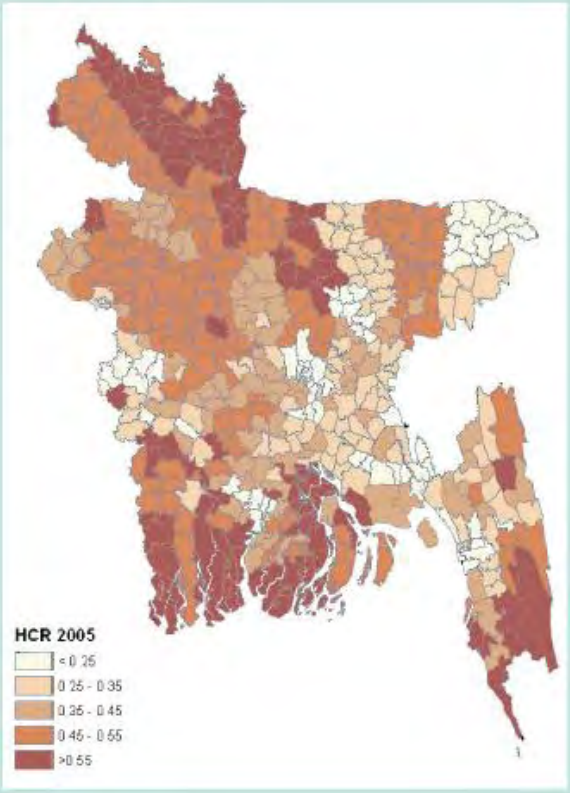
Annex 1


Poverty Map
Map of Flooding and Tidal Surges
Poverty Map
Upazila Level
Proportion of population
below the upper poverty line
Poverty HCR (Upperpoverty line)
< 0.20
0.20 - 0.36
0.36 - 0.48
0.48 - 0.60
> 0.60
Areas Affected by Floods
and Tidal Surges
Severe-moderate river flood
Low river flood
Flash flood
Moderate Tidal Surge
Severe Tidal Surge
Source: BWDB/FFWC

Poverty Map



Extreme Poverty Map