Bangladesh Country Case Study
For National Adaptation Programme of Action (NAPA) Workshop
9-11 September 03
Bhutan

By
Mozaharul Alam

Bangladesh Country Case Study
By
Mozaharul Alam, BCAS, Bangladesh

1 Introduction

The Bangladesh Country Case Study Report is prepared for facilitating training workshop on preparation of National Adaptation Programme of Action (NAPA) which will be held in Bhutan during 9-11 September 03. Key elements and content of the report have been discussed in the preparatory meeting of the Workshop Organizing Committee (WOC) in Bangkok during 12-15 August 03. The report is prepared based on available national development policy and strategy documents, development plans, and climate change vulnerability studies. National Development Plans, National Strategy for Economic Growth, Poverty Reduction and Social Development known as Interim Poverty Reduction Strategy Paper, Vulnerability Assessment to Climate Change and Sea Level Rise, Climate Change Country Study, Initial National Communication to UNFCCC, NAPA Proposal, and other relevant reports are used to prepare this county case study report as agreed in the WOC meeting. It is to be mentioned that the country case study report has highlighted vulnerability context to climate change and variability, and its impacts on national development particularly livelihoods of the affected community.

2 Overview

Bangladesh is one of the South Asian Least Developed Countries and signatory to the United Nations Framework Convention on Climate Change (UNFCCC). Geographical coverage of the country is about 147,570 sq. km with three broader categories of land - hills, uplifted land blocks, and alluvial plains. This low-lying deltaic country is a part of Bengal Basin and formed mainly by the *Ganges*, the *Brahmaputra* and the *Meghna* (GBM) river system. The country is characterised by low per capita gross national product i.e., US$ 370 dollars (WB, 2000), low natural resource base, high population density, and high incidence of natural disasters.

2.1 National Development

2.1.1 Goals and Objectives

Economic emancipation of the ever-growing population of Bangladesh is one of the main objectives of planning activity. Government of Bangladesh (GOB) has thus identified poverty alleviation as the principal objective through human resources development and enhanced investment in education, which can be the means to achieve better human resources. It is increasingly being recognised in Bangladesh, as in other parts of the world, that for development to be meaningful and sustainable over a longer period, environmental concerns must be integrated into all development activities. Further specific environmental actions are also required for a sustainable development including community participation in local level planning and management of local resources.

Environment as a concern for development was first addressed in the Fourth Five-Year Plan (1990-95) and received more emphasis in the Fifth Five-Year Plan (1997-2002). Chapter Ten of this plan, “Environment and Sustainable Development,” elaborately describes the goals and

objectives, suggesting policy outlines and strategies for environmental and resource management towards sustainable development.

A National Strategy for Economic Growth, Poverty Reduction and Social Development is prepared by Economic Relation Division of Ministry of Finance, the People's Republic of Bangladesh in December 2002. This national strategy document states that Bangladesh has one of the most vulnerable economics, characterised by extremely high population density, low resource base, and high incidence of natural disasters. These have implications for long-term savings, investment, and growth.

The National Strategy has also recognised vital link between environment and poverty. Depletion of many environmental resources including land, water and air can make some categories of people destitute even when an economy is growing. It has also stated that degraded environment implies less resources available meaning greater risk of unsustainability. Therefore, policies would strike a realistic balance between the existing livelihood requirements of the people and sound environmental resource management that can ensure sustainability. The group of people at high risk of exposure to poverty and eco-specific environmental degradation need to be incorporated in the poverty reduction strategy. The strategy paper mentioned that people's knowledge, perception and attitude in planning and implementation would be taken as vital for environment friendly development.

The strategy envisions that, by the year 2015, Bangladesh would achieve the following targets:

1. Remove the 'ugly faces' of poverty by eradicating hunger, chronic food-insecurity, and extreme destitution;
2. Reduce the number of people living below the poverty line by 50 per cent;
3. Attain universal primary education for all girls and boys of primary school age;
4. Eliminate gender disparity in primary and secondary education;
5. Reduce infant and under five mortality rates by 65 per cent, and eliminate gender disparity in child mortality;
6. Reduce the proportion of malnourished children under five by 50 per cent and eliminate gender disparity in child malnutrition;
7. Reduce maternal mortality rate by 75 per cent;
8. Ensure access of reproductive health services to all;
9. Reduce substantially, if not eliminate totally, social violence against the poor and the disadvantaged groups, especially violence against women and children; and
10. Ensure disaster management and prevent environmental degradation for overcoming the persistence of deprivation.

2.1.2 Present Status and Trends

Environmental: The two most noticeable institutions are: (a) the National Environmental Council, headed by the Prime Minister of the State; and (b) the Ministry of Environment and Forest (MOEF). The Department of Environment and Pollution Control has been reintroduced as the Department of Environment (DOE), the technical wing of the MOEF with a mandate to implement the policies made by the ministry. Meanwhile, in the informal sector, various other

institutions have mushroomed with diverse means of achieving sustainable environmental management.

To facilitate implementation of the state's call for promotion of environmentally sound resource management, the MOEF formulated the National Environment Policy (NEP), which was subsequently approved by the government in May 1992. The ministry also decided to (a) prepare Guidelines for an Environment Action Plan, (b) adopt the National Conservation Strategy (NCS), and (c) make Environmental Impacts Assessment (EIA) mandatory prior to implementation of any industrial and development related activities.

Quality of natural resource base is deteriorating over the years and little progress has been made to arrest the increasing trend of degradation. The level of organic matter in the soil of Bangladesh is very low and showing declining trend. It occurs through a combination of lowering of soil organic matter and loss of nutrients. Depletion of soil fertility is mainly due to exploitation of land without proper replenishment of plant nutrient in soil. A good productive soil should have an organic matter content of more than 3.5 percent. But in Bangladesh most soils have less than 1.7 percent and some soils have even less than 1% organic matter.

Saline affected areas in the coastal district have increased to about 3.05 million in 1995 from 0.83 million ha in 1966-75 (Karim *et. al.,* 1990 and SRDI, 1997). Noteworthy changes occurred in the categories which lies above 8 ds/m. During the period of 1966-75, a very small amount of area was under the category of more than 8 ds/m, which became intense in 1995.

Economic and Social Development: There has been marked improvement in Bangladesh's macroeconomic environment especially since the early 1990s. The General Macro-Performance Indicator, a subset of the overall policy index[1], increased from an unsatisfactory 2.5 in 1984 to a moderately satisfactory 4 in 1998. This is due to the efforts made by the state during the 1990s to bring stability to macroeconomic aggregates by coordinating fiscal, monetary and exchange rate policies and promoting export-led growth (WB, 1999b).

In addition to steady growth of GDP, the national savings rate has steadily increased over the years. The saving ratio as percentage of GDP increased from 19.66 in 1991 to 23.10 in 2000. Likewise, the investment ratio increased from 16.90 in 1991 to 23.02 in 2000. Private investment has greatly outpaced public investment during the 1990s. The shares of private and public sector investment in GDP were 11.3 percent and 7.3 percent respectively in 1990-91. The corresponding figures for the year 1998-1999 were 13.6 percent and 6.6 percent.

The status of human development as reflected through the Human Development Index (HDI) representing life expectancy, level of literacy, and standard of living (in terms of GDP per capita in purchasing power) has improved from 0.350 in 1980 to 0.470 in 1999. Bangladesh belongs to the group of low human development countries and is ranked 132 among 162 nations included in the Human Development Report of 2001 (UNDP, 2001). According to the 2001 report, the position of Bangladesh is lowest among South-Asian Countries.

Though the economic growth has been contributed to decline income poverty but inequality has been increased in Bangladesh. The rising inequality is attributable to a slow reduction of

[1] A score of 1 implies poor policies for an extended period while a score 6 implies good policies for an extended period.

poverty. The association between growth and inequality is stronger in urban than in rural areas. The Gini ratio deteriorated from 0.36 in 1983-84 to 0.43 in 1995-96 at national level. The ratio deteriorated from 0.35 to 0.39 in rural area and from 0.37 to 0.44 in urban areas during the same period (MOF, 2001). The share of the richest 5 percent households in income was 23.62 percent in 1995-96 compared to 18.30 percent in 1983-84. The share of the poorest 5 percent households in income was 0.88 percent in 1995-96 compared to 1.17 percent in 1983-84. It has been found that, depending on the poverty measure used, one-fifth to one-third of the potential decrease in poverty resulting from growth is estimated to have been lost because of rising inequality (WB, 1999b).

The FiFYP envisages an increase in allocation in social sectors and an increase in program coverage through expansion of successful existing projects and launching of new projects in education, health, family planning, women and youth development, water and sanitation. The document pledged increased emphasis on technical education and skill training to raise the number of skilled workers and promoting export oriented industries. Rural development has been given priority with a total allocation of 10.3 percent of the Plan for reduction of poverty. Among safety net programs, FFW projects are to be reformed so that economically poor areas will receive access to FFW resources. NGOs would be encouraged to continue and expand their pro-poor and rural development projects.

2.1.3 Synergies and Polices

The government of Bangladesh does not have written policy on climate change issues. However, Ministry of Environment and Forest and Department of Environment is dealing climate change issue as a broader environmental issue. They are actively participating in the climate change negotiations and pursuing for integrating climate change and variability particularly natural disaster in the development plan. The Government of Bangladesh is party to many International Multilateral Environmental Agreements (MEAs) including UNFCCC, CBD and CCD.

Many sectoral policies have highlighted the importance of integration of environment and resource management for achieving sustainable development of the nation. The issue of climate change has been recognised in the National Water Management Plan and National Strategy for Economic Growth, Poverty Reduction and Social Development. It has mentioned that important area would be to gather more information on climate change issues and the potential macro economic implications that may arise from increased incidents of floods, droughts and cyclones. However, few efforts have been made to analyse complementary and supplementary issues among the MEAs to prepare a holistic approach for addressing environmental degradation and future challenges.

2.1.4 Barriers

National policies and development strategy documents revealed the necessity to address environmental degradation and natural disasters including climate change towards poverty alleviation and sustainable development. Key barriers to implement policy recommendations are a) issue of prioritisation b) lack of coordination on cross-sectoral issues, c) often very old and regulations, d) translation of policy recommendation into action, e) implementation capacity of stakeholders - institutional and individual capacity building, f) understanding on future challenges and awareness raising, g) linking environmental degradation and impacts of

increased disasters with livelihoods, and h) meaningful community participation. It is also necessary to understand that many successes in the economic and social sectors cannot be sustained through the replication of the business-as-usual approach.

2.2 Climatic Situation

2.2.1 Climate

The climate of Bangladesh is characterized by high temperature, heavy rainfall, often-excessive humidity, and fairly marked seasonal variations. Though more than half of the area is located in the north of the Tropics, the effect of the Himalayan mountain chain makes the climate more or less tropical throughout the year. The climate is controlled primarily by summer and winter winds, and partly by pre-monsoon and post-monsoon circulation. The Southwest Monsoon originates over the Indian Ocean, and carries warm, moist, and unstable air. The easterly Trade Winds are also warm, but relatively drier. The Northeast Monsoon comes from the Siberian Desert, retaining most of its pristine cold, and blows over the country, usually in gusts, during dry winter months.

The country has an almost uniformly humid, warm, tropical climate, throughout the country. There are three main seasons: (1) a hot *summer season*, with high temperatures (5 to 10 days with more than 40^{o}C maximum in the west), highest rate of evaporation, and erratic but heavy rainfall from March to June; (2) a hot and humid *monsoon season* (temperatures ranging from 20^{o}C to 36^{o}C), with heavy rainfall from June to October (about two-thirds of the mean annual rainfall); and (3) a relatively cooler and drier *winter* from November to March (temperatures ranging from 8^{o}C to 15^{o}C), when minimum temperatures can fall below 5^{o}C in the north, though frost is extremely rare.

The mean annual rainfall varies widely within the country according to geographical location, ranging from 1,200 mm in the extreme west to 5,800 mm in the east and northeast. There are three main periods of rainfall, with distinct sources of precipitation:

(1) The *western depression of winter rains*, mainly from 20th January to 25th February, when it rains from 1cm to 4cm.

(2) The *pre-monsoon thunderstorms,* known as the Nor'westers (North-westerlies), which begin about the 10th of March. The Nor'westers arise due to a variety of reasons, the main ones being the steady flow of cool dry air above 1800 meters altitude from the northwest (Anti-Trades), a warm, moist current below 1800 metres from the south, intense evapo-transpiration in the Bengal basin and Assam, and katabatic winds from the surrounding mountains.

(3) The *summer rain*s known as the Monsoons. The main rainy period begins with the entrance of the moisture-laden Southwest Trades, popularly known as the Monsoons, which are drawn to the Indian sub-continent by the intense heat, and consequent low pressure over Punjab (in Pakistan and India) and the Upper Ganges Valley. This gives rise to a "tropical cell", with convection currents of massive proportions. These winds blow across the North Indian Ocean, and reach the Malabar Coast of India two weeks before they come up the Bay of Bengal. One arm of these vast trades moves up the Ganges valley, and brings in rains. It is the orogenic rains caused by the striking of this east-flowing air mass against the Arakan

Yomas, Meghalaya Plateau, and the Himalayas that forms the major part of the rainfall of Bangladesh.

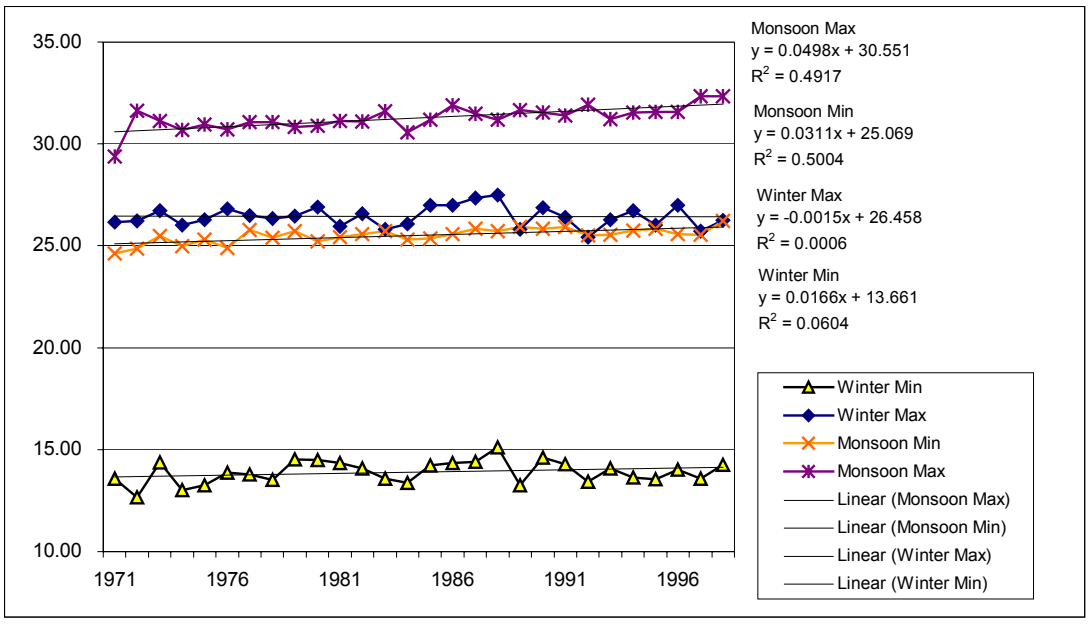
The Monsoon rains start from the end of May and continue till mid October. The total rainfall in these months varies in different parts of the country. It is 122cm in the northwestern part, 149cm in the central part, 338cm in the coastal areas, and over 500cm in the northeastern part - across the borders from Cherapunji and Mawsyriem, two of the rainiest places in the world (Rashid, 1991). Possible connections with *El Nino* have only now begun to attract attention as a major possible influence on climatic patterns in the Sub-continent.

2.3 Climate Change Projections

2.3.1 Trend and Projection of Temperature and Rainfall

Future changes of climatic condition/scenario is available where two general approaches were used to determine future climate change i.e. a) projection based on observed historical data, and b) using available climate model. It is found from the observed data that the temperature is generally increasing in the monsoon season (June, July and August). Average monsoon maximum and minimum temperature shows an increasing trend annually at the rate of 0.05 ^{O}C and 0.03 ^{O}C, respectively. On the other hand average winter (December, January and February) maximum and minimum temperature shows decreasing and increasing trend annually at the rate of 0.001 ^{O}C and 0.016 ^{O}C, respectively (Alam, M. 2002). It is also revealed that the trend has regional variation. Figure 1 shows the trend of temperature from 1971 to 1998.

FIGURE 1. Trend of Maximum and Minimum Temperature in Winter and Monson Season from 1971 to 1998.



SAARC Meteorological Research Centre (SMRC) has studied surface climatological data on monthly and annual mean maximum and minimum temperature, and monthly and annual rainfall for the period of 1961-90. The study showed increasing trend of mean maximum and minimum temperature in some seasons and decreasing trend in some other seasons. Overall

trend of annual mean maximum temperature has shown significantly increasing trend over the period of 1961-90.

The study has also projected climatic elements up to 2050 and 2100 using 5-year running average, and actual values. Based on 5-year running average, the annual mean maximum temperature is likely to rise by 0.48^{O}C and 0.88^{O}C in 2050 and 2100 respectively. It is also found that the annual mean minimum temperature is likely to decrease by 0.06^{O}C and 0.11^{O}C by 2050 and 2100 respectively. The overall annual mean temperature is likely to increase by 0.21^{O}C and 0.39^{O}C by 2050 and 2100 respectively.

The most important finding of the study is seasonal variation of future trend of temperature and rainfall. It is found that in the pre-monsoon season the mean maximum temperature is likely to decrease by 0.44^{O}C and 0.80^{O}C by 2050 and 2100, respectively. Conversely in the southwest monsoon season the mean maximum temperature is likely to increase by 0.90^{O}C and 1.65^{O}C by 2050 and 2100 respectively, and the increasing trend is statistically significant. Table 1 presents projected changes of temperature and rainfall based on 5-year running average method, and Table 2 presents projected changes of temperature and rainfall based on actual trends.

TABLE 1. Projected changes of temperature and rainfall based on 5-year running average method

Season	Max Temp (^{O}C)		Min Temp (^{O}C)		Annual Mean Temp (^{O}C)		Seasonal Rainfall (mm)		Annual Rainfall (mm)	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
Pre-monsoon	-0.438	-0.803	-0.264	-0.484	0.210	0.385	309.73	576.84	304.72	588.65
SW monsoon	0.900	1.650	0.132	0.242			46.54	85.32		
Post-monsoon	1.680	3.080	0.030	0.055			-44.17	-80.90		
Winter	-0.408	-0.748	0.762	1.397			5.47	10.02		

TABLE 2. Projected changes of temperature and rainfall based on actual trend

Season	Max Temp (^{O}C)		Min Temp (^{O}C)		Annual Mean Temp (^{O}C)		Seasonal Rainfall (mm)		Annual Rainfall (mm)	
	2050	2100	2050	2100	2050	2100	2050	2100	2050	2100
Pre-monsoon	-0.846	-1.551	-0.402	-0.737	0.222	0.407	290.90	533.32	295.94	542.55
SW monsoon	0.840	1.540	0.108	0.198			12.74	23.36		
Post-monsoon	1.584	2.904	0.312	0.572			14.05	25.76		
Winter	-0.054	-0.099	0.984	1.804			10.49	19.23		

2.3.2 Climate Change Scenario

Climate change vulnerability studies have used different climate change scenarios to assess impacts, adaptation and vulnerability for different sectors. Climate Change Country Study, a comprehensive study on assessing impacts, adaptation and vulnerability, has used General Circulation Model to develop climate scenarios. Models were run to find correlation with the observed time-series data for 10 particular meteorological stations distributed all over the country both for base and projection years. The model estimated monthly average rate of change in temperature and precipitation for those locations. The rate of change was

superimposed on the observed time-series monthly average data to obtain data for the projection years.

The results revealed that the average increase in temperature would be 1.3°C and 2.6°C for the years 2030 and 2070, respectively. It was found that there would be a seasonal variation in changed temperature: 1.4°C change in the winter and 0.7°C in the monsoon months in 2030. For 2070 the variation would be 2.1°C and 1.7°C for winter and monsoon, respectively. For precipitation it was found that the winter precipitation would decrease at a negligible rate in 2030, while in 2075 there would not be any appreciable rainfall in winter. On the other hand, monsoon precipitation would increase at a rate of 12 per cent and 27 per cent for the two projection years, respectively. Table 3 presents climate change scenarios for the year 2030 and 2075.

TABLE 3. Extent of changes in temperature, precipitation and evaporation

Year	Average Temperature			Temperature Increase[1]			Average Precipitation			Precipitation Increase[2]			Changes in Evaporation[3]		
	W	M	Ave	W	M	Ave	W	M	Ave	W	M	Ave	W	M	Ave
	(°C)			(°C)			mm/month			mm/month					
Base (1990)	19.9	28.7	25.7	0.0	0.0	0.0	12	418	179	0	0	0	0.6	14.6	83.7
Output from GCM															
2030	21.4	29.4	27.0	1.3	0.7	1.3	18	465	189	+6	47	10	0.9	15.8	83.9
2075	22.0	30.4	28.3	2.1	1.7	2.6	00	530	207	-12	112	28	Inf.	135	87.9

Notes:

1) *Estimated values obtained by correlating model output data with the observed data.*
2) *Estimated based on model output data regarding rate of temperature change.*
3) *Estimated using langs Index and expressed in terms of Aridity Index*

W stands for winter, M stands for monsoon, Ave stands for average and Inf. stands for infinity

It was found that there would be excessive rainfall in the monsoon causing flooding and very little to no rainfall in the winter forcing drought. It was also found that there would be drastic changes in evaporation in both winter and monsoon seasons in the projection year 2075. It was inferred from the GCM output that moderate changes regarding climate parameters would take place for the projection year 2030, while for the projection year 2075 severe changes would occur.

The results also reveal that there is a general increasing trend regarding temperature. In 2030, the increase is much pronounced in winter months, although the maximum change is observed for post-winter months, i.e., April, May and June. However, in 2075, the increase in temperature during April and May is much higher; about 4.0°C.

2.3.3 Sea Level Rise

The SAARC Meteorological Research Council (SMRC) carried out a study on recent relative sea level rise in the Bangladesh coast. The study has used 22 years historical tidal data of the three coastal stations. The study revealed that the rate of sea level rise during the last 22 years is many fold higher than the mean rate of global sea level rise over 100 years, which shown the important effect of the regional tectonic subsidence. Variation among the stations has also found. Table 4 represents the trend of tidal level in three costal stations.

TABLE 4. Trend of tidal in three coastal stations

Tidal Station	Region	Latitude (N)	Longitude (E)	Datum (m)	Trend (mm/year)
Hiron Point	Western	$21^{O}48'$	$89^{O}28'$	3.784	4.0
Char Changa	Central	$22^{O}08'$	$91^{O}06'$	4.996	6.0
Cox's Bazar	Eastern	$21^{O}26'$	$91^{O}59'$	4.836	7.8

Source: SMRC, No. 3

2.3.4 Projection of Human and Economic Development

Most of the climate change and development studies have used different projection of human and economic development to assess future vulnerability to climate change, and needs and barriers in order to develop national development strategy. "Bangladesh 2020: A Long-run Perspective Study" carried out by The World Bank and Bangladesh Centre for Advanced Studies (BCAS) has projected human and economic development up to the year 2020. The study is very optimistic in future development of Bangladesh recognizing the enormous potentials, but warning that unless Bangladesh is fully prepared to face the challenges of a highly competitive world of the 21st century, accelerated growth and poverty alleviation could remain a dream. The project human and economic development is presented in Table 5.

TABLE 5. Human and Economic Development Indicators (projected)

Population Characteristics	**2010**	**2020**
Population (million)	150	170
Population Density (per sq. km.)	976	1118
Urban Population (%)	28.5	36.5
Human Resource Development		
Adult Literacy Rate (15 yrs.+, %)	80	95
Primary School Enrolment (gross, %)	96.8	108.3
Secondary School Enrolment (gross, %)	47.3	52.0
Employment and Labour Forces		
Unemployment Rate (%)	11.6	6.5
Civilian Labour Force (million)	86	107
Agricultural Employment (% of labour force)	44.2	38.3
Industrial Employment (% of labour force)	19.7	23.4
Output and Its Distribution		
GDP at Current Market Prices (billion Tk.)	4045	8733
GDP at Current Market Prices (billion $)	96	208
Real GDP Growth Rate	7.0	8.0
Per Capita GDP (1995$)	643	1215
Gross Domestic Investment (% of GDP)	25.0	30.0

Source: BBS; HDD, World Bank, Bangladesh Centre for Advanced Studies; and estimates of Bangladesh 2020 Study.

3 Vulnerability And Adaptation Assessments

3.1 Major Studies

Over the last decade a number of studies have been carried out on impact, adaptation and vulnerability assessment to climate change. The Government of Bangladesh, Academic

Institutes, and Research Organizations have carried out these studies and most of them were carried out collectively. The key climate studies are as follows

- *Effect of Climate Change and Sea Level Rise on Bangladesh* by Dr. Fasiuddin Mahtab (1989) Sponsored by Commonwealth Institute. The study assumed a scenario of a 1-metre change in sea level by middle of next century; it combines a 90 cm (average of 30 cm and 1.5 m) rise in sea level and about 10 cm local rise due to subsidence.

- *The Greenhouse Effect and Climate Change: An Assessment of the Effects on Bangladesh* by Bangladesh Unnayan Parishad (BUP), Centre for Environmental and Resource Studies (CEARS), New Zealand, and Climate Research Unit (CRU), University of East Anglia, UK, 1993.

- *Country Study on Bangladesh under Regional Study of Global Environmental Issues* Project (Asian Development Bank, TA No. 5463) on the Impact of Climate Change in Bangladesh, the Available Options for Adaptation and Mitigation Measure and Response Strategies, 1994 By Bangladesh Institute of Development Studies (BIDS), Dhaka, Bangladesh.

- *Vulnerability of Bangladesh to Climate Change and Sea Level Rise* by Bangladesh Centre for Advanced Studies (BCAS) /Resource Analysis (RA) /Approtech Ltd., 1994 with support from The Netherlands Government.

- *Climate Change Country Study Bangladesh* under U. S. Climate Change Study Programme By Bangladesh Centre for Advanced Studies (BCAS) /BIDS/BUP, 1996 with support from US Government. GCM, MIKE11-GIS and other tools were used in this study.

- *Climate Change and Adaptation Study for Achieving Sustainable Development in Bangladesh*; jointly undertaken by Resource Analysis, the Netherlands; BUP and BCAS.

- *Initial National Communication to the United Nations Framework Convention to Climate Change* with the financial support from GEF by Department of Environment.

3.2 Approach and Methodology

It is revealed from the above mentioned climate change studies that there were two different types of arrangement through which these studies were carried out i.e. government in association with in-country research organizations, and collaborative studies of a research group. In the government sector, Department of Environment under the Ministry of Environment and Forest played significant role in the climate change studies and activities. From the research community, Bangladesh Centre for Advanced Studies (BCAS), Bangladesh Unnayan Parishad (BUP), Bangladesh Institute of Development Studies (BIDS), Bangladesh University of Engineering and Technology (BUET), Bangladesh Agricultural Research Council (BARC) have played major role conducting studies and dissemination of information and outcome.

Vulnerability to Climate Change and Sea Level Rise, and Climate Change Country Study considered as major climate change studies in Bangladesh and used IPCC and UNEP methodology respectively. Both have used different computer models and tools for assessing impacts, vulnerability and adaptation of key sectors and regions of the country. Regarding community participation, in most cases, it was limited to the scientific community due to the

nature of the projects, which did not allow consultation with community at grass root level. These studies were disseminated among the research community and policy makers level.

3.3 Impacts, Vulernability and Adaptation to Cliamte Change

Key climate change studies at national level assessed impacts, vulnerability and adaptation on the following vulnerability in climate change context and sectors. From the climate change studies it appears that the country will be highly susceptible to:

1. Increased flooding, both in terms of extent and frequency,
2. Increased moisture stress during dry periods leading to increased drought both in terms of intensity and frequency, and
3. Increased salinity intrusion during the low flow conditions.

3.3.1 Inundation

In the coastal front there will be stronger-than-usual backwater effect due to sea level rise induced high oceanic stage, resulting into retardation of discharge flow, particularly around the confluence points of the major rivers. Consequently, the risk of floods of high intensity and duration, similar to that occurred in 1998, will be exacerbated. Under climate change scenario about 18 per cent of current lowly flooded areas will be susceptible to higher levels of flooding while about 12 to 16 per cent new areas will be at risk of varied degrees of inundation. On an average about a quarter of the country's landmass is currently flood prone in a normal hydrological year, which may increase to 39 per cent, while the frequency of a catastrophic flood engulfing about two-thirds of the landmass of the country could be increased under climate change scenarios.

By accentuating the syndrome of "too much water in monsoon and too little in winter" further, the changes in climate parameters will also reduce the national potential for fish aquaculture. Unless adequate protection is considered, increased flood vulnerability will affect culture fisheries while excessive evaporation coupled with increase in temperature will lead to decrease in production of culture fisheries.

3.3.2 Moisture Stress

Diminishing rainfall in winter, in addition to already erratic rainfall pattern and spatial distribution, will increase evapo-transpiration significantly. Consequently, severity of moisture stress, particularly in the north-western districts, will increase leading to drought conditions. Recent findings reveal that deficit of moisture on the top soils will increase in a large number of sub-districts (Thana), where the farmers will have no choice other than switching from shallow tubewell irrigation to deep tubewell irrigation. As a result, production of irrigation dependent crops will cause economic hardship for the marginal and poor farmers. Production of wheat and HYV Aus and Boro might no longer be economically suitable under climate change. Increased surface temperature will tend to release more carbon from the topsoil, which in turn will reduce fertility of the soils.

3.3.3 Salinity in the Coastal Zone

Moreover, Increased water demand for irrigation could lead to increased withdrawal from the already lean surface water systems leading to decrease in lean season flow in the rivers. An additional quarter of a million hectare land will become saline affected, on top of currently saline 3.05 million ha, forcing farmers to grow crops of lesser economic return. Lean flows in the distributaries of the Ganges will jeopardize the forest succession processes in the Sundarbans, resulting in low productivity and poor vegetative cover of the forest. That will in turn affect the rich biodiversity of the forest.

3.3.4 Cyclone and Storm Surges

Although there is no indication whether the frequency of the cyclonic activities will increase in the Bay of Bengal, high-intensity cyclonic events will be far more damaging due to increasing density of both population and infrastructure in the coastal plains. Climate change will have increasing threats to sea-facing polders due to sea level rise induced increasing surge heights.

3.3.5 Food Self-sufficiency

Increased potential adverse impacts of climate change are likely to affect agriculture severely. Unfortunately, a large majority of the population engaged in agricultural activities. In absence of hazard resistant crops/seeds it is feared that the food security of the country will be threatened frequently. It is projected that the population of the country will increase to 145 million in 2025 and the agricultural growth should be about 3 per cent to meet the increased demands. But the country is rapidly loosing its agricultural land. Considering the threats posed by the adverse effects of climate change it will be extremely difficult even to maintain the present level of agricultural production. A combination of increased demands and possibility of having somewhat reduced or same levels of agricultural production will challenge the national goals of maintaining food-self sufficiency.

3.3.6 Poverty, Livelihoods and Migrations

The overall impacts of climate change in Bangladesh will have far reaching consequences, not only on the physical features, also on the socio-economic aspects of the country. Agriculture sector is the major provider of employment and there are indications that it will remain so in the near future. Loss of both agricultural land and production will adversely affect livelihood of the rural poor. Loss of income and unemployment could jeopardize the dream of over 50 per cent of the population graduating from below the poverty line. As it happened in the cases of earlier disasters, poverty driven rural population will tend to migrate out to the urban centres. Large scale inter-community migration is likely in increase social unrest.

Loss of livelihood of a large population throughout the country will not only increase the risk of large-scale migration, also will lead to increased competition to the remaining natural resources. The end result of these will be manifested by increased exploitation of natural resource base and gradual degradation of it – both having a negative impact on sustainable resource management. Moreover, taking control over common property regimes will lead to an escalation of social conflicts, an eventuality when acute inequity prevails in a society.

The following section of the report will give more detail on Coastal Zone Vulnerability to Climate Change and Sea Level Rise considering one of the common issues of the deltaic countries. First it describes the most important impacts of climate change in the coastal zone, before discussing the vulnerability of households. In a last section a brief introduction is given to an analytical approach to develop an assessment framework.

3.4 Primary physical effects of climatic changes in Coastal Zone

Climate change is only one aspect of the vulnerability of coastal livelihoods. Vulnerability to climate change means in fact that climate change adversely affects the capability of people to cope with such other "normal" vulnerabilities as: food and income security and safety of properties. This implies that any analysis of vulnerability to climate change should start off with a full vulnerability analysis and then assess to what degree these vulnerabilities are affected by climate change.

It is reported that the coastal zone vulnerability would be acute due to the combined effects of climate change, sea level rise, subsidence, and changes of upstream river discharge, cyclone, and coastal embankments. The selection of key primary physical effects of these "agent of change" (i.e.: salt-water intrusion, drainage congestion, disasters (extreme events) and coastal morphology) is based on a full recognition of possible accumulative effects (WB, 2000). Table 6 presents a framework to make the above discussion more explicit and can be used as causal-impacts matrix during the workshop.

- In the coastal zone, the effect of *saline water intrusion* in the estuaries and into the groundwater would be stimulated by low river flow, sea level rise and subsidence. Pressure of the growing population and economic development will further reduce freshwater availability in future. The adverse effects of salt-water intrusion will be significant on coastal agriculture and the availability of fresh water for public and industrial water supply.

- The combined effect of higher sea water levels, subsidence, siltation of estuary branches, higher riverbed levels and reduced sedimentation in flood-protected areas impedes drainage and will gradually *increase water logging problems.* This effect will be particularly strong in the coastal zone. The problem will be aggravated by the continuous development of infrastructure (e.g. roads) reducing further the limited natural drainage capacity in the delta. Increased periods of inundation may hamper agricultural productivity, and will also threaten human health by increasing the potential for water borne disease.

- *Disturbance of coastal morphological processes* would become a significant problem under warmer climate change regime. Bangladesh' coastal morphological processes are extremely dynamic, partly because of the tidal and seasonal variations in river flows and run off. Climate change is expected to increase these variations, with two main (related) processes involved:

    - Increased bank erosion and bed level changes of coastal rivers and estuaries. There will be a substantial increase of morphological activity with increased river flow, implying that riverbank erosion might substantially increase in the future.
    - Disturbance of the balance between river sediment transport and deposition in rivers, flood plains and coastal areas. Disturbance of the sedimentation balance will result in higher bed levels of rivers and coastal areas, which in turn will lead to higher water levels.
- *Increased intensity of extreme events*. The coastal area of Bangladesh and the Bay of Bengal are located at the tip of northern Indian Ocean, which has the shape of an inverted funnel. The

area is frequently hit by severe cyclonic storms, generating long wave tidal surges which are aggravated because the Bay itself is quite shallow. Cyclones and Storm Surges are expected to become more intense with climate change. Though the country is relatively well equipped in one aspect of disaster management, increased intensity of the disasters implies major constraints to the country's social and economic development. Private sector investment in this area is likely to be affected by the risks of cyclones and increased flooding.

TABLE 6. Relation between agents of change and primary physical effects in the coastal zone of Bangladesh.

Primary Physical Effects / **Agents of Change**		**Salt-water Intrusion**	**Drainage Congestion**	**Coastal Morphology**	**Cyclone and Storm Surges**
Climate change (temperature, precipitation, evapotranspiration)		+	+	-	+++
Changes of upstream river discharge	Peak	-	++	+++	-
	Low	+++	-	-	-
Sea level rise		+++	+++	++	++
Subsidence		++	++	++	++

Source: Rob and Alam

3.4.1 Vulnerability of households

Households (hhs) function in an (local) environment of opportunities and vulnerabilities. Decisions on their activities depend basically on: (i) the locally available resources (local resource base) and the access hhs have to it (opportunities); and (ii) the risk hhs run because of the dynamics of this local resource base. Vulnerability of hhs relates to their resilience against: *shocks* (disastrous unexpected happenings, such as an earthquake or death of an income generating household member); *fluctuations* (mainly referring to seasonal variations in e.g., hydrology and food); and *trends* (long term slow developments such as soil and water quality deterioration).

As mentioned, households in the coastal zone are vulnerable to many more dynamics than climatic changes. Table 2 shows an example list of changes local people have to cope with and are considered potentially vulnerable to. These changes are referred to as the vulnerability context (VC). The table also indicates which changes are considered to be accentuated by climate change.

It is expected that an increased understanding of the vulnerabilities of coastal livelihoods will contribute to the effectiveness of different programs and projects which aim to increase the well being of coastal households.

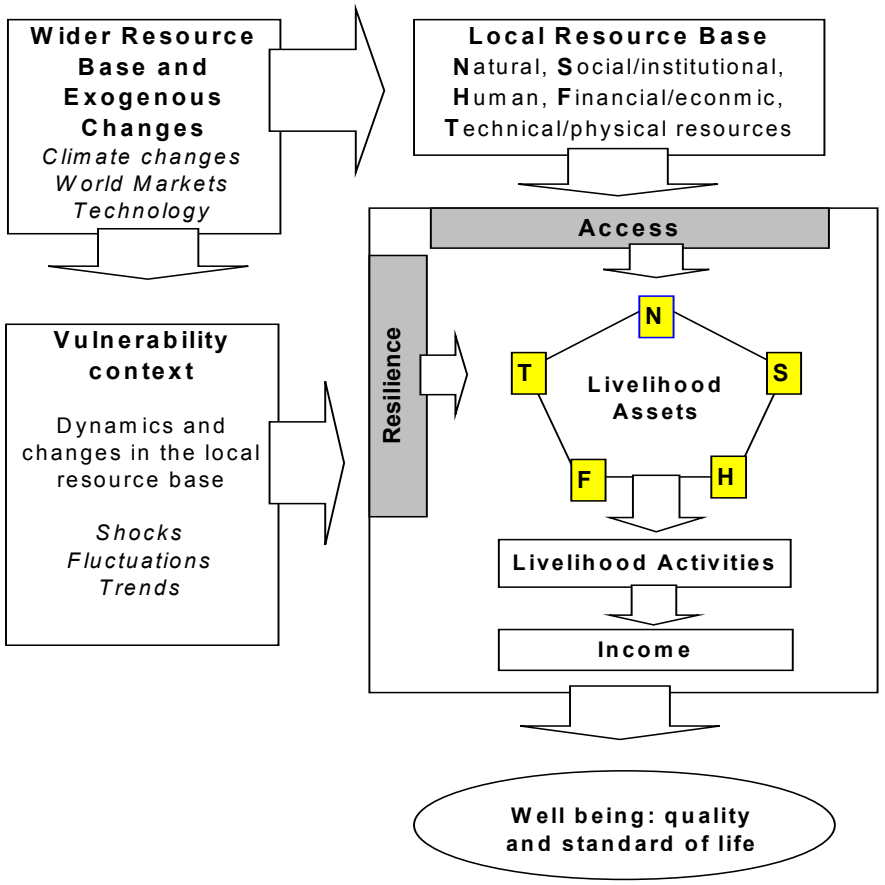
TABLE 7. Examples of changes coastal communities have to cope with (vulnerability context)

Vulnerability Context	Accentuated by Climate Change		
	Exposed Upazilas	Inland Upazilas	Buffer Zone
Shocks			
Cyclones and storm surges	+++	+	-
Floods	++	+++	++
Droughts	-	++	+++
Fluctuations			
Employment	+	++	+
Hydrology/water balance	+	++	+
Food availability	+	+	+
Market prices	+	+	+
Trends			
Increase siltation and drainage congestion	+	+++	++
Increase salinization SW and GW	+++	++	+
Increase bank erosion	+++	+++	+++
Decrease dry season river flows	+	+	++
Increase resource degradation	+	+	+
Change in land use	+++	++	+
Increase GW extraction	+	++	+++
Increase law and order problems	++	+	-
Increase unemployment: (men and women)	+	++	+
Increase water borne diseases	+	++	++
Growth food shortage	+	+	+
Growth migration patterns	++	+	
Reduction fresh water supply	++	+	

3.4.2 An analytical framework for vulnerability assessment

To assess the effectiveness of development programs and projects in terms of their contribution to the livelihood improvement objectives, a conceptual model (Figure 2) has been presented which facilitates to "measure" changes in vulnerability as a result of developments with (and without) interventions. This framework may also be presented in the Bhutan Workshop.

FIGURE 2. An Analytical Framework for Livelihoods and Vulnerability Assessment



The analytical framework is based on a sustainable livelihood concept, which parts from the recognition that households decide on activities, based on a set of *capital assets* they have. These *livelihood activities* (e.g., to send children to school or lease out of land) would generate *income* (cash, goods and services) which can be used for: consumption (food, housing, clothes); inputs in activities (fertilizers, irrigation water); investments (land, equipment); or social payments (loans, memberships, taxes). Household's capital assets cover the full range of material and immaterial resources. Carney (1998) considers five categories: natural; social and institutional; human; financial and economic; and technical resources.

The vulnerability of households refers to their capacity to cope with the dynamics of the vulnerability context. This *resilience* is a function of the assets of the household, which is in turn depends on the *access* hh have to the local resource base.

3.5 Adaptation to Climate Change in the Coastal Zone

Adaptations to climate change aiming to improve livelihood conditions could be considered within two broader areas of activities.

- Reducing the vulnerability context; and

- Increasing the resilience through increasing assets.

The first type of interventions should be taken at "above hhs" or government levels; the second type can be taken on a hh-level. However, also these interventions will depend greatly on government supporting actions, mainly in the sense of creating an enabling environment.

Discussions to find a proper balance between these kind of adaptations are just starting and little experience is available about the effectiveness and feasibility of interventions on a local scale and the extent to which such interventions depend on government support. A CIDA-CARE supported study (started in 2002) on the Reduction of Vulnerabilities for Climate Change (RVCC) for 6,000 households in the southwestern region of Bangladesh, is expected to collect new and relevant experience in this context.

The following first gives an overview of interventions to reduce VC, identified in a World Bank study for Bangladesh (WB, 2000) and subsequently discusses the role of planning and possibilities for sector-crosscutting measures at national government level.

3.5.1 Reducing the vulnerability context

The mentioned World Bank study focused on the identified major physical impacts: drainage congestion; salt water intrusion; morphologic dynamics; and natural disasters. The study developed a general framework for a comparative assessment of various adaptations, which considered the effectiveness, feasibility and current state of different *physical and institutional interventions.* See Table 8.

Drainage congestion

Physical adaptations aim at improving the run-off from land after flooding which requires mainly two steps: (i) bringing water from the land into the main drainage system; and (ii) draining water to the sea. At present, step i is done under gravity, mostly through regulators which open during low tides. Increasing the drainage capacity of existing infrastructure seems a feasible and effective way to reduce drainage congestion where culverts, bridges, regulators etc hamper drainage. When higher water levels impede this process, pumping remains the ultimate solution. Step ii requires a well-maintained drainage network. Continuous dredging is an option, which can be reduced by the construction of regulators and/or tidal basins. Tidal basins stand out as a preferred option from an environmental and maintenance perspective (since tidal basins would substantially reduce the maintenance dredging and bring sediments to the *beel* areas). The tidal basin experience in Khulna-Jessore Drainage Rehabilitation Project proves that this is a feasible approach.

Institutional adaptation includes proper O & M arrangements, design criteria for drainage capacity of infrastructure, and establishment & support of local water management. These possibilities do not score very high, having low feasibility and effectiveness.

Salt-water intrusion

Specific *physical adaptations* for the salinity problem should focus on increasing surface water flows from upstream, increasing local storage capacity of fresh surface or groundwater, and desalinization plants and equipment. The Gorai River Restoration Project is an example of increasing surface water flows through deviating water from the Ganges River towards the

southwest. Effectiveness of such measures is high, but feasibility is low because of high cost. Possibilities for increased local storage of surface and groundwater in the area itself are low as well. Desalinization plants and equipment are too expensive as possible adaptation measure.

Institutional adaptations for salinity include maintenance and operation of sluices and other regulators, groundwater management, land use practice, extension services, and water saving techniques. Improving maintenance and operation of sluices and other regulators to hold water in areas that are under increased stress from salinization, or establishing effective groundwater management both score high on effectiveness but low on feasibility. Land use practice can be influenced by incentives to change agricultural practices so that agricultural demand for fresh water goes down.

Morphological dynamics

Physical adaptations to the threat of increased erosion would include mangrove greenbelts, cross dams and/or river training works. Mangrove greenbelts in the foreshore areas and along the coastal embankments, and cross dams at the same time enhance accretion. River training works, e.g., through bank protection or strong holds are confined to the estuarine river branches. All these measures are effective. The main challenges for cross dams and river training works are in feasibility, in particular as it requires long-term maintenance. The high effectiveness and feasibility of mangrove greenbelts are well acknowledged.

Institutional adaptations would aim at protecting mangroves & wetlands, and land use arrangements (including land tenure laws) & policies. Although loss of land, and the creation of new land are common phenomena in Bangladesh, there does not appear to be a functional legal and administrative system for addressing these issues. For example, taking accreted land into culture for either forestry or agriculture falls under the jurisdiction of different ministries. Therefore, changing land tenure laws and policies, though potentially effective, will meet serious institutional limitations. A sustainable adaptation to climate change will require reforms in these policies.

Natural disasters

Physical adaptations include the construction of new infrastructure such as cyclone shelters and /or coastal embankments and landfills, modification of existing infrastructure combined with improved warming systems, and mangrove greenbelts. Construction of coastal embankments and landfills should focus on special areas such as urban centers and concentrations of industrial activities. Design of new high value infrastructure (roads, sluices and embankments) could be altered with consideration of climate change. New and existing mangrove belts (as mentioned earlier) appear to be effective in protecting against coastal storms, and in facilitating sedimentation (Haider, 1992). Such activities in Bangladesh needs to be streamlined by ensuring peoples' participation in maintaining and benefit sharing.

Institutional adaptations in this respect include improving forecasting, warning and evacuation procedures, adapting land use & development policy, and maintenance of existing and future coastal embankments. Improvement of the forecasting system seems highly promising, though implementation could be deterred by institutional and communication problems. Adapting land use development policy seems an effective tool. Required institutional arrangements, however, seem almost unattainable, and therefore this adaptation

scores low on feasibility. Embankments are effective, but they do not score high on feasibility because of costs and organization needed to maintain them.

TABLE 8. Effectiveness of possible adaptation measures to reduce the vulnerability context

Primary Physical Effects / Adaptations Measures	Salt-water Intrusion	Drainage Congestion	Coastal Morphology	Cyclone and Storm Surges
Increasing drainage capacity	-	+++	++	-
New regulator and tidal basin	+++	+++	+	-
Proper operation and maintenance	++	++	+	-
Desalinization plant	++	-	-	-
Effective landuse planning	++	+	++	+
Coastal Afforestation and greenbelt plantation	-		+	+++
River training	-	++	+++	-
Increase cyclone centers	-	-	-	+++
Improve warning system	-	-	-	+++
Design and build new infrastructure incorporating CC and sea level rise.	+	++	++	+++
Improvement of Coastal Livelihoods System and Well-being				
Education	-	+	-	+
Health	+	++	-	+
Income	+++	+++	++	++
Housing	-	+	+++	+++
Food Security	++	+++	++	++

Source: Rob and Alam

3.6 Past and Current Practices and Coping Mechanisms to Climate Variability and Extreme Events

The government of Bangladesh does not have any climate change policy and strategy to combat with anticipated adverse impacts of climate change. However, in order to design the institutional and functional arrangements for disaster management, the government of Bangladesh has taken initiatives to frame a disaster management policy. This policy would take care of all aspects, such as accurate definition of disaster threats, organizational arrangements required to prepare responses to and recover from disaster events, assessment of resources available to deal with threats, and recognition of ways for the national disaster management policy to interlock with other national development policies. Along with the

policy, a well planned, carefully designed, and action-oriented detailed plan for disaster management is also in the process of preparation. This is of paramount importance to Bangladesh both at national and local levels, for a coordinated and effective effort to cope with the disaster situation.

There are various Government and community-based organizations working in the field of disaster management and mitigation. The focal point of the Government of Bangladesh for disaster management is the Disaster Management Bureau (DMB), a specialized organization under the Ministry of Disaster Management and Relief. The Bangladesh Meteorological Department (BMD) is responsible for forecasting natural disasters, particularly cyclones, droughts, storms, etc. The Bangladesh Space and Remote Sensing Organization (SPARRSO) is responsible for providing satellite images to BMD, particularly as an aid to make the daily weather forecast. The Flood Forecasting and Warning Centre (FFWC) of the Bangladesh Water Development Board forecasts flood, with help from the Surface Water Modelling Centre (SWMC) and EGIS. The Department of Agriculture Extension provides different services to mitigate agricultural losses after disasters.

Bangladesh has set a pioneer example in disaster management during the cyclones of 1991 and 1997. The role of the government and non-government organizations during the pre and post-disaster periods helped shrink the number of deaths and damage. The initiatives were appreciated and recognized worldwide.

3.6.1 Structural Measures

The Government of Bangladesh has commenced both structural and non-structural measures for flood mitigation. With the assistance of the World Bank, a 'Flood Action Plan' with 26 components was undertaken immediately after the devastating flood of 1988.

Previously, disaster mitigation tended to be viewed as structural mitigation measures only. This concept has changed rapidly over the past few years. Structural measures for flood control like storage reservoirs, embankments of levees, channel improvements, and floodway bypasses are expensive and time consuming. The GoB gives equal importance at present to both structural and non-structural mitigation measures. It is strongly believed by the GoB that non-structural mitigation measures need to be complemented by structural mitigation measures.

As a part of structural mitigation measures the GoB with its own and external resources has so far constructed 1,841 cyclone shelters, and 200 flood shelters for evacuation of people threatened by cyclone or flood. In addition, coastal embankments about 3,931 km long have been made to protect coastal land from inundation by tidal waves and storm surges, and drainage channels of total length 4,774 km have been constructed.

The Government of Bangladesh has undertaken a Green Belt Project in the coastal areas. This is a participatory reforestation program aimed at reducing the adverse impacts of natural disasters, particularly cyclones and storm surges in the coastal regions.

3.6.2 Institutional and Non-Structural Measures

A very effective cyclone warning system has been established in the country. Bangladesh Meteorological Department (BMD) has a network of four radar stations at Dhaka, Rangpur,

Cox's Bazar, and Khepupara, as well as satellite ground stations to receive imageries from NOAA, GMS, and InSAT to monitor cyclones as soon as they form in the Bay of Bengal. An effective communication system also exists in BMD for exchanging information both at national and international levels. SPARRSO can track cyclones every hour through the reception of imagery from GMS and NOAA satellites.

To raise awareness among students on various hazards and disaster management as per GoB policy, a chapter on disaster management has been included in the educational curricula from class V to XII. The GoB has also made to hold a compulsory session of at least 2 hours on disaster management in the curricula of all types of Training Institutes that train officials and non-officials.

For non-structural mitigation the GoB has emphasized on legislation, training and public awareness, institution building, and warning systems. Up to December 2000, the Disaster Management Bureau has conducted a total of 453 courses, workshops and seminars under the project, and about 23,000 participants have attended the programs. They include Government and Semi-Government officials of different levels, public representatives, NGO officials, local leaders, representatives of mass media, teachers, Imams (religious leaders) of mosques, and fishermen. Besides this, DMB has supported holding of disaster management training workshops in other institutes. As part of the public-awareness activities, booklets containing public information about cyclone, floods, etc., and calendars and posters with disaster information have been regularly printed and distributed at the grass-roots levels.

Following the devastating cyclone of 1970, the Bangladesh Red Crescent Society started the Cyclone Preparedness Programme (CPP) in 1972. In June 1973, the GoB approved and accepted the new program of the Red Crescent Society, and since then the Ministry of Disaster Management and Relief and the Red Crescent Society have started to operate the CPP jointly (Mohammed, 1991). CPP has a volunteer force of 27,330 trained men, and 5,466 women to disseminate cyclone information, and carry out rescue operations if a cyclone strikes the coast. Bangladesh Radio and Television at frequent intervals transmit warning messages for the events. After the devastating cyclone of 1991, the Government of Bangladesh has also established a number of multipurpose cyclone centers in the coastal areas (DMB, 1998).

As part of the non-structural measures to cope with cyclones, the GoB is committed to improve its cyclone warning and dissemination system in all parts of the country. As part of an ongoing project supporting comprehensive disaster management, initiatives have already been undertaken to review the existing warning system, and evolve simplified, easily understandable cyclone warning signals and messages that are scientific and realistic. Progress has been made to design a simple warning procedure, which is under government consideration for adaptation.

The role of social capital during natural calamities cannot be ignored. Social capital is the network of ad hoc organizations created during emergency situations to respond to the needs of suffering people. It has been observed during the devastating floods of 1988 and 1998, and during the cyclone of 1991 that spontaneous, value-driven relatives, organizations, and networks rendered valuable help and assistance to the victims. In the typologies of mitigation and coping mechanisms, social capital has been identified as an important resource. BIDS undertook a study on its role after the flood of 1998.

4 Overview of NAPA Process

4.1 Preparation Process

The international formulation mission of the United Nations Development Programme (UNDP) prepared National Adaptation Programme of Action (NAPA) proposal. The proposal prepared in consultation with the Secretary, Ministry of Environment and Forest; Secretary of Planning Commission; Director General of Department of Environment; concerned persons of the Planning Commission and other relevant Government agencies, civil society bodies ad donors such as DFID and CIDA. The draft document was further refined at the stakeholders meetings organized by the Ministry of Environment and Forest. The project proposal has sent to GEF for fund approval with concurrence from the concerned agencies and accordingly GEF Secretariat has approved the proposal in April 2003.

4.2 Institutions Involved

Various institutions in the country have potential to play role in the preparation and implementation of the National Adaptation Programme of Action (NAPA). Their participation in the preparation and promotion of the NAPA will be valuable but specific levels of involvement will depend on the priority sectors and adaptation activities that will be covered in the NAPA.

The Ministry of Environment and Forest is the government agency that is responsible for the planning and execution of all activities on environmental protection and management. It is both the GEF and UNFCCC National Focal Point and thus executes NAPA. The following institutes will be involved at different stage of NAPA preparation.

Government Ministries

Ministry of Environment and Forest
Ministry of Agriculture
Ministry of Disaster Management and Relief
Ministry of Civil Aviation and Tourism
Ministry of Chittagong Hill Tracts Affairs
Ministry of Fisheries and Livestock
Ministry of Land
Ministry of Planning
Ministry of Water Resources
Ministry of Local Government

Government Agencies

Bangladesh Water Development Board
Bangladesh Forest Research Institute
Bangladesh Bureau of Statistics
Bangladesh Meteorological Department
Department of Environment
Disaster Management Bureau
Department of Fisheries
Department of Agricultural Extension
Local Government Engineering Department

Planning Commission
Space Research and Remote Sensing Organisation
Water Resource Planning Organization

Non-Government Organizations/Research Organisation

Bangladesh Centre for Advanced Studies
Bangladesh Unnayan Parisahd
Bangladesh Environmental Lawyers Association
Bangladesh Disaster Preparedness Centre
Bangladesh Institute of Development Studies
CARE Bangladesh
CARITAS
Dhaka Ahsania Mission
IUCN-Bangladesh
Nijera Kori

4.3 Priority Sectors

a) Agriculture and Food Security
b) Terrestrial and Freshwater Ecosystem
c) Coastal Zone and Marine Ecosystem
d) Disaster Control (floods and drought)
e) Human Health, and
f) Human Settlement and Infrastructure (as result of urbanization).

4.4 Capacity Needs

The NAPA proposal has highlighted the existing capacity of the country both in public and research community. The NAPA will draw expertises from existing research organization having track record in the climate change activity. It will also use expertise and available data and information from the relevant organizations and departments. However, the following capacity is required to prepare a comprehensive NAPA document.

1. Capacity Building of Stakeholders at Local Level, Regional Level and National Level

2. Capacity to understand the importance of climate change and variability of the stakeholders without that good NAPA can not be formulated

3. Prioritisation of Options and Measures and integrate into the development strategy which require rigours exercise and negotiation capability of environment department.

5 Conclusion

It is found that development of Bangladesh is highly depended on biophysical, socio-economic and institutional capacity those are at risk to climate change and sea level rise. In order to maintain and, if possible, enhance current thrust towards achieving sustainable development Bangladesh should find ways and means to reduce the threats of climate change,

and increase resilience of the society and its physical systems to face the adverse impacts. Minimization of adverse impacts on crop agriculture; enhance resilience of vulnerable groups to extreme climatic events; minimize impacts on their property and livelihoods system; institutional capacity building; peoples participation; and integration of climate change issues in the sectoral development plan will assist sustainable development.

Increase level of understanding among the policy and decision makers on future risk of climate change in the context of economy, environment and social development which could be done through conducting workshops, seminars, roundtable discussions etc. It should also highlight opportunities of new and additional funding under convention and protocol and threats due to lack of institutional capacity. Research institutes, non-government organizations, community based organization need to be used for enhancing resilience of vulnerable groups. This should be done through working with the community and use their indigenous knowledge.

Annex: Data and information for exercises and MCA, developed in consultation with Lead Experts

NAPA Topic	**Lead Expert(s)**
Vulnerability	Paul Desanker/Tom Downing/Mizan Khan
Stakeholders	Annie Roncerel/Mozaharul Alam
Multi-criteria screening/Economic aspects	Klaus Broersma/IVM/Mizan Khan
Project development	Olav Lundstrol/Philip Baker