Ministry of Environment and Forest
Government of the People's Republic of Bangladesh

National Adaptation Programme of Action (NAPA)

Final Report
November 2005

Foreword

The Government of the People's Republic of Bangladesh has recognised climate change as an important issue and attempts are being made to incorporate potential response measures for reducing impacts of climate change into overall development planning process. It is being increasingly recognized that the adverse impacts of climate change in an already vulnerable country such as Bangladesh will put additional stress on overall development of the country. The issue has also been recognised at the higher political level of the country. The Prime Minister Begum Khaleda Zia in her speech at the Workshop on Capacity Building for Preparation of National Adaptation Programme of Action (NAPA) held in Dhaka in September 2002 stated that "while for countries, the impacts might be lifestyle threatening, for others it is life threatening". It has been emphasised that as a natural disaster prone country, Bangladesh has developed a variety of coping mechanisms at formal and informal levels. This has greatly reduced loss of life and property from such disasters. However, in recent years, the frequency of extreme climatic events, such as floods and cyclones has increased worldwide. This is causing havoc to many vulnerable countries and communities particularly in the Least Developed Countries.

The National Adaptation Programme of Action (NAPA) for Bangladesh has been prepared by the Ministry of Environment and Forest (MOEF), Government of the People's Republic of Bangladesh as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The preparation process has followed the generic guiding principles outlined in the NAPA Annotated Guideline. The whole preparation process was guided by the a high powered Project Steering Committee headed by the Secretary, Ministry of Environment and Forests and member from other key ministries, department and agencies including Ministry of Finance and Planning. The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized necessity of addressing environmental issue and natural resource management with the participation of stakeholders. Policy makers of Government, local representatives of the Government (Union *Parishad* Chairman and Members), scientific community members of the various research institutes, researchers, academicians, teachers (ranging from primary to tertiary levels), lawyers, doctors, ethnic groups, media, NGO and CBO representatives and indigenous women contributed to the development of the NAPA for Bangladesh.

The NAPA of Bangladesh draws upon the understanding gathered through discussion with relevant stakeholders in four sub-national workshops and one national workshop, prior research, background papers prepared by Six Sectoral Working Groups (SWG) i.e. a) Agriculture, Fisheries and Livestock coordinated by Bangladesh Agricultural Research Council (BARC), b) Forestry, Biodiversity and Land-use coordinated by IUCN, Bangladesh, c) Water, Coastal Zone, Natural Disaster and Health coordinated by Water Resources Planning organization (WARPO), d) Livelihood, Gender, Local Governance and Food Security coordinated by Bangladesh Institute for Development Studies (BIDS), e) Industry and Infrastructure coordinated by Department of Environment (DoE), and f) Policies and Institutes coordinated by Bangladesh Centre for Advanced Studies (BCAS), and expert judgments.

In the course of the preparation of the report it has become clearer that climate change will exacerbate many of the existing problems and natural hazards that the country faces. But there are various coping mechanisms, formal and informal, already in place. What is new is the urgency of the matter to be integrated within the development process so that when the Climate Change impacts become more clearly discernible, the nation shall be ready to handle that as almost a routine affair in its development process. The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development. Future coping strategies and mechanisms are suggested based on existing process and practices keeping main essence of adaptation science

which is a process to adjust with adverse situation of climate change.

The NAPA is the beginning of a long journey to address adverse impacts of climate stimuli including variability and extreme events and to promote sustainable development of the country. The Government of the People's Republic of Bangladesh expects that the implementation of the projects suggested in the NAPA will begin soon and urges global community to play their role and comply with commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol (KP). The Government of the People's Republic of Bangladesh also expects that the Least Development Countries Fund (LDCF) will be replenished immediately with adequate fund for implementation of the NAPA.

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Table of Contents

Table of Contents

List of Tables

List of Figures

Acronyms and Abbreviations

ADB	Asian Development Bank
AIG	Alternative Income Generation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agriculture Research Institute
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BFRI	Bangladesh Fisheries Research Institute
BIDS	Bangladesh Institute of Development Studies
BRDI	Bangladesh Rice Research Institute
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CBD	Convention on Biological Diversity
CCC	Climate Change Cell
CEGIS	Center for Environment and Geographic Information Services
CIDA	Canadian International Development Agency
COP7	Seventh Session of the Conference of the Parties
DAE	Department of Agricultural Extension
DoE	Department of Environment
DOF	Department of Fisheries
DPHE	Department of Public Health and Engineering
ENSO	El Nino and the Southern Oscillation
FD	Forest Department
FEJB	Forum of Environment Journalist Bangladesh
FMP	Forest Management Plan
GBM	Ganges-Brahmaputra-Meghna
GCM	General Circulation Model
GDP	Gross Domestic Product
GFDL	Geo Fluid Dynamic Laboratory
GOB	Government of Bangladesh
GPWM	Guideline for Participatory Water Management
HDE	Human Development Index
HES	Household Expenditure Survey
HYV	High Yielding Variety
ICDDRB	International Centre for Diarrhoeal Disease Research, Bangladesh
IPCC	Intergovernmental Panel on Climate Change
IUCN	The World Conservation Union
IWRM	Integrated Water Resource Management
LDC	Least Developed Country
LEG	LDC Expert Group
LGED	Local Government Engineering Department

Acronyms and Abbreviations

MEAS	Marine, Earth and Atmospheric Science
MOEF	Ministry of Environment and Forest
MOFDM	Ministry of Food and Disaster Management
MOWR	Ministry of Water Resources
NAPA	National Adaptation Programme of Action
NEMAP	National Environmental Management Action Plan
NIPSON	National Institute for Preventive & Social Medicine
NWMP	The National Water Management Plan
OECD	Organization for Economic Cooperation and Development
OFRD	On-farm Research Division
PRSP	Poverty Reduction Strategy Paper
RA	Resource Analysis
R&D	Research and Development
RVCC	Reducing Vulnerability to Climate Change
SAARC	South Asian Association for Regional Cooperation
SMRC	SAARC Meteorological Research Centre
SRDI	Soil Resources Development Institute
SRES	Special Report on Emission Scenario
SST	Sea Surface Temperature
STW	Shallow Tubewell
TBM	Tidal Basin Management
UNDP	United Nations Development Programme
UNCCD	United Nations Convention on Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
WARPO	Water Resources Planning Organization
WB	World Bank
WFP	World Food Programme

Glossary of Terms

Land Type (by depth of flooding)

F0 (highland)	0-30 cm, Intermittent flooding, land suited to HYV rice in wet season
F1 (medium highland)	30-90 cm, Seasonal flooding, land suited to local varieties of Aus and T. Aman in monsoon season
F2 (medium lowland)	90-180 cm, Seasonal flooding, land suited to B. Aman in wet season
F3 (lowland)	180-300 cm, Seasonal flooding, land on which B.Aman can be grown in wet season
F4 (very lowland)	>300 cm, Seasonal or perennial flooding does not permit growing of B. Aman in the wet season

Agriculture

B Aman	Broadcast Aman; a rice crop usually planted in March/April under dryland conditions, but in areas liable to deep flooding. Also known as deep water rice. Harvested in October to December. All varieties are highly sensitive to day length.
T Aman	Transplanted Aman; a rice crop planted usually July/August, during the monsoon in areas liable to a maximum flood depth of about 0.5 meter. Harvested in November/December. Local varieties are sensitive to day length whereas modern varieties are insensitive or only slightly sensitive.
Boro	a rice crop planted under irrigation during the dry season from December to March and harvested April to June. Local Boro varieties are more tolerant of cool temperatures and are usually planted early in areas which are subject to early flooding due to rise in river levels. Improved varieties, less tolerant of cool conditions are usually transplanted from February onwards. All varieties are insensitive to day length.
B Aus	broadcast Aus; a rice crop planted March/April under dryland conditions. Matures on premonsoon showers to be harvested in June/July, and is insensitive to day length.
T Aus	Transplanted Aus; a rice crop, transplanted March/April usually under irrigated conditions and harvested June/July. The distinction between a late panted Boro (c.v) and early transplanted Aus is academic since the same varieties may be used. Varieties are insensitive to day length.
Kharif	the wet season (typically March to October) characterized by monsoon rain and high temperatures.
Kharif 1	the first part of the kharif season (March to June). Rainfall is variable and temperatures ad high. The main crops grown are Aus, summer vegetables and pulses. Broadcast Aman and jute are planted.
Kharif 2	the second part of the kharif season (July to October) characterized by heavy rain and floods. T. Aman is the major crop grown during the season. Harvesting of jute takes place. Fruits and summer vegetables may be grown on high land.
Rabi	the dry season (typically November to February) with low or minimal rainfall, high evapotranspiration rates, low temperatures, and clear skies with bright sunshine. Crops grown are boro, wheat, potato, pulses and oilseeds.

Glossary of Terms

HYV	high yielding variety; introduced varieties developed through formal breeding programmes HYVs have a higher yield potential than local varieties but require correspondingly high inputs of fertilizer and irrigation water to reach full yield potential.
Local	varieties developed and used by farmers. Sometimes referred to as local varieties improved varieties (LIVs)
NCA	net cultivable area; total area which is undertaken for cultivation

Executive Summary

It is well recognized both in the scientific and negotiating community that Bangladesh would be one of the most adversely affected country to climate change. Low economic strength, inadequate infrastructure, low level of social development, lack of institutional capacity, and a higher dependency on the natural resource base make the country more vulnerable to climate stimuli (including both variability as well as extreme events).

The National Adaptation Programme of Action (NAPA) is prepared by the Ministry of Environment and Forest (MOEF), Government of the People's Republic of Bangladesh as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The preparation process has followed the generic guiding principles outlined in the annotated guideline prepared by LDC Expert Group (LEG). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized necessity of addressing environmental issue and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution. Therefore, involvement of different stakeholders was an integral part of the preparation process for assessing impacts, vulnerabilities, adaptation measures keeping urgency and immediacy principle of the NAPA. Policy makers of Government, local representatives of the Government (Union *Parishad* Chairman and Members), scientific community members of the various research institutes, researchers, academicians, teachers (ranging from primary to tertiary levels), lawyers, doctors, ethnic groups, media, NGO and CBO representatives and indigenous women contributed to the development of the NAPA for Bangladesh.

The stakeholder consultation workshops pointed that the erratic behavior of weather some times first time in their memory such as fogs in places where these were never heard of during summer time, drought, salinity intrusion far from the sea, floods including flash flood, and cyclone and storm surges as major problems they are facing in different parts of the country. Problems related to floods include water logging and drainage congestion, early and untimely floods, localized inundation and flash floods. Salinity intrusion due to reduction of freshwater flow from upstream, salinization of groundwater and fluctuation of soil salinity are major concern. Continuous and prolonged droughts, extreme temperature and delayed rainfall are major problems that agriculture sector is facing. Storms, cyclones and tidal surges appear to have increased in the coastal areas.

It is revealed that adverse effects of climate stimuli including variability and extreme events in the overall development of Bangladesh would be significant and highly related to changes in the water sector. Most damaging effects of climate change are floods, salinity intrusion, and droughts that are found to drastically affect crop productivity almost every year. Climate change induced challenges are: (a) scarcity of fresh water due to less rain and higher evapo-transpiration in the dry season, (b) drainage congestion due to higher water levels in the confluence with the rise of sea level, (c) river bank erosion, (d) frequent floods and prolonged and widespread drought, (e) wider salinity in the surface, ground and soil in the coastal zone. It was found that the population living in the coastal area are more vulnerable than the population in other areas. The agricultural sector will face significant yield reduction. Thus food-grain self sufficiency will be at risk in future.

The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development. Future coping strategies and mechanisms are suggested based on existing process and practices keeping main essence of adaptation science which is a process to adjust with adverse situation of climate change.

Sharing knowledge and experiences of existing coping strategies and practices to other area that would come under similar problems related to climate change. Development of techniques for transferring knowledge and experiences from one area/ecosystem is also necessary.

Some initial activities have already been pioneered in Bangladesh in adaptation to climate change at the community level. Several workshops at national and international level have been organized to develop better

understanding on approaches on adaptation and increase negotiation skills in the Conference of the Parties to the UNFCCC. Notable among them are the International Workshop on Community Level Adaptation to Climate Change organized by Bangladesh Centre for Advanced Studies in association with IIED and IUCN, Dialogue on Water and Climate Change organized by IUCN Bangladesh. Pilot level activities are being carried out to increase resilience of individual and community. For example in the Reducing Vulnerability to Climate Change (RVCC) project in a number of flood-prone villages in coastal Bangladesh implemented by the CARE international in partnership with local NGOs has generated much useful knowledge in how to communicate climate change (and adaptation) messages at the community level.

Addressing future problems related to sea level rise appear to be a complex issue for Bangladesh and therefore integrated approach both in terms of sectors and technologies need to be analyzed along with acceptability by the communities for whom the technologies would be suggested.

It is evident from the science of climate change and impacts studies that severity of impacts and frequency will increase in future and therefore limitation of existing coping strategies need to be assessed. Moreover, preparation for this on regular basis will reduce impacts but will not solve the problem. Insurance as a mechanism may be considered for which further analysis is necessary.

Considering above background the following adaptation measures have been suggested for Bangladesh to address adverse effects of climate change including variability and extreme events based on existing coping mechanisms and practices. The suggested future adaptation strategies are:

1. Reduction of climate change hazards through coastal afforestation with community participation.
2. Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.
3. Capacity building for integrating climate change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.
4. Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.
5. Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.
6. Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).
7. Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.
8. Enhancing resilience of urban infrastructure and industries to impacts of climate change.
9. Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.
10. Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.
11. Promoting adaptation to coastal crop agriculture to combat increased salinity.
12. Adaptation to agriculture systems in areas prone to enhanced flash flooding in North East and Central Region.
13. Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.
14. Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh.
15. Exploring options for insurance and other emergency preparedness measures to cope with enhanced climatic disasters.

1 Introduction

The National Adaptation Programme of Action (NAPA) of Bangladesh draws upon the understanding gathered through discussion with relevant stakeholders in 4 sub-national workshops and one national workshop, prior research, background papers prepared for this report as well as research carried out for these background reports, and expert judgments. In the course of the reparation of the report it has been clear that climate change will exacerbate many of the existing problems and natural hazards that the country faces. But there are various coping mechanisms, formal and informal, already in place. What is new is the urgency of the matter to be integrated within the development process so that when the Climate Change impacts become more clearly discernible, the nation shall be ready to handle that as almost a routine affair in its development process.

2 Context

Bangladesh, except for the hilly regions in the northeast and southeast and terrace land in northwest and central zones, is one of the largest deltas in the world, formed by the dense network of the distributaries of the mighty rivers namely the Ganges, the Brahmaputra and the Meghna. The country is located between 20°34' to 26°38' north latitude and 88°01' to 92°42' east longitude. The total land area is 147,570 sq. km. and consists mostly of low and flat land. A network of more than 230 major rivers with their tributaries and distributaries crisscross the country.

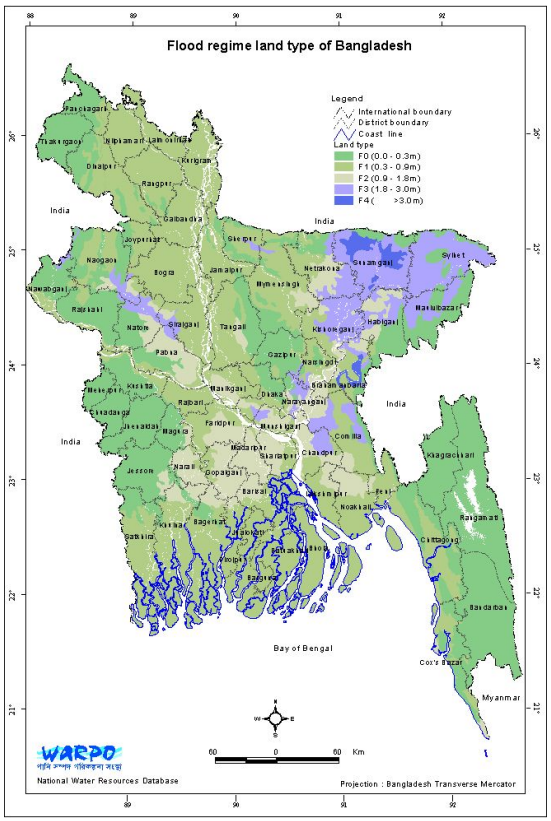
2.1 Characteristics

This section provides a brief description of the biophysical, social, economic, technological and political context of the country. These characteristics depict exposure, sensitivity, adaptive capacity and vulnerability of these systems to climate variability and change.

2.1.1 Physiographic Condition

The land area of the country may be divided broadly into three categories i.e. floodplain (80 %), Pleistocene terrace (8 %), and tertiary hills (12 %) based on its geological formation. The floodplain comprises of a succession of ridges

Figure – 1. Flood Regime and Land Type of Bangladesh



(abandoned levees) and depressions (back swamps or old channels). Differences in the elevation between adjoining ridge tops and depressions range from less than 1 meter on tidal floodplains, 1 meter to 3 meters on the main rivers and estuarine floodplains, and up to 5 to 6 meters in the Sylhet Basin in the north-east. Only in the extreme northwest do land elevations exceed 30 meters above mean sea level. The tertiary hill soil occupy the Chittagong hills in the south-east, and the low hills and hillocks of Sylhet in the north-east. The two major uplifted blocks (Pleistocene terrace) are known as Madhupur (in the central Bangladesh) and Barind tracts in the north-west.

The land type of the country has been classified according to depth of inundation with seasonality. All land types except highlands are exposed to monsoon flooding for part or whole of the year. Land area with different flood depths as well as seasonality is given in Table 1.

Floodplains located in the north-western, central, south-central and north-eastern regions are subject to regular flooding at different frequency and intensity while the coastal plain is subject to

Table 1. Land Areas of Different Flood Phases

Land type	Maximum depth of flooding	Seasonally flooded	Permanently flooded
Medium Highland 1 (F0)	0.3m	16%	0%
Medium Highland 2 (F1)	0.9m	44%	1%
Medium Lowland (F2)	1.8m	23%	1%
Lowland (F3)	3.0m	11%	3%
Very lowland (F4)	>3.0m	1%	1%
Total		95%	6%

Source: NWMP estimates

cyclones and storm surges, salinity intrusion and coastal inundation. Pleistocene terrace land is characterized by moisture stress while flash flood is common in the hilly areas and the piedmont plains in the northeast and northwestern parts of the country.

2.1.2 Demographic Situation

It has a population of about 131 million (BBS, 2002) with very low per capita Gross Domestic Product (GDP) of US$ 351 per annum (UNDP, 2004). Of this, just about a quarter was in the urban areas including the metropolitan cities . Population of the country has been growing fast in the sixties and the seventies. The inter-census growth rates had been rising and then falling over the last four decades or so. The falling population growth rate had been possible due to a sharp decline in the total fertility rate which had fallen from 6.3 per woman of reproductive age (15-49) in 1975 to 3.0 by 2004 (NIPORT and Mitra and Associate: 2005). For the future under the assumed rates for this report, the expected population for the year 2030 is 186 million, 61 million in the urban and the rest 125 million in the rural areas.

Most people, live in the rural areas. On the other hand, urbanization is growing fast in the country. Between 1961 and 1974, the rate of growth in urban population had been 6.7 % per annum. Between 1974 and 1981 it shot up further to 10.7 % per annum. Since then the rate has fallen, but between 1991 and 2001 it was 3.15 % which is just double the rate of overall population growth.

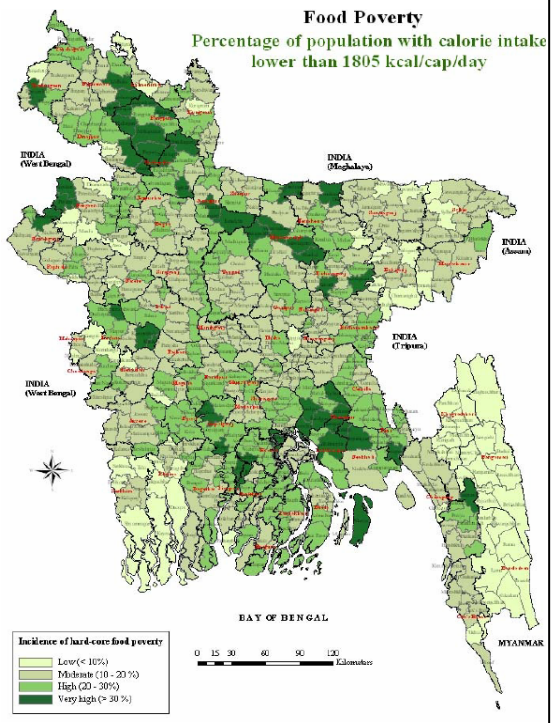
Spatial distribution of population is important in the context of climate change. It is estimated that about 79% (70% inland plain and 9% inland hills) peoples live somewhat away from the sea and rest 21% (15% coastal plain and 6% coastal hills) accounts for population in the coastal districts.

2.1.3 Socio-economic Condition

Bangladesh has performed fairly well in terms of macroeconomic stability in general and economic growth in particular over the last decade. Market oriented economic reforms and deregulations in early 1990s led to a more stable macroeconomic environment compared with that in 1970s and 1980s. The Gross Domestic Product (GDP) growth rate improved steadily during the 1990s. The average annual GDP growth was 4.65 % from 1991 through 1995 and rose further to 5.5 % from 1996 through 2000. However, despite the recent macro economic achievements, poverty is still pervasive and endemic in Bangladesh. The disparity between the rich and poor is also growing.

Agriculture, manufacturing industries, and various services such as transport and trade services are the major economic sectors of the country. While there is some debate regarding the direct contribution of agriculture to the national income, two facts remain undisputed. Firstly, there is a decreasing trend in its share in GDP. Secondly, despite this, it is still of paramount importance, because it still supports a large number of people and most other sectors or activities depend on it, either for processing its products, or servicing the sector. Further, the government strives for self sufficiency in food grain and attaches great importance to maintaining a sustainable growth rate in agricultural sector.

Figure – 2. Spatial Distribution of Poverty



Source: GOB and FAO, 2004

The status of human development as reflected in the Human Development Index (HDI) representing life expectancy, level of literacy, and standard of living (in terms of GDP per capita at purchasing power parity has improved from 0.350 in 1980 to 0.509 in 2002. Bangladesh has moved from a low human development category to a medium human development category and is ranked 138 among 177 nations (UNDP, 2004). It is true that the macro economic situation is getting better but still 36 % of the people are living on a dollar per day or less.

According to the Household Income and Expenditure Survey (HIES) of Bangladesh Bureau of Statistics (BBS), using the most commonplace definition, about half of the population could be considered poor in the mid-1990s, while a quarter of the population could be considered extreme poor. The situation remained basically unaltered by the turn of the century.

Levels of poverty vary substantially across the country and are strongly correlated with spatial distribution of food insecurity. The United Nations World Food Programme (WFP) has reported that the poorest upazilas can be found in the north-west, the coastal belt, Mymensingh, Netrakona, Bandarban and Rangamati. In terms of absolute numbers, districts with more than one million people living in extreme poverty include Sirajganj, Naogaon, Bogra, Mymensingh and Chittagong (GOB and FAO, 2004). Figure 2 shows the spatial distribution of poverty in the country.

2.1.4 Infrastructure, Industries and Technologies

Over the last decades significant development happened in infrastructure particularly transport system for increasing connectivity of rural growth centers with cities and large market. The transport system of Bangladesh operates through four modes. Road, rail, inland waterways and airways. Land transport infrastructure particularly road network is fragmented by numerous ferry crossings and land transport has to move over circuitous routes because of extensive river systems. Costs for construction and maintenance of transport infrastructure particularly road network are very high because of difficult terrain strewn with numerous water courses, periodic flooding requiring elevated infrastructure embankments, and poor soil conditions coupled with general scarcity of construction materials and lack of adequate construction industry.

Bangladesh is predominantly an agricultural country but a number of large scale industries are based on both indigenous and imported raw materials. Jute, cotton, textile, paper and newsprint, sugar, cement, chemicals, fertilizers and tanneries are most important among them. Readymade Garments is one of key foreign currency earning industries.

The country is depended on imported technologies but diffusion is very high particularly telecommunication and computer technologies. The country will be connected with supper information highway very soon and information technology is an emerging field.

2.1.5 Policy, Planning, Institutions and Governance

Economic emancipation of the ever-growing population of Bangladesh is the main goal and poverty alleviation is one of the principal objectives and means of government policy. Halving poverty by the year 2015 is a key target set in the *Unlocking the Potential National Strategy for Accelerated Poverty Reduction* widely known as Poverty Reduction Strategy Paper (PRSP), finalized in2005. It has recognized necessity of human resources development and enhanced investment in education, which can be the means to achieve better human resources.

The PRSP (GoB: 2005) states that Bangladesh has one of the most vulnerable economies, characterized by extremely high population density, low resource base, and high incidence of natural disasters. These have implications for long-term savings, investment, and growth.

Climate change and related extreme events are recognized as major impediments to growth in recently developed policy documents such as Coastal Zone Policy. National Water Policy has recognized that it is necessary to reduce knowledge gap for addressing climate change in water sector. PRSP recognizes the direct links between poverty and vulnerability to natural hazards: "*Given the risk and vulnerability to natural hazards that are likely to continue as a serious threat to national development efforts, macro level policies for disaster risk reduction, mitigation and management must be adopted in view of alleviating disaster-induced poverty*". It has also proposed a comprehensive and anticipatory approach to reduce Bangladesh's vulnerability: "*… to reduce vulnerability to natural, environmental and human induced hazards through community empowerment and integration of sustainable risk management initiatives in all development programs and projects*".

The government of Bangladesh (GOB) has established an inter-ministerial committee on climate change headed by the Minister for Environment and Forest (MOEF) and with representation from relevant government ministries and departments as well as key Non-governmental organizations (NGOs) and research institutions. The Department of Environment (DOE) under the MOEF has also set up a Climate Change Cell (CCC) to act as Secretariat for climate change related work within the government. There is also a National Environment Committee to determine environmental policies chaired by the Prime Minister and with representation from Members of parliament (MPs) as well government and civil society. It may be pointed out, however, that the institutional capacity including human resource quality in most such organizations are weak and poor and needs substantial improvement if the challenges of climate change are to be faced squarely.

2.2 Key Environmental Stresses

There are a number of environmental issues and problems that are hindering development of Bangladesh. A brief description of key environmental stresses in relation to NAPA are given below.

2.2.1 Land and Soil

Agricultural land is decreasing rapidly as it has been diverted to other uses, mainly for urbanization and building of human settlements. The annual loss of arable land stands at about 100 thousand ha per year.

In addition to structural change of land use, riverbank erosion is rampant in areas along the active river channels of the Ganges, the Jamuna and the Tista rivers and in the coastal and offshore areas of Bangladesh. About 1.7 million hectares of floodplain areas are prone to riverbank erosion (Karim and Iqbal, 2000). It has been observed that between 1973 and 1996, a total of 73,552 ha of land was eroded while only 10,628 ha of land have been formed by accretion (WARPO, 2000).Physical, chemical and biological properties of soil are deteriorating due to a number of reasons including loss of micro nutrient, salinity intrusion, lack of proper replenishment of plant nutrient etc. In Bangladesh most soils lack adequate organic matter. Forty five percent net cultivable area has even less than 1% organic matter. Out of 2.85 million hectares of the coastal and offshore areas about 1.2 million hectares of arable land are affected by varying degrees of soil salinity. Tidal flooding during wet

season, direct inundation by saline or brackish water and upward or lateral movement of saline ground water during dry season and inundation with brackish water for shrimp farming are key causes for salinization of coastal land. The severity of salinity problem has increased over time with the desiccation of the soil.

2.2.2 Water

Bangladesh is richly endowed with water resources. The water ecosystem comprises the tributaries and distributaries of the three major rivers system, the Ganges-Padma, the Brahmaputra, and the Meghna (GBM), and numerous perennial and seasonal wetlands known locally as *haors, baors, pukurs, dighies, khals and beels*. Owing to the fact that 92% or more of Bangladesh's annual runoff enters the country from outside its borders, there is a high degree of uncertainty about the quantum of the water that will be available from trans-boundary rivers in future. River flows have very large seasonal variations. In the monsoon the combined flow of the Ganges and the Brahmaputra reaches a peak between 80,000 to 140,000 m3/s in the July-August or early September period. (NWMP, 2001). Dependable flow (80%) in the Ganges (according to Ganges Water Treaty) can be less then 1,000 m3/s from February to April period. In the river Brahmaputra flows (dependable) is less then 4,000 m3/s during March and April (NWMP, 2001).

Mainly two types of problems exist in the coastal water bodies, namely, salinity in the estuarine areas, and water pollution in the marine zone. The magnitude of these problems depends on seasonal freshwater flow from the rivers, and operation of seaports.

Generally, water scarcity is a dry season phenomenon when the availability becomes less than the demand, or the quality of the water restricts its use. Dry season water resources are comprised of the runoff and trans-boundary river inflow, together with water contained in surface water bodies and groundwater. Scarcity is also dependent on the amount of soil moisture available at the beginning of the season. Trans-boundary inflow in the dry season has decreased due to upstream development, and withdrawal of water for irrigation and other purposes. Groundwater is the major source of irrigation and domestic water supply in Bangladesh. There has been a tremendous increase in the suction mode technology in irrigation & water supply using groundwater sources since 80's. Contamination of shallow aquifer has recently been identified as a major problem with about 25% of the population exposed to arsenic level exceeding Bangladesh standards (0.05mg/l) (NWMP, 2001). Other problems in different parts of the country include, water logging (particularly in the coastal and urban centers) as well as poor water management and drainage systems in many places.

2.2.3 Biodiversity

The terrestrial and aquatic areas of the country support a large number of diverse biological populations, both plant and animal. Notwithstanding insufficient baseline information on biological resources, it is believed that development practices have caused a significant depletion of terrestrial and aquatic species diversity. Over-exploitation of some very common species in an unwise manner has led to their being reduced to a vulnerable status.

Sundarbans mangrove forest in the south-west forms a unique environment of floral-faunal assemblages. Leaf litter undergoing decomposition provides particulate and dissolved organic matter to the estuarine ecosystem, and this complex detritus-based food web supports a number of marine and brackish water organisms. The Sundarbans supports a very rich and diverse fish fauna of 400 species, 270 species of birds, and over 300 species of plants. It is an important staging and wintering ground for migratory shore birds, gulls, and terns. The mangrove is the largest remaining tract of habitat for the Royal Bengal Tiger (*Panthera tigris*). St. Martin's Island is an important nesting area for marine turtles, and a wintering ground for migratory shore birds.

In addition to the Sundarbans (which has been declared by UNESCO as "World Heritage Site") there are also other significant wetlands (both coastal and inland-fresh water) with important plant (e.g. swamp forest), animal, aquatic species and over-wintering grounds for many migratory bird species.

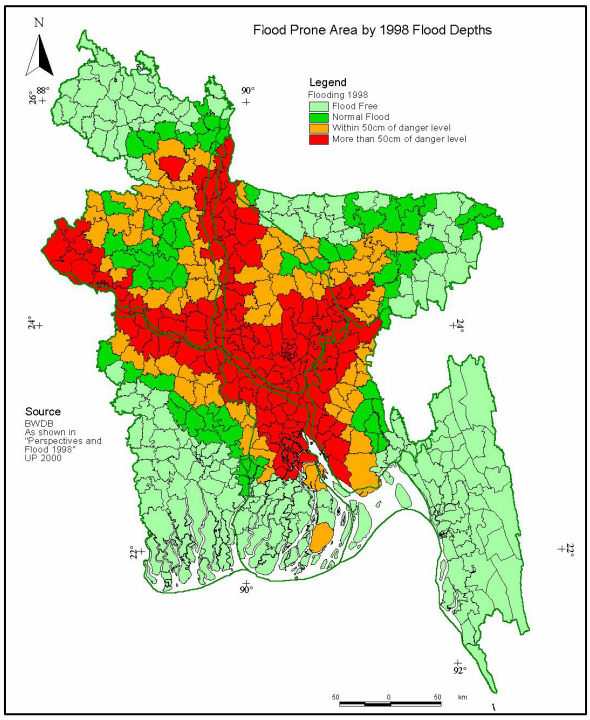
2.2.4 Disasters

The geographical setting of Bangladesh makes the country vulnerable to natural disasters. Every year one or more natural calamities upset people's lives in some part of the country. The major natural hazards include flood, cyclone and storm surge, flash flood, drought, tornado, earthquakes, riverbank erosion, and landslide.

Flood in Bangladesh is a normal phenomenon. Floods affect about 80% of land in Bangladesh. In a normal year, 20-25% of the country is inundated by river spills and drainage congestions. Approximately 37%, 43%, 52% and 60% of the country is inundated with floods of return periods of 10, 20, 50 and 100 respectively (MPO, 1986). Four types of flooding occur in Bangladesh.

- Flash floods caused by overflowing of hilly rivers in eastern and northern Bangladesh (in April-May and in September-November).

Figure 3. Flood Prone Area by 1998 Flood Depth



Source: WARPO

Table 2. Impacts of Major Floods

Event	Impact
1954 floods	Affected 55% of country
1974 flood	Moderately severe, over 2,000 deaths, affected 58% of country, followed by famine with over 30,000 deaths
1984 flood	Inundated 52,520 sq-km, cost estimated at US$378 million
1987 floods	inundated over 50,000 sq-km, estimated damage US$ 1.0 billion, 2055 deaths
1988 floods	Inundated 61% of country, estimated damage US$ 1.2 billion, more than 45 million homeless, between 2,000-6,500 deaths
1998 floods	1,100 deaths, inundated nearly 100,000 sq-km, rendered 30 million people homeless, damaged 500,000 homes, heavy loss to infrastructure, estimated damage US$ 2.8 billion
2004 floods	Inundation 38%, damage US$ 6.6 billion, deaths 700, affected people nearly 3.8 million

- Rain floods caused by drainage congestion and heavy rains.
- Monsoon floods in the flood plains of major rivers (during June-September).
- Coastal floods due to storm surges.

In Bangladesh floods, cyclonic storm surges are major killers as well as cause of most direct and indirect damage. In more recent years over 1970-98, cyclonic storms and floods killed more than 4.6 hundred thousand and 41 thousand peoples respectively. It affected another nearly 45 million and 356 million peoples respectively (UNDP, 2001).

When a major disaster has stuck, the whole economy suffered. Agriculture suffered probably more than non-agricultural sectors. Yet, as Islam (1997) has found, even in such a situation floods

Table 3. Relationship of Climate Change and Variability with Physical Vulnerability Context

Climate Change					Climate Variability			
Increase average temperature	Increase average rainfall	Decrease average rainfall	Sea level rise	Erratic temperature (extreme heat or cold)	Erratic rainfall (excessive rainfall and lack of timely rainfall, untimely rainfall)	Erratic tidal Wave	Cyclone and storm surges	**Physical Vulnerability Context**
+	++		++		+	+	+	Inundation
+		++			+			Low Flow
			++			++	++	Salt Water Intrusion
	++				++			Flash Flood
++		++ +		++	+			Drought
	+		++			++		River Morphology

Note: +++ refers to high, ++ refers to moderate, and + refers to low level of relationship

cause much of the damage indirectly though the sectoral linkage effects.

Devastating floods of 1987, 1988 and 1998 inundated more than 60% of the country. The 1998 flood alone caused 1,100 deaths, inundated nearly 100,000 sq-km, rendered 30 million people homeless, damaged 500,000 homes and caused heavy losses to infrastructure. In 2004, floods inundated 38% of the country. Figure 3 shows flood prone area of Bangladesh and Table 2 indicates broad adverse impacts of major floods during the last 50 years.

2.3 Adverse Effects of Climate Change and Variability on Biophysical and Key Sectors

Over the last decade a number of studies have been carried out on impacts, vulnerability and adaptation assessment for Bangladesh to climate change and sea level rise. Major climate change impacts and vulnerability assessment studies are (a) Assessment of Vulnerability Bangladesh to Climate Change and Sea Level Rise, 1994 (b) Climate Change Country Study Bangladesh under U. S. Climate Change Study Programme, 1997 (c) Climate Change and Adaptation Study for Achieving Sustainable Development in Bangladesh, 2000, (d) Country Study on Bangladesh under Regional Study of Global Environmental Issues Project of Asian Development Bank (ADB, 1994) and (e) Synthesis Report on Dialogue on Water and Climate Change, 2004. Bangladesh has also submitted its Initial National Communication to the United Nations Framework Convention on Climate Change. The second National Communication is due to start in 2006.

Most of the studies have assessed impacts of, and vulnerability and adaptation to climate change and sea level rise by sectors and geographic areas such as water, coastal zone, agriculture, infrastructure, forestry and health to. It has been observed that the vulnerability of the country to climate change is the result of a complex interrelationship among biophysical, social, economic and technological characteristics of the country. It is revealed that many anticipated adverse impacts of climate change including sea level rise, higher temperatures, enhanced monsoon precipitation and run-off, potentially reduced dry season precipitation, and an increase in cyclone intensity would in fact aggravate

many of the existing stresses that already pose a serious impediment to the process economic development of Bangladesh. The climate change policy, particularly adaptation thus becomes a part and parcel of the development policies of the country.

The adverse effects of climate change including variability and the extreme events on the overall development of Bangladesh are significant and in many cases related to possible changes to be experienced in the water sector. Most damaging effects of climate change are floods, salinity intrusion, and droughts that are found to drastically affect crop productivity almost every year. Climate change induced challenges are: (a) scarcity of fresh water due to less rain and higher evapo-transpiration in the dry season (b) drainage congestion due to higher water levels in the confluence with the rise of sea level, (c) river bank erosion, (d) frequent floods and prolonged and widespread drought, (e) wider salinity in the surface, ground and soil in the coastal zone (WB, 2000).

Low level of economic development and corresponding low investment capacity, inadequate infrastructure, low level of social development, lack of institutional capacity, and a high dependency on the natural resource base make the country highly vulnerable to climate change (including both variability as well as extreme events). It was found that the population living in the coastal area are more vulnerable than the population in other areas (Alam and Laurel, 2005). The agricultural sector will face significant yield reduction. Thus food-grain self sufficiency will be at risk in future (BCAS/RA/Approtec, 1994, and Alam, 2004).

The ultimate key impacts of climate change and variability will be on livelihoods of the peoples depending on natural resource base and services of other sectors including infrastructure and industries. For example, the changes in agriculture may lead to a fall in domestic production of food, fodder and fiber. What all of these mean is falling output, employment and incomes of the people may fall lowering their consumption that will lead to a rise in malnutrition and income poverty.

3 Framework for Adaptation Programme

3.1 An overview of Climate Variability and Change

The pattern and behavior of climate and weather play a significant role in freshwater availability, agriculture, economic growth and performance, and livelihoods. Recent studies and the regional stakeholder consultation workshops have revealed that the erratic nature of rainfall and temperature has indeed increased (NAPA Regional Workshop reports 2005). Adverse effects of erratic nature of rainfall and temperature on agricultural productivity and availability of freshwater is already quite evident in many areas of Bangladesh.

3.1.1 Observed Changes

Observed data indicates that the temperature is generally increasing in the monsoon season (June, July and August). Average monsoon time maximum and minimum temperatures show an increasing trend annually at the rate of 0.05^{O}C and 0.03^{O}C, respectively. On the other hand average winter time (December, January and February) maximum and minimum temperatures show respectively a decreasing and an increasing trend annually at the rate of 0.001^{O}C and 0.016^{O}C (Rahman Alam: 2003). Regional variations have been observed around the average trend (SMRC, 2003).

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 an increasing trend of mean maximum and minimum temperature in some seasons and decreasing trend in some others. Overall the trend of the annual mean maximum temperature has shown a significant increase over the period of 1961-90.

There is also clear evidence of increased saline intrusion in the coastal zones. For example in the coastal city of Khulna the main power station needs to collect fresh water to cools its boilers by sending a barge upstream to get freshwater. Over the last one decade the barge has to go further and

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°48’	89°28’	3.784	4.0
Char Changa	Central	22°08’	91°06’	4.996	6.0
Cox’s Bazar	Eastern	21°26’	91°59’	4.836	7.8

Source: SMRC, No. 3

further upstream to get suitably fresh water for the purpose. While there are other factors behind the salinity intrusion (such as the withdrawal of water at Farakka by India to divert water flows to Calcutta), the trend towards salinization in the coastal zone is very clear.

Other impacts such and changes in coastal morphology are not so clear cut (for example the changes in coastal erosion seems to be matched by an equivalent accretion-albeit at different points along the coast). (Similarly cyclones have also not shown a perceptible increase in either frequency or intensity, but there is anecdotal evidence that stormy weather conditions are more frequent than in the past (although not of cyclone–like intensity).)

It is revealed in a study carried out by SAARC Meteorological Research Council (SMRC) that there has been a significant increasing trend in the cyclone frequency over the Bay of Bengal during November and May which are main months for cyclone in the Bay of Bengal (SMRC, 2003).

The SAARC Meteorological Research Council (SMRC) carried out a study on recent relative sea level rise in the Bangladesh coast (SMRC 2003). The study has used 22 years historical tidal data at three coastal stations. The study shows that the rate of sea level rise during the last 22 years is many (4.0 mm/year at Hiron Point, 6.0 mm/year at Char Changa and 7.0 mm/year at Cox’s Bazar) times higher than the mean rate of global sea level rise over 100 years. It must be pointed out however that the rise in sea level includes that due to regional tectonic subsidence. Variation among the stations was also found. Table 4 represents the trend of tidal level in three coastal stations

3.1.2 Future Scenarios

Future changes of temperature and rainfall are estimated for Bangladesh using two general approaches i.e. (a) projection based on observed data, and (b) using available climate model. It is to be noted that projection based on observed data had no scope to incorporate future concentration of CO_2 in the atmosphere under different emission scenario. Therefore it would be wise not to use these for vulnerability analysis.

Earlier vulnerability and adaptation assessment studies carried on Bangladesh have used both older and newer versions of General Circulation Models. Details are given in Box. 1. National Adaptation Programme of Action for Bangladesh has complied future impacts, vulnerability and adaptation based on existing model outputs. It considered future changes in the climate as given in Table 5.

Table 5. Future Climate Scenarios used for Preparation of NAPA for Bangladesh

Year	Temperature change (°C) Mean (standard deviation)			Precipitation change (%) Mean (standard deviation)			Sea Level Rise (cm)
	Annual	DJF	JJA	Annual	DJF	JJA	
2030	1.0	1.1	0.8	5	- 2	6	14
2050	1.4	1.6	1.1	6	- 5	8	32
2100	2.4	2.7	1.9	10	- 10	12	88

Note: Adopted from Agarwala et al., IPCC TAR Report

3.2 Actual and Potential Adverse Effects of Climate Change

3.2.1 Present Impact of Climate Variability and Extreme

Most damaging effects of erratic behavior of present climate and extreme events are flood, drought, and heat stress that are found to drastically adversely affect crop productivity in almost every year. About 1.32 m ha of cropland is highly flood-prone and about 5.05 m ha moderately flood-prone. Besides crops, perennial trees and livestock are damaged by flood every year. In two severe flood years of 1974 and 1987, the shortfalls in production from trend were about 0.8 and 1.0 Mmt of rice, respectively. During 1984, flood affected both Aus and Aman rice crop and the shortfall was about 0.4 Mmt.

Drought of different intensities in Kharif, Rabi and pre-Kharif seasons cause damage to 2.32 m ha of T. aman and 1.20 m ha of rabi crops annually. Yield reductions due to drought vary from 45-60% in T. aman and 50-70% in rabi crops in very severe drought situation. In the severe drought year of 1979 the shortfall was about 0.7 million tons. During 1981 and 1982 drought affected the production of monsoon crop (Aman) and the shortfalls from the trend were 0.5 and 0.3 Mmt, respectively.

3.2.2 Potential Future Vulnerability

Over the last decade a number of studies have been carried out on impacts, vulnerability and adaptation assessment for Bangladesh to climate change and sea level rise. Regional stakeholder consultation workshops have identified vulnerability of different sectors in the context of

Box 1. Knowledge Base on Scenario Building in Bangladesh

General Circulation Model (GCM) used by the US Climate Change Study team for Bangladesh reported 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 to a negligible rate in 2030, while in 2075 there would not be any appreciable rainfall in winter at all. On the other hand, monsoon precipitation would increase at a rate of 12 % and 27 % for the two projection years, respectively (Ahmed et, al., 1999).

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 for year 2075. It was inferred from the GCM output that moderate changes regarding climate parameters would take place by 2030, while severe changes would occur by 2075.

The results also reveal a trend of a general increasing temperature. In 2030, the increase is much more 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^{O}C (Ahmed et, al., 1999).

OECD has recently carried out 17 General Circulation Models for Bangladesh in order to assess changes in average temperature and precipitation using a new version of MAGICC/SCENGEN. It has selected 11 out of the 17 models which best simulate current climate over Bangladesh. The models were run with the Intergovernmental Panel on Climate Change (IPCC) B2 scenario of Special Report on Emission Scenario (SRES) (Agarwala et, al., 2003).

The climate models all estimate a steady increase in temperatures for Bangladesh, with little inter-model variance. Somewhat more warming is estimated for winter than for summer. With regard to precipitation - whether there is an increase or decrease under climate change is a critical factor in estimating how climate change will affect Bangladesh, given the country's extreme vulnerability to water related disasters. The key is what happens during the monsoon? Most of the climate models estimate that precipitation will increase during the summer monsoon because air over land will warm more than air over oceans in the summer. This will deepen the low pressure system over land that happens anyway in the summer and will enhance the monsoon. It is notable that the estimated increase in summer precipitation appears to be significant; it is larger than the standard deviation across models. This does not mean that increased monsoon is certain, but increases confidence that it is likely to happen. The climate models also tend to show small decreases in the winter months of December through February. The increase is not statistically significant, and winter precipitation is just over 1% of annual precipitation. However, with higher temperatures increasing evapo-transpiration combined with a small decrease in precipitation, dry winter conditions, even drought, are likely to be made worse (Agarwala et, al., 2003).

climate variability and change. Summary of vulnerability of different sectors is given below. Much of the future vulnerability due to climate change will not necessarily add any new climate related hazards to the already well known ones of floods, droughts and cyclones, but will enhance both the frequency as well as intensity of such climatic events in future. Particularly, the areas prone to the floods, cyclones and salinity intrusion all may increase in future. The climate related hazards will in turn be compounded by other factors including land use patterns, water management and control of river flows upstream. Some of the specific vulnerabilities due to climate change impacts are described below.

3.2.2.1 Water Resources

Water related impacts due to climate change and sea level rise are likely to be some of the most critical issues for Bangladesh, especially in relation to coastal and riverine flooding, but also in relation to the enhanced possibility of winter (dry season) drought in certain areas. The effects of increased flooding resulting from climate change will be the greatest problem faced by Bangladesh as both coastal (from sea and river water), and inland flooding (river/rain water) are expected to increase. In addition, changes of the riverbed level due to sedimentation and changes in morphological processes due to seasonal variation of water level and flow are also critical for Bangladesh.

Sedimentation and River Bed Rise

The process of sedimentation may rise as water level gradients due to higher downstream water levels at sea resulting in lower flow velocities.. The morphologically highly dynamic rivers in Bangladesh are expected to adapt to such changes in water levels over a period of time of several decades. The changes in bed levels in turn will cause additional changes in river levels, which effect will propagate the impact of sea level rise in upstream direction. The first assessments of this effect in the study for the Jamuna Bridge showed the importance of this feed back mechanism (Rendel et al., 1990).

Forecasts show that at the bifurcations of the Jamuna river with its distributaries Dhaleswari river and Old Brahmaputra river, the bed level will rise 0.08, 0.12 and 0.41 m at the mouth of the Dhaleswari river and 0.05, 0.08 and 0.27 m at the mouth of the Old Brahmaputra river for the years 2015, 2025 and 2095 respectively (BCAS/RA/ Approtech, 1994). This will probably result in a considerable increase in the discharges in the distributaries and a small decrease of the discharges in the Jamuna and Padma rivers. The discharge distribution at the tributaries of the Ganges and the Padma rivers (Gorai and Arial Khan rivers) will change also due to the considered sedimentation. These changes might be of important consequences for the course of the main river channels in Bangladesh.

Change of Land Type

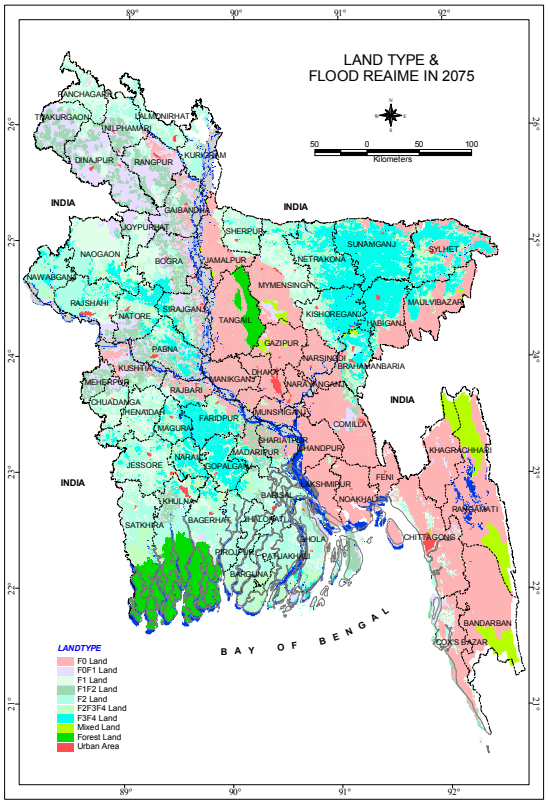
Bangladesh Climate Change Country Study (1997) assessed vulnerability of water resources considering changes in flooding conditions due to a combination of increased discharge of river water during monsoon period and sea level rise for the two projection years, 2030 and 2075.

From the analysis it is found that much of the impact would be for F_0 land followed by F_1 land in the year 2075 where embankment played an important role in restricting the extent of flood affected areas. Again, it is the F_0 land followed by F_1 land in 2030 which would experience much of the changes in he north-central region in 2030. A combination of development and climate change scenarios revealed that the Lower Ganges and the Surma floodplain would become more vulnerable compared to the rest of the study area. On the other hand, the north-central region would become flood free due to embanking of the major rivers (Alam, et al., 1999). Table 6 shows changes in land type and flood regime in 2030.

3.2.2.2 Coastal Zone

Several studies indicate 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 (BCAS/RA/Approtech, 1994, WB, 2000). Four key types of primary physical effects i.e. saline water intrusion; drainage congestion; extreme events; and changes in coastal morphology have been identified as key vulnerabilities in the coastal area of Bangladesh (WB, 2000). A

Figure – 4. Flood Regime and Land Type in 2075



relationship between agents of change and primary physical effects in the coastal zone of Bangladesh is given in Table 7.

- The effect of saline water intrusion in the estuaries and into the groundwater would be enhanced by low river flow, sea level rise and subsidence. Pressure of the growing population and rising demand due to economic development will further reduce relative availability of fresh water supply in future. The adverse effects of saline water intrusion will be significant on coastal agriculture and the availability of fresh water for public and industrial water supply will fall.

- The combined effect of higher sea water levels, subsidence, siltation of estuary branches, higher riverbed levels and reduced sedimentation in flood-protected areas will impede drainage and 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:

Table 6: Changes in Land Type Flooding Regime

Land Type	Study Area	Transformed in 2030			
		F0	F1	F2	F3F4
F0	43,060	**23,415**	16,033	3,442	170
F0 + F1[1]	1,184	592	592		
F1	31,986	4,399	**9,519**	17,672	396
F1 + F2[2]	260		130	130	
F2	15,572	2,440	162	**7,903**	5,067
F2 + F3 + F4[3]	362			127	235
F3F4	14,076	2,080	9	155	**11,836**
Urban area[4]	757	757			
River bank/sand bar etc.	1,539				
Forest	5,546				
Mixed land	178				
No data	647				
Total	**115,167**	**33,683**	**26,445**	**29,429**	**17,700**

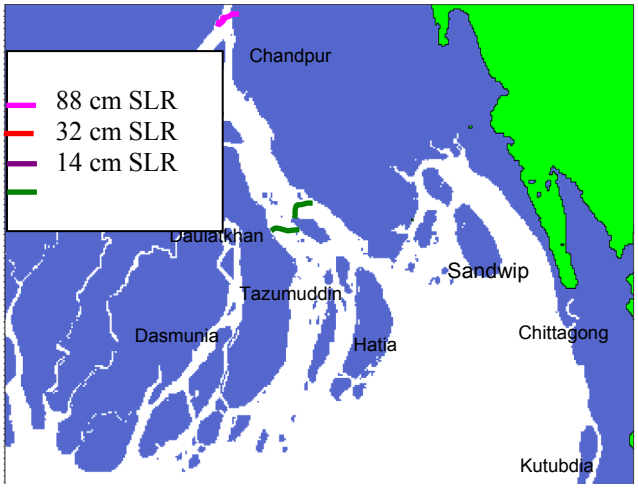
- ♦ Increased bank erosion and bed level changes of coastal rivers and estuaries. There will be a substantial increase of morphological activity with increased river flow, implying that riverbank erosion might substantially increase in the future.

- ♦ 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 urges are expected to become more intense with climate change. Though the country is relatively well equipped particularly in managing the aftermath of sy, cyclones, the increased intensity of such disasters implies major constraints to the country's social and economic development. Unless proper adaptive measures are undertaken, private sector investment in the coastal zone is likely to be discouraged by the increased risks of cyclones and flooding.

The salinity intrusion, for different sea level rise scenarios, has been estimated using mathematical models. From the analysis it is found that the area under salinity level of 5 ppt under the Business as Usual scenario is increasing. The 5 ppt line move from lower tip of Sundarbans to the point of lower Meghna river at Chandpur by year 2100 under an assumed SLR of 88 cm. The salinity front will move about 60 km to the north in about 100 years. . The SLR will increase the salinity level in the Tentulia River, at present the only fresh water pocket in the estuary. Figure 5 shows the changes of salinity front under different levels of sea level rise.

Figure 5. Impact on Salinity, Intrusion of 5 ppt Salinity Line for Different Sea Level Rise



Due to backwater effect the water levels around the polders are also likely to be affected. A hydrodynamic model shows that high water levels at the surrounding rivers of polders may increases in the range of 30 to 80 cm for sea level rise in the range of 32 to 88 cm. This rise will eventually hamper the proper functioning of a number of polders.

Table 7. 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, evapo-transpiration)		+	+	-	+++
Changes of upstream river discharge	Peak	-	++	+++	-
	Low	+++	-	-	-
Sea level rise		+++	+++	++	++
Subsidence		++	++	++	++

Source: Rahman, A., and Alam, M., 2004

3.2.2.3 *Crop Agriculture and Food Security*

Various studies indicate that a rise of 1 to 2^0 C in combination with lower solar radiation causes sterility in rice spikelets. High temperature was found to reduce yields of HYVs of *aus, aman* and *boro* rice in all study locations and in all seasons. The effect was particularly evident at a rise of temperature by 4^0C. Climate changes, especially in temperature, humidity and radiation, have great effects on the incidence of insect pests, diseases and microorganisms. A change of 1^0C changes the virulence of some races of rust infecting wheat.

The production of crop in Bangladesh is constrained by too much water during the wet season and too little during the dry season. Presently total irrigated area is 4.4 million ha which is more than 50 % of the potentially irrigable area of 7.12 million ha cultivated area. This area is being irrigated through surface and ground water resource. Irrigation coverage through Shallow tubewells (STWs) during the dry period has grown very fast following a policy of privatization and deregulation. As a result, the groundwater table in Bangladesh is declining at a rapid rate causing STWs non-operating in many parts of the country during dry period. Lack of surface water during the dry season limits the function of Low Lift Pumps. A simulation study conducted under the climate change country study assessed the vulnerability of foodgrain production due to climate change in Bangladesh. Two general circulation models were used for development of climate scenarios. The experiments considered impact on three high yielding rice varieties and a high yielding wheat variety. Sensitivity to changes in temperature, moisture regime and carbon dioxide fertilization was analyzed against the baseline climate condition.

The GFDL model predicted about 17 % decline in overall rice production and as high as 61 per cent decline in wheat production compared to the baseline situation (under what scenario?). The highest impact would be on wheat followed by rice (*aus* variety). This translates to a reduction of 4.5 million tons of rice at the present level (2002) of production. Of the three varieties of rice grown in Bangladesh, the *aus* rice (grown during the summer, monsoon period under rain-fed conditions) seems to be the most vulnerable. The other model, Canadian Climate Change Model (CCCM) predicted a significant fall in food-grain production. It should be noted, however, that this scenario was based on projecting existing cropping patterns into the future-which is not necessarily what will happen, as there are signs of significant changes in cropping patterns already occurring.

It was noticed that temperature increase of 4^oC would have severe impact on food-grain production, especially for wheat production. On the other hand, carbon-dioxide fertilization would facilitate food-grain production. A rise in temperature would cause significant decrease in production, some 28 % and 68 % for rice and wheat, respectively. Moreover, doubling of atmospheric concentration of CO_2 in combination with a similar rise in temperature would result into an overall 20 % rise in rice production and 31 % decline in wheat production. It was found that *boro* rice would enjoy good harvest under severe climate change scenario with doubling of atmospheric concentration of CO_2 (Karim et al., 1999).

The apparent increase in yield of boro (dry season rice crop generally grown under irrigated conditions and includes high yielding varieties) and other crops might be constrained by moisture stress. A 60 % moisture stress on top of other effects might cause as high as 32 % decline in boro yield, instead of having an overall 20 % net increase. It is feared that moisture stress would be more intense during the dry season, which might force the Bangladeshi farmers to reduce the area for boro cultivation. Shortfall in foodgrain production would severely threaten food security of the poverty-ridden country.

Under a severe (4^oC temperature rise) climate change scenario the potential shortfall in rice production could exceed 30 % from the trend, while that for wheat and potato could be as high as 50 % and 70 %, respectively (Karim, 1996). Under a moderate climate change scenario the crop loss due to salinity intrusion could be about 0.2 Mt (Habibullah et al., 1998). The loss of production due to such effects may be relatively higher compared to that under floods. However, the loss incurred in other sectors could be much higher in case of floods than the direct climatic

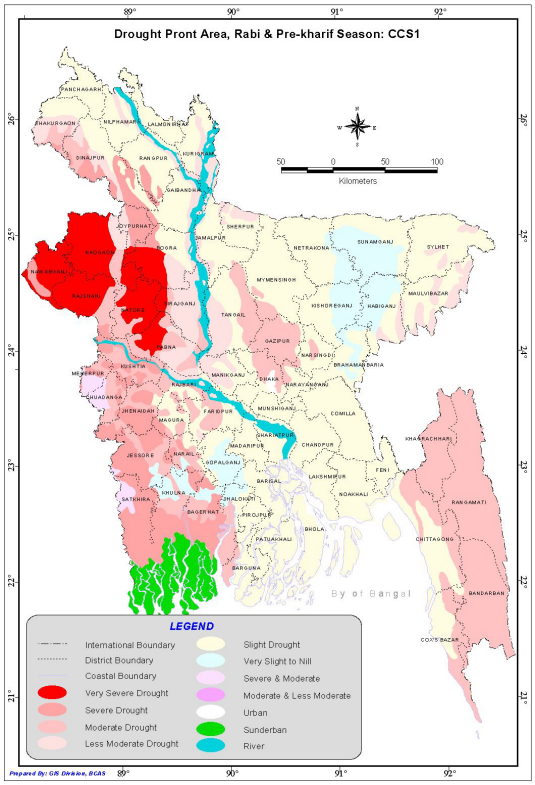
changes.. The effect of low-flow on agricultural vulnerability is considered to be much less intense compared to other effects. The ultimate impacts of loss of food grain production would increase import of food which will require spending hard currency (see later).

3.2.2.4 Forestry and biodiversity

Bangladesh is endowed with a number of natural forest ecosystems including inland Sal forest (*Shorea Robusta*), dipterocarp forest, savanna, bamboo bushes in the hilly regions and freshwater swamp forests. It also has littoral mangrove ecosystems and swamp forests In addition to the forests the country also has a very rich aquatic biodiversity (with over 400 species) and bird and plant life. The biodiversity (including both in the forested areas as well as elsewhere) is undergoing threats due to human interventions and fragmenting of habitats, etc. Climate change impacts will add an extra dimension to these ongoing stresses.

Bangladesh Climate Change Country Study has made an attempt to qualitatively analyze the impact of climate change on forest resources of Bangladesh. It was found that increased rainfall during the monsoon would cause increased runoff in forest floor instead of infiltration into the soil. As a result there would be enhanced soil erosion from the forest floor. The erosion problem would be more pronounced in poorly dense hill forest areas. Prolonged floods would severely affect growth of many timber species, while it would cause high incidence of mortality for Artocarpus species. In contrast, enhanced evapotranspiration in winter would cause increased moisture stress, especially in the Barind and Madhupur Tract areas, affecting the Sal forest ecosystem. The tea plantations in the north-east would also suffer due to moisture stress. It was found that the Sundarbans mangrove forest would be the most severely affected by climate change. Due to a combination of high evapotranspiration and low-flow in winter, the salinity of the soil would increase. As a result the growth of freshwater loving species would be severely affected. Eventually the species offering dense canopy cover would be replaced by non-woody shrubs and bushes, while the overall forest productivity would decline significantly. The degradation of forest quality might cause a gradual depletion of

Figure – 6. Drought Impacted Area in 2030



rich diversity of the forest flora and fauna of the Sundarbans ecosystem (Ahmad et al., 1999).

3.2.2.5 Human health

High summer temperatures could result in enhanced deaths due to heat stress, but the extent of such impacts have not been quantitatively assessed yet. However, the combination of higher temperatures and potential increases in summer precipitation could create favorable conditions for greater intensity or spread of many infectious diseases. Still, the perceived risk to human health is low relative to those in other sectors (such as water resources) mainly because of the higher uncertainty about many of the possible health outcomes. Increased risk to human health from increased flooding and cyclones seems most likely. Changes in infectious disease are less certain as the causes of outbreaks of infectious disease are quite complex and often do not have a simple relationship with increasing temperature or change in precipitation. It is not clear if the magnitude of the change in health risks resulting from climate change will be significant compared to current risks. It is also not clear if increased health risk will be apparent in the next few

decades. However, in general climate change is expected to present increased risks to human health in Bangladesh, especially in light of the poor state of the country's public health infrastructure. Life expectancy is only 61 years, and 61% of children are malnourished (World Bank, 2002). Perhaps more illustrative of this point, though, is the low expenditure of US$12 per person per year that the Bangladeshi government makes on health, well below the US$21 spent in low income countries in general (World Bank, 2002). Another factor to consider is that access to adequate health care is already difficult for the poorest and most vulnerable-who are also likely to be the group most adversely impacted by any adversial change in human health.

3.2.3 Peoples Perception of Impacts of Climate variability and Change

Four regional stakeholder consultative workshops in each of the major administrative divisions of the country had been held to solicit people's perception of impacts and vulnerability to climate variability and change. Stakeholders from various walks of life including farmers, fishermen, businessmen, social activists, representatives of civil society and women joined these workshops. These stakeholder consultation workshops pointed to erratic behavior of weather some times first time in their memory such as fogs in places where these were never heard of during summer time, drought, salinity intrusion far from the sea, floods including flash flood, and cyclone and storm surges as major problems they are facing in different parts of the country . Problems related to floods include water logging and drainage congestion, early and untimely floods, localized inundation and flash floods. Salinity intrusion due to reduction of freshwater flow from upstream, salinization of groundwater and fluctuation of soil salinity are major concern. Continuous and prolonged droughts, extreme temperature and delayed rainfall are major problems that agriculture sector is facing. Storms, cyclones and tidal surges appear to have increased in the coastal areas. While the local people did not necessarily relate any of these observed changes to future climate change they did notice trends and changes in patterns that had already occurred or were still occurring. There was a clear sense from all the workshops around the country that local people felt that the climate had indeed changed, mostly for the worse, over the years.

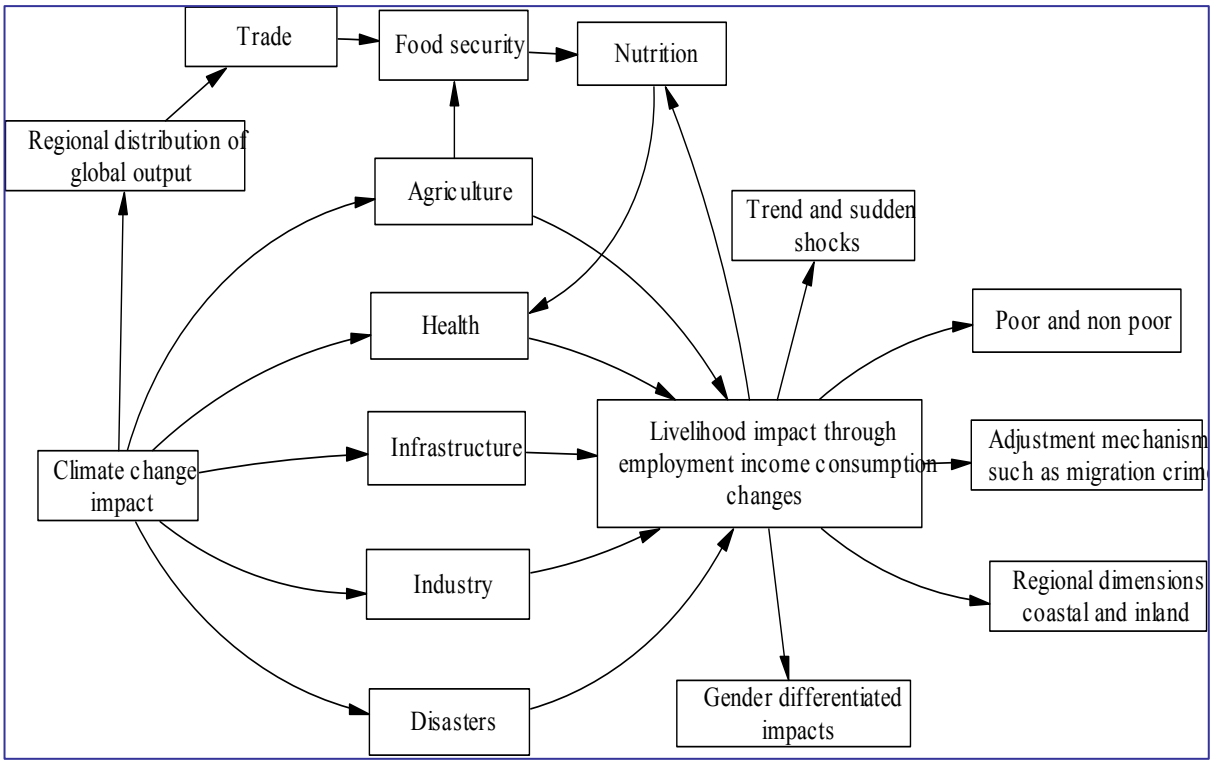
3.2.4 Impacts on Livelihood

Whatever happens to climate and subsequently to various other sectors, all these are important for the main reason that these affect the lives and livelihood of the people. The NAPA exercise tried to figure out these likely changes as a second round impacts of climate change. Figure 7 illustrates the generic links of immediate climate change impacts with issues of livelihood concerns. Climate change is expected to have major physical impacts on agriculture, industry, infrastructure, disaster, health and energy and consequently on people's livelihood in terms of employment, income and consumption (including food security). Various groups in society will experience the impacts in various degrees dependent upon their initial economic conditions (poor or non-poor), location (coastal or non-coastal, rural or urban) and gender. Furthermore some of the impacts and consequent adaptation may be observed at the macroeconomic level such as trade to close the future food gap.

The impacts on livelihood due to climate change depend on the nature and severity of the physical impacts relating to agriculture, water availability and quality, disaster-proneness, hospitability of the physical environment due to rising temperature and changing water regimes to pathogenic activity and coastal inundation. Given these physical changes including sea level rise, the livelihood impacts may be felt in several ways, not necessarily in any given sequence although the final outcome is always a diminution in employment or employability, income and consumption, although the impacts may be felt in different degrees by different socio-economic groups These mean a poorer Bangladesh compared to a situation without climate change and lower level of development. Climate change impacts on livelihood thus become a challenge of development under most adversarial changes in dynamics of nature.

On a more specific plane, in absence of climate change, the projected requirements for food grains by 2030 will be 42.5 mn mt. The best that Bangladesh can produce by 2030 is 37.8 mn mt

Figure 7. Intensity of Impacts on Different Sectors due to Climate Change



requiring an annual import of 4.7 mn mt about that time. Of the total import, 0.8 mn mt or nearly 16% is expected to be the result of additional shortfall due to climate change.

Part of the vulnerability will be due to water shortages for agriculture. But there are other areas where water-related vulnerability may increase. Some of this would be related to health and disaster. On the other hand, extensive water-logging that is being experienced now may exacerbate creating major problems of livelihood for a poor person all of whose land may be submerged permanently.

Both flooding and drought may increase in frequency. Particularly floods may be more devastating creating major problems of livelihood and macroeconomic dislocations, slowing growth and pushing people down the poverty line. Also if cyclones and storm surges increase in frequency and intensity, the potential losses to life and livelihood would be most severe.

The health problem will arise due to climatic factors such as temperature rise, increased SST and ENSO and degrading water quality as well shortage giving rise to increased likelihood of cholera, diarrhea, dysentery, malaria and typhoid and also involuntary fetus abortion in the coastal areas due to rising salinity leading to hypertension. Increased food insecurity will exacerbate the problems further by causing more widespread malnutrition. Unfortunately these are little calibrated or not enough to be superimposed on to socio-economic trends to refine the livelihood impacts. Yet, one can safely assume that the poor will suffer much more disproportionately than the non-poor and more so in the coastal and rural areas than elsewhere.

Taking a livelihoods analysis approach to potential impacts of climate change it is clear that the most vulnerable groups within each community are the poorest amongst them and even within the poor groups the most vulnerable are the women, children, elderly and the sick. It is therefore quite likely that the adverse impacts from climate change will fall disproportionately on these most vulnerable groups within the country as a whole as well as within each vulnerable region of the country.

Therefore any attempt to adapt to or cope with the adverse impacts of climate change will need to have special emphasis on protecting and helping these most vulnerable groups.

3.2.5 *Summary of Important Climate Change Aspects for Bangladesh*

Impacts of climate variability (and quite possible also of climate change) on the biophysical system and consequences on different sectors are already evident in different parts of the country. It is also found that coastal zone, northwestern zone, central region and piedmont plain are most susceptible to present climate variability and anticipated future climate change. A summary of types of physical impacts, vulnerable areas and impacted sectors along with the strength of these impacts are given Tables 8 and 9.

3.3 NAPA Framework and Relationship with Development Goals

Bangladesh has been preparing its medium term national development plan known as the Five-Year Plan since 1973. Along with the other sectoral development strategies and priorities, the Fourth Five Year Plan for the first time and subsequently the Fifth Five-Year Plan (1997-2002) more urgently tried to address the need of protection and conservation of the environment towards sustainable development of the economy.. The major environmental issues identified and addressed in the Fifth Five-Year Plan are natural disasters, industrial pollution, health and sanitation, deforestation, desertification, changes in climatic condition, salinity and deteriorating habitat of flora and fauna. Since the Fifth Five Year Plan, there had been no other. But the government has prepared and just approved a Poverty Reduction Strategy Paper (PRSP) which has more or less reiterated the same concerns in various forms within the document apart from a separate chapter on environment wherein these are reiterated from the point of view of resource management,

Table 8. Causes of Impacts, vulnerable areas and impacted sectors

Climate and Related Elements	**Critical Vulnerable Areas**	**Most Impacted Sectors**
Temperature rise and drought	• North-west	• Agriculture (crop, livestock, fisheries) • Water • Energy • Health
Sea Level Rise and Salinity Intrusion	• Coastal Area • Island	• Agriculture (crop, fisheries, livestock) • Water (water logging, drinking water, urban) • Human settlement • Energy • Health
Floods	• Central Region • North East Region • Char land	• Agriculture (crop, fisheries, livestock) • Water (urban, industry) • Infrastructure • Human settlement • Health • Disaster • Energy
Cyclone and Storm Surge[1]	• Coastal and Marine Zone	• Marine Fishing • Infrastructure • Human settlement • Life and property
Drainage congestion	• Coastal Area • Urban • South West	• Water (Navigation) • Agriculture (crop)

Source: NAPA Team

[1] *Frequency of formation cyclone in the Bay resulted frequent return of fisherman from the deep sea*

Table 9. Intensity of impacts on different sectors due to Climate Change

Physical Vulnerability Context								
Extreme Temperature	Sea Level Rise		Drought	Flood		Cyclone and Storm Surges	Erosion and Accretion	**Sectoral Vulnerability Context**
	Coastal Inundation	Salinity Intrusion		River Flood	Flash Flood			
+++	++	+++	+++	+	++	+++	-	Crop Agriculture
++	+	+	++	++	+	+	-	Fisheries
++	++	+++	-	-	+	+++	-	Livestock
+	++		-	++	+	+	+++	Infrastructure
++	+++	++	-	++	+	+	-	Industries
++	+++	+++	-	++	-	+	-	Biodiversity
+++	+	+++	-	++	-	++	-	Health
-	-	-	-	-	-	+++	+++	Human Settlement
++	+	-	-	+	-	+	-	Energy

Source: NAPA Team

environmental health, biodiversity and multilateral environmental agreements including those related to climate change (see later).

3.3.1 Urgency and Immediacy of Adaptation Measures

The urgency and immediacy of adaptation needs are assessed based on the level or degree of adverse effects of climate change on the nation keeping the overall development activities and critical sectors in mind within the framework of PRSP. It has also considered degree of impacts on natural eco-systems (coastal zone, freshwater, etc.), production system (agriculture, fisheries, livestock, industries, biodiversity, etc.), and the human system (poverty, livelihood, food security, etc.).

It has also considered changes in frequency and intensity of natural disasters (cyclone, floods, drought etc.) and subsequent impacts on above systems. One of the key assumptions considered is that the delay to start adaptation measures could increase vulnerability, or lead to increase cost of adaptation at a later stage.

3.3.2 Complementary with National Goals and other MEAs

The National Adaptation Programme of Action (NAPA) has been prepared the adaptation measures as a set of actions complementary to national goals and objectives of other multilateral environmental agreements to which Bangladesh is one of the signatories. For example "Strategic Block II: Critical Sectors for Pro-poor Economic Growth" section of PRSP has identified climate change as one of the important concerns for water resource management. Other concerns like floods, drainage congestion, droughts, river erosion and accretion, cyclones, water quality and rights, and surface water salinity, as discussed earlier will be aggravated under a warmer climate. Climate change, particularly sea level rise is identified as a matter of grave concern for Bangladesh. The Policy matrix under the "Comprehensive Disaster Management towards Poverty Reduction and Growth" in the document has recognized NAPA as an ongoing activity to address some of the pertinent climate change issues. Policy Matrix 18: Environment and Sustainable Development identified that integration of climate change

adaptation in all policies, programmes and projects as one of the key targets. Awareness raising has been identified as a future need in this regard. The NAPA is also clearly closely related to other environment related policies and programmes in particular the National Action Plan on Biodiversity as well as the earlier implemented National Environmental Management Action Plan (NEMAP).. There will be a need to ensure compatibility with these others plans, policies and programmes in implementing the actions recommended in the NAPA. A key feature of any adaptation action to climate change proposed to be undertaken (either through the NAPA or other programmes) is that they need to be well integrated with other ongoing activities so that they can build upon the synergy among them to be cost effective rather than stand-alone activities at higher cost.

3.3.3 Potential Barriers to Implementation

There are a number of barriers to implementation o actions for adaptation to climate change in Bangladesh. A lack of awareness, both of the potential gravity and the extent of the problem as well as possible actions that could be taken, is the foremost amongst these barriers. This lack of awareness exists at all levels from national level policy makers to sectoral and local level officials as well as amongst civil society and the most vulnerable communities themselves. Therefore, awareness raising is clearly a major area of initial action to be prioritized.

Another barrier (also related to lack of awareness amongst the key groups and institutions) is the lack of incorporation of climate change impacts in developing policies, plans and programmes in some of the most climate sensitive sectors (e.g. water management, agriculture, disaster management, etc). True the need for such integration is being slowly realized. Yet, the actual integration in planning, designing and implementation of then policies is still a far cry and therefore needs to be accelerated considerably.

A final barrier to actually implementing adaptation actions (where awareness has been raised already) is the lack of adequate tools, knowledge and methodologies to provide guidance and advice to the people making their decisions. This is equally applicable at the technical level in different sectors, e.g. water management but also at the grassroots levels for the vulnerable communities themselves. Thus generating good knowledge, data, methodologies and tools (and then disseminating them) will need to be an important activity in the short term.

4 Identification of Key Adaptation Needs

4.1 Existing Knowledge on Coping Strategies

Coping with extreme climatic events like floods, drought, and cyclone and storm surges is not new to the peoples of Bangladesh. Over the period of time both government and non-government organizations have initiated number of activities to minimize the adverse effects of extreme natural events.

The country 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 lower the number of deaths and damage. The initiatives were appreciated and recognized worldwide. As a part of adaptation measures, the GoB has constructed over time nearly two thousand cyclone shelters in the coastal area, and about 200 flood shelters for evacuation of people threatened by cyclone or flood. In addition, about 3,931 km long coastal embankments have been constructed over the years to protect coastal land from inundation by tidal waves and storm surges. Similarly, drainage channels with a total length of 4,774 km have been dug.

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

Increasing salinity has exacerbated the problem of drinking water availability in the coastal zone. Rain water harvesting is an adaptation measure in

such circumstances. Both government and non-government organizations are playing significant role in disseminating rainwater harvesting technologies.

Floating agriculture during flooding (monsoon) season is not new in some part of coastal area but both government and non-government organizations are promoting this technology through training and cross visit. The development of salinity tolerant species by BARI and BRRI is a recent technological development to address salinity for crop agriculture. Establishment of shallow tube-well for irrigation to reduce impact of salinity, supplementary irrigation and drainage control in the drought prone area depending on seasons are common technologies to grow crops.

It is reported in the consultation workshops that farmers adopt short duration crop variety based on situation i.e. depth and duration of flood, timing of flood, recession of flood water etc. Artificial management of temperature through different techniques and technologies for poultry and livestock such as the use of wet jute bags over shade, use of exhaust fans (during hot weather), electric bulbs for heating room (in winter season) is common.

4.2 Future Coping Strategies and Mechanisms

The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development. Future coping strategies and mechanisms have been suggested based on existing process and practices, particularly in other geographic areas which may face problems similar to those elsewhere at present. Development of techniques for transferring knowledge and experiences from one area/ ecosystem to another is thus necessary.

Some initial activities have already been pioneered in Bangladesh as adaptation to climate change at the community level. For example a project called "Reducing Vulnerability to Climate Change (RVCC)" under implementation in a number of flood-prone villages in coastal Bangladesh by CARE, an international NGO, with local partners has generated much useful knowledge about communicating climate change (and adaptation) messages at the community level. This knowledge was also shared at an international workshop on Community Level Adaptation to Climate Change held in Dhaka in January 2005.

Addressing future problems related to sea level rise appear to be a complex issue for Bangladesh as it involves various interactive production systems as well as human systems together with physical ecosystems all within the overall parameters of coastal zone dynamics. An integrated systems approach acceptable to the communities at large may be suggested.

It will also be important to monitor the actual impacts of climate change in different parts of the country to more accurately predict. This will help in more clearly targeting the problems for resolution.

It is evident from the science of climate change and impacts studies that severity of impacts and frequency will increase in future and therefore limitation of existing coping strategies need to be assessed. New and improved adaptation measures may be increasingly called for. This necessitates creating a research system or sub-systems within the existing ones for studying the problems due to climate change for future coping strategies and actions.

No adaptation measure can entirely eradicate the adverse impacts of climate change and climatic variability. A part of the cost, however small, has to be borne by the society. To strengthen the capacity to withstand such losses, insurance mechanisms need to be strengthened and sensitized to the future needs. Areas for such insurance schemes may include crop failures, losses due to cyclones and storm surges and other natural hazards.

4.3 List of Measures/Activities

The following adaptation measures have been suggested for Bangladesh to address adverse effects of climate change including variability and extreme events. These are based both on existing coping mechanisms and practices, and suggested future strategies and coping mechanism mentioned above. These are categorized into two major types i.e. intervention and facilitating.

4.3.1 Intervention Type Measures

1. Promoting adaptation to coastal crop agriculture to combat increased salinity.
2. Adaptation to agriculture systems in areas prone to enhanced flash flooding in North East and Central Region.
3. Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh.
4. Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.
5. Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.
6. Reduction of climate change hazards through coastal afforestation with community participation.
7. Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.
8. Enhancing resilience of urban infrastructure and industries to impacts of climate change including floods and cyclone.

4.3.2 Facilitating Type Measures

1. Capacity building for integrating Climate Change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.
2. Exploring options for insurance to cope with enhanced climatic disasters.
3. Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).
4. Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.
5. Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.
6. Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.
7. Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.

5 Criteria for Selecting Priority Activities

5.1 Selection Criteria

The NAPA Guidelines list a number of criteria in 3 different sections under different names for prioritization of activities from the long list of adaptation needs: The 10 Guiding Elements (Sec 7 a-j) of the Guidelines contain some criteria, such as complementary to existing national and sectoral plans and programmes including national action plans under the UNCCD & CBD, sustainable development, gender equality, and cost effectiveness. Section 15 of the Guidelines lists 4 general criteria, such as level or degree of adverse effects of climate change, poverty reduction, synergy with other MEAs and cost effectiveness.

Again Section 16 says that these 4 criteria will be applied to, inter alia: a) loss of life and livelihood; b) human health; c) food security and agriculture; d) water availability, quality and accessibility; e) essential infrastructure; f) cultural heritage; g) biological diversity; h) land-use management and forestry; I) other environmental amenities; and j) coastal zones, and associated loss of lands. For example, poverty reduction is related to health, food security and water availability. In a similar manner, the degree of an adverse effect can be measured in terms of loss of life and livelihood, loss of health, loss of land, loss of biodiversity etc. Considering the set of criteria in this way helps in determining where criteria overlap or are correlated.

It is further stated that the selected set of criteria should be locally-driven and *inter alia* is added to criteria of both sections 15 & 16. The LEG interpretation is that the list can be seen as a checklist of possible relevant criteria, depending on the country, area, sector etc. The Guidelines provide enough flexibility in finalizing the country-specific appropriate set of criteria for prioritization of adaptation activities.

In the context of Bangladesh, the following considerations are of vital importance for selecting the set of criteria and their ranking:

1. Almost two-third of the 40 million strong labor force is engaged in agriculture and related activities, which are largely nature and water-dependent. But these are the sectors likely to be hit hardest by climate change, particularly in the southern coastal and northern drought-prone areas of Bangladesh.
2. Impacts and vulnerabilities can be looked at from several overlapping angles, sectoral or regional perspectives or in terms of loss of life, livelihood or income. In the context of Bangladesh, it is more rational and just to gauge vulnerabilities and multiple stresses on the lives and livelihoods of the poor.
3. As poverty reduction is a complex and composite phenomenon, selection of NAPA projects looked into the potential of socio-economic empowerment and development of skills and capabilities of the poor as well.
4. The fact that poverty reduction initiatives to enhance adaptive capacity of the poor may not always pass the economic efficiency criteria has also been taken into consideration.

5.2 Prioritization Criteria and Indicators

In conformity with the guiding elements of country-drivenness, simplicity and flexibility in procedures, set in the NAPA Guidelines, poverty reduction and security of livelihoods with a gender perspective has been ranked as the most important set of criteria for prioritization of adaptation needs and activities. This ranking (in descending order) has been suggested by the stakeholders at the four regional and one national workshops.

a. Impact of climate change on the lives and livelihoods of the communities
b. Poverty reduction and sustainable income generation of communities
c. Enhancement of adaptive capacity in terms of skills and capabilities at community & national levels
d. Gender equality (as a cross-cutting criteria)
e. Enhancement of environmental sustainability
f. Complementary and synergy with national and sectoral plans and programs & other MEAs
g. Cost effectiveness.

Once the general and specific goals for an adaptation measure are fixed, different options to meet them need to be considered. As there is a lack of concrete, quantifiable data in some places/ areas, multi-criteria analysis, as against cost-benefit or cost-effectiveness analysis, would be appropriate. Here community-led decision-making, stakeholder preference, expert judgment, national goal and strategy etc. have been taken into consideration.

6 List of Priority Activities

The Project Concept Notes presented in this section are the product of an iterative process of identification, refinement and prioritization carried out during the NAPA development process. Most of the original project ideas were put forward from the regional consultative workshops and the different sectoral reports. This resulted in a long list of over 40 or so project ideas (many of which were very similar to each other).

The long list of project ideas was amalgamated into a shorter list of fifteen projects by the NAPA writing team (which consisted of representatives from all the sectoral Working Groups as well as the Regional Workshops).

The final prioritization of the list was done through the national consultative workshop held on 15 September 2005 in Dhaka with over 100 stakeholders from different sectors and groups, including both government as well as non-government.

Table 10. The Final List of the Projects

Sl. No.	Project Title	Type of Project	Primary Implementing Agency	Total Cost
1	Reduction of climate change hazards through Coastal afforestation with community participation.	Intervention	Forest Department (FD)	Full project: USD 23 million Project design: 100,000
2	Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise.	Intervention	Department of Public Health Engineering (DPHE)	Full project: USD1.5 million Project design: USD 25,000
3	Capacity building for integrating Climate Change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.	Capacity building	Water Resource Planning Organization (WARPO)	USD2.0 million Project design: USD 25,000
4	Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disasters.	Awareness and Capacity Building	Ministry of Environment and Forest (MoEF)	Full project: USD7 million Project design: USD 50,000
5	Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains.	Intervention	Disaster Management Bureau (DMB) and Local Government Engineering Department (LGED)	Full project: USD5 million Project design: USD: 50,000
6	Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).	Capacity building	Department of Environment (DOE)	Full project: USD 1 million Design phase: USD 25,000
7	Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.	Awareness raising	Board of Education	Full Project: USD 0.5 million Project design: USD 25,000
8	Enhancing resilience of urban infrastructure and industries to impacts of climate change	Capacity building	Department of Environment (DOE)	Full project: USD 2 million Design phase: USD 25,000

Table 10. The Final List of the Projects *(continued)*

Sl. No.	Project Title	Type of Project	Primary Implementing Agency	Total Cost
9	Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.	Intervention	NGO consortium	Full project: USD 5 million Design phase: USD 50,000
10	Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.	Research	Bangladesh Agricultural Research Council (BARC)	Full project: USD 5 million Design phase: USD 50,000
11	Promoting adaptation to coastal crop agriculture to combat increased salinity.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full Project: USD:6.5 million Project design: USD 50,000
12	Adaptation to agriculture systems in areas prone to enhanced flash flooding–North East and Central Region.	Intervention	Bangladesh Agricultural Research Institute (BARI)	Full project: USD6.5 million Project design: USD 50,000
13	Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.	Intervention	Department of Fisheries (DOF)	Full Project: USD4.5 million Project design: USD 50,000
14	Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh	Intervention	Department of Fisheries (DoF)	Full project: USD 4 million Project design: USD 50,000
15	Exploring options for insurance to cope with enhanced climatic disasters.	Research	Department of Environment (DOE)	Full Project: USD0.2 million Project design: USD 25,000

6.1 NAPA Bangladesh Project Concept Note

Project No. 1

Title: Reduction of Climate Change Hazards through Coastal afforestation with community participation

Type of project: Intervention (with awareness raising and policy elements)

Rationale/justification, in relation to climate change, including sectors concerned

The location of Bangladesh has made it prone to natural calamities like flood, draught, storms, cyclones and tidal surges. Frequency and occurrence of storm surges is projected to increase as a consequence of climate change in the coastal areas of Bangladesh. The presence of forest plays a vital role in stabilizing shorelines and providing protection against cyclones and other extreme events. The coastal areas of Bangladesh especially the Meghna estuary are exposed to cyclone and tidal surges. A thick forest belt is required to act as a buffer zone in order to provide protection to these vulnerable coastal areas.

In the NAPA regional workshop held in Khulna, the threats arising from decreasing mangrove forest cover and the impacts of salinity intrusion in coastal areas were discussed. Recent experiences with tsunami have strengthened the theoretical basis that mangrove forests reduce the vulnerability from natural disasters. The participants recalled the past initiatives for the creation of greenbelts in the Forest Management Plan (FMP) and the Coastal Greenbelt Project and highlighted the need for widening of the forest belt. A community based afforestation program with deep-rooted, salt- tolerant species was suggested.

The involvement of the local people, especially the women will enhance their adaptive capacities and livelihoods in general. The project is set to provide synergy with the National Biodiversity Strategy and Action Plan, where afforestation is one of the critical working components.

Description

Objectives and activities

- Strengthen the adaptive capability further, so as to face the more vulnerable situation that arises out of climate change scenario.
- Creation of a shelterbelt along the coastal zone
- Generation of Employment Opportunities
- Enhanced Carbon sink under the global context

Inputs and Activities

- Identify Community Based Organizations (CBO) and other participants for the implementation of social forestry programs in the coastal zones of Bangladesh
- Capacity building of the participants through training on i) Nursery ii) Afforestation iii) Care and Maintenance.
- Capacity building of the stakeholders through various awareness tools
- Afforestation (i) Nursery ii) Planting iii) Maintenance)
- Monitoring and reporting
- Trained manpower for community mobilization
- Experts and experienced manpower to provide technical training on i) Nursery and, ii) Afforestation
- Capable, experienced and expert forestry professionals to supervise on the job activities such as i) Nursery ii) Afforestation iii) Maintenance.
- Adequate fund to undertake activities envisaged.

Short-term outputs

- Generation of Employment Opportunities
- Development of local skills
- Enhance the income of poor while participating in the program
- Awareness generation

Potential long-term outcomes

- Enhancement of a vegetative cover along the coast of Bangladesh
- Creation of vegetative cover under a ‘shelter-belt’ concept

- Enhanced capability to combat the impact of cyclone and tidal surges
- Reduction in the magnitude of devastation arising out of cyclone and tidal surges
- Add to the global Carbon sequestration aspect
- Manpower development
- Creation of job opportunities

Implementation

Institutional arrangement

Primary implementing agency: Forest Department

Secondary implementing agencies: NGOs and CBOs

Risks and barriers

- Administrative complicacies in getting suitable land to undertake afforestation
- Flow of fund for the project activities

Evaluation and monitoring

- Participatory monitoring under the leadership of IUCNB shall be the evaluation and monitoring tool for the project

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD 23 million

Project design: 100,000

Project No. 2

Title: Providing drinking water to coastal communities to combat enhanced salinity due to sea level rise

Type of project: Intervention (with awareness raising and policy elements)

Rationale/justification, in relation to climate change, including sectors concerned

Ground and surface water in coastal areas is affected by salinity intrusion through rivers and aquifers. With the current increase in climate change and sea level rise, people in the coastal areas will severely suffer from scarcity of safe drinking water.

Given this situation, finding alternative sources (e.g., rain water harvesting, surface and ground water treatment) of safe drinking water is essential for the safety of the present and future generation. Therefore, a comprehensive strategy should be developed for access to safe drinking water from alternative sources.

Description

Objectives and activities

Development of a comprehensive strategy for safe drinking water supply in coastal areas

Inputs and Activities

- Multi-disciplinary expertise:
- Water resource development expert for identifying alternative drinking water sources,
- IWRM expert for assessing options for integrated water resource development,
- Public health expert for incorporating health issues with drinking water sources development strategy
- Identification of existing drinking water sources.
- Review of existing technical capabilities to utilize safe drinking water sources.
- Understanding community interest to alternative sources.
- Review of national plans and policies.
- Develop short and long term strategy for alternative source of safe drinking water.
- Development of alternative source of safe drinking water

Short-term outputs

- In-depth potable water resource availability and alternative options
- Safe drinking water sources for present use

Potential long-term outcomes

- Improved management system for safe drinking water supply
- Improved preparedness programme for drinking water supply in crisis situation

Implementation

Institutional arrangement

Primary implementing Agency: DPHE

Secondary implementing Agencies: LGED, BWDB, NIPSOM, NGOs and Local Community

Risks and barriers

- Lack of comprehensive knowledge base for developing strategy

Evaluation and monitoring

- A committee formed by MoLGRD and Ministry of Health and Family Welfare

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD1.5 million

Project design: USD 25,000

Project No. 3

Title: Capacity building for integrating Climate Change in planning, designing of infrastructure, conflict management and land-water zoning for water management institutions.

Type of project: Capacity building (with some policy and research elements)

Activities

- Filling Climate Change Knowledge Gap for Water Resources Planning
- Formulation of Land and Water Zonation for Climate Change Adaptation in Bangladesh
- Development of Conflict Management Instruments/Tools for Sustainable Drainage Systems
- Development of Capacity Building Tools for Designing Structural Adaptation

Rationale/justification, in relation to climate change, including sectors concerned

The community of climate change scientists and their numerous publications at the international domain have identified the Bengal coast as highly vulnerable to climate change induced water resources adversities (e.g., sea level rise, water logging, and floods). The National Water Management Plan (NWMP, 2001) has also formally identified a gap in knowledge related to this issue and has asked for this gap to be filled up for future adaptation. NWMP's demand-supply approach primarily considered the current water resources availability and constraints issues. It left out the sustainability issues that consider climate change related factors in the planning of water resources.

From past experience, it can be observed that climate change issues are not adequately considered while designing water resources structures. Lack of proper assessment of climate change in designing and implementing structures make structural interventions more prone to climatic hazards. Consideration of climate change issues and adaptive measures needs to be a regular part of the activities of water sector managers. Engineers and water sector managers can contribute to the sustainable management of water resources if their knowledge can be more contextualized with climate change science and adaptation options. At the same time, institutional and policy development is also essential for facilitating water sector managers in designing multi-objective projects involving all stakeholders.

Water resources management in Bangladesh is a multi-stakeholder issue. Different stakeholders and interest groups have their own diverse interests in the management of water and land resources in Bangladesh. This often creates situations of conflict. Moreover, with the increased climatic extremities the areas of conflict between various interest groups (i.e., fishers and farmers) are expected to aggravate further. Drainage, which is an essential facility for farmers, is often hampered by the activities of fishers. In this situation, the stakeholders need to build their adaptive capacities in multiple ways. One major way would be to build capacity for negotiating sustainable conflict management, particularly in the water sector. Furthermore, the increasing climatic physical changes such as increased sedimentation in tidal rivers etc. also call for measures for sustainable adaptive measures.

Considering the above context, land and water zonation is also necessary that considers the interests of stakeholders for the sustainable

development of the coastal area. Zonation of land and water will facilitate sustainable management of agriculture, fisheries, mangrove forests, navigation, drainage, flood control, wetland restoration as well as human settlements and livelihood activities.

Description

Objectives and activities

- Incorporation of climate change issues and concerns in water sector policies and plans.
- Capability development and networking of water resources sector planners, and professionals to address climate change hazards
- Develop mechanisms and tools for both analytical purposes, e.g. Integrated Water Resource Management (IWRM), Water Balance Models) and negotiation, e.g., Guidelines for Participatory Water Management (GPWM), as well as for consideration of more people friendly traditional drainage systems, e.g., Tidal Basin Management (TBM). The development of such tools for negotiation would benefit agriculture, human settlements, forest and fisheries as well as natural and man-made drainage structures.
- Delineation of land and water zones considering sustainable use of resources in respect to climate change
- Development of design manuals and identification of vulnerable structures for designing structural adaptation.

Inputs

- Experts and experienced manpower to provide technical training for planning, designing for incorporating CC for water sector and other sectors
- Design experts for developing the manuals and identification of climate change issues
- IWRM expert and TBM expert for determining integrated water resource management options
- Adequate and timely funding for smooth implementation
- Anthropologist, Conflict Management Experts and so forth
- Data sets related to climate change and water resources planning
- Land and water use data sets

Short-term outputs

- Trained water sector planner and designer
- Greater understanding for better planning in the water resources sector considering the CC related issues and probable consequences
- Trained professionals
- Design manuals
- Identified vulnerable structures
- Local and national level conflicting issues identified and tools and mechanisms to resolve drainage and water resources related conflicts available
- Resolution mechanism to resolve conflicts and trade-off between local and national interest
- Land and water zone for human and environment

Potential long-term outcomes

- Climate Change related database and planning tools
- Knowledge development sustainable water resource planning that will consider CC issues
- More proactive action towards sustainable resource utilization
- Practice of more sustainable adaptation measures
- Better equipped knowledge for adaptation in long term issues on Climate Change
- Practice of sustainable utilization of land and water considering interest of all stakeholders

Implementation

Institutional arrangement

Primary implementing Agency : WARPO

Secondary implementing Agencies: DoE (Climate Cell) CEGIS, IWM and Universities and research organizations, BWDB, LGED,

RHD, MoL, MoWR, MoEF, DAE, DoF, FD, DoLS, CEGIS, CBOs

Risks and barriers

- WARPO is not sufficiently strengthened as per agencies process
- Lack of cooperation among different agencies in knowledge gap filling
- Inadequate fund for structural adaptations
- Lack of trade-off attitude between influential stakeholders
- Proper implementation of zoning

Evaluation and monitoring

- A committee formed jointly by MoEF, MoWR, MoLG & RD, MoC and MoFDM for evaluation and monitoring.

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

USD 5.0 million

Project design: USD 50,000

Project No. 4

Title: Climate change and adaptation information dissemination to vulnerable community for emergency preparedness measures and awareness raising on enhanced climatic disaster

Type of project: Awareness raising (with capacity building elements)

Rationale/justification, in relation to climate change, including sectors concerned

Increase in temperature and change in precipitation and sea level, as well as the possible increase in frequency and intensity of severe climate events will affect human health both directly (e.g., death due to heat stress) and indirectly (e.g., famine resulting from changes in rainfall). Most of these impacts will be negative, i.e., any health benefits from less severe winters for example, will be offset by the rapid changes to the environment to which human biology and culture have become accustomed. This could include changes in the distribution of diseases, impacts on agriculture or changes to conditions in coastal areas, which have large populations, especially in the developing world.

Therefore, more awareness about diseases due to climate change and changes in human behavior will be a feasible solution to protect human health. This will be particularly true for developing countries like Bangladesh that has low technical capability to fight against outbreaks of easily communicable diseases.

Description

Objectives and activities

- Protect people from climate change related health problems through awareness programmes
- Development of guidelines for awareness and behavioral change programmes

Inputs and Activities

- Environmental Health Experts for identifying climate change related diseases and possible remedial measures
- Community mobilization expert to develop guidelines of awareness and behavioral change programmes

Short-term outputs

- Existing and possible future disease identification
- Identification of remedial measures
- Guidelines for adaptation of human health to the impact of climate change.

Potential long-term outcomes

- Improvement of human health treatment facilities.
- Improved preparedness programme for sever communicable diseases

Implementation

Institutional arrangement

Primary implementing agency : Ministry of Environment and Forest

Secondary implementing agencies : Directorate of Health, ICDDRB, NGOs

Risks and barriers

- Respective organizations may not have

enough technical capability to identify diseases

- Community may not response to make change in ethnic / present behavior

Evaluation and monitoring

- A committee formed by the MoH and FW

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD7 million

Project design: USD 50,000

Project No. 5

Title: Construction of flood shelter, and information and assistance centre to cope with enhanced recurrent floods in major floodplains

Type of project: Intervention (with policy and awareness raising elements)

Activities:

- Construction of Multipurpose Cyclone – Flood Shelters in High Vulnerable Areas

Rationale/justification, in relation to climate change, including sectors concerned

Coastal areas are vulnerable to cyclones and storm surges. Heavy wind and sea water destroy houses and properties. Lives are lost in remote coastal areas due to the absence of shelters. To protect people and livestock from cyclones and cyclone induced floods, suitable shelters are required for people and their livestock. The rest of the time when there are no natural disasters, these shelters can be used as schools, community centers, or for other purposes.

With the projected Sea Level Rise, the height of the shelters may prove to be inadequate. The shelters may need to be redesigned and strengthened in order to incorporate climate change considerations.

Description

Objectives and activities

- Increase the height and strengthening proposed shelters from climate change induced hazards

Inputs

- Reviewing existing condition of cyclone shelters
- Improvement of design criteria in context of climate change
- Adoption of new criteria in construction of new shelters
- Experts of Disaster Management
- Engineers for designing shelters

Short-term outputs

- Shelters for vulnerable people in cyclone prone remote coastal area

Potential long-term outcomes

- Safety of life from climate change induced cyclone and flood
- Improvement of disaster management system.

Implementation

Institutional arrangement

Primary implementing Agency: DMB, LGED

Secondary implementing Agencies: BMD, BWDB

Risks and barriers

- Non-availability of fund
- Proper utilization of shelters
- Proper construction of shelters

Evaluation and monitoring

- A committee formed by MoFDM.

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD5 million

Project design: USD: 50,000

Project No. 6

Title: Mainstreaming adaptation to climate change into policies and programmes in different sectors (focusing on disaster management, water, agriculture, health and industry).

Type of project: Capacity building (with awareness raising, policy and research elements)

Rationale/justification, in relation to climate change, including sectors concerned

Many of the key sectors (such as disaster management, water, agriculture, health and industry) are vulnerable to climate change impacts and need to include such potential impacts in their sectoral design and investments.

Description

Objectives and activities

- To mainstream climate change impact assessment (and adaptation) into sectoral planning and policy in the disaster management, water, agriculture, health and industry sectors .

Inputs and Activities

- Climate change and sectoral experts to advise sectoral
- Planners and policy makers on the ways of incorporating and mainstreaming climate change impacts into sectoral plans and policies.

Short-term outputs

- Greater awareness of climate change issues and their importance in sectoral planning and policies

Potential long-term outcomes

- Mainstreaming of climate change impacts (and adaptation) into sectoral plans and policies.

Implementation

Institutional arrangement

Primary implementing agency: DOE

Secondary implementing agencies: WARPO, FD, DOF, BARC, Universities,

Risks and barriers

- Lack of understanding and awareness of the climate change issues within the sectoral agencies

Evaluation and monitoring

- Through a multi-sectoral multi-stakeholder review committee

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD 1 million

Design phase: USD 25,000

Project No. 7

Title: Inclusion of climate change issues in curriculum at secondary and tertiary educational institution.

Type of project: Awareness raising (with policy elements)

Rationale/justification, in relation to climate change, including sectors concerned:

Climate change will affect large parts of the country over very long periods of time (several decades). Therefore it is imperative that the younger and future generations are made aware of the problem (and solutions) of the climate change impacts by getting such knowledge incorporated into school curriculum at both secondary as well as primary levels.

Description

Objectives and activities

- To incorporate climate change impacts and adaptation into school curriculum at secondary and primary levels

Inputs and Activities

- Develop an appropriate curriculum on climate change impacts and adaptation for primary school students
- Develop an appropriate curriculum on climate change for secondary school students.
- Incorporate the courses on climate change into the school curriculum

Short-term outputs

- Climate change course curriculum for primary school students
- Climate change course curriculum for secondary school students

Potential long-term outcomes

- Future generations of primary and secondary

school students will learn about climate change impacts and adaptation

Implementation

Institutional arrangement

Primary Implementing agency: Board of education

Secondary implementing agencies: Universities

Risks and barriers

- The Education Board fails to allow the newly developed courses into the school curriculum

Evaluation and monitoring

- A multi-stakeholder review committee will monitor the project activities and evaluate its products.

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full Project: USD 0.5 million

Project design: USD 25,000

Project No. 8

Title: Enhancing resilience of urban infrastructure and industries to impacts of climate change including floods and cyclone

Type of project: Capacity building (with policy and awareness raising elements)

Activities:

- Specification in National Building Code for building industry and infrastructure in potentially vulnerable areas
- Community based safe dumping place of the pollutants
- Rationale/justification, in relation to climate change, including sectors concerned
- Urban infrastructure in the major cities of the country will be adversely affected by climate change impacts, especially floods and cyclones. These need to be made more resilient to withstand those impacts.

Description

Objectives and activities

- To enhance resilience to climate change (including floods and cyclones) in urban and industrial sectors in the major cities

Inputs and Activities

- Development of better building codes for buildings
- Development of better waste management for industries
- Development of better warning systems

Short-term outputs

- Greater understanding of climate change impacts and enhanced awareness and readiness in urban and industrial sectors

Potential long-term outcomes

- Enhanced resilience of urban and industrial infrastructure to the impacts of climate change

Implementation

Institutional arrangement

Primary implementing agency: DOE

Secondary implementing agencies: HBDC, Min of Industries, FBCCI, DCCI,

Risks and barriers

- Lack of understanding and awareness of the climate change issues within the concerned agencies

Evaluation and monitoring

- Through a multi-sectoral multi-stakeholder review committee

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD 2 million

Design phase: USD 25,000

Project No. 9

Title: Development of eco-specific adaptive knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climate change.

Type of project: Intervention (at community level, involves awareness raising and capacity building elements)

Rationale/justification, in relation to climate change, including sectors concerned

The agro-ecological regions of the country are very diverse and will be impacted in very different ways. However, in all the ecological regions the poor (including women, elderly and children) are the most vulnerable and likely to also be most adversely impacted by climate change. Hence eco-specific actions for helping vulnerable communities (with emphasis on women, children and elderly) need to be developed and disseminated to the vulnerable communities to allow them to adapt to potential impacts of climate change.

Description

Objectives and activities

- To develop actions in each of the main ecological regions of the country to adapt to the eco-specific impacts of climate change in those regions
- To disseminate the knowledge on eco-specific adaptation to the most vulnerable communities in each eco-region (with emphasis on women, children and the elderly).

Inputs and Activities

- Selection of main eco-regions (four or five)
- Selection of local partners in each region
- Development of pilot actions and learning
- Sharing learning
- Disseminating action packages to vulnerable communities

Short-term outputs

- Adaptation packages to be used by vulnerable communities in different eco-regions of the country

Potential long-term outcomes

- Most vulnerable sections of communities in each eco-region will be able to adapt to adverse impacts of climate change

Implementation

Institutional arrangement

Primary implementing agency: NGO consortium

Secondary implementing agencies: NGOs, local government

Risks and barriers

- Failure to develop adequate adaptation packages in each eco-region

Evaluation and monitoring

- Through a multi-sectoral and multi-stakeholder review committee

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD 5 million

Design phase: USD 50,000

Project No. 10

Title: Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future

Type of project: Research

Rationale/justification, in relation to climate change, including sectors concerned

Crop agriculture is still the mainstay of the economy and rural workforce in Bangladesh and will be very vulnerable to impacts of climate change in future. Therefore, it will be imperative to develop improved varieties of all types of crops to withstand the potential impacts of climate change such as floods, droughts, high temperature, salinity, etc.

Description

Objectives and activities

- To develop new varieties of crops such as rice, wheat etc, to tolerate saline, flood and drought conditions.

Inputs and Activities

- Laboratory facilities (hardware and human resources) for plant breeding in the main crop research institutes in the country

Short-term outputs

- New varieties of salt, drought and flood tolerant crops developed

Potential long-term outcomes

- Flood-prone, drought-prone and salinity-prone areas of the country adopt the new varieties and reduce their vulnerability to climate change impacts.

Implementation

Institutional arrangement

Primary implementing agency: BARC

Secondary implementing agencies: BARI, BRRI, DAE, NGOs

Risks and barriers

- Failure to develop new varieties
- Evaluation and monitoring
- Through a multi-sectoral, multi-stakeholder review committee

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full project: USD 5 million

Design phase: USD 50,000

Project No. 11

Title: Promoting adaptation to coastal crop agriculture to combat salinization.

Type of project: Intervention (with policy, awareness raising and research elements)

Rationale/justification, in relation to climate change, including sectors concerned

Significant part of the coastal area is facing salinity problems due to tidal surge flooding. It is anticipated that salinization and tidal surges would be pronounced under warmer climate particularly due to seal level rise. Therefore crop agriculture need new approaches and technologies to deal with salinization in the coastal area. No crop is cultivated during Kharif season due to high depth of standing water in the field. Water recedes late from the crop field and keeps soil muddy at the time of appropriate sowing of the next candidate crops. Traditional land preparation is not possible. Affected community needs food, fodder, fuel and feed earlier than the next rice crop (Boro rice, wheat, potato, etc). At this condition the affected communities remain half -fed, ill fed, malnourished and moves to cities or other areas for job and livelihood.

Description

Objectives and activities

- The main objective of the wet bed no-tillage methods maize production is to produce maize, (before next Boro rice crop) for tidal surge flood affected community after loss of Aman rice crop. It will also help to meet fuel and fodder need of the community;
- Produce selected vegetables and fruits on raised bed to meet day-to-day demands of the affected households. Some cash is also generated from sale proceed of the vegetables.
- Motivate the affected community to adapt the above technologies to combat with coastal inundation due to tidal surge after loss of crops or no crop items.

Inputs

- Maize seeds, fertilizers, are the major inputs required.
- Maize harvester/ Sheller would be required.
- Audiovisual appliances for training of the community would be required.
- For supervision of field activities transport would be required.

Short-term outputs

- Production of food, fodder, fuel, and feeds needed by he affected community before the next Boro rice and wheat crop.
- Production of fruits and vegetables.
- Meet household's demand for vegetables and fruits partially or fully meet.
- Family nutrition is improved
- Generate cash by selling output partially

Potential long-term outcomes

- Adoption of the technology would help the community to adapt with flood/ tidal surge and sea level rise.
- Affected community would not migrate to cities for job and livelihood.

- When the Sorjan beds are made it would generate vegetables and fruit continually.
- Social consequences of mass scale migration to cities would to some extent be halted.

Implementation

Institutional arrangement

The technology was designed by the On–farm Research Division (OFRD) of BARI. OFRD has a network of field research sites with sub-professional posted at the field level. Professional scientists posted at the district level supervise the field activities. Department of Agricultural Extension (DAE) is mandated for extension of technology, having field workers at village level. Planning and implementation might be responsibility of extension with technical support from OFRD, BARI. Soil Resources Development Institute (SRDI) having professional posted at the district level monitor soil salinity. NGOs are working all over the country. The project might be implemented by DAE. NGOs may also be involved in the implementation of activities. As the technology is of different nature local consultants having background in farming system might be required for successful implementation of the activity. BARC may do the overall coordination of the project during implementation stage.

Primary implementing agency: BARI?

Secondary implementing agencies: DAE, SRDI, NGOs

Risks and barriers

The community should be organized to join the production system in a contiguous large block. Otherwise protection of the crop from birds and jackal would be difficult. Moreover, cobs from a single isolated plot are likely to be stolen by the children. This may also cause social problem. Other than these no risk and barriers were noticed while designing the technology.

Evaluation and monitoring

- This is not a traditional type of technology. Thus it would require constant technical supervision in the field in all stages of production to develop the intended benefit.
- An independent multidisciplinary team should be formed by BARC for monitoring and evaluation of the activities to assess performance of the technology in generating the intended benefits.

Financial resources

- As mentioned above this is not a traditional technology. The project would require services of project staff and local consultants.
- Production cost depends on the size of field block (tentatively 5 ha blocks of 10 farmers in clusters) and their number (tentatively 1000 clusters).
- Farmers and the sub professional at the field level would require training on the concept and production/ harvesting packages of the technology.
- Audiovisual aid would be needed for the training activities.
- Sufficient number of field days would be required to disseminate the technology.
- Rapid appraisal would be required to identify specific location and communities
- Detail planning may estimate demand on the financial resources.
- Demand of financial resources would depend on size of the sorjan beds and the total number that would be replicated. Detail costing may be worked out during detail planning and implementation.

An indicative and tentative financial resource estimate for five years is provided as below:

Full Project: USD 6.5 million

Project design: USD 50,000

Project No. 12

Title: Adaptation to agriculture systems in areas prone to enhanced flash flooding–North East and Central Region.

Type of project: Intervention (with policy, awareness raising and research elements)

Rationale/justification, in relation to climate change, including sectors concerned

North east and central regional of the country are prone to flood and will become more prone under

anticipated future climate change. Crop field and homesteads are inundated by flood, crops and seedlings are damaged/lost, water recession is delayed, water logging is prolonged, community needs immediate and/or early harvest of vegetables before a regular vegetable crop. Therefore crop agriculture need new approaches and technologies to deal with flood. No crop is cultivated during Kharif season due to high depth of standing water in the field. Water recedes late from the crop field and delay time of appropriate sowing of the next candidate crops. Traditional land preparation is not possible. Affected community needs food, fodder, fuel and feed earlier than the next rice crop (Boro rice, wheat, potato, etc). At this condition the affected communities remain half-fed, ill fed, malnourished and moves to cities or other areas for job and livelihood.

Description

Objectives and activities

- The main objective of the no-tillage methods potato cultivation is to produce staple food, (before next Boro rice crop) for flood affected community after loss of Aman rice crop.
- Produce selected vegetables to meet day-to-day demands of the affected households. Some cash is also generated from sale proceed of the vegetables.
- Motivate the affected community to adapt the above technologies to combat with inundation due to flood after loss of crops or no crop items.

Inputs

- Potato seeds, fertilizers and mulch material are the major inputs. The mulch material like water hyacinth is available after the flood.
- Seeds and some fertilizer are needed.
- The floating substratum is made of water hyacinth, which is available during flood.

Short-term outputs

- Produce potato and cash by selling potato to meet the needs of the flood-affected community. Potato at the rate of 18-20 t/ha is obtainable from the production system.
- Produce vegetables to meet day-to-day requirement of the affected community.
- Generate continuous supply of nutrition
- Generate cash by selling the vegetables.

Potential long-term outcomes

- This is a contingency option for the flood affected community. In the long–term people might get a means to continue with farming, instead of migrating to cities after the flood. This would to some extend reduce social problems of migration of the distressed community to cities.
- The system, as because require almost no cost, is suitable for the distressed community to adapt. Thus it is likely that the community would continue to adopt the adaptation tool.
- The production system is a potential source of nutrition from the vegetables, which the distressed community very often suffers from especially at the time of flooding.

Implementation

Institutional arrangement

The technology was designed by the On-farm Research Division (OFRD) of BARI and tested in different agroecosystems. OFRD has a network of field sites in the vulnerable areas with sub professional posted at the field level. DAE is mandated to transfer technology with sub professional posted at the village level. The two groups of workers may jointly implement the production system. DAE will have the lead role. SRDI monitor the soil fertility and salinity. SRDI may also be included in implementation of the activity. The targeted areas are not traditionally potato growing. Potato seeds are not locally available. Seed tuber and fertilizer cost is high. Affected community would need credit for the purpose of cultivating the crop. Thus, other than OFRD, BARI, DAE, SRDI, BADC Krishi Bank and NGOs have to be included in the implementation of the programme. BARC should be in charge of overall coordination of the project. A mechanism has to be developed. Implementation of the activity might require services of local consultant having background in farming systems.

Although the floating bed technique of vegetable

production is a farmers' practice, scientists from OFRD, BARI attempted to refine it to be more productive and profitable. A team of researcher and extension official joined by NGOs might extrapolate the technology. Implementation of the activity might require services of local consultant having background in farming system.

Primary implementing agency: BARI (OFRD)

Secondary implementing Agencies: DAE, SRDI, KB, NGOs

Risks and barriers

- During design stage of the technology no other risk except rodent making holes beneath the mulch was noticed. The rodent can be control with available crop production practices.
- Potato seeds in the flood affected areas especially in the northeastern areas are not normally available because these areas are not traditional potato growing areas. Government or NGOs would have to take initiatives to deliver the potato seeds at the farmers door step.
- The crop would require sufficient mulch material.
- During the design stage peoples expressed mixed reaction about the technology because it was not targeted to flood affected community.
- Affected community need to be motivated to adapt the technology.

Evaluation and monitoring

- As the technology is different from the traditional ones it will require services of local consultants preferably from the group of scientists who designed it. Close and constant monitoring during the implementation will be required in the field.
- An independent monitoring team of the professionals from research and extension would be necessary to monitor and evaluate performance of the technology. BARC would form a multidisciplinary monitoring and evaluation team.

Financial resources

- The technology would require high cost of production because of high cost of seeds (60%). Total cost would depend on the block size (preferably 5 ha each of 10 farmers) in one hand and the number of such blocks (1000 block).
- This can be worked out when there is policy decision on size of unit block and number of such block.
- Farmers and sub professionals at the field level would require training on the concept and production package of the technology.
- Audiovisual aids would be needed for the training activities.
- For dissemination of the technology sufficient field days would be necessary.
- A comprehensive budget has to be worked out for the purpose.
- Total cost will depend on size of the unit bed preferably one meter in breadth and 4 meter in length) having 20 such bed in a cluster and 1000 such clusters.
- Sufficient number of field days has to be organized to explain the merit of the technology so that more farmers adopt the technology.

An indicative and tentative financial resource estimate for five years is provided as below:

Full project: USD6.5 million

Project design: USD 50,000

Project No. 13

Title: Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.

Type of project: Intervention (with research, policy and awareness raising elements)

Rationale/justification, in relation to climate change, including sectors concerned

Flood is an annual phenomenon in Bangladesh. However, recent experiences show that both frequency and intensity of flood has increased and every year many parts of the country is devastated by floods, often causes losses to agricultural crops, livestock and other assets.

Every year hundreds and thousands of culture ponds float due to floods resulting in the loss of fish and the poor fish farmers incur financial losses. Sometimes, they are assisted by the government under the after flood rehabilitation programs, however, this is not a long-term solution to the problem. Therefore, adaptation to the changing hydrodynamic phenomena should be developed and practiced in order to avoid or reduce the devastating effect of floods. The projected increase in rainfall will further aggravate the situation.

Presently, culture fisheries contribute more than 50% to the total fish production from inland waters in the country and are mainly represented by pond culture of fish. Sometimes, as an adaptive effort some farmers are used to increase the height of pond dykes and/or put fence around the pond in order to protect their fish from escaping. However, this is not widely practiced. Increasing height of pond dyke above the flood level is usually not cost-effective. Promotion of net and other fencing remains as viable option for protecting fish from floating and thus could reduce the fish crop loss.

Description

Objectives and activities

The overall objective of the activity is to reduce the fish crop loss from increased flooding and promote adaptive viable options for fish culture suitable for the flood prone areas of Bangladesh. However, the specific activities would be

- promote/introduce net fencing of ponds to prevent escaping of fishes from culture ponds
- promote pen and cage culture of fish in floodplain areas during flood season with as an alternate option for fish culture.

Inputs

- Inputs will be required in the form of transportation, production of awareness and training materials, awareness creation activities, organizing training programs, demonstration of pen and cage culture techniques and net fencing, etc.

Short-term outputs

- Protection to flood vulnerable culture ponds and other culture facilities will be afforded which in-turn will ensure the financial benefits to fish farmers
- Fish production from floodplain areas will be increased through promotion of pen and cage culture practices

Potential long-term outcomes

- Socio-economic condition of the marginal farmers will be improved with more contribution to GDP
- Adaptation strategies to increased floods is likely to be replicated in other flood vulnerable areas of Bangladesh resulting in the positive impact on fish production
- Rehabilitation programs for culture fisheries after floods will not be required
- Adaptation to floods will be achieved

Implementation

Institutional arrangement

Department of Fisheries (DoF): DoF should be the implementation agency and should coordinate the all project activities, organize trainings, producing awareness materials. Fisheries Office at the Upazila level should directly be involved with field level implementation and supervising NGO activities.

NGO: Local NGOs could be engaged by DoF to carry out specific activities, like survey of ponds, promotional activities at the field level and mobilizing fish farmers

Bangladesh Fisheries Research Institute (BFRI): BFRI could be employed for conducting research and impact assessment.

Primary implementing agency: DOF

Secondary implementing agencies: FRI, NGOs

Risks and barriers

- Cost-effectiveness may determine the adoption of the practice. The landlords may take up pen culture practice. Replication of the practice would depend on the outcomes of the project and government willingness.

Evaluation and monitoring

- The project progress should be monitored and evaluate internally on a quarterly basis by the project. Subsequently, technical and

financial progress should be monitored and evaluated on a half yearly basis through BARC and donor agency team. Participatory monitoring could also be done involving the local community in the process.

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full Project: USD4.5 million

Project design: USD 50,000

Project No. 14

Title: Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh

Type of project: Intervention (with awareness raising and policy elements)

Rationale/justification, in relation to climate change, including sectors concerned

Sea level rise and tidal surges will increase salinity of the coastal area and inward intrusion. Some area of the coastal area is already facing problems related to salinity. In spite of the shift in the biodiversity from freshwater species to salt water species, fisheries resources as a whole will have positive impacts from the climatic change in the area. The reason is that higher water levels and higher temperature regimes would lead higher productivity of the fisheries resources. However, individual coastal aqua farmers would need to adapt their culture practice to cope with more flooding with the sea water to get the best benefit of the higher productivity.

Regional Consultation Workshops identified salinity problem and suggested to introduce and extend coastal aquaculture, predominantly with saline water fish species and shrimp. The activity is also complementary to the strategic plan and National Fisheries Policy. Although, environmental issues often raised, but with the changing climatic scenario coastal aquaculture would be viable and pragmatic option.

Description

Objectives and activities

The overall objective of the project is to utilize the saline waters of the coastal areas to boost up fish production. However, the specific objectives of the project would be to:

- Develop culture technology for salt tolerant fish species having potential for use in coastal aquaculture
- Piloting and promotion of developed aquaculture in the priority areas of coastal region.
- Develop linkages with weather forecasting agencies through networking
- Helping the coastal aquafarmers, particularly the shrimp farmers, in protecting the crops from floods.

Inputs

- Collection of geo-morphological, meteorological and hydrological data: A wide range of data will be collected on the above areas with a view to understand the causes and effect salinity intrusion. These data will be used to build some predictive.
- Zoning of the coastal belt based on the predicted extent and intensity of salinity intrusion: Based on the collected information, the coastal belt will be divided into a number of zones depending on the extent and depth of inundation and timing of inundation by saline water. The purpose of zoning would be to formulate fisheries or aquaculture strategies suitable for each of the zones.
- Develop culture packages for a number of potential salt tolerant fish species to be used in different identified zones of the coastal belt: A number species suitable for culture at different salinity regimes and at different depths, representing different identified zones. The culture period should be short. Appropriate technology for their propagation and farming will be developed. Emphasis will be given on the pond and pen culture of fish.
- Piloting of culture technology in limited area in a priority zone: The developed technology will be piloted in order to adjust to local conditions. This piloting will be done in small area of a prioritized area of the coastal belt.

- Promotion of piloted culture practices in a prioritized zone of the coastal area: Extension activities will be undertaken to boost up the developed and piloted culture practices in a highly prioritized zone of the coastal belt.
- Identify the threats in existing shrimp farms and recommend remedies to mitigate the threats: Many existing shrimp farms are presently subjected to tidal surge and floods resulting in crop loss. Threats from all potential sources would be identified and assessed and possible mitigation measures will be recommended.
- Suggest potential new areas for shrimp culture within coastal areas: Analyzing the data collected through the project new potential areas for shrimp culture will be identified.
- Undertake promotional activities for shrimp culture: Promotional activities like farmer contact, providing training, counseling, booklet and poser production, proving some inputs to farmers, organizing rallies, hatchery development etc. could be undertaken.
- Disbursement of livelihood support fund: Fund will be disbursed to most vulnerable section of people, particularly vulnerable women for undertaking AIG activities.

Short-term outputs

- Development of a comprehensive database on the geo-morphological, ecological, biological, meteorological and hydrological information of the coastal area of Bangladesh
- Development of culture technology for a number of fin fish species suitable for culture in shallow saline waters.
- Expansion of aquaculture in the area vulnerable to climate change
- Increased production of fish and shrimp

Potential long-term outcomes

- Culture practices replicated and fish production increased
- Socio-economic of the coastal people improved

Implementation

Institutional arrangement

Bangladesh Fisheries Research Institute (BFRI): BFERI will undertake all data collection activities, development of culture technologies, piloting of the technologies, identification of suitable culture areas and training to farmers.

Primary implementing agency: Department of Fisheries (DoF)

Secondary implementing agencies: FRI, NGOs

Risks and barriers

- Past information about meteorological parameters, biophysical parameters, etc. may not be readily available as per necessity of the project.
- Appropriate personnel to make a CBEC committee may or may not be available.
- Uncertainty of local salt and aqua farmers' cooperation.
- Guarding against poaching/theft of experimental fish may not work properly.
- Severe cyclonic storm may damage the experimental enclosure fully or partly.

Evaluation and monitoring

- Evaluating and monitoring authority: Bangladesh Agricultural Research Council and/or financial support provider
- Frequency of evaluation and monitoring: Half Yearly and Annually
- Type of evaluation and monitoring: Both financial and physical
- Method of evaluation and monitoring: Progress report, workshop presentation and field visits.

Financial resources

An indicative and tentative financial resource estimate for five years is provided as below:

Full project: USD 4 million

Project design: USD 50,000

Project No. 15

Title: Exploring options for insurance to cope with enhanced climatic disasters.

Type of project: Research (with policy elements)

Rationale/justification, in relation to climate change, including sectors concerned:

Insurance can be a significant means of risk reduction for different vulnerable sectors, including property, infrastructure, agriculture, etc). However, the insurance market and its possibilities is little understood in these different sectors.

Description

Objectives and activities

- To explore the possibility of insurance market for climate vulnerability in different vulnerable sectors in the country
- Inputs and Activities
- Experts on insurance and different sectors (including infrastructure, agriculture, transport, etc) to be hired to carry out study in consultation with stakeholders from vulnerable sectors.

Short-term outputs

- Policy recommendations on how to develop the insurance market to reduce risk of climate impacts

Potential long-term outcomes

- Improved risk reduction of key vulnerable sectors through insurance market

Implementation

Institutional arrangement

Primary implementing agency: DOE (to hire consultants and experts)

Secondary implementing agencies: Universities, Research institutes

Risks and barriers

- Possibility that insurance companies may not wish to invest in climate sensitive areas

Evaluation and monitoring

- Review committee to review study reports

Financial resources

An indicative and tentative financial resource estimate for the activities provided below:

Full Project: USD0.2 million

Project design: USD 25,000

7 NAPA Preparation Process

Bangladesh National Adaptation Programme of Action (BDNAPA) has been prepared by the Ministry of Environment and Forest (MOEF), Government of the People's Republic of Bangladesh as a response to the decision of the Seventh Session of the Conference of the Parties (CoP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The preparation process has followed the generic guiding principles outlined in the annotated guideline prepared by LDC Expert Group (LEG). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized necessity of addressing environmental issue and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution. Therefore, involvement of different stakeholders was an integral part of the preparation process for assessing impacts, vulnerabilities, adaptation measures keeping urgency and immediacy principle of the NAPA. Policy makers of Government, local representatives of the Government (Union Parishad Chairman and Members), scientific community members of the various research institutes, researchers, academicians, teachers (ranging from primary to tertiary levels), lawyers, doctors, ethnic groups, media, NGO and CBO representatives and indigenous women contributed to the development of the NAPA for Bangladesh. The entire process and steps of the preparation of Bangladesh NAPA is presented in the Figure 8.

At the highest level it has a Project Steering Committee (PSC) headed by Secretary Ministry of Environment and Forest. The Project Steering Committee is represented by high level officials and experts from different government and non-government organizations to provide guidance. In addition to the Ministry of Environment and

Forest, other noteworthy government ministries and agencies involved in the PSC are Ministry of Planning, Economic Relation Division, Ministry of Agriculture, Ministry of Food and Disaster Management, Water Resource Planning Organization, Ministry of Fisheries and Livestock, Ministry of Land, Department of Environment etc. The Project Steering Committee is represented by government, non-government and international research institutes including Bangladesh Institute of Development Studies (BIDS), Bangladesh Forestry Research Institute (BFRI) Bangladesh Centre for Advanced Studies (BCAS), IUCN Bangladesh etc.

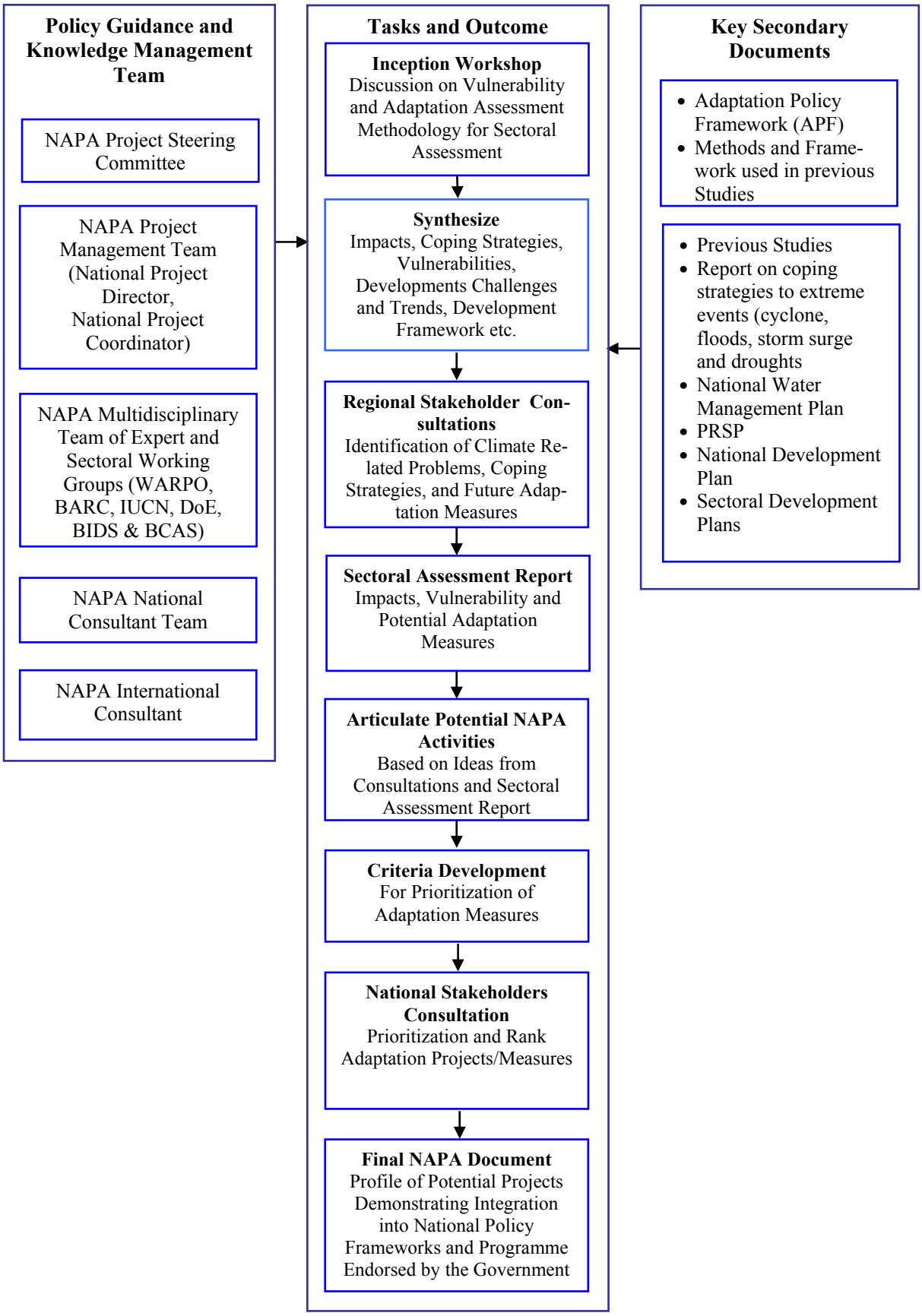
The second group of stakeholders is a multi-disciplinary team of experts and sectoral working groups with critical roles and responsibilities to analyze vulnerability of the natural, economic and social systems and connect it will overall development of the country. The six Sectoral Working Groups (SWG) are a) Agriculture, Fisheries and Livestock coordinated by Bangladesh Agricultural Research Council (BARC), b) Forestry, Biodiversity and Land-use coordinated by IUCN, Bangladesh, c) Water, Coastal Zone, Natural Disaster and Health coordinated by Water Resources Planning organization (WARPO), d) Livelihood, Gender, Local Governance and Food Security coordinated by Bangladesh Institute for Development Studies (BIDS), e) Industry and Infrastructure coordinated by Department of Environment (DoE), and f) Policies and Institutes coordinated by Bangladesh Centre for Advanced Studies (BCAS). It is anticipated that participation of key stakeholder in the preparation process will help in mainstreaming adaptation to climate change into national and sectoral development policies and plans as well as implementation of adaptation projects in future. Members of the project steering committee, sectoral working group and experts attended the inception workshop, regional stakeholder consultation workshops, and national stakeholder consultation workshop.

The third group of stakeholders involved in the preparation process were from local and regional (divisional towns) level including people from the local government, local level non-government organizations, farmers and women. The local level stakeholders were involved in the regional consultation workshops. The NAPA project has organized regional stakeholder consultation workshops in Rajshahi (north-west region), Khulna (south-west region), Sylhel (north-east region) and Chittagong (south-east region) during December 2004 and January 2005. Drought is a recurrent phenomenon of the north-west region and anticipated that it will increase under changes in climatic system. South-west and south east regions are part of coastal area with salinity, and freshwater availability problems. It is anticipated that salinity intrusion will increase and freshwater availability will decrease in these areas particularly in the dry season. North-east region is a combination of low hills and depressed area and are prone to flash flood.

The objectives of the regional stakeholder consultation workshops were a) identification of existing problems related to variability, extremes and climate change and rank them if possible, b) Identification of existing coping mechanisms and measures, c) Suggestion for improvement of existing measures, d) Identification of new measures and idea to address anticipated future change in intensity and extent of present problems. The identified problems and suggestions have been incorporated in the sectoral analysis and future programme of action. In addition to the regional stakeholder consultation workshops each sectoral working groups have organized meeting with different sectoral agencies for checking possibility of integration into sectoral policies and plans.

Based on earlier climate change impacts, vulnerability and adaptation studies and regional stakeholder consultation workshops National Consultant Team prepared first draft Bangladesh NAPA which has been discussed in the National Consultation Workshop. The National Consultation Workshop, organized by the Forum of Environmental Journalist of Bangladesh (FEJB), has discussed all project identified based on local need and are complementary to national development goals and objectives. The National Consultation Workshop has also ranked the projects using prioritization criteria developed by NAPA team. The national consultant prepared the final Bangladesh NAPA incorporating comments and suggestions made during National Consultation Workshop. Then the document was accepted by the Steering Committee.

Figure 8. Preparation Process of NAPA Bangladesh



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