



# BANGLADESH: WATER SECTOR

Assessing the Investments & Financial Flows  
Required to Adapt to Climate Change



**UNDP ENVIRONMENT & ENERGY GROUP | DECEMBER 2011**



## **Capacity development for policy makers: addressing climate change in key sectors**

In May 2008, the United Nations Development Program (UNDP) launched the global project, “Capacity Development for Policy Makers to Address Climate Change”. The overall goals of the project are twofold:

- Increased national capacity to raise awareness and co-ordinate Ministerial and stakeholder views on climate change, leading to enhanced participation in the UNFCCC process;
- Support for long-term climate change planning and priority setting, using assessments of investment and financial flows to address climate change in key sectors, which can provide a better understanding of the magnitude and intensity of national efforts needed to tackle climate change, as well as provide more accurate estimates of the funds needed to implement mitigation and adaptation actions.

Bangladesh is one of the 15 countries participating in the project that undertook the assessment of investment and financial flows, using a UNDP methodology. National experts in Bangladesh identified three key sectors for the assessment: energy (for mitigation actions), and agriculture and water (for adaptation options).

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### **Disclaimer**

The views expressed in this publication are those of the author(s) and do not necessarily represent those of the United Nations, including UNDP, or their Member States.

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# **UNDP GLOBAL PROJECT: CAPACITY DEVELOPMENT FOR POLICY MAKERS TO ADDRESS CLIMATE CHANGE**

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## **Assessment of the Investments and Financial Flows to Adapt to Climate Change in the Water Sector**

**FINAL REPORT: WATER SECTOR**

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## 1 INTRODUCTION

Change in the global climate is obviously not a nature driven phenomenon; it is now widely accepted by policy makers and scientists that changes in the global climate and associated sea level rise is human induced. The Intergovernmental Panel on Climate Change (IPCC) concluded, “the balance of evidence suggests a discernible human influence on global climate”. The exact magnitude of the changes in the global climate is still uncertain and subject of worldwide scientific studies.

The latest report of the Inter-governmental Panel on Climate Change (IPCC) concludes that human activities are almost certainly the primary cause of observed climate change (IPCC, 2007) and at the same time the development and management of water resources by humans has altered the natural availability of water resources around the world. Now it is also unequivocal that the observed warming over several decades has been linked to changes in the large-scale hydrological cycle such as: increasing atmospheric water vapor content; changing precipitation patterns, intensity and extremes; reduced snow cover and widespread melting of ice; and changes in soil moisture and runoff (Bates et al., 2008). IPCC (2007) also projected that increased precipitation intensity and variability are projected to increase the risks of flooding and drought in many areas. The frequency of heavy precipitation events (or the proportion of total rainfall from heavy falls) will be very likely to increase over most areas during the 21st century, with consequences for the risk of rain-generated floods. At the same time, the proportion of land surface in extreme drought at any time is projected to be likely to increase. The above-mentioned consequences will make water management more complicated and often even an impossible task.

Bangladesh is a welfare country, it has a set of welfare objectives for its population. Poverty reduction is one of the most cherished national objectives. The results of research in Bangladesh and abroad demonstrate that Bangladesh is one of the worst victims to adverse impacts of climate change (Harmeling, 2009), which will drastically reduce its welfare level as such. The magnitude and extent of such reduced welfare level due to climate change in particular; therefore, constitute the components of cost of climate change.

According to an estimate by OXFAM, developing countries may need in the order of \$50 billion per year to adapt to climate change. Obviously this is beyond the financial reach of developing countries. Developed countries have a legal obligation under Art 4(4) of UNFCCC to, “assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.” Consequently, in 2005, the G8 Plan of Action included an agreement to assist developing countries to adapt to climate change.

In practice, comprehensive methodologies to develop a financial portfolio for adaptation investments as a tool to facilitate adaptation choices are very scanty and long overdue. But to understand the full array of adaptation options it is crucial to prioritize the most effective adaptation strategies. Better estimates of the budget implications of “climate resilient development activities” are needed to implement the national strategies and plans and to inform discussions concerning possible international assistance.

In this assessment a brief methodological framework for developing a financial portfolio of investments is applied on the water management sector in Bangladesh. In a nutshell, the proposed portfolio can suggest economically viable adaptation mechanisms through prioritizing the proposed adaptation measures, identifying their cost and evaluating qualitatively their expected benefits.

### 1.1 Objectives

The objective of this assessment is therefore two fold. On the one hand, it develops technical knowledge and approaches to assist developing countries to cost, prioritize and sequence robust adaptation strategies of water sector into the development plans and budgets of Bangladesh.

On the other hand, it intends to estimate the cost of adaptation for specific activities in the water sector in order to inform national policy makers as well as the international community’s efforts on the additional resources needed to allow developing countries adapt to climate change.

## 1.2 Background

### 1.2.1 Previous Analyses Utilized

Prior to planning and assessing the adaptation measures in the water sector, it is essential to gather knowledge on the vulnerability of the water sector that will help to understand the climate risk and to identify a range of adaptation options pertinent to the sector. Vulnerability assessment studies focusing Bangladesh that built the basis for this I&FF assessment can be broadly summarized as follows:

- The frequency and intensity of **hydro-meteorological disasters** are expected to be perturbed due to the change in climate (Alam, 2004; Ali, 1996; Asaduzzaman, et al., 1997; Department of Environment, 1993; Habibullah, et al., 1999; Hossain, 1989; Huq, et al., 1995; Jennifer, et al., 2006; Mirza, et al., 2005; Moudud, et al., 1988; Osman, et al., 2006; Shamsuddoha, et al., 2007; Walter, et al., 2002; World Bank, 2000).
  - a. Specifically, the hydrological regime of **flooding** in Bangladesh has already been observed to be changing (Choudhury, et al., 2004; Dhar, et al., 2004; Messerli, et al., 2006; Rana, et al., 2000) and in future it is expected to be altered further in terms of frequency and intensity (extent and depth) (Ahmad, 2006; Ahmad, 2006; Ahmed, 2003; Asada, et al., 2005; Climate Change Cell, 2009 I; Karim, et al., 2002; Mirza, et al., 1997; Mirza, et al., 2001; Mirza, et al., 2003; Mirza, et al., 2003; Mirza, et al., 2005).
  - b. The risk of meteorological **drought** is going to be increased, especially in the northwest region of Bangladesh (Dhar, et al., 2004; Shahid, et al., 2008). This situation will be further aggravated due to reduction of surface water flow in the dry season in the Ganges/Brahmaputra/Meghna (GBM) basins (Mirza, 2004; Mirza, et al., 1997; Mirza, et al., 2005; Quadir, et al., 2003).
  - c. The coastal region of Bangladesh is particularly vulnerable due to already observed and anticipated **sea level rise** associated due to climate change (Aerts, 1997; Begum, et al., 1997; Begum, et al., 1997; Gaan, 2005;

Warrick, et al., 1993; Ahmed, et al., 1996; Ali, 2000). The flood regime, both in the coastal and inland areas, will be affected due to rise in the sea level (Mirza, et al., 2005; Nicholls, 2004; Nishat, 2008; Quadir, et al., 2003).

**Salinity intrusion** in the southern region of Bangladesh has vast implications on different economic and non-economic sectors (Aerts, 1997).

- d. Projected sea level rise and an increase in the sea surface temperature has direct correlation with the intensity and frequency of **cyclonic events** in the Bay of Bengal and associated inland propagation of storm surge events (Ali, 1996; Ali, 1999; Ali, 2003; Karim, et al., 2008; Khan, et al., 2000).
- The water sector is particularly vulnerable to climate change. Other socio-economic sectors like agriculture, fisheries, forestry, natural environment etc. will also be affected due to the change in climate and its associated impact on the water sectors (Asian Development Bank ADB, 1994; Asian Development Bank ADB, 2008; Choudhury, et al., 2005; Fung, et al., 2006; Islam, et al., 2008).

Other than the vulnerability and impact studies, a large number of studies have been conducted related to structural and non-structural adaptation in water sector, which informed this I&FF assessment as well. In brief, those are summarized below:

- A number of alternative flood management strategies are elaborated in (Ahmad, 2006; Ahmed, 2005; Ahmed, et al., 1996; Alam, 2004; Alam, 2008; Alam, et al., 1999; Alam, et al., 2007; Amadore, et al., 1996; Ramamasy, et al., 2007). Overall flood risk management and damage reduction options are highlighted in (Siddiqui, et al., 2006; Brouwer, et al., 2006).
  - a. Specifically, several research initiatives (Climate Change Cell (CCC), 2008; Karim, et al., 2002; Rana, et al., 2000; Siddiqui, et al., 2006) have highlighted the importance of flood hazard zoning for pre-adaptive management strategies. Flood plain monitoring is also proposed as an adaptation strategy by Huq (Huq, et al., 2003).

- b. A number of initiatives (Brouwer, et al., 2007; Kausher, et al., 1993; Mallick, et al., 2005; Paul, et al., 2006) have proposed non-structural flood management strategies like coping, community preparedness and increasing the adaptive capacity. Improvements in the existing flood forecasting system is elaborated in Ahmad and Madsen (Ahmad, 2003; Bangladesh Water Development Board, 2008; Madsen, et al., 2004; Paudyal, 2002). The importance of regional cooperation is elaborated as adaptation through flood management by Ahmad (Ahmad, 2003).
  - c. Effective flood management strategies for water supply and sanitation and salinity protection are elaborated by Ahmed (Ahmed, 2004; Asian Development Bank (ADB), 2008).
  - d. Flood management strategies for saving agricultural production are elaborated by Azam (Azam, 1996). Ensuring the optimum use of water is considered as an adaptation strategy for crop culture by Islam and Khan (Islam, et al., 2008; Khan, et al., 2004).
  - e. Possible infrastructural adaptation options include constructing flood control, drainage and irrigation projects (Halls, et al., 2008). An example of infrastructural adaptation mainstreamed in the design of the proposed Padma Bridge is illustrated by the Center for Environmental and Geographic Information Services (Center for Environmental and Geographic Information Services (CEGIS), 2010).
- Possible adaptation options for drainage and water logging problems are elaborated by Khan (Khan, 2005).
  - Adaptation options for flood and storm surge protection, river and delta management, ecosystem protection in the coastal zone is elaborated by Ahmed and others (Ahmed, et al., 1996; Ali, 1999; Amadore, et al., 1996; Kausher, et al., 1993; Khan, 2005; Milliman, et al., 1996; Ministry of Water Resources, 2006; Saari, et al., 2003; Salequzzaman, et al., 2003).

The above-mentioned vulnerability, impact and adaptation studies are used in developing a common understanding for the selection of adaptation options.

Moreover, Bangladesh submitted the National Adaptation Programme of Action (NAPA) in 2005 (Ministry of Environment and Forest (MoEF), 2005) to the UNFCCC, which identified several sectors that might potentially be affected by climate change. Similarly, the recently published Bangladesh Climate Change Strategy and Action Plan (Ministry of Environment and Forest (MoEF), 2009) also identified key climatic parameters that might affect different sectors and the investment needs for adaptation and mitigation.

Other than the above-mentioned studies, three other studies have been found very relevant and supportive in particular for this assessment.

- Firstly, the National Water Management Plan prepared by the Water Resources Planning Organization (WARPO, 2004) has been consulted for baseline setting of I&FF computation, where a total of 84 project portfolio was proposed for integrated water resources planning.
- Secondly, two other studies have been consulted to identify and cost adaptation options:
  - o The “Climate Change Cell” published a research report titled “Economic Modeling of Climate Change Adaptation Needs for Physical Infrastructures in Bangladesh” in 2009 (Climate Change Cell, 2009 i), where a methodology was developed for economic cost computation for adaptation options in the water, transportation and health sectors. The concept of economic modeling is partly replicated in this assessment for cost computation.
  - o Another consulted document is the global study titled “Economics of Adaptation to Climate Change”, an initiative by the World Bank, which has been widely consulted and followed for the identification of adaptation options and the computation of I&FF.

### 1.2.2 Institutional Arrangement and Collaborations

The project was implemented by the Ministry of Environment and Forests (MoEF). The Secretary of the Ministry is the National Focal Point (FP) for climate change and in such capacity is also the chairperson of the Country Team (CT) of the project. The Secretary provided



policy guidance and maintained overall oversight of the activities through the Joint Secretary (Development), the MoEF who was designated as the Administrative Focal Point of the project for coordination of the team leaders and the National Project Coordinator (NPC). In addition, there were 2 more Team Focal Points who assisted the FP and the Project Focal Point in coordinating the activities of the project in the 3 key sectors as well as in other areas (policy, advocacy and consolidated I&FF) on behalf of the government.

While the MoEF was the lead ministry for the I&FF assessments, the Ministries of Agriculture, Water Resources and Power & Energy took the lead in their sectors. Other ministries with cross-cutting or inter-sectoral linkages such as the Ministries of Disaster Management, Health, Food, Land, Fisheries & Livestock, Local Government, Communication, Science & Technology, Industries, Commerce, Finance, and Planning played key roles in the thematic area consultative groups together with relevant civil society, NGOs, academia and think tanks.

The Ministry of Water Resources is the apex body of the Government of the People's Republic of Bangladesh for development and management of the whole water resources of the country. It formulates policies, plans, strategies, guidelines, instructions and acts, rules, regulations, etc. relating to the development and management of water resources, and the regulation and control of the institutions reporting to it. It prepares and implements development projects relating to flood control and drainage (FCD); flood control, drainage and irrigation (FCDI); riverbank erosion control; delta development and land reclamation; etc. and provides irrigation, drainage, flood protection, bank erosion protection, land reclamation facilities by constructing barrages, regulators, sluices, canals, cross-dams, embankments and sea-dykes along the banks of the rivers and the coast, etc.

The Ministry, through its implementing arm - the Bangladesh Water Development Board (BWDB) -, implements the FCD/FCDI and other development projects. It also collects, processes, stores and disseminates hydrological and hydraulic data and information through the BWDB. It provides flood forecasting and warning information through the Flood Forecasting and Warning Centre (FFWC) of BWDB. The Ministry prepared the

Guidelines for Participatory Water Management (GPWM), which are being widely followed by stakeholders at all levels.

The Ministry through its macro-planning arm –the Water Resources Planning Organization (WARPO) prepared the National Water Policy, Coastal Zone Policy, National Water Resources Database (NWRD), National Water Management Plan (NWMP) and Integrated Coastal Resources Database (ICRD). Data can be collected from WARPO for nominal charges.

The Ministry has also research and coordinating institutions such as the River Research Institute (RRI) responsible for physical and mathematical water modelling; the Bangladesh Haor and Wetland Development Board (BHWDB) for the development of haors (bowl-shaped large tectonic depressions) and wetlands; the Institute of Water Modelling for mathematical water modelling; and the Centre for Environmental and Geographic Information Services (CEGIS) for integrated environmental analysis using GIS, remote sensing (RS), database and IT. The Joint Rivers Commission of Bangladesh acts as the secretariat of the Ministry for dealing with the sharing and management of the waters of the trans-boundary Rivers.

Other principal activities of the Ministry include expansion of irrigated areas, water conservation, surface and groundwater use, estuary control, anti-salinity measures and anti-desertification activities, re-excavation of canals and rehabilitation of embankments, international cooperation, liaison with international organizations, processing matters relating to treaties and agreements with other countries and world bodies in the field of water development and management.

According to the National Water Policy from 1999 the Ministry is responsible for the formulation of a framework for institutional reforms to guide all water sector related activities and will:

- exercise water allocation power in identified scarcity zones on the basis of specified priorities and determine the priority for allocating water during critical periods;
- sustain shallow groundwater aquifers, regulating the

extraction of water in identified scarcity zones with full public knowledge;

- prepare specific drought monitoring and contingency plans for each region experiencing recurrent seasonal shortage of water etc.;
- empower local government or any other body, to allocate water in scarcity zones during periods of severe drought, monitor the water regimes and enforce the regulations etc.;
- confer water rights on private and community bodies to provide secure, defensible and enforceable rights to ground/surface water etc.;
- ensure the minimum requirement of stream-flows for maintaining the conveyance of the channel.

Other than the Ministry of Water Resources, a number of other ministries are also partners in the overall development of water resources in Bangladesh. Among them, the Ministry of Agriculture (MoA) and its two arms, the Bangladesh Agricultural Development Corporation (BADC) and Barind Multipurpose Development Authority (BMDA), as well as the Local Government Engineering Department (LGED) under the Local Government Division and Rural Development and Cooperative Division (RD & CD). The Ministry of Land and Survey of Bangladesh is also a key contributor in water resources development programmes. Almost all the ministries and respective departments have been linked under these assessments during the national inter-ministerial dialogue and specific key personnel working in these institutions has been consulted to provide information on the updated reports, policy and budgetary contributions.

### 1.2.3 Basic Methodology and Key Terminology

#### BASIC METHODOLOGY

As outlined in the methodology guidebook developed by UNDP under this assessment of investment and financial flows to address climate change, the methodology used straightforward. Once the scope of a sector is clearly defined, the relevant investment costs for that sector are projected for two future scenarios:

1. a baseline scenario, which reflects a continuation of current policies and plans, i.e., a future until the year 2030 when no new measures are taken to address climate change (otherwise referred to as a “business-as-usual” scenario), and

2. a climate change scenario until the year 2030, in which new mitigation measures are taken (a “mitigation scenario”) or new adaptation measures are taken (an “adaptation scenario”).

The investment and financial flows between the baseline and mitigation or between the baseline and adaptation scenarios are then compared to determine the changes in investment and financial flows needed to mitigate emissions from the sector or to adapt to the impacts to the sector. For this purpose, an eight-step methodology is proposed in the methodology guidebook which is illustrated below:

#### STEP 1 [Establish key parameters of the assessment](#)

- Determine in detail the scope of the sector;
- Identify the preliminary measures of mitigation;
- Specify the period of evaluation and the reference year
- Select an analytical approach

#### STEP 2 [Compile historical I&FF data and other input data for scenarios](#)

- Compile data of I&FF and O&M annually,
- Disaggregated by investment entity & source
- Separate investment flows with respect to financial flows

#### STEP 3 [Define reference scenario](#)

- Highlight the scenario on the basis of:
- Socio-economic trends
- Changes and technological advances;
- Sectoral and national plans and
- Expected investments given current sectoral and national plans

#### STEP 4 [Derive I&FF estimates for reference scenario](#)

- Estimates of I&FF annually disaggregated by investment entity and funding source
- Estimates the O&M annually disaggregated by investment entity and funding source
- Estimate annual subsidy costs for each relevant investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment

#### STEP 5 [Define adaptation scenario](#)

- Describe socioeconomic trends, technological change, mitigation (or adaptation) measures, and

investments given implementation of adaptation measures

- Taking into account the situation of climate change Derive / estimate / project the I&FF for the mitigation scenario;

#### STEP 6 Derive I&FF for adaptation scenario

- Estimate annual IF and FF for each investment type, disaggregated by investment entity and funding source
- Estimate annual O&M costs for each IF, disaggregated by investment entity and funding source
- Estimate annual subsidy costs for each relevant investment type and for IF, FF, and O&M costs, if subsidies are included explicitly in the assessment

#### STEP 7 Subtract 3 from 5 to estimate changes in I&FF needed to implement adaptation

- Calculate changes in cumulative IF, FF, and O&M costs, by funding source, for individual investment types and for all investment types

#### STEP 8 Evaluate policy implications

- Integrate climate change in regional projects, regional and national strategy,
- Strengthen the capacities of all stakeholders,
- Integrating these options in national reference
- Involve local entities proactively; give responsibility/empowerment to the people
- Develop activities that support the generation of income/revenue

#### STEP 9 Synthesis results in report

The cost accounting parameters can be distinguished between two distinct types of investments: investment flows and financial flows.

- An “investment flow” (IF) is the capital cost of a new physical asset with a life of more than one year, such as the capital cost of a new agricultural irrigation system or flood control embankments. Investment flows are limited to new physical assets because such investments have climate change implications for the duration of the operating lives of the facilities and equipment purchased.
- A “financial flow” (FF) is an ongoing expenditure on

programmatic measures; financial flows encompass expenditures other than those for expansion or installation of new physical assets. Examples of financial flows include expenditures for an agricultural extension program for farmers, a malaria prevention program to distribute mosquito nets, or the implementation of improved forest management techniques.

Other than this, “operation and maintenance” costs are also separated from the IF and FF flow enumeration.

Other terminologies used in this study are given below:

- An “investment entity” is an entity responsible for an investment. In this report, three types of investment entities: families, companies and government are used.
- The “sources of I & FF funds” are the origins of the funds invested by investment entities, e.g. domestic equity, foreign debt, domestic subsidies, foreign aid.
- A “scenario” is an internally consistent and plausible characterization of future conditions over a specified period. For assessment of I & FF for adaptation in the water sector, the team used a baseline scenario and a mitigation scenario.
- The “evaluation period” is the time horizon for assessment i.e. the number of years.
- The “base year” is the first year of the assessment period, that is to say the first year of baseline, mitigation and adaptation.

#### KEY TERMINOLOGY

The methodology distinguishes between investment flows and financial flows:

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## 2 SCOPE, DATA INPUTS, AND SCENARIOS

### 2.1 Sectoral Scope

Climate change is a global phenomenon, the water sector of Bangladesh is dependent on the global to regional hydrological regime and thus the sectoral scope of this assessment pertinent to climate change and water resources will evolve from global to regional to local perspectives. In this regard, prior to the elaboration of the sectoral scope it is essential to understand the global to national perspectives of climate change and its impact on the water sector.

#### 2.1.1 Climate change at global scale

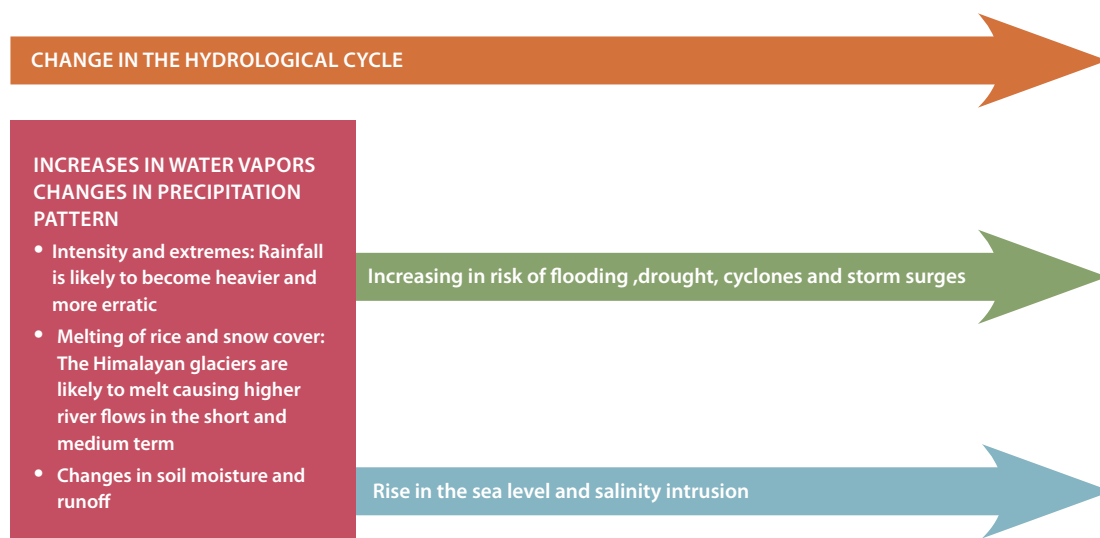
The Intergovernmental Panel on Climate Change (IPCC) predicts that global temperature will rise between 1.8 °C and 4.0 °C by the last decade of the 21st century. As a consequence, the following changes are expected:

- The frequency of extreme hydrological events will increase

- The intensity of extreme hydrological events will increase
- The occurrence of erratic and unusual weather patterns will increase
- Sea Level will rise; to what level is being debated
- Hot and humid conditions will increase the incidence of water borne and vector borne diseases like malaria, dengue fever and diarrhoeal diseases.

The accelerating changes in our global climate will undoubtedly cause major changes in the patterns of the water cycle. The magnitude and frequency of extreme hydrological events including precipitation, floods, cyclones, storm surges, and droughts and other phenomena would increase and adversely affect the water sector. Globally, the water sector has already been experiencing significant stresses of these natural hazards. Changes in the hydrological cycle are directly linked with the occurrences of hydro-meteorological disasters and as a consequence these disasters are looming in a more intense and frequent pattern (see the following diagram).

Figure 1: Likely impact of climate change on hydrological cycle and water resources system



### 2.1.2 National perspective

Bangladesh frequently faces extreme natural behaviour not only for its geographical position but also for the rapid changing of global climate. The effects of global climate change are evident now, as the people across the planet are experiencing through irregular weather conditions. This will have impacts on the composition of the atmosphere, hydrology, geomorphology, ecology, soil, land use, biological diversity, and vegetation etc.

Bangladesh is highly influenced by the Ganges-Brahmaputra-Meghna (GBM) river system, exhibiting a high degree of vulnerability to current climate variability and the key realities in the water sector of the country are too much water during the monsoon causing floods and too little or scarcity of water during the dry season. And being the lowest riparian in the Ganges-Brahmaputra-Meghna (GBM) river systems, this country bears the brunt of floods, discharging over 80 percentage of the GBM basin-wide runoff within five-months, and receives residual flows from the trans-boundary rivers during the lean season. Bangladesh has already experienced five mega flood events over the last 25 years that have never experienced before. At the same time, many of the rivers in Bangladesh have been facing severe low flow situations during the dry season. It is expected that climate change will further aggravate these occurrences. In the coastal zone, observational records have already been showing that the sea level is rising and salinity intrusion has already engulfed most of the southern zone, which is the habitat of more than 30 million people and the location of world's largest mangrove heritage "The Sundarbans". It is expected that, by the end of this century, sea level may rise in the scale of 0.5m to 1.5m. These figures are subject to debate, but there exists no debate that millions of inhabitants in the coastal region of Bangladesh will be forced to migrate, freshwater resources in the coastal region will face severe scarcity, inundation due to storm surge might be much higher than before etc.

The national economy of Bangladesh is consequently highly responsive to climate variability and change. High intensity of extreme weather events as well as hydrological events has been posing a serious threat to Bangladesh's sustainable development. In terms of environment, economy and social aspects, Bangladesh is highly at risk

for its higher dependency on the use of the water resources, and adapting to climate change in the water sector is now seen as a prerequisite for sustainable development, because the overall growth and development of Bangladesh's economy will be retarded by reduced agricultural viability and productivity, decreasing water resources, with subsequent threats to the integrity of the country's environment and increasing natural disasters. In particular, the poorest of the poor are more vulnerable due to their high dependency on water resources for their livelihoods and health.

The National Adaptation Plan of Action (NAPA) has provided a broad list of climatic parameters that might critically impact different sectors over different geographical locations of Bangladesh. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) has elaborated the immediate impact of global warming, its consequences and investment need for adaptation or mitigation measures to combat the adverse impact of climate change through a flow diagram (given in figure 1).

Table 1: Climatic parameters that might impact different sectors of different geographical location

CLIMATE AND RELATED ELEMENTS	CRITICAL VULNERABLE AREAS	RESULTANT IMPACT
Temperature rise and drought	North-west	• Agriculture (crop, livestock, fisheries)
		• Water scarcity
		• Energy
		• Health
Sea Level Rise and Salinity Intrusion	Coastal Area, Island	• Agriculture (crop, fisheries, livestock)
		• Water (water logging, drinking water, urban)
		• Human settlement
		• Energy
Floods	Central Region, North East Region, Char land	• Agriculture (crop, fisheries, livestock)
		• Water (urban, industry)
		• Infrastructure
		• Human settlement
		• Health
		• Disaster
Cyclone and Storm Surge <sup>1</sup>	Coastal and Marine Zone	• Marine Fishing
		• Infrastructure
		• Human settlement
		• Life and property
Drainage congestion	Coastal Area, Urban, South West	• Water (Navigation)
		• Agriculture (crop)

Figure 2: Likely impact of climate change in Bangladesh and required investments (Source: Ministry of Environment and Forest ; MoEF, 2009)





Apart from this, local people's perception has also been explored to have a clear understanding on the likely impact of climate change on water sector. Pertinent to this, some studies has been found which were carried out in the coastal areas of the Noakhali District on behalf of the IUCN Bangladesh Country Office in order to assess the perception from people in these areas. Local people's experiences in this regard are:

- Excessive rainfall at present, untimely and irregular distribution.
  - The annual rainfall over the coastal zone is increasing.
  - Bhola and Chittagong show a decreasing trend of precipitation.
  - The rainfall of the winter and pre-monsoon seasons were found to have an increasing trend except for Bhola.
- Increase in tidal bore, not from cyclonic events, variation in tidal flow: The five deadliest tropical cyclones (super cyclones) of the Bay of Bengal were recorded in a study. Four of these cyclones hit Noakhali at the Chittagong coast.
- Increase infrequency of flash floods: In the last 25 years, Bangladesh has experienced six severe floods. In 2007, two successive and damaging floods inundated the country in the same season. During high floods, river bank erosion is common. It can result in the loss of thousands of hectares of agricultural land and villages.
- Increase in surface temperature: It was observed in a study that surface air temperature is increasing at the rate of 0.03-0.06<sup>o</sup> C/decade. The sea surface temperature has increased by 0.47<sup>o</sup>C during the period of last 50 years and at the rate of 0.094<sup>o</sup>C/decade.
- Increase in droughts and dry spells, storms and hailstorms.
- Intensity of mist fog increased in winter.
- Monsoon rainfall has shifted, as a result land preparation and crop plantation of Kharif II has also shifted.
- Severity of cold temperatures and their duration is decreasing.
- Because of the reduced winter period insect infestation in the crop field is increasing.

Finally, from the literature review and following the suggestions made in the initial national inter-ministerial

dialogue on climate change, the following sub-sectors are considered in the assessment of financial and investment flows (IF and FF) in the water management sector:

- Flood management
- Drought management
- Water supply and sanitation
- Urban drainage
- Storm surges and cyclone
- Erosion control measure
- Institutional development and enabling environment.

## 2.2 Data Inputs and Scenarios

### 2.2.1 Assessment Period and Cost Accounting Parameters

In this assessment, the year 2010 is considered as the base year. For future IF and FF calculation, the next 20 years (up to year 2030) have been considered as the assessment period. The portfolios as suggested by the NWMP have been adopted as the baseline on which none of the program has started to be implemented on year 2005 (which is the recommended base year of the I&FF methodology). Thus the year 2010 was selected as the base year.

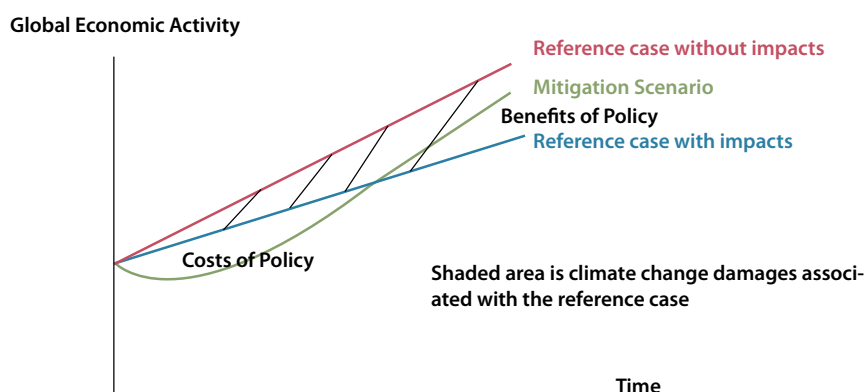
The accounting units are U.S. dollars in 2010 constant values and a conversion rate of 1 USD=BDT 70 has been used.

### 2.2.2 Analytical Approach

The approach for calculating the additional I&FF needed is the projection of additional investment needed to equal marginal cost of adaptation to marginal avoided damages. Conceptually, the analytical approach is based on the hypothetical model suggested by Gunasekera and Ford (2005) on climate change, which consists of the following determinants:

- I. Reference case without impacts;
- II. Climate change damage costs or reference case with impacts;
- III. Cost of policy;
- IV. Benefits of avoided climate change; and
- V. Net benefits of adaptation and mitigation.

Figure 3 Climate change policy framework for benefit cost analysis (the fish diagram)



(Source: Ministry of Environment and Forest; MoEF, 2009)

Under the current scope of the assessment, only the third component is taken for detailed cost computation. But another challenging task is the selection of an appropriate inflation and discounting rate. Analyzing the historical inflation rate, an inflation of 5.5% per annum is used for cost projection.

Climate change impacts and adaptation/mitigation policies have long-term character, and a cost analysis of climate change policies therefore involves a comparison of economic flows that occur at different points in time. The choice of the discount rate has a big influence on the result of any climate change cost analysis. The debate on discount rates is a long-standing one. At present there exist two major schools of thoughts related to discounting (IPCC, 1996, Chapter 4):

- a prescriptive approach based on what rates of discount should be applied, and
- a descriptive approach based on what rates of discount people (savers as well as investors) actually apply in their day-to-day decisions.

The prescriptive approach applies to the so-called social discount rate (also known as the Ramsey rule), which is the sum of the rate of pure time-preference and the rate of increased welfare derived from higher per capita incomes in the future. The social discount rate can thus be described by two parameters: a rate of pure preference for the present (or rate of impatience, see Loewenstein and Prelec (1992))  $\delta$ ,

and a factor  $\gamma$  that reflects the elasticity of marginal utility to changes in consumption. The socially efficient discount rate  $r$  is linked to the rate of growth of GDP per capita,  $g$  in the following formula:

$$r = \delta + \gamma g$$

Intuitively, as suggested by this formula, a larger economic growth should induce to make less effort for the future. This is achieved by raising the discount rate. In an intergenerational framework, the parameter  $\delta$  characterizes the ethical attitude towards future generations. Using this formula, the Second Assessment Report of IPCC (1996) recommended using a discount rate of 2–4%. It is fair to consider  $\delta = 0$  and a growth rate of GDP per capita of 1–2% per year for developed countries and a higher rate for developing countries that anticipate larger growth rates. On the other hand, the descriptive approach takes into consideration the market rate of return to safe investments, whereby funds can be conceptually invested in risk-free projects that earn such returns, with the proceeds being used to increase the consumption for future generations. In developed countries, rates of around 4–6% are probably justified (Watts, 1999)<sup>1</sup>. In developing countries like Bangladesh, the rate could be as high as 10–12%.

Comparing both the concepts, in this assessment we enumerate all costs valued in constant 2010 prices and future costs are discounted at a rate of 5% for computation of net present value (NPV).

<sup>1</sup> Rates of this level are in fact used for the appraisal of public sector projects in the European Union (EU).

### 2.2.3 Historical IF, FF and O&M Data, and Subsidies

Over the last 12 years, a total of USD 1,310 million has been spent for the development of water resources sector in Bangladesh. The annual investment profile in the development programmes is given in the following table.

**Table 2: Historical profile of investment in water sector**

INVESTMENT HEADS	CUMULATIVE RADP ALLOCATION (TOTAL IN MILLION US\$)
Irrigation and command area development	130
Study project	71
Integrated rural development	21
Flood control, and/or irrigation and/or drainage	315
River bank protection	208
Coastal zone management	123
Dredging	44
Town protection	287
Integrated water resources management	111
<b>GRAND TOTAL</b>	<b>1,310</b>

Note: RADP is the revised annual development programme; Source: Annual Development Program, Ministry of Finance, GoB

It has been observed that over the 12-year period that foreign contributions in the water sector have started to decline since 1999-2000 and reached at the lowest level in 2005-2006. After that the foreign investment proportion has started to rise again and until the current year (2010-2011) the trend shows a significant rise towards the initial level (1999-2000).

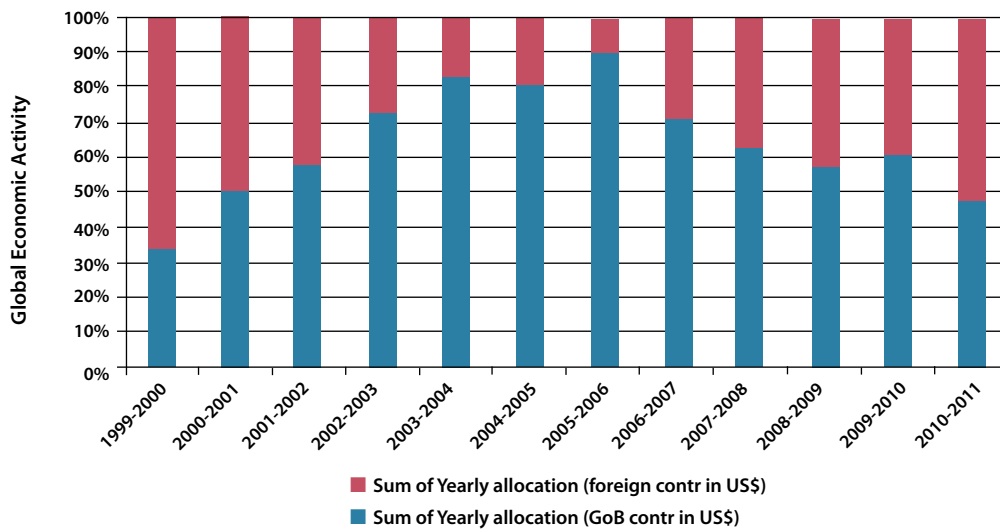
**Table 3: Historical profile of Government and foreign investment in water sector (values are shown in constant 2010 US \$, discount rate: 1USD = BDT 70)**

YEAR	YEARLY ALLOCATION (GOB CONTRIBUTION IN MILLION US\$)	YEARLY ALLOCATION (FOREIGN CONTRIBUTION IN MILLION US\$)
1999-2000	56	109
2000-2001	67	69
2001-2002	60	43
2002-2003	70	26
2003-2004	82	17
2004-2005	66	16
2005-2006	111	13
2006-2007	54	22
2007-2008	43	25
2008-2009	56	42
2009-2010	72	47
2010-2011	69	74
<b>GRAND TOTAL</b>	<b>807</b>	<b>503</b>

Source: Annual Development Program, Ministry of Finance, GoB

The ratio of foreign and domestic contributions over this period is 1:1.6. The annual profile of domestic vs. foreign investment is shown in the following figure:

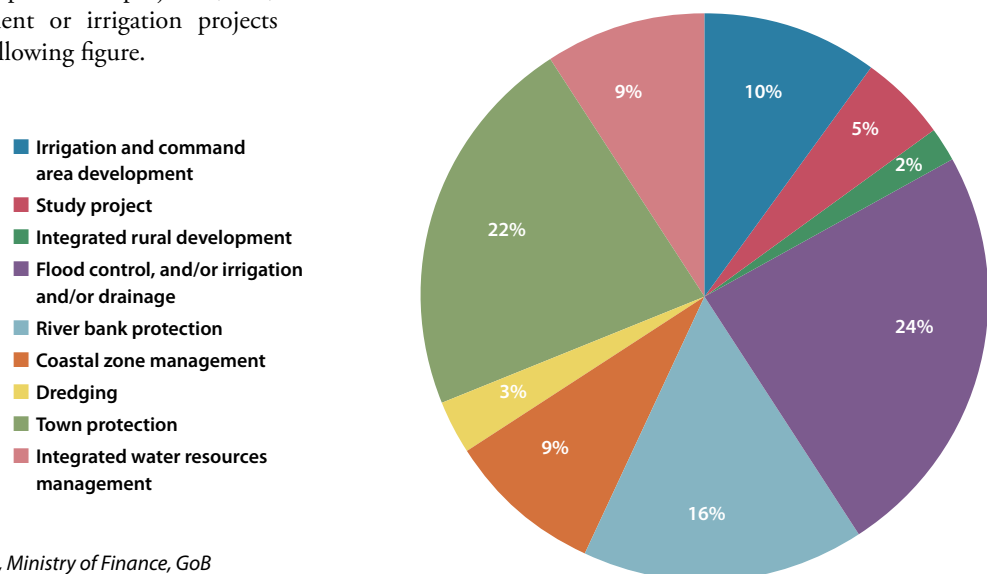
**Figure 4: Historical investment proportion by government and foreign fund in water sector**



Source: Annual Development Program, Ministry of Finance, GoB

Over the same period, the maximum annual investment has been spent for the development of flood control, drainage and irrigation projects (24%), followed by town protection projects (22%), river bank protection projects (16%) and command area development or irrigation projects (10%) which is shown in the following figure.

**Figure 5: Cumulative investment proportion in different category of water sector development projects (1999-2011)**



Source: Annual Development Program, Ministry of Finance, GoB

In the water sector, the Bangladesh Water Development Board (BWDB) is the key agency that consumed most of the investments (90.15%) over the last 12 year period. Other than this, the Barind Multipurpose Development Authority (BMDA; 3.57%) followed by the Bangladesh Agricultural Development Corporation (BADC; 2.58%) are holding minor shares in investments.

**Table 4: Cumulative investment shares of different institutions involved in water sector development of Bangladesh (1999-2011)**

AGENCY	CUMULATIVE RADP ALLOCATION (TOTAL IN MILLION US\$)
BADC	34
BHWDB	1
BMDA	47
BWDB	1,181
LGED	18
MoA	2
MOL	1
MoWR	5
RD& CD	0
RRI	2
SOB	2
WARPO	18
<b>GRAND TOTAL</b>	<b>1,310</b>

[Note: RADP is the revised annual development programme; Source: Annual Development Program, Ministry of Finance, GoB]

#### 2.2.4 Baseline Scenario

The Ministry of Water Resources has published the National Water Resources Management Plan (NWMP) in 2004 where a total of 84 projects have been listed under eight broad categories of the detail investment portfolio. In this assessment, this is considered as the baseline for the assessment of investment and financial flow until 2030. The NWMP's investment portfolio can be classified in the following categories:

- Coastal Protection
- Erosion control
- Flood protection
- General environmental responsibilities and pollution control

- Institutional development
- Irrigation and drought management
- Legislative environment
- Major river and water management
- Research, information dissemination and management
- Urban Drainage
- Water supply and sanitation.

Although it was planned in the NWMP that different investment programmes were supposed to be started from 2001, this has not been the case so far. So as the implementation of the NWMP programmes have not been materialized yet, it was assumed that all the investment programmes will start after the current year (2011).

Under this assessment, baseline investments until 2030 have been planned to be spent for some selected Programmes that have been proposed under the NWMP portfolio. It is to be noted that the Programmes have been selected on the basis of their relevance to climate change impact and adaptation issues. Broadly, the Programmes have been categorized under the following head:

- Coastal protection
- Erosion control and dredging
- Flood protection and management
- Irrigation and drought management
- Urban drainage
- Water supply and sanitation
- Institutional improvement and enabling environment.

A brief summary of the individual programmes under the above-mentioned investment heads are elaborated below (see Annex 1 for details):

##### 2.2.4.1 Coastal protection

A total of four NWMP proposed Programmes have been selected for coastal protection with net discounted worth till year 2030 is USD 479 million, of which financial flow is 4.5% and investment flow is computed as 95.5%. Annual O&M accumulation over this period is estimated as USD 329 million.

### **PROGRAM 1 Rationalization of Existing FCD Infrastructure**

The NWMP has proposed this Programme which falls under investment cluster head “Agriculture and Water Management”. The TA cost of this Programme will be BDT 100 million and the other costs will be BDT 21371.7 million. Hence the overall costs of the Programme will be 21,471.7 million. The purpose is to assess and rationalize all existing FCD schemes by specifying and implementing the appropriate course of action for each scheme according to the following options: a) continuation of the present situation; b) handover to beneficiaries or local govt.; c) rehabilitation and improvement; d) complete withdrawal. Both coastal and inland FCD will be included, although the former will generally receive higher priority.

### **PROGRAM 2 Land Reclamation, Coastal Protection and Afforestation**

NWMP has proposed this Programme, which falls under investment cluster head “Agriculture and Water Management”. The overall cost of the Programme will be BDT 5,866.9 million combining the TA cost and other Programme cost. The main purpose of the study is to undertake the reclamation of land from estuary region and sea. Another purpose of this Programme is to embank and where necessary provide arboreal protection to accreted land and thereby protecting life/property/livelihoods from tides.

### **PROGRAM 3 Cyclone Shelters and Killas**

The NWMP has proposed this Programme, which falls under investment cluster head “Disaster Management”. The overall cost of the Programme will be BDT 9,894.6 million, combining the TA cost and other Programme cost. This purpose of this Programme is to provide flood proofing systems to manage natural disasters and takes special account the particular needs of women and children while motivating the people themselves to develop different flood proofing measures. The Programme will also provide safe havens in the form of proven infrastructure comprising raised and covered cyclone shelters and killas (raised mounds) where both humans and livestock can take refuge. In the long term the Programme will be extended to cover lower risk areas corresponding to a maximum return periods of 1:100 years.

### **PROGRAM 4 Bari-level Cyclone Shelters**

The NWMP has proposed this Programme, which falls under investment cluster head “Disaster Management”.

The overall cost of the Programme will be BDT 1,747.9 million, combining the TA cost and other cost. This Programme aims at providing flood proofing systems to manage natural disasters and takes special account the particular needs of women and children while motivating the people themselves to develop different flood proofing measures. It also intended to provide safe havens in the form of 12m<sup>2</sup> concrete framed buildings on raised 72m<sup>2</sup> earth platforms, one in each bari in the coastal areas.

#### **2.2.4.2 Erosion control and dredging**

Under the investment head erosion control and dredging, one Programme proposed in the NWMP portfolio has been considered as baseline investment. A total of USD 209 million has been proposed for capital investment of which a total of USD 245 million has been considered as O&M.

### **PROGRAM 5 Main Rivers Erosion Control at Selected Locations**

The NWMP has proposed this Programme, which falls under investment cluster head “Main Rivers”. The overall cost of the Programme will be BDT 21,500 million, combining the TA cost and other Programme cost. It will look at all possibilities of minimizing the socio-economic impacts of erosion and will formulate an updated strategy for dealing with the problem. This Programme will provide for the subsequent investments to be determined by that strategy.

#### **2.2.4.3 Flood protection and management**

Three programmes have been planned to be invested under this head. A total of USD 238 million has been proposed to be spent for flood protection and management as capital investment under three different Programmes of which 100% is investment flow and a total of USD 488.6 million is planned to be invested as O&M.

### **PROGRAM 6 Dhaka Flood Protection**

The NWMP has proposed this Programme, which falls under investment cluster head “Major Cities”. The overall cost of the Programme will be BDT 5,423 million, combining the TA cost and other cost. The main purpose is to provide protection against floods with an acceptable flood return period. It will provide flood control infrastructures along right bank of the Balu River, which will

include construction of a flood embankment, flood wall and drainage sluices.

#### **PROGRAM 7 Rajshahi Flood Protection**

The NWMP has proposed this Programme, which falls under investment cluster head “Major Cities”. The overall cost will be BDT 400 million, combining the TA cost and other cost. This Programme will deliver suitable remedial measures necessary to ensure the flood embankment groins remain effective as flood protection for the city of Rajshahi.

#### **PROGRAM 8 Large and Small Town Flood Protection**

The NWMP has proposed this Programme, which falls under investment cluster head “Towns and Rural Areas”. The overall cost of this Programme is BDT 14,460 million, where technical costs of this Programme are included in the capital costs. The purpose is to develop appropriate flood protection works for selected Large and Small Towns.

#### **2.2.4.4 Irrigation and drought management**

For irrigation and drought management, a total of two investment Programmes have been planned to be invested in baseline investment, where the capital investment might cost around USD 49 million of which 100% is investment flow. Apart from the capital cost, a total of USD 26.9 million is considered as O&M.

#### **PROGRAM 9 Promotion of Expanded Minor Irrigation and Improved On-farm Water Management**

The NWMP has proposed this Programme, which falls under investment cluster “Agriculture and Water Management”. The overall cost of this Programme is 310 million where technical costs of this Programme are included in the capital costs. The purpose is promoting continued minor irrigation development, including groundwater irrigation, and improving the efficiency of resource utilization.

#### **PROGRAM 10 Improved Performance of Existing Public Surface Water Irrigation Schemes**

The NWMP has proposed this Programme, which falls under investment cluster “Agriculture and Water Management”. The overall cost is BDT 3,275 million where other cost is BDT 3,275 million. The Programme will envisage

the decentralization and transfer of “public water scheme management”, including irrigation schemes, increased water use efficiency and a major increase in cost recovery.

#### **2.2.4.5 Urban drainage**

A total of two investment Programmes have been considered for urban drainage improvement, where the capital investment is USD 1206 million of which 100% is investment flow and USD 2702 million is planned to be spent as O&M.

#### **PROGRAM 11 Dhaka Storm water Drainage**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall cost of this Programme is 38,500 million where technical costs are included in the capital costs. It is intended to develop and extend the storm water drainage network as the city continues to expand and grow. The final option selection will depend on local conditions in each area of the city, including: (a) gravity or pumped systems; (b) open or covered drainage networks; and (c) need to set aside low lying areas for storm water retention to reduce peak flows.

#### **PROGRAM 12 Large and Small Town Storm water Drainage**

The NWMP has proposed this Programme, which falls under investment cluster “Towns and Rural Areas”. The overall cost is BDT 64,000 million where technical costs are included in the capital costs. The Programme will consist of upgrading and new storm water drainage facilities in 388 Large and Small Towns throughout the country. The final option selection will depend on local conditions and requirements in each town, including: (a) gravity or pumped systems; (b) open or covered drainage networks; and (c) need to set aside low lying areas for storm water retention to reduce peak flows.

#### 2.2.4.6 Water supply and sanitation

For water supply and sanitation, maximum proportion of investment of USD 3058 million has been planned to be incur, to be spent under 8 different Programmes, of which 100% is investment flow and USD 6462.8 million is planned to be invested as O&M.

##### **PROGRAM 13 Dhaka Bulk Water Supply and Distribution Systems**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall cost of meeting demands accruing during NWMP timeframe is 90,150 million. Additional NWMP provision to maintain capacity ahead of demand is 5,000 million. Finally total costs are 95,150 million. Water allocation for domestic and municipal use is the first priority. The purpose is to address the need for “...safe and affordable drinking water supplies through various means...” for all inhabitants, especially the urban poor. Policy also mandates that investments to improve and extend water services in the major cities should be paralleled by appropriate and substantive institutional and financial reform to attain.

##### **PROGRAM 14 Chittagong Bulk Water Supply & Distribution Systems**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall cost of meeting demands accruing during NWMP timeframe is 22,017 million. Additional NWMP provision to maintain capacity ahead of demand is 2,000 million. Finally total costs are 24,017 million. The purpose is to address the need for “...safe and affordable drinking water supplies through various means...” for all inhabitants, especially the urban poor. Policy also mandates that investments to improve and extend water services in the major cities should be paralleled by appropriate and substantive institutional and financial reform to attain.

##### **PROGRAM 15 Khulna Bulk Water Supply & Distribution Systems**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall Programme cost is 7,879 million BDT and technical costs are included in the capital costs. The purpose is to deal with the massive task of rehabilitation, improvement and extension of the Khulna city’s water supply systems in

order to raise coverage levels to 95% by 2010, and then to sustain it at 100% beyond that date. It will be accomplished through the development of new water sources, improvement and expansion of the existing DTW-fed system, and the introduction of safe hand-pumps fed by small DTW systems in peri-urban and poor communities.

##### **PROGRAM 16 Rajshahi Bulk Water Supply & Distribution Systems**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall cost is BDT 5,087 million and technical costs are included in the capital costs. The purpose is to deal with the massive task of rehabilitation, improvement and extension of the Rajshahi city’s water supply systems in order to raise coverage levels to 95% by 2010, and then to sustain it at 100% beyond that date. The Programme will be accomplished through the development of new water sources, improvement and expansion of the existing DTW-fed system, and the introduction of safe hand-pumps fed by small DTW systems in peri-urban and poor communities.

##### **PROGRAM 17 Dhaka Sanitation and Sewerage System**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall cost is BDT 89,676 million and technical costs are included in the capital costs. The purpose is to provide appropriate sanitation facilities for all inhabitants of Dhaka & to raise service coverage to 98% by 2010 and 100% by 2025. Initial investment packages are expected to focus on raising the standards of basic sanitation (hygienic latrines and community facilities), especially for the urban poor, coupled with a concerted effort to rehabilitate the existing waterborne sewerage system.

##### **PROGRAM 18 Chittagong Sanitation and Sewerage Systems**

The NWMP has proposed this Programme, which falls under “Major Cities” investment cluster head. The overall cost is BDT 13,979 million where technical costs are included in the capital costs. Main purpose is to provide appropriate sanitation facilities for all inhabitants to raise and sustain service coverage at 100% by 2010. Initial investment packages are expected to focus on raising the standards of basic sanitation (hygienic latrines and community facilities), especially for the urban poor, coupled with a concerted effort to improve and extend the small-bore sewerage system. In the medium to longer



term, a conventional waterborne sewerage system will be developed to serve up to 15% of the population by 2025.

#### **PROGRAM 19 Khulna Sanitation and Sewerage System**

The NWMP has proposed this Programme, which falls under “Major Cities” investment cluster head. The overall cost is BDT 5,664 million where technical costs are included in the capital costs. The main purpose is to provide appropriate sanitation facilities for all inhabitants to raise and sustain service coverage at 100% by 2010. Initial investment packages are expected to focus on raising the standards of basic sanitation (hygienic latrines and community facilities), especially for the urban poor, plus the development of small-bore sewerage systems. In the longer term, a conventional waterborne sewerage system will be developed to serve up to 15% of the population by 2025.

#### **PROGRAM 20 Rajshahi Sanitation and Sewerage Systems**

The NWMP has proposed a Programme titled “Rajshahi Sanitation and Sewerage Systems”, which fall under water supply and sanitation investment head of the baseline cost. The overall cost is about BDT 3,874 million and technical costs are included in the capital costs. The purpose is to provide necessary drainage and sanitation, including treatment of domestic wastewater and sewage and replacement of open drains and construction of sewers, in the interest of public health according to NWPo. Improvement of Rajshahi Sanitation and Sewerage Systems is necessary as there is no conventional waterborne sewerage system and in the slums and other disadvantaged areas, people are dependent on ‘hanging latrines’ and open defecation which exacerbates pollution and public health problems and increases the likelihood of epidemic outbreaks of waterborne and water-related diseases.

#### **2.2.4.7 Institutional development and enabling environment**

A total of nine NWMP proposed programmes have been selected for institutional development and enabling environment with net discounted worth till year 2030 is USD 96 million, of which financial flow is 62.8% and investment flow is computed as 37.2%. Annual O&M accumulation over this period is estimated as USD 30.16 million.

#### **PROGRAM 21 NWRD Improved Data Collection and Processing Facilities**

Given that water resource planning and management requires a very wide range of information drawn from myriad institutional sources, this program is intended to familiarize the many stakeholder institutions with the potential benefits that well organized, accessible data represents and to facilitate the realization of that potential. Beginning with a process of consultations with all stakeholder institutions, principles of common standards; access protocols and data pricing options will be agreed and a proposal written. Other objectives include the establishment of one-stop data retrieval and the availability of all reports in digital format. This program is relevant to the NWPo as it provides improved, better organised management of information, and is in keeping with the NWPo call for a systematic, comprehensive overhaul of the sector’s data systems. Overall duration of the program is 2 years. Total capital cost is estimated as BDT 15.00 M. Full amount of the capital investment is attributed as financial flow.

#### **PROGRAM 22 Water Resources Management Long Term Research and Development**

The NWPo recognizes the important contribution that well focused and coordinated research can play in facilitating the wise and sustainable use of water resources. In particular, the Policy calls for strengthened research capacity at water resource and agricultural institutions. This program simply provides funds for unspecified research in the long term. Total duration of the program is 17 years. Total capital cost is estimated as BDT 1,700.00 M and the full amount is attributed as investment flow.

#### **PROGRAM 23 Raising Public Awareness in the Wise Use and Management of Water**

Public awareness campaigns by all relevant agencies in the water sector are to be seen as an important vehicle for the active promotion of all the key components in the NWPo and the NWMP, fostering increased consultation and participation, and increased awareness of all water sector issues at local, regional and national levels. This program will consider, assess and implement various publicity campaigns around the country to this end, such as radio broadcasts, newspaper articles, cinema advertising, promotional videos, rural trade fairs, extension services, etc. Total duration of the program is 20 years. Total capital

cost is estimated as BDT 180.00 M and annual O&M is BDT 65.70 M. BDT 70.0 M is attributed as financial flow and the remaining amount of BDT 110.0 is estimated as investment flow.

#### **PROGRAM 24 Alternative Financing Methods for Water Management**

The availability of and access to adequate financial resources for operations and maintenance; emergency work; rehabilitation; replacement and new development is a major sustainability issue in Bangladesh's water sector. The current trend to decentralise management responsibility is expected to take the pressure off central finances. This program will study needs and opportunities for alternative financing (such as an independent regulatory framework), and then promote various local and international sources of finance (thirteen different sources have been identified at this stage). The NWPo recognises the importance of promoting alternative financing in such clauses as: "...improve the investment climate for the private sector in water development and management" (NWPo §3.01e), and; "the formulation of options for investment and management" (NWPo §4.051). Total duration of the program is 10 years. Total capital cost is estimated as BDT 2900.00 M. BDT 40.0 M is attributed as financial flow and the remaining amount of BDT 250.0 is estimated as investment flow.

#### **PROGRAM 25 BWDB Regional and Sub-regional Management Strengthening**

The BWDB is responsible for controlling the flow of water in all rivers and aquifers. To this end it is the strategy of GoB to prepare integrated river improvement initiatives which give due importance to all stakeholders. This program is intended to provide the necessary support to BWDB to enable it to prepare such initiatives at regional and sub-regional levels consistent with the GoB strategy. Overall duration of the program is 6 years. Total capital cost is estimated as BDT 250.00 M and annual O&M expenditure is BDT 3.60 M. BDT 178.8 M is attributed as financial flow and BDT 71.2 as investment flow.

#### **PROGRAM 26 WARPO Capacity Building**

WARPO has suffered considerably in the past from a lack of permanence, with adequate funding support being provided only during national plan preparations and little in-between. Furthermore, prevailing employment

conditions make the appointment and retention of suitable staff difficult. This program intends to render WARPO sustainable while building its capacity such that it becomes a centre of excellence characterized by committed high calibre staff. This will be achieved by revision of WARPO's legal establishment, restructuring of WARPO staffing, relocation to a permanent suitable office and various capacity building programs. Overall duration of the program is 5 years. Total capital cost is estimated as BDT 660.00 M. BDT 250.0 M is attributed as financial flow and BDT 410.0 as investment flow.

#### **PROGRAM 27 Disaster Management Bureau Capacity Building**

This program will provide the resources necessary to continue ongoing capacity building activities throughout the short and medium terms in order that the DMB can address its mandate in an increasingly effective fashion. Overall duration of the program is 10 years. Total capital cost is estimated as BDT 2,200.00 M and annual O&M is BDT 116.00 M. Full amount of the capital investment is attributed as investment flow.

#### **PROGRAM 28 Capacity Building for Other Organisations**

The NWPo requires the GoB or its responsible agencies to undertake comprehensive and integrated analysis of relevant hydrological factors across all related water-using sectors for the purpose of managing the river systems and providing early warning systems of natural disasters like flood and drought. NWPo also requires water bodies like haors, baors and beels are preserved for maintaining the aquatic environment and facilitating drainage. This program provides for capacity building of three key agencies involved in these activities, namely: Bangladesh Meteorological Department, River Research Institute and Bangladesh Haor and Wetland Development Board. Overall duration of the program is 4 years. Total capital cost is estimated as BDT 300.00 M and annual O&M is BDT 22.50 M. Full amount of the capital investment is attributed as financial flow.

#### **PROGRAM 29 BWDB Capacity Building**

This program is intended to strengthen BWDB in several ways: improved flood forecasting and warning; strengthened surface and groundwater monitoring and dissemination; support for erosion and accretion forecasting; support for drought forecasting; re-orientation

programs especially with regard to the social and environmental dimensions of water resources management, MIS, HRD and other related fields of BWDB; a new central office and upgraded regional centres. Total duration of the program is 10 years. Total capital cost is estimated as BDT 1,316.00 M and annual O&M is BDT 65.70 M. BDT 50.0 M is attributed as financial flow and the remaining amount of BDT 1,266.0 is estimated as investment flow.

Table 5: Baseline Scenario: Cumulative Discounted IF, FF and O&amp;M Estimates, by Investment Type, Investment Entity and Funding Source (in million US\$)

FUNDING SOURCE	COASTAL PROTECTION			EROSION CONTROL AND DREDGING			FLOOD PROTECTION AND MANAGEMENT			IRRIGATION AND DROUGHT MANAGEMENT			URBAN DRAINAGE			WATER SUPPLY AND SANITATION			GRAND TOTAL		
	FF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M		Total	
	Beneficiary	3	157	194	-	-	61	61	5	21	132	158	-	-	1,094	1,094	0	68		11,365	11,433
Government	18	424	172	615	-	209	184	393	-	238	292	530	201	-	1,271	1,743	3,014	0	3,182	2,575	5,758
Private	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,398	-	1,398
Grand Total	21	459	329	809	-	209	246	455	-	238	489	727	359	-	1,271	2,837	4,108	0	4,649	13,941	18,589

Note: I&FF are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2

Annual IF, FF, and O&M cost estimates for each investment type in the baseline scenario in the following table:

Table 6: Baseline Scenario: Annual IF, FF and O&amp;M Estimates by Investment Type (in million US\$)

YEAR	COASTAL PROTECTION			EROSION CONTROL AND DREDGING			FLOOD PROTECTION AND MANAGEMENT			IRRIGATION AND DROUGHT MANAGEMENT			URBAN DRAINAGE			WATER SUPPLY AND SANITATION			GRAND TOTAL	
	FF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M		Total
	2010	0.2	12.7	12.9	-	-	-	-	-	0.3	0.1	0.4	-	-	-	-	0.1	219.1		95.8
2011	0.2	15.1	20.9	-	-	-	13.5	-	3.5	0.3	0.1	3.9	-	40.3	-	-	247.7	308.5	556.2	634.8
2012	0.2	15.9	6.7	22.8	-	-	14.2	29.9	4.1	3.6	3.0	6.2	12.9	75.2	116.4	191.6	260.0	548.7	808.8	1,080.2
2013	0.2	16.7	7.0	23.9	-	-	-	14.9	31.4	4.6	3.8	10.3	8.2	79.0	184.8	263.8	-	271.1	875.8	1,147.0
2014	0.2	17.5	7.3	25.1	-	15.7	-	15.7	33.0	4.8	4.0	10.8	14.2	82.9	194.0	277.0	-	284.7	919.6	1,204.3
2015	1.7	37.5	7.7	46.9	-	16.5	20.6	37.0	-	16.4	34.6	51.1	4.2	87.1	203.7	290.8	-	298.9	983.8	1,282.8
2016	1.8	39.4	8.1	49.3	-	17.3	21.6	38.9	-	17.3	36.4	53.6	4.4	91.4	213.9	305.3	-	313.9	1,033.0	1,346.9
2017	1.8	41.4	8.5	51.7	-	18.2	22.7	40.8	-	18.1	38.2	56.3	4.6	96.0	224.6	320.6	-	329.6	1,084.7	1,414.3
2018	1.9	43.4	13.4	58.8	-	19.1	23.8	42.9	-	19.0	40.1	59.1	4.9	100.8	235.9	336.6	-	343.1	1,138.9	1,482.0
2019	2.0	45.6	40.9	88.5	-	20.0	25.0	45.0	-	20.0	42.1	62.1	5.1	105.8	247.6	353.5	-	360.3	1,195.9	1,556.2
2020	2.1	47.9	42.9	92.9	-	21.0	26.3	47.3	-	19.9	44.2	64.1	5.4	111.1	260.0	371.1	-	378.3	1,241.4	1,619.7
2021	2.2	50.3	45.1	97.6	-	22.1	27.6	49.6	-	20.9	46.4	67.3	-	116.7	273.0	389.7	-	397.2	1,303.4	1,700.6
2022	2.4	52.8	47.3	102.5	-	23.2	29.0	52.1	-	21.9	48.2	70.1	-	122.5	286.7	409.2	-	417.1	1,368.6	1,785.7
2023	2.5	55.4	49.7	107.6	-	24.3	30.4	54.7	-	23.0	50.6	73.6	-	128.6	301.0	429.6	-	437.9	1,437.0	1,875.0
2024	2.6	58.2	52.2	113.0	-	25.5	31.9	57.5	-	24.2	53.1	77.3	-	135.1	316.1	451.1	-	459.8	1,508.9	1,968.7
2025	2.7	40.6	54.8	98.1	-	26.8	33.5	60.3	-	25.4	55.8	81.2	-	141.8	331.9	473.7	-	482.8	1,584.3	2,067.1
2026	2.9	42.6	57.5	103.0	-	28.2	35.2	63.4	-	26.7	58.6	85.3	-	148.9	348.5	497.4	-	507.0	1,663.5	2,170.5
2027	3.0	44.7	48.3	96.1	-	29.6	37.0	66.5	-	28.0	61.5	89.5	-	156.3	365.9	522.2	-	532.3	1,746.7	2,279.0
2028	3.2	47.0	50.8	100.9	-	31.0	38.8	69.9	-	29.4	64.6	94.0	-	164.2	384.2	548.3	-	558.9	1,834.0	2,393.0
2029	3.3	49.3	53.3	105.9	-	32.6	40.7	73.3	-	30.9	67.8	98.7	-	172.4	403.4	575.8	-	586.9	1,925.7	2,512.6
2030	3.5	51.8	56.0	111.2	-	34.2	42.8	77.0	-	32.4	71.2	103.6	-	181.0	423.6	604.5	-	616.2	2,022.0	2,638.2

(Note: Cost streams are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2)

### 2.2.5 Adaptation Scenario

Although Bangladesh is virtually contributing zero to the greenhouse gas emissions which affect global climate change, it is ironic that it has to suffer so disastrously from the effects of climate change that is likely to occur in the coming decades. It must, therefore, adapt itself to the changing circumstances. The people of Bangladesh have become adapted over generations to the risk of floods, droughts and cyclones. In areas where inundation is at risk, they raise their houses on mounds, above the normal flood level, and adjust their cropping patterns to take advantage of the flood water. Farmers across the country are adapted to local flooding and rainfall patterns by growing a wide range of indigenous and high-yielding varieties of rice and other crops. Rural roads, paths, tracks and other infrastructures, such as schools, are also raised above flood level, where possible. Potential adaptation measures those pertinent for water regime are described below:

Bangladesh has recently finalized its Bangladesh Climate Change Strategy and Action Plan (BCCSAP) in 2009, which provides a set of programmes under six priority action pillars (see figure 8). It is a 10-year programme (2009-2018) for capacity building and increasing the country's resilience to climate change challenges. The first five-year part based on six themes encompasses 44 programmes related to adaptation and mitigation.

Figure 6: Six thematic areas of the BCCSAP (2009)



For the adaptation scenario, the same investment heads as for the baseline scenario are used like coastal protection, erosion control and dredging, flood protection and management, irrigation and drought management, urban drainage and water supply and sanitation have been considered. A total of 33 investment programmes have been planned to be implemented over a period of next 20 years till year 2030. From the BCCSAP we have identified the following programmes are selected for detail IF and FF calculation in the water sector.

Table 7: Possible adaptation options as outlined in the BCCSAP

THEME	PROGRAMME	ADAPTATION SECTOR
T1: Food security, social protection and health	P1. Institutional capacity for research towards climate resilient cultivars and their dissemination	Irrigation and drought Management
T1: Food security, social protection and health	P2. Development of climate resilient cropping systems	Irrigation and drought Management
T1: Food security, social protection and health	P3. Adaptation against drought	Irrigation and drought Management
T1: Food security, social protection and health	P7. Water and sanitation programme in climate vulnerable areas	Water supply and sanitation
T2: Comprehensive Disaster Management	P2: Improvement of cyclone and storm surge warning	Coastal Protection
T3: Infrastructure	P1. Repair and maintenance of existing flood embankments	Flood management
T3: Infrastructure	P2. Repair and maintenance of cyclone shelters	Coastal Protection
T3: Infrastructure	P3. Repair and maintenance of existing coastal polders	Coastal Protection
T3: Infrastructure	P4. Improvement of urban drainage	Urban drainage
T3: Infrastructure	P5. Adaptation against Floods	Flood management
T3: Infrastructure	P6. Adaptation against tropical cyclones and storm surges	Coastal Protection
T3: Infrastructure	P7. Planning and design of river training works	Erosion control and dredging
T3: Infrastructure	P8. Planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work	Erosion control and dredging

Moreover, a number of investment portfolio elements proposed in the NWMP have also been considered in the adaptation scenario. Thus the adaptation scenario has been derived adding the additional adaptation programmes to the baseline scenario investment programmes. The total capital cost for the adaptation scenario (cumulative discounted) has been enumerated as USD 17.91 billion of which 3.3% is financial flow and 96.7% is investment flow. Moreover USD 23.56 billion is for operation and maintenance.

Each of the adaptation programmes considered under the broad investment heads are summarized below (See Annex B for details):

#### 2.2.5.1 Coastal protection

To protect the coastal belt, an extensive network of polders has already been constructed in Bangladesh. However, with the sea level rises expected as a result of climate change, the height of the dykes will need to be raised further. In addition to, following scheme needs to be taken:

- Effective management and up-gradation of existing polders and construction of additional new polders
- Provide support to scale up afforestation and reforestation
- Develop coastal green belts as a measure against storm surge
- Repair, maintenance, and construction of cyclone shelters for protection against storm surge
- Improve existing cyclone forecasting and warning system
- Analysis of meteorological data to improve prediction of changes in the pattern of cyclonic events.

A total of five Programmes have been chosen to be implemented under the coastal protection investment head, which has been proposed to be implemented immediately within a period of next five years till year 2014. Total investment cost is estimated as USD 2.8 billion of which USD 0.25 billion is FF, USD 2.57 billion is IF and USD 0.32 billion may be invested for yearly O&M. Details of the investment Programmes are written below:

#### **PROGRAM 30 Improvement of cyclone and storm surge warning**

The BCCSAP has proposed this Programme under the theme “Comprehensive disaster management”. The objective of this Programme is the improvement of cyclone and storm surge warning and dissemination. Total cost of the Programme is estimated as USD 38 million including USD 36.1 million as investment flow and USD 1.9 million as financial flows. Annual operation and maintenance cost is estimated as USD 0.90 million. The proposed Programme will review the present warning systems and will propose for making improvements where necessary and also propose for dissemination of warning systems through awareness campaigns.

#### **PROGRAM 31 Repair and maintenance of existing cyclone shelters**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to make existing cyclone shelters safe and functional. Total cost of the Programme is estimated as USD 1219 Million including USD 1097 million as investment flow and USD 122 million as financial flow. Annual operation and maintenance cost is estimated as USD 27.5 million. Major activities under this programme are to survey and prepare GIS based maps showing the location of all the cyclone shelters on the coastal belt including a database describing their present status and repair needs; plan for the immediate repair or redesign (wherever necessary) including approach roads and also awareness building in communities concerning cyclone.

#### **PROGRAM 32 Repair and maintenance of existing coastal polders**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to repair and reconstruct the existing polders in the coastal belt of Bangladesh. Total cost of the Programme has been estimated as USD 892 million including USD 802.8 million as investment flow and USD 89.2 million as financial flow. Yearly operation and maintenance cost of the Programme is estimated as USD 20 million. The focus of this Programme is to survey the conditions of the coastal polders; prepare GIS maps with present coverage of areas protected by these polders and based on future Programme of sea level rise –plan, design and cost immediate rehabilitation of existing dykes, polders and embankments.

### **PROGRAM 33 Adaptation against tropical cyclones and storm surges**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to plan and implement an investment Programme to ensure that the coastal area, including all islands, adapts to future cyclones and storm surges. Total cost of the Programme is estimated as USD 696 million including USD 661 million as investment flow and USD 35 million as financial flow. Annual operation and maintenance cost of the Programme is USD 17 million. The activities of this Programme will focus on analyzing meteorological data to improve predictions in the changes in the pattern of cyclonic events; plan and develop coastal green belt as a measure against storm surge; upgrade existing coastal polders and construct and maintain cyclone shelters for protection against storm surge.

### **PROGRAM 34 Improved Water Management and Salinity Control in the Sundarbans**

The NWMP has proposed this Programme under the investment head cluster “Major river and water management”. Technical costs of this Programme are included in the capital costs. Overall Programme cost is BDT 250 million of which TA cost is estimated as BDT 150 million and other cost is around BDT 100 million. The purpose of this Programme is to develop a much improved state of knowledge of the interactions between the ecological health of the Sundarbans forest reserve and the aquatic environment. It is intended to provide clear guidance on long-term water management needs for the Sundarbans forest.

#### **2.2.5.2 Erosion Management**

Climate change is likely to increase rainfall in the Brahmaputra-Ganges-Meghna basin in the monsoon season. This is likely to cause further instability in the already unstable river system. Higher rainfall in upper catchments may also increase sediment movements. Overall, river systems are expected to become more unstable as a result of climate change. Effective River training works is the only option as an adaptation measure to control river erosion.

A total of three Programmes have been chosen to be implemented under this investment head, on a long term basis over a period of thirteen years, starting from year

2012 and ended at year 2024. Total investment cost is estimated as USD 0.42 billion of which USD 15.9 million is FF, USD 322 million is IF and USD 86.56 million may be invested for accumulated yearly O&M. Details of the individual investment Programmes are listed below:

### **PROGRAM 35 Planning, design and construction of river training works**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to put in place effective river training works to control river bank erosion. Total cost of the Programme is USD 301 million including USD 286 million as investment flow and USD 15 million as financial flow. The operation and maintenance cost of the Programme is USD 7.15 million USD per year. The activities of this project are identification of erosion prone areas, physical and hydro-dynamic modeling, design of river training programmes and execution of river training works.

### **PROGRAM 36 Planning, design and implementation of resuscitation of the network of rivers and khals through dredging and de-siltation work**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to revive the network of rivers and khals of the country. Total cost is USD 17.1 million, including USD 16.3 million as investment flow and 0.9 million as financial flow. Operation and maintenance cost of the Programme is USD 0.41 million per year. The activities of this project are to prepare a GIS based river resuscitation master plan on the Thana development plan; execute de-siltation plan in a phased manner and develop participatory operation and management plan.

### **PROGRAM 37 River Dredging for Navigation**

The NWMP has proposed this Programme which falls under investment head cluster “Main Rivers”. Total cost of the Programme is about BDT 1,542 million of which technical cost is about BDT 60 million and other cost are about BDT 1,482 million. The main purpose of this Programme is to restore the IWT waterways in a cost-effective manner, with a structured approach recognizing both the technical and management issues that have to be overcome. A comprehensive national dredging management plan would be prepared covering short to long-term dredging requirements, as well as dredger operations and

the role of the private sector. The Programme also makes provision for both capital dredging of the major rivers, much of it being deferred maintenance, and maintenance dredging thereafter.

### 2.2.5.3 Flood management

Climate change has already been evident on observed incidences of increase in the frequency, timing and magnitude of the inland flood events, which are expected to aggravate in the coming future. Following flood management options can be considered:

- **Flood forecasting system:** Improvement of the existing flood forecasting and early warning systems by increasing lead times and strengthening dissemination mechanisms.
- **Flood Evacuation shelters:** Flood Evacuation shelters: Establishment of multipurpose shelter more as well as ensuring proper management of this infrastructure.
- Flood Zoning, Flood Insurance, Adjustment Cropping Calendar, Watershed management.
- **Flood management infrastructure:** Effective management and up-gradation of existing flood management infrastructures such as polders, embankments, sluices, pump stations and construction of additional one.

A total of seven Programmes have been chosen to be implemented under the flood management investment head, on a long term basis over a period of eighteen years, starting from year 2012 and ended at year 2030. The total investment cost is estimated as USD 2.78 billion of which USD 0.24 billion is FF, USD 2.5 billion is IF and USD 0.75 billion may be invested for yearly O&M. Details of the individual investment Programmes are written below:

#### **PROGRAM 38 Repair and maintenance of existing flood embankments**

The BCCSAP has proposed this programme, which falls under the theme “Infrastructure”. The objective of this programme is to ensure continued flood protection by repairing and rehabilitating existing flood embankments. Total cost of the programme is estimated as USD 96 Million including USD 86.4 million as investment flow and USD 9.6 million as financial flow. Yearly cumulative operation and maintenance cost is estimated as USD 2.16

million. The activities of this project are to assess conditions of all existing flood embankments, prepare GIS maps, assess immediate repair and rehabilitation of existing embankments and appurtenant structures taking future forecast flood levels into account.

#### **PROGRAM 39 Infrastructure: Adaptation against floods**

BCCSAP has proposed this programme under the theme “Infrastructure”. The objective of this programme is to make flood prone areas more resilient. Total cost of the programme is USD 2318 million including USD 2086 million as investment flow and USD 232 million as financial flow. The operation and maintenance cost of the programme is USD 52 million per year. The focus of this project is to develop a flood vulnerability map based on future projected climatic parameters; flood plain zoning corresponding to various level of vulnerability; long term improvement in flood forecasting and warning and development of DEM; plan, design and construct flood management infrastructures in light of likely future flood levels and hydrological modeling of the Ganges-Brahmaputra-Meghna basin against future climate change scenarios.

#### **PROGRAM 40 Flood Proofing in the Char lands and Haor Basin**

The NWMP has proposed this Programme, which falls under the investment head cluster “Towns and Rural Areas”. The overall Programme cost is BDT 2, 599.4 million where TA costs are included in the capital costs. The purpose of this Programme is to develop flood proofing systems to manage natural disasters by providing proven cost effective technologies for flood proofing such as encouraging raised dwellings and the construction of communal flood shelters.

#### **PROGRAM 41 National, Regional and Key Feeder Roads - Flood Proofing**

The NWMP has proposed this Programme that is under the investment head cluster “Disaster Management”. The overall Programme cost is BDT 1 0,904.8 million where TA costs are included in the capital costs. This Programme targets the flood proofing needs of key portions of Bangladesh’s highway network. Under this Programme, the National Highways, Regional Roads and Type A, and Feeder Roads will be raised by the central Roads and Highways Department (RHD). Type B Feeder Roads and Rural Roads will be raised by the Local Government Engineering Departments (LGEDs).



#### **PROGRAM 42 Railway Flood Proofing**

The NWMP has proposed this Programme under the investment head cluster “Disaster Management”. The overall Programme cost is BDT 9 77 million where TA costs are included in the capital costs. This Programme is targeted at the flood proofing needs of key portions of Bangladesh’s railway network. To fulfill the purpose, some 78km of railway lines in high-risk areas will be raised by 1m and 47km in low risk areas will be raised by 0.5m. Apart from transport benefits, the raised embankments can act as safe havens and can facilitate the movement of relief goods during flood emergencies.

#### **PROGRAM 43 Improved Water Management in the Haor Basins of the NE Region**

The purpose of the program is to safeguard the water resources and to preserve the semi-natural characteristics of the whole Basin with special attention being paid to the ecologically important sites. The estimated cost of the program will be Tk1000M, of which Tk120M would be spent on preparatory studies. The program, which is planned to take 15 years to complete, is suitable for GoB financing, but with other claims on government revenue, some external financing will almost certainly be needed. Total capital cost of the program is estimated as BDT 1000 M, of which BDT 880 M is investment flow and the remaining is financial flow. Moreover, BDT 26.4 M/yr is expected to be incurred as operation and maintenance cost for the program.

#### **PROGRAM 44 Regional River Management and Improvement**

The aim of the program is to ensure that river management plans are prepared and implemented in a comprehensive and cost-effective manner. One of the main focuses of this program is to ensure devolved and decentralized water management, where particular focus is given to the upper tier of three levels of river system management, the other two being the responsibilities of Local Government and community groups. It will provide the resources to plan, develop and maintain the regional river systems in an integrated manner, interfacing with these other institutions and responsive to stakeholder needs. This is a 25 years program where the total capital investment is estimated as BDT 16,200.00 M of which full proportion is attributed as investment flow. Moreover, BDT 1,256.60 M/yr is estimated as recurrence cost for O&M.

#### **2.2.5.4 Irrigation and drought management**

Drought in Bangladesh is seasonal and can destroy crops, causing hardship to poor agricultural labourers. Drought most commonly affects the north western region, which causes lower rainfall than the rest of the country. Bangladesh has been planning to take initiative for preparing essential infrastructures for harnessing surface water by setting up the Barrages, deep Tube Wells and it is also necessary to adjust this situation in the existing cropping pattern.

A total of thirteen Programmes have been chosen to be implemented under this investment head, to be implemented on a long terms basis over a period of eighteen years, starting from year 2012 and ended at year 2030. Total investment cost is estimated as USD 2.7 billion of which USD 106.8 million is FF , USD 2.6 billion is IF and a total of USD 0.89 billion may be invested for yearly O&M. Details of the individual investment Programmes are written below:

#### **PROGRAM 45 Food security, social protection and health: Institutional capacity for research towards climate resilient cultivars and their dissemination**

The BCCSAP has proposed this programme that has been covered under the theme “Food security, social protection and health”. The objective of this programme is to build the institutional capacity of research centers and expertise of researchers to develop climate resilient cultivars of food and other crops. Total cost of the programme is USD 5.1 million including USD 0.7 million as investment flow and USD 4.4 million as financial flow. The activities of this project are to collect, conserve, characterize and document local improved cultivars, conduct research on climate resilient varieties of rice, wheat and other non-crop vegetables, conduct field trials and disseminate climate resilient locally improved cultivars and newly developed varieties and strengthen the capacity of agricultural research institutes, facilities, scientists and technicians.

#### **PROGRAM 46 Food security, social protection and health: Development of climate resilient cropping systems and production technologies**

The BCCSAP has proposed this programme” under the theme “Food security, social protection and health”. The objective of this programme is to develop climate resilient

cropping systems appropriate to different agro-climatic regions and sub-regions. Total cost of the programme is 1.7 Million USD including USD 0.4 million as investment flow and USD 1.3 million as financial flow. The activities of this project are to identify agro-economic zones vulnerable to climate change, develop climate resilient cropping patterns and associated water management systems, develop early warning against flood, drought, tidal surge, insects etc. and to develop organized seed production and supply system.

**PROGRAM 47 Food security, social protection and health: Adaptation against drought, salinity submergence and heat**

The BCCSAP has proposed this programme under the theme “Food security, social protection and health”. The objective is to develop drought management options for farmers. Total cost of the programme is USD 0.8 Million of which 100% is financial flow. Activities of this project are to prepare GIS maps for areas vulnerable to drought, flood and salinity and to develop and test adaptive measures in drought, salinity, submergence and hot/cold weather by appropriate cultivars, cropping pattern, land and water management practice and effective dissemination to farmers.

**PROGRAM 48 New Public Surface Water Irrigation Schemes**

The National Water Policy suggested that the government should continue promoting the development of surface water irrigation where feasible and to focus where practical on the conjunctive use of groundwater and surface water. The overall objective of this program is to increase agricultural production and reduce demand on groundwater abstraction by promoting and implementing new surface water irrigation schemes. Overall duration of the proposed program is 15 years. Total capital cost of the project is estimated as BDT 6,125.00 M and annual O&M is B 306.30 BDT 306.30. Out of the total capital cost, 100% of the cost is attributed as investment flow.

**PROGRAM 49 New Public Deep Tubewell Irrigation Schemes**

It is the policy of the Government that “support of private development of groundwater irrigation for promoting agricultural growth will continue” (NWPo §4.7). GoB policy is that TW irrigation should be a private rather than a public sector activity. However,

subsidised DTW irrigation development in socially deprived areas where irrigation is otherwise unaffordable may be justified on social and economic grounds; where drilling is difficult or costly and where surface water is limited. This program will deal with the installation of an estimated 2000 new deep tube wells to meet these needs. The project will take 10 years to complete. Total program cost is BDT 2200 M where 100% is attributed as investment flow. In addition to this, BDT 367.40 M is estimated as O&M cost.

**PROGRAM 50 Supplementary Irrigation and Drought Proofing of Rural Water Supplies**

The NWMP has proposed this Programme, which falls under the investment head cluster “Disaster Management”. Capital cost is about BDT 1,041 million of which technical costs are about BDT 115 million and other cost are about BDT 926.4 million. The purpose is to promote supplementary irrigation during the drought-prone aman season, as well as including efforts to drought-proof rural water supplies.

**PROGRAM 51 Main Rivers Abstraction Projects**

This Program is intended towards augmenting dry season surface water availability for multipurpose use through abstraction from the main rivers by means other than barrages. The principal options that this program may take up are main river pump stations and dredging and associated works at distributary offtakes. Overall duration of this program is 10 years. Total capital cost is estimated as BDT 4,480.00 M of which 100% is considered as investment flow. Moreover, annual O&M expenditure is estimated as BDT 672.00 M.

**PROGRAM 52 Ganges Barrage and Ancillary Works**

The NWMP has proposed this Programme, which falls under the investment head cluster “Main Rivers”. The overall cost is about BD 50,858 million. It has been planned to serve both environmental purposes and other multi-purpose linkage. The purpose is mainly to serve three construction elements involving (i) dredging and training works at the Gorai off take to provide immediate additional flows for environmental purposes; (ii) a barrage across the Ganges to control dry season Ganges flows and provide substantially greater flows for multi-purpose use; and (iii) a Gorai head works structure to control wet and dry season flows entering the GDA, enabling planned and manageable development to take place.

**PROGRAM 53 Meghna Barrage and Ancillary Works**

The NWMP has proposed this Programme, which falls under investment head cluster “Main Rivers”. Technical costs is about BDT 750 million and other cost is about BDT 14,978 million. Capital cost of is about BDT 50,858 million. The purpose is the irrigation and drainage improvement in the NE and SE region and for this it has planned to conduct a feasibility study for investment in river control works as part of an integrated development in the NE and SE regions. It has been proposed to construct a barrage at Bhairab on the Meghna River.

**PROGRAM 54 Brahmaputra Barrage and Ancillary Works**

The NWMP has proposed this Programme, which falls under investment head cluster “Main Rivers”. Technical costs is about BDT 4,140 million and other cost is about BDT 82,833 million. Total capital cost (I&FF) is about BDT 86,973 million. The purpose is to build a barrage to harness the Brahmaputra waters to meet national needs and this has planned to conduct a feasibility study for different option(s), including detailed engineering design for the necessary investment in a barrage, head works and ancillary works. Other activities include developing the distribution systems and management capacity development to complement this Programme.

**PROGRAM 55 Ganges Dependent Area Regional Surface Water Distribution Networks**

The NWMP has proposed this Programme, which falls under investment head cluster “Main Rivers”. The overall cost is about BDT 8,911 million on which technical costs are included in the capital costs. The purpose is to accommodate supplementary flows for salinity control, as well as for development of LLP irrigation and other consumptive needs. It will provide capital investments necessary to develop both regional and local river distributary systems as part of the overall GDA development.

**PROGRAM 56 North East and South East Regional Surface Water Distribution Networks**

The NWMP has proposed this Programme, which falls under investment head cluster “Main Rivers”. Overall cost is about BDT 2,576 million of which technical costs are included in the capital costs. The purpose is to make a provision for the capital investment in both regional and local river system development, based on augmentation of the surface water from a barrage on the Meghna.

**PROGRAM 57 North Central and North West Regional Surface Water Distribution Networks**

Provision is made in this program for the capital investment in both regional and local river system development, based on augmentation of the surface water from a barrage on the Brahmaputra. Overall duration of this program is 12 years. Total capital expenditure for this program is BDT 12,862.00 M of which total investment entity is attributed as investment flow. Annual O&M is estimated as BDT 385.90 M.

**2.2.5.5 Urban drainage**

The current drainage systems of the major cities were designed by using the historical rainfall data. These design capacities will be exceeded in the future. One of the major impacts of climate change is likely to be an increase in the number of episodes of short duration and heavy rainfall. This will result in water logging due to drainage congestion. Following initiative can be taken as adaptive measures in terms of this issue:

- Improvement in the urban drainage capacity including pumping provisions, detention storages
- Restoration of pervious surfaces for enhancing infiltration capacity
- In new urban areas the design and construction of adequate sewers to take account of the likely impacts of climate change.

A total of six Programmes have been chosen to be implemented under this investment head, to be implemented on a long terms basis over a period of eighteen years, starting from year 2012 and ended at year 2030. Total investment cost is estimated as USD 1.15 billion of which USD 0.5 million is FF , USD 0.99 billion is IF and a total of USD 0.69 billion may be invested for yearly O&M. Details of the individual investment Programmes are written below:

**PROGRAM 58 Improvement of urban drainage**

The BCCSAP has proposed this Programme under the theme “Infrastructure”. The objective of this Programme is to prevent drainage congestion and water logging that may result from heavy rainfall in urban areas. Total cost of the Programme is USD 863 million, including USD 857 million as investment flow and USD 5.7 million as financial flow. The operation and maintenance cost of the

Programme is USD 21.43 million per year. The activities of this project are to assess the drainage capacity of the major cities (Dhaka, Chittagong, Rajshahi and Khulna) and selected old district towns and investigate the structural and non-structural causes of water logging within the cities and their immediate surroundings using hydro-dynamic modeling and improve by investigation and design, their drainage capacity.

#### **PROGRAM 59 Chittagong Flood Protection**

The NWMP has proposed this Programme, which falls under “Major Cities” investment cluster head. Overall cost is BDT 877 million where technical costs are included in the capital costs. This aim is to provide an embankment or flood wall on the Karnaphuli River banks, proper maintenance of the existing sea dyke along with construction of new wave protection works, drainage sluices etc. In addition, it has planned to provide installation of pumps for selected areas and maintenance of internal drains.

#### **PROGRAM 60 Chittagong Storm water Drainage**

The purpose is to develop and extend the storm water drainage network for Chittagong city to mitigate Chittagong’s storm water drainage problem by providing a properly planned, comprehensive drainage system ranging from collection of water at local street level to dispose of accumulated drainage water through pump stations.

#### **PROGRAM 61 Khulna Flood Protection**

The NWMP has proposed this Programme, which falls under “Major Cities” investment cluster head. The overall cost is BDT 444 million where technical costs are included in the capital costs. Some of the lower, southern parts of Khulna are vulnerable to flooding during spring tides and a flood protection embankment with tidal sluices has been constructed to provide protection. However, the protected area is vulnerable to waterlogging when the drainage sluices cannot be operated due to high external water levels. In other parts of the city, local flooding is caused by heavy rainfall due to inadequate storm drainage. This Programme contains measure to address these problems.

#### **PROGRAM 62 Khulna Storm water Drainage**

The NWMP has proposed this Programme, which falls under “Major Cities” investment cluster head. Overall cost is BDT 444 million where technical costs are included in the capital costs. The purpose is to develop and extend the

storm water drainage network for Chittagong city to mitigate Khulna’s storm water drainage problem by ensuring a properly planned, comprehensive drainage system ranging from collection of water at local street level to disposal of accumulated drainage water at pump stations.

#### **PROGRAM 63 Rajshahi Storm water Drainage**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. The overall Costs is BDT 5,224 million where technical costs are included in the capital costs. It is intended to develop and extend the storm water drainage network as the city continues to expand and grow. Final option selection will depend on local conditions in each area of the city, including: (a) gravity or pumped systems; (b) open or covered drainage networks; and (c) need to set aside low lying areas for storm water retention to reduce peak flows.

#### **2.2.5.6 Water supply and sanitation**

The projected climate change and variability is likely to have a significant impact on the water supply and sanitation sector in Bangladesh. The water supply and sanitation systems, particularly in the coastal region of the country, are vulnerable to such factors as cyclonic and storm surges and flooding. To improve this situation we need to:

- Conserve water effectively
- Harvest rain water
- Recycle and reuse of water
- Set up deep tube wells
- Desalinization of saline water.

A total of six Programmes have been chosen to be implemented under this investment head, to be implemented on a long terms basis over a period of eighteen years, starting from year 2012 and ended at year 2030. Total investment cost is estimated as USD 2.8 billion of which USD 24.1 million is FF , USD 2.7 billion is IF and a total of USD 10 billion may be invested for yearly O&M. Details of the individual investment Programmes are written below:

#### **PROGRAM 64 Food security, social protection and health: Water and sanitation Programme for climate vulnerable areas**

The BCCSAP has proposed this Programme under the theme “Food security, social protection and health”. The objective is to ensure adequate water supplies and improved sanitation. Total cost of the Programme is USD 24.6 Million including USD 0.5 million as investment flow and USD 24.1 million as financial flow. O&M cost is USD 0.01 million USD per year. The activities of this Programme are to monitor changes in water quality and quantity available for drinking and forecast future changes due to climate change and plan for and invest in additional water supply and sanitation facilities.

#### **PROGRAM 65 Inventory and Asset Management Plan of the Water Supply and Sanitation Sector**

The NWMP has proposed this Programme, which falls under investment cluster “Major Cities”. Technical costs are 12.5 million and there are no other costs. The purpose is to improve water, sanitation and sewerage services in the major cities, urban and rural areas together with appropriate institutional and financial reform. A key part of this is to improve service efficiency and financial viability.

#### **PROGRAM 66 Large and Small Town Water Supply and Distribution Systems**

The NWMP has proposed the Programme, which falls under “Towns and Rural Areas” investment cluster head. The overall Programme cost is about BDT 44,055 million and technical costs are included in the capital costs. Main purpose is to provide resources for the implementation of piped water supply schemes fed from DTW or surface water sources in order to serve 100% of the population (of each town) with piped drinking water supplies by year 2010 as NWMPo highlights the water supply problems facing Bangladesh’s urban areas (large and small) and water tables are receding due to heavy groundwater abstraction.

#### **PROGRAM 67 Rural Water Supply and Distribution Systems**

The NWMP has proposed the Programme, which falls under “Towns and Rural Areas” investment cluster head. Overall cost is BDT 74,234 million and technical costs are included in the capital costs. NWMPo recognizes that “The rural areas of Bangladesh suffer from a lack of quality drinking water”. For this, the purpose of the proposed Programme is to improve the quality of water supply

services (reliability and access) in areas already served as well as extending the coverage to 100% by 2005.

#### **PROGRAM 68 Large and Small Town Sanitation and Sewerage Systems**

The NWMP has proposed the Programme, which falls under “Towns and Rural Areas” investment cluster head. The overall cost is 34,894 (million BDT) and technical costs of this Programme are included in the capital costs. The main purpose is to provide appropriate sanitation facilities for all inhabitants to raise service coverage to 100% by 2010 in both large and small towns. The investment focus is expected to concentrate on raising the overall standards of basic sanitation, with campaigns for the construction of hygienic latrines (with and without septic tanks) and community sanitation facilities, especially for the urban poor.

#### **PROGRAM 69 Rural Sanitation**

The NWMP has proposed the Programme, which falls under “Towns and Rural Areas” investment cluster head. The overall cost is BDT 31,622 million and technical costs are included in the capital costs. The purpose is to provide hygienic sanitation facilities for the whole rural population and raise service coverage to 100% by 2010. The main affordable investment choices are expected to be hygienic pit latrines and household latrines with septic tanks to provide an improved level of comfort and privacy.

#### **2.2.5.7 Institutional development and enabling environment**

A total of eight NWMP proposed programmes have been selected for institutional development and enabling environment with net discounted worth till year 2030 is USD 183 million, of which financial flow is 58.9% and investment flow is computed as 41.1%. Annual O&M accumulation over this period is estimated as USD 209.5 million.

#### **PROGRAM 70 Regulatory and Economic Instruments**

This program is intended to prepare enforceable guidelines and advisory manuals concerning standards, regulation and economic instruments for the water sector. The program is planned to be completed by 2 years. Total capital expenditure is estimated as BDT 152.00 of which 100% is attributed as financial flow.

#### **PROGRAM 71 Water Resources Management Research and Development Studies**

This specific program is designed in line with the policy proposition made by NWPo, which recognizes that well focused and coordinated research can play in facilitating the wise and sustainable use of water resources. In particular, the Programme focuses on strengthening research capacity for water resource and agricultural institutions. It listed a total of ten research themes related to flood control and management; water resources management; sociological and institutional issues. Total capital cost of the program is BDT 800 M of which 100% is attributed as financial flow. Tentative duration of the overall program is estimated as 8 years.

#### **PROGRAM 72 Private Sector Participation in Water Management**

One of the main objectives of the NWPo is to "... improve the investment climate for the private sector in water development and management" (NWPo §3.01e) This program is planned to be continued in the same vein by promoting the creation of a legal and regulatory framework to aid investor/provider confidence, and also in improving access of the rural and urban poor to adequate credit facilities. Special tax/duty privileges to attract foreign investment to the water sector, and establishment and public awareness raising of consumer rights in relation to private water supply schemes will also be investigated under this. Total capital cost of the program is BDT 35.00 M of which full proportion of investment is attributed as financial flow. Duration of the program is 2 years.

#### **PROGRAM 73 Water and Environment Funds**

This Programme is intended to broaden the scope and increase the utility and effectiveness of such instruments in Bangladesh particularly those pertaining to the abstraction of both surface and groundwater; arsenic mitigation, effluent scrubbing and cost recovery across the board. Overall duration of the program is 2 years. Total capital expenditure is estimated as BDT 40.00 M of which 100% is attributed as financial flow.

#### **PROGRAM 74 Local Government Needs Assessment for Water Management**

This Programme assesses the implications of challenges related to the institutional framework and institutional capacity building and human resource development needs for water resources management projects. According to the

proposition made by the NWPo, Local Government Institutions (LGIs) are delegated the responsibility for managing water sector development projects less than or equal to 1000ha, where LGI will coordinate stakeholder participation at all stages of water sector project cycles. Total capital expenditure is estimated as BDT 170.00 M where full proportion is attributed as financial flow. Duration of the project is 2 years.

#### **PROGRAM 75 FCD and FCD/I Management Rationalisation**

This Programme is intended to facilitate the transfer of FCD/I scheme management as per policy. Three steps will be involved. In the short term BWDB will receive capacity building with respect to environmental and social issues, while in consultation with the stakeholders a range of transfer options will be identified and prepared. Finally these options will be pilot tested at selected locations during the short and medium term. Total capital expenditure for this program is BDT 1300.00 M where BDT 900 M is attributes as investment flow and BDT 400 M as financial flow. Annual O&M expenditure is estimated as BDT 25.2 M. The duration of the program is 6 years.

#### **PROGRAM 76 Local Government Capacity Building for Water Management**

This Programme is intended to deliver the necessary capacity building and human resource development in response to the needs assessments carried out under previously stated program titled Local Government Needs Assessment for Water Management. The Programme will begin with the establishment of a Central Training Unit and thereafter comprises a long and sustained effort beginning in the short term of the NWMP and continuing throughout the remainder of its 25 years. Overall capital cost of the Programme is BDT 12,100.00 of which 100% is attributed as investment flow. BDT 771.90 M is estimated as annual O&M expenditure.

#### **PROGRAM 77 Department of Environment Capacity Building**

As far as aquatic resources are concerned, DoE is mandated to protect water quality and ensure efficiency of use and in particular to monitor (and establish standards of) effluent disposal to prevent water pollution. This Programme allows for institutional capacity building of DoE including the establishment of representational offices down to District level. Total capital expenditure of

the program is estimated as BDT 365.00 M of which 100% is attributed as financial flow. Total duration of the project is 5 years.

Individual investment amount under each of the Programme and other salient investment features are summarized in Annex under Table CC.

**Table 8: Adaptation Scenario: Cumulative Discounted IF, FF and O&M Estimates, by Investment Type, Investment Entity and Funding Source (in million US\$)**

FUNDING SOURCE	COASTAL PROTECTION				EROSION CONTROL AND DREDGING				FLOOD PROTECTION AND MANAGEMENT				INSTITUTIONAL DEVELOPMENT AND ENABLING ENVIRONMENT				IRRIGATION AND DROUGHT MANAGEMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
Beneficiary	3	34	157	194	-	-	61	61	-	-	302	302	1	2	-	3	5	24	158	187
GoB	264	424	494	1,182	16	229	271	516	243	599	940	1,783	167	109	240	516	102	2,657	756	3,515
Private	-	2,572		2,572	-	302		302	-	2,173		2,173	-	-		-	-	1		1
<b>GRAND TOTAL</b>	<b>266</b>	<b>3,031</b>	<b>651</b>	<b>3,948</b>	<b>16</b>	<b>531</b>	<b>332</b>	<b>879</b>	<b>243</b>	<b>2,772</b>	<b>1,242</b>	<b>4,257</b>	<b>168</b>	<b>111</b>	<b>240</b>	<b>519</b>	<b>107</b>	<b>2,682</b>	<b>914</b>	<b>3,703</b>

Note: I&FF are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2

Annual IF, FF, and O&M cost estimates for each investment type in the adaptation scenario in the following table:

**Table 9: Adaptation Scenario: Annual IF, FF and O&M Estimates by Investment Type (in million US\$)**

YEAR	COASTAL PROTECTION				EROSION CONTROL AND DREDGING				FLOOD PROTECTION AND MANAGEMENT				INSTITUTIONAL DEVELOPMENT AND ENABLING ENVIRONMENT				IRRIGATION AND DROUGHT MANAGEMENT			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2010	49.7	532.2	64.9	646.8	-	-	-	-	0.1	10.1	-	10.2	14.0	9.5	-	23.5	-	0.3	0.1	0.4
2011	54.8	587.8	77.1	719.8	-	-	-	-	0.1	24.7	19.8	44.6	17.7	10.5	-	28.2	3.5	17.2	0.1	20.8
2012	57.6	617.2	81.8	756.6	-	2.3	-	2.3	0.1	38.6	58.8	97.6	17.2	11.0	12.8	41.0	10.6	260.7	12.6	283.8
2013	60.5	648.1	85.9	794.5	-	2.4	1.2	3.6	0.1	40.6	61.7	102.4	16.7	11.6	13.4	41.7	11.1	273.7	38.0	322.8
2014	63.5	680.5	90.2	834.2	-	18.2	1.3	19.5	0.1	42.6	65.3	108.0	15.0	10.7	14.1	39.7	11.7	287.4	39.9	338.9
2015	1.7	37.5	7.7	46.9	2.1	59.6	32.0	93.8	64.9	627.0	141.4	833.2	14.3	11.2	15.2	40.7	13.9	302.1	41.9	357.8
2016	1.8	39.4	8.1	49.3	2.2	62.6	33.6	98.5	68.1	658.4	148.4	874.9	12.9	8.7	16.0	37.5	14.6	317.2	44.0	375.7
2017	1.8	41.4	8.5	51.7	2.4	65.8	35.3	103.4	71.5	691.3	155.9	918.6	11.8	8.7	16.8	37.3	15.3	322.7	75.7	413.7
2018	1.9	43.4	13.4	58.8	2.5	69.0	37.1	108.6	75.1	725.8	163.7	964.6	12.4	9.2	17.6	39.2	16.1	338.8	79.5	434.4
2019	2.0	45.6	40.9	88.5	2.6	72.5	39.0	114.0	78.8	762.1	171.8	1,012.8	13.0	9.6	18.5	41.1	16.9	355.8	81.8	454.5
2020	2.1	47.9	42.9	92.9	2.7	76.1	40.9	119.7	0.2	56.0	87.5	143.7	9.4	5.1	23.3	37.8	15.8	345.8	85.9	447.5
2021	2.2	50.3	45.1	97.6	2.9	79.9	42.9	125.7	0.2	58.8	95.5	154.5	9.9	5.3	24.5	39.7	9.1	320.0	99.2	428.3
2022	2.4	52.8	47.3	102.5	3.0	80.2	45.1	128.2	0.2	54.2	99.7	154.1	10.4	5.6	25.7	41.7	9.6	322.0	96.6	428.2
2023	2.5	55.4	49.7	107.6	3.1	84.2	47.3	134.7	0.2	56.9	104.7	161.8	10.9	5.9	27.0	43.7	10.1	307.8	91.1	408.9
2024	2.6	58.2	52.2	113.0	3.3	88.4	47.6	139.3	0.2	59.7	110.0	169.9	11.4	6.2	28.3	45.9	0.2	117.4	138.0	255.6
2025	2.7	40.6	54.8	98.1	-	26.8	33.5	60.3	-	60.9	115.5	176.3	12.0	6.5	29.7	48.2	-	122.6	132.9	255.5
2026	2.9	42.6	57.5	103.0	-	28.2	35.2	63.4	-	63.9	121.2	185.2	12.6	6.8	31.2	50.6	-	128.7	139.3	268.1
2027	3.0	44.7	48.3	96.1	-	29.6	37.0	66.5	-	67.1	127.3	194.4	9.8	7.1	32.8	49.7	-	5.6	146.3	151.9
2028	3.2	47.0	50.8	100.9	-	31.0	38.8	69.9	-	70.5	133.7	204.1	10.3	7.5	34.4	52.2	-	5.9	153.6	159.5
2029	3.3	49.3	53.3	105.9	-	32.6	40.7	73.3	-	49.4	91.7	141.1	10.8	7.9	36.1	54.8	-	6.2	149.7	155.9
2030	3.5	51.8	56.0	111.2	-	34.2	42.8	77.0	0.0	52.3	96.3	148.6	11.2	8.1	38.0	57.2	-	6.5	157.1	163.7

Note: I&FF are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2



Table 8: Adaptation Scenario: Cumulative Discounted IF, FF and O&amp;M Estimates, by Investment Type, Investment Entity and Funding Source (in million US\$) (continued)

FUNDING SOURCE	URBAN DRAINAGE				WATER SUPPLY AND SANITATION				GRAND TOTAL
	FF	IF	O&M	Total	FF	IF	O&M	Total	
Beneficiary	-	-	1,160	1,160	0	116	12,622	12,738	14,645
GoB	6	1,496	2,228	3,729	24	4,007	3,930	7,961	19,202
Private	-	857		857	-	1,719		1,719	7,624
<b>GRAND TOTAL</b>	<b>6</b>	<b>2,353</b>	<b>3,388</b>	<b>5,747</b>	<b>24</b>	<b>5,841</b>	<b>16,553</b>	<b>22,418</b>	<b>41,471</b>

Table 9: Adaptation Scenario: Annual IF, FF and O&amp;M Estimates by Investment Type (in million US\$) (continued)

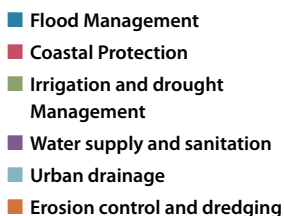
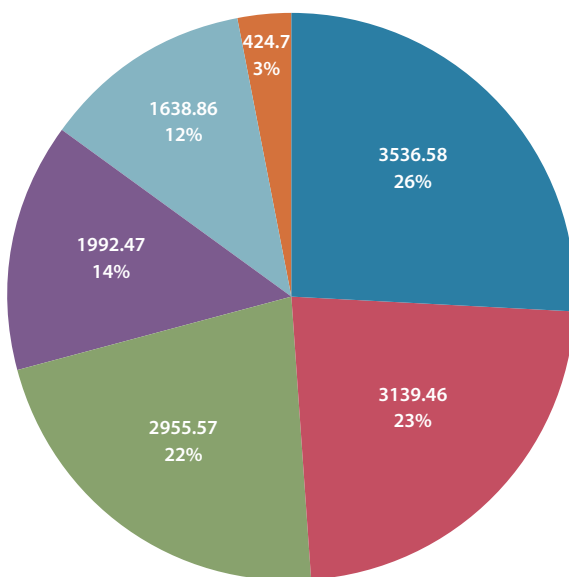
YEAR	URBAN DRAINAGE				WATER SUPPLY AND SANITATION				GRAND TOTAL
	FF	IF	O&M	Total	FF	IF	O&M	Total	
2010	-	3.4	-	3.4	3.5	238.3	84.3	326.1	1,010.5
2011	-	44.1	8.2	52.3	3.8	278.1	295.9	577.8	1,443.4
2012	-	94.9	125.1	219.9	4.0	326.8	586.1	916.8	2,318.1
2013	-	99.6	215.2	314.8	4.2	343.1	938.2	1,285.4	2,865.3
2014	-	104.6	225.9	330.6	4.4	360.2	1,041.2	1,405.9	3,076.8
2015	-	109.8	237.2	347.1	4.6	378.3	1,172.5	1,555.3	3,274.9
2016	-	111.1	249.1	360.2	4.8	397.2	1,262.1	1,664.1	3,460.2
2017	-	116.7	261.6	378.2	-	416.9	1,325.1	1,742.1	3,645.1
2018	-	122.5	273.1	395.6	-	437.8	1,391.4	1,829.2	3,830.3
2019	-	128.6	286.7	415.4	-	459.7	1,461.0	1,920.6	4,047.0
2020	1.4	344.5	337.7	683.6	-	482.7	1,534.0	2,016.7	3,542.0
2021	1.5	361.7	354.6	717.8	-	506.8	1,610.7	2,117.5	3,681.1
2022	1.5	377.9	372.3	751.8	-	532.1	1,691.2	2,223.4	3,829.9
2023	1.6	396.8	391.0	789.4	-	558.7	1,775.8	2,334.5	3,980.7
2024	1.7	416.6	410.5	828.9	-	586.7	1,864.6	2,451.3	4,003.9
2025	1.8	437.5	431.0	870.3	-	616.0	1,957.8	2,573.8	4,082.6
2026	1.9	459.3	452.6	913.8	-	646.8	1,955.5	2,602.3	4,186.3
2027	-	161.2	423.6	584.8	-	679.1	2,053.3	2,732.4	3,875.9
2028	-	169.2	444.8	614.0	-	713.1	2,156.0	2,869.1	4,069.7
2029	-	168.7	399.5	568.2	-	748.7	2,263.8	3,012.5	4,111.8
2030	-	177.2	419.5	596.7	0.0	786.2	2,377.0	3,163.1	4,317.6

## 3 RESULTS

### 3.1 Incremental Changes in IF, FF, O&M Costs

A total of USD 25.84 billion is estimated as incremental Investment and Financial Flows for the analyzed investment components needed for adaptation in the water sector. The majority of the investment proportion is planned to be invested for water supply and sanitation (50%), followed by irrigation and drought management (14%), flood management (14%), protection of coastal zone (12%), urban drainage (7%), erosion control and dredging (2%) and for institutional development and enabling environment (1%). Cumulative discounted cost figures and sectoral proportions of investment are portrayed in figure below.

**Figure 7: Incremental adaptation investment proportions, by cumulative discounted worth and proportion (%)**



As can be seen from Table 10, annual cumulative investment flows have increased by 229% (\$ 5255 million to \$17321 million), whereas financial flows have increased by around 10 times (\$ 82 million to \$830 million) for the adaptation scenario. At the same time, annual O&M have been found to increase by \$ 13 billion.

It is to be noted that financial flows have been planned to be spent only for planning coastal protection, institutional development and irrigation and drought management, while under the adaptation scenario it is planned to be spent for every investment head starting from coastal protection to water supply and sanitation. The maximum amount of financial flows might be required for coastal protection (\$ 245 million) followed by flood protection and management (\$ 243 million), institutional development (\$ 108 million), and for irrigation and drought management (\$107 million) etc. Cost accounting under climate change scenarios is a new topic, as well as the planning for investments. In this regard, more understanding was required through appropriate planning studies for each of the investment program and thus more financial flow has been planned to be spent for the adaptation scenario.

Similar to the portfolio proportion made in the NWMP, the maximum amount of investment flows might be spent for water supply and sanitation (\$2783 million). It will be followed by irrigation and drought management (\$2633 million), coastal protection (\$2572 million), flood protection and management (\$2534 million), urban drainage (\$1146 million), erosion control and dredging (\$322 million) and for institutional development and enabling environment (\$75 million).

It is evident from Table 11 that the majority proportion of investment and financial flows have been planned to be spent over the first nine years (year 2011 to year 2019). The rationale behind this is very clear, climate change is no longer a future threat; upcoming investments have to be done as fast as possible. Despite this not all investments have been planned to be injected within this nine year period, capacity development is also a factor and it is not practical that all the investment shall start from the first day. In this regard, lag in starting of different investment has been planned. But annual O&M figures are steadily increasing over the planning period, as more and more

O&M budget will be required as cumulative investment increases over time.

It is also to be noted from Table 10 that private investment sources are negligible throughout the baseline scenario, but as outlined in the national water policy as well as in the NWMP, private sector investment is encouraged and the concept has been introduced in I&FF calculations. Thus private sector investment has been planned to be increased by more than five times under the adaptation scenario. Under the baseline scenario, more than 31% investment might be sourced from beneficiaries, followed by 65% from Government and only 4% from private sources. Under the adaptation investment scenario, this proportion will be changed and it is planned that 35% will come from GoB sources, 38% from beneficiaries and 27% from the private sources.

Table 10: Incremental Cumulative Discounted IF and FF Estimates by Investment Type, Investment Entity and Funding Source (in million US\$)

FUNDING SOURCE	COASTAL PROTECTION				EROSION CONTROL AND DREDGING				INSTITUTIONAL DEVELOPMENT AND ENABLING ENVIRONMENT				IRRIGATION AND DROUGHT MANAGEMENT				URBAN DRAINAGE				
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	
Beneficiary	-	-	-	-	-	-	-	-	-	1	2	-	3	5	17	137	159	-	-	86	86
GoB	245	-	322	567	16	20	87	122	107	73	210	390	102	2,615	750	3,467	6	289	599	894	
Private	-	2,572	-	2,572	-	302	-	302	-	-	-	-	-	1	-	1	-	857	-	857	
<b>GRAND TOTAL</b>	<b>245</b>	<b>2,572</b>	<b>322</b>	<b>3,139</b>	<b>16</b>	<b>322</b>	<b>87</b>	<b>425</b>	<b>108</b>	<b>75</b>	<b>210</b>	<b>392</b>	<b>107</b>	<b>2,633</b>	<b>887</b>	<b>3,627</b>	<b>6</b>	<b>1,146</b>	<b>685</b>	<b>1,838</b>	

Note: I&FF are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2

Table 11: Incremental Adaptation Cost: Annual IF, FF and O&amp;M Estimates by Investment Type (in million US\$)

YEAR	COASTAL PROTECTION				EROSION CONTROL AND DREDGING				INSTITUTIONAL DEVELOPMENT AND ENABLING ENVIRONMENT				IRRIGATION AND DROUGHT MANAGEMENT				URBAN DRAINAGE			
	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total	FF	IF	O&M	Total
2010	49.6	519.4	64.9	633.9	-	-	-	-	0.1	10.1	-	10.2	8.6	5.3	-	13.9	-	-	-	-
2011	54.6	572.7	71.6	698.9	-	-	-	-	0.1	11.1	19.8	31.0	10.7	5.8	-	16.6	3.5	16.9	-	20.3
2012	57.4	601.3	75.2	733.9	-	2.3	-	2.3	0.1	24.4	28.9	53.4	9.9	6.1	12.8	28.8	10.6	257.6	12.5	280.7
2013	60.2	631.4	78.9	770.5	-	2.4	1.2	3.6	0.1	25.6	30.3	56.1	9.1	6.4	13.4	28.9	11.1	270.5	36.1	317.8
2014	63.3	663.0	82.9	809.1	-	2.6	1.3	3.8	0.1	26.9	32.3	59.4	7.8	6.8	14.1	28.7	11.7	284.0	38.0	333.7
2015	-	-	-	-	2.1	43.2	11.5	56.8	64.9	610.6	106.7	782.2	8.2	7.1	14.8	30.1	13.9	298.5	39.9	352.3
2016	-	-	-	-	2.2	45.3	12.0	59.6	68.1	641.1	112.1	821.3	7.3	4.4	15.5	27.3	14.6	313.5	41.8	369.9
2017	-	-	-	-	2.4	47.6	12.6	62.6	71.5	673.2	117.7	862.3	5.9	4.3	16.3	26.5	15.3	318.8	73.5	407.6
2018	-	-	-	-	2.5	50.0	13.3	65.7	75.1	706.8	123.6	905.4	6.2	4.5	17.1	27.8	16.1	334.7	77.2	428.0
2019	-	-	-	-	2.6	52.5	13.9	69.0	78.8	742.1	129.7	950.7	6.6	4.7	18.0	29.2	16.9	351.5	79.4	447.7
2020	-	-	-	-	2.7	55.1	14.6	72.5	0.2	36.1	43.3	79.6	6.9	4.9	18.9	30.7	15.8	341.3	83.4	440.4
2021	-	-	-	-	2.9	57.9	15.4	76.1	0.2	37.9	49.1	87.2	7.2	5.2	19.8	32.2	9.1	315.3	96.5	420.9
2022	-	-	-	-	3.0	57.0	16.1	76.1	0.2	32.2	51.5	84.0	7.6	5.5	20.8	33.8	9.6	317.1	93.8	420.4
2023	-	-	-	-	3.1	59.8	16.9	79.9	0.2	33.8	54.1	88.2	8.0	5.7	21.8	35.5	10.1	302.6	88.1	400.7
2024	-	-	-	-	3.3	62.8	15.7	81.8	0.2	35.5	56.8	92.6	8.4	6.0	22.9	37.3	0.2	111.9	134.9	247.0
2025	-	-	-	-	-	-	-	-	-	35.5	59.7	95.1	8.8	6.3	24.1	39.2	-	117.5	129.6	247.1
2026	-	-	-	-	-	-	-	-	-	37.3	62.6	99.9	9.2	6.6	25.3	41.1	-	123.4	136.1	259.5
2027	-	-	-	-	-	-	-	-	-	39.1	65.8	104.9	9.7	7.0	26.5	43.2	-	-	142.9	142.9
2028	-	-	-	-	-	-	-	-	-	41.1	69.1	110.1	10.2	7.3	27.9	45.3	-	-	150.0	150.0
2029	-	-	-	-	-	-	-	-	-	18.6	23.9	42.5	10.7	7.7	29.3	47.6	-	-	145.9	145.9
2030	-	-	-	-	-	-	-	-	0.0	19.9	25.1	45.0	11.2	8.1	30.7	50.0	-	-	153.2	153.2

Note: I&FF are converted into present value by discounting the future costs using the discount rate stated in the section 2.2.2

Table 10: Incremental Cumulative Discounted IF and FF Estimates by Investment Type, Investment Entity and Funding Source (in million US\$) (continued)

FUNDING SOURCE	WATER SUPPLY AND SANITATION				FLOOD PROTECTION AND MANAGEMENT				GRAND TOTAL
	FF	IF	O&M	Total	FF	IF	O&M	Total	
Beneficiary	0	19	9,391	9,410	-	-	105	105	9,762
GoB	24	1,598	699	2,321	243	361	648	1,253	9,014
Private	-	1,166		1,166	-	2,173		2,173	7,072
<b>GRAND TOTAL</b>	<b>24</b>	<b>2,783</b>	<b>10,090</b>	<b>12,897</b>	<b>243</b>	<b>2,534</b>	<b>753</b>	<b>3,530</b>	<b>25,848</b>

Table 11: Incremental Adaptation Cost: Annual IF, FF and O&amp;M Estimates by Investment Type (in million US\$) (continued)

YEAR	WATER SUPPLY AND SANITATION				FLOOD PROTECTION AND MANAGEMENT				GRAND TOTAL
	FF	IF	O&M	Total	FF	IF	O&M	Total	
2010	-	3.4	-	3.4	3.5	105.7	84.3	193.5	855.0
2011	-	3.7	8.2	12.0	3.8	116.5	295.9	416.2	1,195.0
2012	-	23.6	8.6	32.2	4.0	157.1	385.8	546.8	1,678.2
2013	-	24.8	39.5	64.2	4.2	164.9	540.9	710.0	1,951.2
2014	-	26.0	41.4	67.5	4.4	173.1	624.1	801.6	2,103.7
2015	-	27.3	43.5	70.8	4.6	181.8	682.1	868.5	2,160.6
2016	-	24.5	45.7	70.2	4.8	190.9	747.2	942.9	2,291.1
2017	-	25.7	48.0	73.7	-	200.3	784.5	984.9	2,417.5
2018	-	27.0	48.8	75.8	-	210.4	823.7	1,034.1	2,536.8
2019	-	28.3	51.2	79.6	-	220.9	864.9	1,085.8	2,662.0
2020	1.4	239.2	90.5	331.0	-	231.9	908.2	1,140.1	2,094.3
2021	1.5	251.1	95.0	347.6	-	243.5	953.6	1,197.1	2,161.0
2022	1.5	261.8	99.7	363.1	-	255.7	1,001.3	1,256.9	2,234.4
2023	1.6	274.9	104.7	381.2	-	268.5	1,051.3	1,319.8	2,305.4
2024	1.7	288.6	110.0	400.3	-	281.9	1,103.9	1,385.8	2,244.8
2025	1.8	303.1	115.5	420.3	-	296.0	1,159.1	1,455.1	2,256.8
2026	1.9	318.2	121.2	441.3	-	310.8	1,217.0	1,527.8	2,369.7
2027	-	13.0	75.7	88.7	-	326.3	1,277.9	1,604.2	1,983.9
2028	-	13.6	79.5	93.1	-	342.7	1,341.8	1,684.4	2,083.1
2029	-	5.3	15.9	21.2	-	359.8	1,408.9	1,768.7	2,025.9
2030	-	5.7	16.7	22.4	0.0	377.8	1,479.3	1,857.1	2,127.7

## 3.2 Policy Implications

### 3.2.1 Current policy regime

So far none of the national sectoral policies take into account the inherent risk of climate change and therefore the implication of impacts of climate change in water related projects have not been accounted in any policy and projects. However, the GoB is aware of the importance of climate change and is sensitive to climate variability in general as well as its vulnerability. Eight sectoral policies have been reviewed as listed below for establishing policy implications in mainstreaming climate change adaptation in water sector development projects.

**Table 12: Policies Reviewed in Relation to Water Climate Change**

National water policy	(Ministry of Water Resources; MoWR, 1999)
Coastal zone policy	(Ministry of Water Resources; MoWR, 2005)
Environment policy	(Ministry of Environment and Forest; MoEF, 1992)
National policy for safe water supply and sanitation	(Ministry of Local Government, Rural Development and Cooperatives; MoLGRDC, 1998)
National agricultural policy	(Ministry of Agriculture; MoA, 1999)
National fisheries policy	(Ministry of Fisheries and Livestock; MoFL, 1998)
National Plan for Disaster Management	(Disaster Management Bureau, 2010)
Land use policy	(Ministry of Land; MoL, 2001)

In the following sub-sections the above-mentioned policy briefs are given.

#### 3.2.1.1 National Water Policy (Ministry of Water Resources (MoWR), 1999)

The National Water Policy (NWP) is the first water policy document on water resources management for the country released in January 1999. The policy does not make any specific statement on the issue of climate change and its impact on water resources. However, based on the NWP, the National Water Management Plan (NWMP) was for-

mulated where climate change has been acknowledged as a "knowledge gap".

*Policy issues that indirectly address the adverse effect of climate change on water resources:*

- i. The Policy considers in the introduction common hydro-meteorological phenomena like alternating flood and water scarcity during the wet and dry season, river sedimentation and bank erosion as the most crucial challenges. If this policy recommendation is implemented then it will provide the database required to plan for adaptation.
- ii. The policy under section 4.6 concentrates on the issue of inland salinity intrusion from sea in the southwest and considers that this intrusion is causing groundwater to be unfit for consumption. Although the statement does not suggest any adaptation policy, it indirectly infers the need for alternative sources of water supply for the community.

*Policy issues that indirectly correlate with climate change adaptation and mitigation procedures:*

- i. The section on River Basin Management (section 4.1) emphasizes on cooperation with co-riparian countries. The policy renders importance in exchange of data of the rivers between the sharing countries which might even help in flood forecasting in the lower riparian regions. This is a positive approach in climate change adaptation, as flood is one of the extremities or water related disaster that might exaggerate due to climate change.
- ii. The policy, under section 4.2, considers framing rules, procedures and guidelines for combining water-use and land-use planning. Successful implementation of this policy will help adaptation and mitigation. If some additional concern for climate change induced extremes are included and acted on.
- iii. The policy, under section 4.2, highlights the importance of preparing and implementing sub regional and local water-management plans in conformity with NWMP. This increases the potential to work on climate related issues locally by both NGOs and private sectors.
- iv. The NWP highlights the necessity of undertaking comprehensive development and management of

the main rivers through a system of barrages and other structural and non-structural measures under section 4.2.j. The policy also calls for developing early warning and flood-proofing systems to manage flood and drought. The statements facilitate further adaptation towards climate change as it safeguards the people from the effect of the extremes like flood and drought.

- v. Section 4.3 of the policy states that the Government can redirect use (of water) during periods of droughts, floods, cyclones, and other natural disasters. The statement clearly creates the scope of emergency adaptation to climate change related water shortage and climate extremity issues in the near future.
- vi. The NWP calls for the improvement of resource utilization through conjunctive use of all forms of surface water and groundwater for irrigation and urban water supply under section 4.7. It also promotes strengthening of crop diversification programmes for efficient water utilization. This policy statement is directly applicable for adaptation to safeguard crop agriculture.
- vii. The policy under section 4.7 addresses the need for strengthening appropriate monitoring organizations for tracking groundwater recharge, regulating surface and groundwater use, and monitoring changes in surface and groundwater quality. Under climate change induced low flow regime, there would be increased dependency on groundwater and both irrigation and water supply in that case depends on groundwater. Hence the statement prioritizes the need to manage groundwater along with surface water which will help in tackling climate change.
- viii. The policy states under section 4.9 that fisheries and wildlife are to receive due emphasis in water resources planning in areas where their social impact is high. As the Sundarbans is a hotspot for flora and fauna if it gets sufficient freshwater flow it may save the forest from further degradation.
- ix. One of the most significant statements of the policy is under section 4.13 on the preservation of haors, baors and beels. This step is certainly advancement in preserving surface water as streams and river flow, which are assumed to decline during dry season due to climate extremities and variability.
- x. Section 4.15 considers development of a central da-

tabase and management information system (MIS) consolidating information from various data collection and research agencies on the existing hydrological systems, supply and use of national water resources, water quality, and the eco-system. This is a major step towards advanced research that can incorporate climate related studies and technology transfer.

### 3.2.1.2 Coastal Zone Policy (Ministry of Water Resources (MoWR), 2005)

The Ministry of Water Resources developed the Coastal Zone Policy in 2005, which is of immense importance as the coastal zones have salient features related to climate change issues. It is to be noted that, during the development of the policy sufficient sensation has been raised and the issue of climate change has been duly acknowledged. Cyclones, storm surges, floods, drought, earthquakes, erosion, salinity intrusion and arsenic contamination are some of the natural hazards that are frequent in coastal zones. Lack of safe drinking water, overexploitation of natural resources, water logging, river siltation and hill cutting also add to the vulnerabilities. The coastal zone of Bangladesh has diverse eco-systems: mangrove, marine, estuary, islands, coral, sandy beaches and sand dunes. This part of the country has both a 'world heritage site' and 'ecologically critical areas'. The Coastal Zone policy and CDS (Coastal Development Strategy) focus on these issues concentrating exclusively on climate change.

Policy issues that directly consider the adverse effect of climate change on coastal areas:

In section 1.1 of the policy, it is directly mentioned that the coastal area is vulnerable to risks from climate change. In section 4.3 it is mentioned that the majority of households in this area are vulnerable to climate change.

Policy issues those directly state adaptation procedures for climate change:

A complete section (Section 4.8.3) is devoted to climate change in coastal areas as well as adaptation procedures and directly mentions adaptive measures towards sea level rise. The section highlights the following:

- i. Continuing existing institutional arrangements to monitor climate change
- ii. Supporting the upgrading of technology and institutional strengthening for enhancing the capacity to generate better data and more accurate long-term prediction and risk related to climate change
- iii. Implementing adaptive measures that are identified in relation to climate change and coastal zone
- iv. Maintaining sea-dykes along the coastline as first line of defense against predicted sea-level rise
- v. Making an institutional framework to monitor/detect sea level rise and planning to cope with its impact.

Policy issues that indirectly correlate with climate change adaptation and mitigation procedures:

- i. Special measures will be taken to conserve and develop the natural environment of the Sundarbans. This is a required step for safeguarding the Sundarbans against possible climate change impacts.
- ii. Measures will be taken for afforestation in the coastal areas including newly accreted chars. This is a safeguard against water surge and other hazards that are common in the coastal belt of Bangladesh and are extreme events that are likely to increase in extent and frequency due to climate change.
- iii. Salt-tolerant crop varieties will be developed and extended in the coastal belt which is more of a direct approach against salinity intrusion due to reduced upstream flow and sea level rise. Section 4.4.2 also suggests that adequate upland flow shall be ensured in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of soil salinity from the sea.
- iv. The scope of irrigation facilities will be explored and extended in this area and comprehensive water management for agriculture will be implemented which is a must in the variable climatic conditions during climate change.
- v. As water scarcity is going to be a major problem in the overall variable rainfall, salinity intrusion and sea level rise condition in the coastal area, appropriate water management system stated in section 4.4.2 is of utmost importance. Polders utilizing existing infrastructures will be established for freshwater storage and other water utilization. Step will be tak-

en to ensure sustainable use and management of ground water.

- vi. Through its responsible agencies, the Government will properly plan and implement schemes for reclamation of balanced land from the sea and rivers. This is a major step towards the sea level rise issue as much of the land is supposed to go under water due to the rise.
- vii. Effective measures will be taken for protection against erosion and for rehabilitation of the victims of erosion. Safety measures will be enhanced by combining cyclone shelters, multi-purpose embankments, killas, road system and disaster warning system. These are all protective measures even if indirectly, against climate change.

#### **3.2.1.3 Environment Policy (Ministry of Environment and Forest (MoEF), 1992)**

The Environmental Policy and Implementation Programme (EPIP) for Bangladesh were pronounced by the Ministry of Environment and Forest in 1992 (MoEF, 1992) prior to finalization of the UNFCCC. As such the environment policy of Bangladesh is totally silent about climate change. Now the MoEF is planning to revise the environment policy very soon and it may be expected that the updated policy will fully responsive to climate change.

#### **3.2.1.4 National Policy for Safe Water Supply and Sanitation (Ministry of Local Government, Rural Development and Cooperatives (MoLGRDC), 1998)**

The Policy was introduced by the Ministry of Local Government, Rural Development and Cooperatives of Government of the People's Republic of Bangladesh. The goal of the policy is to ensure that all people have access to safe water and sanitation services at an affordable cost and making the water supply and sanitation system equitable and sustainable. According to the policy, 'Safe water supply means withdrawal or abstraction of either ground or surface water as well as harvesting of rain-water and its subsequent treatment, storage, transmission and distribution for domestic use. Sanitation means human excreta and sludge disposal, drainage and solid waste management.'



Policy issues that state the adverse effects of climate change:

The policy reflects on the government's responsibility to supply safe water and sanitation during disasters but no specific demarcation of climate change and its effect has been done in the policy.

Policy issues that correlate with climate change adaptation and mitigation procedures:

Some policy is required considering safe water supply and sanitation to adapt with the socio-economic changes due to the depletion of natural resources that might occur due to climate change. The related policy statements are stated below.

- i. It is necessary to expand and improve the water supply and sanitation services in order to satisfy the basic needs of the increasing population. The need to expand these facilities is greater in the case of under privileged groups and regions.
- ii. It is important in bringing about behavioral changes regarding use of water and sanitation that is to minimize waste of supply water.
- iii. The policy concentrates on reducing incidence of water borne diseases.
- iv. The policy ensures proper storage, management and use of surface water and ground water and preventing its contamination.
- v. The policy states that taking necessary measures for storage and use of rain water and ensuring storm-water drainage in urban areas is important.
- vi. Adoption of necessary measures in urban areas to prevent contamination of ground and surface water by solid and liquid wastes is also a priority issue in the policy.
- vii. Adoption of water supply and sanitation technology options appropriate to specific regions, geological situations and social groups must be considered.
- viii. Improvement of the existing technologies and conduct of continuous research and development activities to develop new technologies is also a policy objective.
- ix. The policy calls for capacity building at the local/community level to deal effectively with local water and sanitation problems.

- x. All government and non-government bodies should be prepared to take necessary measures for immediate response before and after natural disasters. Involvement of all other stakeholders is also necessary. During natural disasters, necessary measures shall be taken on an emergency basis so that people have access to safe water and do not have to drink contaminated water. Necessary measures shall also be taken to prevent contamination and damage of tube wells during natural disaster.
- xi. Use of compost and bio-gas made from waste will be promoted.

### 3.2.1.5 National Agriculture Policy (Ministry of Agriculture (MoA), 1999)

Water and agriculture is interlinked and the National Agriculture Policy (NAP) was developed by the Ministry of Agriculture with a view to develop and sustain agricultural growth in such a way that it ensures the nation with a self-sufficient reliable food security system. NAP 1999 or the New Agricultural Extension Policy (NAEP) 1996 has no specific statement made on the issue of climate change and its impact on agriculture. The National Agricultural Policy Draft 2009 specifically mentions the word climate change as an environmental vulnerability.

Policy issues that indirectly consider the adverse effects of climate change on agriculture:

No such issue has been cited in the policy.

Policy issues that indirectly correlate with climate change adaptation and mitigation procedures:

- i. The policy, under section 3.5, ensures supplementary irrigation in severe and extremely severe drought affected areas, which is an adaptive measure against climate induced variable rainfall and low surface flow. Also section 9.1 states target oriented research programmes will be conducted for region-wise research on irrigate and rain-fed cultivation.

### 3.2.1.6 National Fisheries Policy (Ministry of Fisheries and Livestock (MoFL), 1998)

The National Fisheries Policy was developed by the Ministry of Fisheries and Livestock in 1998. The goal of the policy is to enhance the fisheries production along with poverty alleviation through creating self-employment and improvement of socio-economic conditions of the fishers. It also concentrates on the fulfillment of the demand for animal protein and achievement of economic growth through earning foreign currency by exporting fish and fisheries products.

Policy issues that states the adverse effect of climate change

Though the policy in its objectives pronounces ‘maintenance of ecological balance’ and ‘conservation of biodiversity’, it does not directly count ‘climate change’ as a threat to fish resources. But the policy states that flood control, water drainage and construction of dam and barrage in the irrigation projects without any proper EIA and installment of fish pass, release of hazardous chemicals and poisonous substances from the slum area and different industrial plants into the river and other water bodies, pollution of water using chemical insecticides and fertilizers in the agricultural fields, reduction of water holding capacity of rivers, beels and haors due to siltation, and harvesting of excessive amounts of fish to meet the demand of growing populations are considered as the main reasons that might hamper fish production in the country.

Policy issues that correlate with climate change adaptation and mitigation procedures

Climate change combat has various aspects, one is to reduce emission of GHG or mitigation and another is to adapt with the changing climate. Securing our food sector is a challenging but most crucial adaptation step towards climate change. Some points that would help the fish resources and water resources to attain its ultimate sustainability are enlisted below:

- i. The policy concentrates on conserving fish habitats from damage and taking appropriate care during the implementation of all developmental activities such as flood control, irrigation and drainage projects,

agriculture, industries, road and urban development projects.

- ii. Surveys will be conducted of the water bodies, which become water-logged or closed water bodies due to the flood control and irrigation projects to fulfill the possibility of those water bodies for use in fish culture.
- iii. Lakes, beels, ditches-canal and other open water bodies should not be completely dewatered. Instead, water bodies like haors, baors and beels would be renovated for fish culture and these water bodies would not be reduced in size.
- iv. Integrated prawn and fish culture along with rice will be encouraged in brackish water bodies. Measures will be taken to conserve biodiversity in the coastal region and necessary steps will be taken to culture fish/shrimp along with rice crop. Arrangements will be established within the polders (embankment) and flood control projects to conserve wild life. Each polder will be coupled with arrangements for fish/shrimp culture with rice either in concurrent or in rotational system.

### 3.2.1.7 Land Use Policy (Ministry of Land (MoL), 2001)

The Bangladesh Land Use Policy 2001 is approved by the Ministry of Land of the GoB. The main objectives of the land use policy are prevention of excessive land use due to the ever increasing demand for crop production, maximum utilization of inlands and wetlands, preservation of ‘Khas Lands’ and helping in reducing the number of landless people in Bangladesh.

Policy issues that states the adverse effects of climate change:

No specific statement considering the impact of climate change on the country or its resources is made in the policy. But the importance of afforestation, environment and mutual sustainability of land use and forest are focused upon in the policy.

Policy Issues that Indirectly Correlate with Climate Change Adaptation and Mitigation Procedures:

- i. Water bodies shall not be used in such way that it contradicts the fisheries policy and still contribute in agricultural irrigation.
- ii. Existing water bodies shall not be encroached for any other land use.
- iii. Embankments shall be made in a way that provides drainage facility and water-logging does not occur within the enclosed area.

#### 3.2.1.8 National Plan for Disaster Management (Disaster Management Bureau, 2010)

Apart from the five-year plan, the National Plan for Disaster Management can be treated as a medium term plan. The Plan addresses key issues like risk reduction, capacity building, climate change adaptation, livelihood security, gender mainstreaming, community empowerment and response and recovery management. Standing Orders on Disaster was introduced in 1997 by the Ministry of Food and Disaster Management. The Ministry has recently launched the National Plan for Disaster Management to be implemented during 2008-2015.

Issues that directly consider the adverse effect of climate change on coastal areas:

The plan states that climate change adds a new dimension to community risk and vulnerability. Although the magnitude of these changes may appear to be small, they could substantially increase the frequency and intensity of existing climatic events (floods, droughts, cyclones etc). The natural calamities will expand in areal and seasonal extents as per the statement. The plan also states that droughts will cover larger areas and rain will become more concentrated, indicating towards more floods due to climate change.

Policy issues that directly or indirectly state adaptation procedure for climate change:

- i. Disaster management would involve the management of both risks and consequences of disasters that would include preventive emergency response and post-disaster recovery.
- ii. Non-structural mitigation measures such as ‘com-

- munity disaster preparedness training’ advocacy and ‘public awareness’, requiring integration of structural mitigation with non-structural measures, are given high priority. Community involvement for preparedness programmes for protecting lives and properties is a major focus of the Plan. Involvement of local government bodies would be an essential part of the strategy. Self-reliance should be the key for preparedness, response and recovery.
- iii. Identifying who and what are vulnerable to the occurrence of these threats and how these are likely to affect them is another step that is highlighted in the Plan.
  - iv. The Plan states that investigation will be done to find out the measures that are possible to take for prevention and mitigation of occurrences of disaster events, (unlikely to be possible in the case of the natural phenomenon but possible in the case of man-made disasters and environmental degradation).
  - v. The plan asks for an effective system within the government to link and co-ordinate the processes of planning and the management of sustainable development, environmental management and disaster reduction.
  - vi. To combat drought according to the Plan, it is essential for Bangladesh to utilize its water resources, both surface and groundwater. Ground water resources is depleting to such an extent that arsenic contamination is increasing at an alarming rate. The scope of increasing the irrigation areas by LLP is limited. In these circumstances, the plan concludes that there is no other option but to use surface water to meet the water deficit created by droughts in the Kharif-II season.
  - vii. To sum up it can be said that the indirect steps towards climate change adaptation by disaster management are:
    - a) Professionalizing the Disaster Management System
    - b) Mainstreaming Risk Reduction
    - c) Strengthening Institutional Mechanisms
    - d) Empowering Risk Communities
    - e) Expanding Risk Reduction Programming
    - f) Strengthening Emergency Response Systems
    - g) Developing and Strengthening Networks.

### 3.2.2 Policy Gaps

From the above analysis, significant knowledge has been gathered as well as a number of gaps have been identified which are listed below:

Bangladesh has already enacted its climate change strategy and action plan, which provides the principle guideline for adaptation, and mitigation planning. Name of the implementing agencies under each programmes are stated in the strategy but it is not clear how to coordinate and how to manage the finance.

Sectors in which mitigation and /or adaptation is required has already been identified in NAPA and BCCSAP. But linkage of adaptation and mitigation activities with the national development programmes and projects has yet to be started. But for better linkage, a road map for Bangladesh is required for mainstreaming climate change considerations across all sectors and at all levels.

National priority issues have been identified in the long-term, medium term and short-term planning documents and to some extent climate change has been linked with some issues. But efforts targeting toward adapt or to mitigate climate change with overall objective of achieving the national priorities are yet to be achieved. Some of the national policies have addressed climate change directly, but most of them do not. The following gaps are identified in terms of mainstreaming climate change considerations in the national development planning:

- Currently, most policy responses continue to address climate change, development, and disaster management independently;
- There certainly remains a lack of interaction and institutional overlap among policy makers; in other words, there is a need for more coordination across different ministries;
- There is a lack of comparison between the implications of different policy interventions to adapt to climate change;
- While many of the CC adaptation policies are consistent with traditional developmental policies (especially in areas of disaster reduction), some CC implications will require changes in policies and new policy instruments, for which there is a considerable knowledge gap;

- There is a lack in understanding synergies in and/or obstacles to simultaneous progress in promoting enhanced adaptive capacity and sustainable development;
- There are gaps between spatially explicit analyses of vulnerability and aggregate integrated assessment models; and
- There are gaps in developing new decision support mechanisms that can identify robust coping strategies in the face of the many critical climate change uncertainties.

The main recommendation is “Integrate adaptation policies with policies for sustainable economic development and disaster management in order to achieve the most from scarce resources”.

### 3.2.3 Mainstreaming Climate Change in Water Resources Sector Development

Historically, domestic investment in water sector has been following a fairly steady state, but contribution from foreign investment is in decline. The GoB’s vision regarding management of climate change for uninterrupted and sustainable development is an integral part of the Vision 2021. But the question is how the Government will plan and manage the additional financing for adaptation and mitigation to combat the adverse impact of climate change.

Mainstream climate change in the development process should be pursued from the development agencies. But prior to that it is urgent to adjust relevant policies to accommodate climate risk management. It is now understood that poorest of the poor segment will be the affected most and thus adjusting the poverty alleviation policies, strategies and programmes to accommodate the increasing needs of adaptation could immense help getting out of this. Bangladesh has a very good disaster management policy and long-term strategy, a slight adjustment of it to accommodate climate change considerations or specific propositions for alteration of climate-induced hydro-meteorological disasters could enhance its effectiveness and ensure development for a longer period in future. It might also be necessary to adjust/fine tune/create legal support for certain functions of current institutional arrangements and administrative procedures. For example, National water policy has been prepared in 1999 that has not been updated yet considering the climate change concerns, and there exists no legal bindings to enforce the policy recommendations.

Setting the appropriate legislative framework is fundamental to effective implementation of the water policy. The existing legislation related to any form of water management in Bangladesh requires supplementing in a number of key areas. This policy will be given effect through a National Water Act encoding specific provisions of the water policy to facilitate its implementation. Preparation of the water act is underway and it will have immense help in mainstreaming climatic concerns in development agenda.

Now the most intriguing question at this point is, who would mainstream climate risk management (in all development sectors and agencies) and which organization should be given the responsibility to coordinate all the activities and practices involving both development and adaptation. The Government of Bangladesh officially launched the “Climate Change Unit (CCU)” under the Ministry of Environment and Forest (MoEF) in June 2010. The Unit will act as a key institution in information generation through research and implantation of adaptation and mitigation projects. The MoEF and CCU have already approved 97 projects for implementation in vulnerable coastal zone, drought prone area, flood and low lying ecosystem, hilly and haor area, and charlands covering mainly water, agriculture, forestry, infrastructure, health, capacity building sectors etc. Some of the projects are approved for conducting action research and institutional strengthening. However, most of these projects will be implemented by the different relevant government institutions. Some of the projects will be implemented by NGOs and Civil Society Organisations at both national and local levels. Particularly, for the water sector, Water Resources Planning Organisation (WARPO) has been playing the pivotal role as macro planning organization. Thus WARPO and CCU can work jointly as coordinator and monitoring authority of the proposed organizations.

In Bangladesh, no separate climate change policy exists, but hopefully we have a adaptation/mitigation strategy (BCCSAP) approved by the Cabinet of the Government. But still the challenges remain, where the propositions made in the strategy should be accommodated in the sectoral policies as well as within the “rules of business” of the respective ministries.

Another plausible steps made by the Government is the creation of an enabling environment for using renewable energy alternatives it has proposed tax-free purchase of equipment, and value added tax (VAT) exemption on imports.. Moreover, the industrial sector will receive tax break for approved R&D expenditure to innovate and promote energy efficient technology. This initiatives should extend for all the sectors for importing/purchasing tools and conduction research on climate change.

Implementation of the identified actions, options and measures should need financing. Adaptation measures can be financed in many ways, though in this study we have proposed for three alternatives, beneficiary, Government and private. Foreign direct investment or grants are uncertain and difficult to project. In this regard, the probable FDI or grant will be poured into the Government’s investment. In total, the financial mechanism for implementation could be National Climate Change Fund, Bangladesh Climate Change Trust Fund, other bilateral donor funds, multilateral donor funds and international convention funds including Global Environmental Facility (GEF) trust fund, LDCF (Least Developed Countries Fund), Special Climate Change Fund (SCCF), Adaptation Fund (Kyoto Protocol), Clean Development Mechanism (CDM), Joint Implementation and ET.

Now the most important task for mainstreaming climate change in the national policy regime is the formulation of a national climate change policy that will facilitate the integration of climate change issues into national development planning and to provide a framework for sectoral policies. It is a prerequisite that all the policy formulation should be carried out in a consultative way by involving key officials if concerned ministries/sectors together with professional, academia, NGOs and civil society leaders, as well as the general public. Yes, Bangladesh has already moved several steps ahead than others by formulating the BCCSAP, which has also been approved by the Government. Now according to the BCCSAP, following steps should be carried out in a systemic and on urgent basis:

- Prepare a consultation paper on the National Climate Change Policy for the integration of climate change issues into development planning and sectoral policies and how they should be formulated for discussion with key stakeholders.

- Incorporate climate change concerns in all sectoral policies and strategic issues through appropriate revisions in consultation with relevant stakeholders.
- Publish the national climate change policy.

#### 3.2.4 Domestic resource mobilization

Climate change and variability impacts greatly on development, which has to be climate resilient. Most of the coping and adaptation to climate change at household and micro-level are addressed from own resources and capacity. However, in future, the risks as well as impacts are most likely to increase. This will over burden the people and their communities. As such national governments should support community initiatives to enhance their coping capacity with relevant technology and resources, primarily from domestic sources. This interprets identification and addressing climate risks as part and parcel to development. Implementation of local development plans should follow the following approach:

- Respective line/sectoral agencies will demand for their sectoral budget according to their plan, based on the local risk reduction action plan and implementation process.
- Community based organisations will demand and draw on local government development plan and budget.

National water policy (under section 4.4) stated that “The management of public water schemes, barring municipal schemes, with command area up to 5000 ha will be gradually made over to local and community organisations and their O&M will be financed through local resources”. But while collecting from the beneficiary sources, it should not be viewed from the business perspective rather it should be oriented towards the welfare economic principles. Their ability to pay should be viewed in the context of service provider’s (public institutions and enterprises) own ability to meet costs, it should never forget the impact of service fees on household budget. More than one fourth of the total populations in Bangladesh lives below the lower poverty line, thus pressurizing or pushing them into zero-sum budget decision will do the reverse rather attaining the national objective of poverty alleviation.

Private sector investment is encouraged in the National Water Policy, “The Government may confer water rights on

private and community bodies to provide secure, defensible and enforceable ownership rights to ground water and surface water for attracting private investment”. Now it also evident that a huge amount of private financing is available for irrigation in all over Bangladesh.

#### 3.2.5 Global negotiations and financing options

Combating the adverse impact of climate change composes of adaptation and mitigation, which needs technological support to understand and plan and finance to implement. These two areas have gained attention in all the climate change negotiation talks. Bangladesh and other LDCs are pursuing on the basis of two principles. First, the [resent day climate change is the result mainly of historical GHG emission by western and other industrialist countries. Thus the finance for adaptation and mitigation should come from mainly from these countries, which does not preclude national actions by the affected countries on their own (Ministry of Environment and Forest (MoEF), 2009). Secondly, how the finance will come and be managed is a matter of global negotiation. But all the funds should come on a purely grant basis as the need for adaptation arise because of to climate change due to historical emission of GHGs by the industrialized countries. Achieving the energy efficiency in both industrial and local level is a means for mitigation, but it also needs to be financed. However, in this point Bangladesh’s strategy is unless the additional costs of adopting efficient technology is not paid for through the international financial mechanism, Bangladesh will not be able to adopt them which also need to be financed on a grant basis.

Primarily, Bangladesh has planned it’s strategy for combating the adverse impact of climate change following the Bali Action Plan (COP 13, 2007), which identified a set of actions essential to achieve a secure climate future. Where Bangladesh has identified development and poverty eradication as the first priority and opposed any action that may jeopardize the attainment of secure access to food, energy and livelihoods. In 2008, at the UN General Assembly, Bangladesh spoke on behalf of the Least Developed Countries (LDC) emphasizing the need for immediate international support to build the LDC’s resilience to global warming and climate change. In the later sessions of the COP, Bangladesh has continuously pursuing for to build the capacity of Bangladesh and other LDCs and Bangladesh has

been pointing out time and again that the resources available for adaptation are grossly inadequate to meet the needs of the country, who will bear the brunt of climate change. Again it was agreed in COP 15 that the developed countries would generate a fund of USD 30 billion for the period of 2010-2012 to provide new and additional resources for adaptation and mitigation. In continuation to this, they have also committed to develop a fund of USD 100 billion by year 2020 to support the developing countries. In COP 16, it has been decided that a part of the promised fund will be flow through “Green Climate Fund”.

Although the commitment of mobilizing the funding has not been materialized properly, but Government of Bangladesh has established a National Climate Change Fund where it is desired that all development partners who so wish will contribute to this fund. Initially, USD 300 million has been deposited to the fund from Bangladesh’s own contribution. Another proposed initiative is a Bangladesh climate Multi Donor Trust Fund (MDTF) managed by the World Bank has been initiated where USD 125 Million has been initially deposited but it may rise up. to 160-170 million within a limited time frame. Objective of both the fund is to implement the proposed programmes mentioned in the BCCSAP.

### 3.3 Key Uncertainties and Methodological Limitations

Global climate risks have now started to take concrete shapes and it is widely predicted that Bangladesh is one of the country’s most vulnerable to climate change. Adaptation to climate change risk will put additional strain on water resources development efforts of Bangladesh. Only the economic cost is expected to be much higher, even excluding the social and environmental costs.

The study has opened a window to dive deeper into the issues of climate change with respect to water and environment. More integrated approach towards assessing impacts of climate change may be a welcome attempt for the government as the challenge has marked strokes on the economy through erratic extremes of hydro-meteorological disasters in Bangladesh.

Two major uncertainties of this study are:

- Cost calculations are more normative or judgmental rather than focusing on the specificity. Thus the cost figures are subject to vary and need detail study for

each of the individual investment programmes prior to final implementation.

- Inflation and discounting rate used in this study might be varied over time and need more theoretical debate among the practitioners prior selecting a single rate for investment planning.

Definite needs for future research in this respect may be identified as:

- Integrated 1st order physical modeling of climate change: This modeling will establish linkage between magnitudes of difference in elements of climate change and levels of impacts on biotic and abiotic components of water for medium and long term considerations.
- Integrated 2nd order physical modeling of climate change: This modeling will link the results of 1st order modeling with macro-economic implications of such results under medium and long term.
- Policy formulation phase will require further research on (i) change in climate change adaptation needs, (ii) reforms in land and water use profiles, (iii) reconstitution of terms of international trade with respect to abatement and adaptation costs and benefits.
- A wider forum for brainstorming on these issues is urgent because the climate change factors are incipient and impacts are undercutting our economic strength in terms of drawing more and more resources to repair the severe dents.

## 4 SUMMARY

Over the last 12 years, a total of USD 1,310 million has been spent for the development of water resources sector in Bangladesh where major investment proportions have been spent on Flood control, and/or irrigation and/or drainage, where more than three-fifth of the investment has been sourced from internal sources. It is also to be noted that, Bangladesh Water Development Board has spent more than ninety percent of the investment.

A total of 29 programmes have been selected for baseline scenario till year 2030 which worth around US\$ 15.6 billion. Baseline investment has been disaggregated under seven different heads: Coastal protection, Erosion control and dredging, Flood protection and management, Irrigation and drought management, Urban drainage and Water supply and sanitation and Institutional development and Enabling Environment.

For adaptation, under the same investment head, a total 48 programmes have been selected in addition to the baseline investment programs which worth around US\$ 41.5 billion and incremental cost for adaptation is estimated more than US\$ 25.8 billion.

The Bangladesh climate change strategy and action plan (BCCSAP) has been recognized as key strategic document for implementing adaptation options. But now the most important task for mainstreaming climate change in the national policy regime is the formulation of a national climate change policy that will facilitate the integration of climate change issues into national development planning and to provide a framework for sectoral policies.



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## ANNEX A: BASELINE INVESTMENT PROGRAMME DETAILS

PRO-GRAMME	INVESTMENT HEAD	CAPI-TAL COST (MIL-LION BDT)	PRI-VATE CON-TRIBU-TION (%)	GOB CON-TRI-BU-TION (%)	BENEFI-CIARY'S CON-TRIBU-TION (%)	DU-RA-TION	AGENCY	PRO-POSED START	PRO-POSED END	IF PRO-PORTION	FF PRO-PORTION
AW 007	Coastal Protection	21471.7	0	85	15	20	BWDB, LGED	2017	2036	93%	7%
AW 008	Coastal Protection	5866.9	0	100	0	24	BWDB, DoFOREST	2011	2034	95%	5%
DM 001	Coastal Protection	9894.6	0	100	0	15	LGED	2012	2026	100%	0%
DM 002	Coastal Protection	1747.9	0	100	0	25	DMB	2013	2037	100%	0%
MR 010	Erosion control and dredging	21500	0	100	0	25	BWDB, NGO	2016	2040	100%	0%
MC 010	Flood protection and management	5423	0	100	0	23	BWDB	2013	2035	100%	0%
MC 016	Flood protection and management	400	0	100	0	9	BWDB, RCC	2013	2021	100%	0%
TR 007	Flood protection and management	14460	0	100	0	25	BWDB	2013	2037	100%	0%
EE 007	Institutional development and enabling environment	15	0	100	0	2	WARPO	2011	2012	0%	100%
EE 009	Institutional development and enabling environment	1700	0	100	0	17	WARPO	2019	2035	0%	100%
EE 010	Institutional development and enabling environment	180	0	100	0	20	WARPO	2012	2031	61%	39%
EE 013	Institutional development and enabling environment	290	0	100	0	10	WARPO	2012	2021	0%	100%
ID 004	Institutional development and enabling environment	250	0	100	0	6	BWDB	2012	2017	6%	94%
ID 006	Institutional development and enabling environment	660	0	100	0	5	WARPO	2011	2015	62%	38%
ID 008	Institutional development and enabling environment	2200	0	100	0	10	DMB	2012	2021	36%	64%
ID 009	Institutional development and enabling environment	300	0	100	0	4	BMD, RRI, BHWDB	2013	2016	0%	100%
ID 010	Institutional development and enabling environment	1316	0	100	0	10	BWDB	2012	2021	96%	4%
AW 001	Irrigation and drought manage-ment	310	0	85	15	15	DAE	2012	2026	100%	0%
AW 002	Irrigation and drought manage-ment	3275	0	85	15	20	BWDB, BMDA, CBO, LGI, NGO	2014	2033	100%	0%
MC 011	Urban drainage	38500	0	100	0	22	DWASA, DCC	2014	2035	100%	0%
TR 008	Urban drainage	64000	0	100	0	25	POROSHO-VA, LGI	2013	2037	100%	0%
MC 002	Water supply and sanitation	95150	30	65	5	24	DWASA	2012	2035	100%	0%
MC 003	Water supply and sanitation	24017	30	65	5	24	CWASA	2012	2035	100%	0%
MC 004	Water supply and sanitation	7879	30	65	5	23	KCC	2013	2035	100%	0%
MC 005	Water supply and sanitation	5087	30	65	5	23	RCC	2013	2035	100%	0%
MC 006	Water supply and sanitation	89676	0	100	0	24	DWASA	2012	2035	100%	0%
MC 007	Water supply and sanitation	13979	20	75	5	24	CWASA	2012	2035	100%	0%
MC 008	Water supply and sanitation	5664	20	75	5	23	KCC	2013	2035	100%	0%
MC 009	Water supply and sanitation	3874	20	75	5	23	RCC	2013	2035	100%	0%

## ANNEX B: ADAPTATION INVESTMENT PROGRAMME FEATURES

PRO-GRAMME	INVESTMENT HEAD	CAPI-TAL COST (MIL-LION BDT)	PRI-VATE CON-TRIBU-TION (%)	GOB CON-TRI-BU-TION (%)	BEN-EFICI-ARY'S CON-TRIBU-TION (%)	DU-RA-TION	Agency	Pro-posed start	Pro-posed end	IF Propor-tion	FF Pro-portion
EA 009	Coastal Protection	250	0	100	0	10	DoFOREST, DOE, BWDB, WARPO	2012	2021	12%	88%
T2P2	Coastal Protection	38	95%	5%	0%	5	MoFDM, Red Crescent, NGO, CBO	2012	2014	95%	5%
T3P2	Coastal Protection	1,219	90%	10%	0%	5	MoFDM, Red Crescent, NGO, CBO	2012	2014	90%	10%
T3P3	Coastal Protection	892	90%	10%	0%	5	MoWR and Its agencies	2012	2014	90%	10%
T3P6	Coastal Protection	696	95%	5%	0%	5	MoWR, MOEF, MoFDM	2012	2014	95%	5%
MR 011	Erosion control and dredging	1542	0	100	0	10	IWTA, BWDB	2012	2021	96%	4%
T3P7	Erosion control and dredging	301	95%	5%	0%	10	MoWR, IWM, IWFM, CEGIS, WARPO, RRI	2015	2024	95%	5%
T3P8	Erosion control and dredging	17	95%	5%	0%	10	MoWR, BWDB, RD&C, MoFDM, Union Parishad	2015	2024	95%	5%
DM 003	Flood management	2599.4	0	100	0	10	NGO, LGED	2013	2022	100%	0%
DM 004	Flood management	10904.8	0	100	0	25	RHD, LGED	2011	2035	100%	0%
DM 005	Flood management	977	0	100	0	25	BR	2011	2035	100%	0%
EA 007	Flood management	1000	0	100	0	15	BHWDB	2013	2027	88%	12%
MR 006	Flood management	16200	0	100	0	25	BWDB	2012	2036	100%	0%
T3P1	Flood protection and management	96	90%	10%	0%	5	MoWR and Its agencies	2015	2019	90%	10%
T3P5	Flood protection and management	2,318	90%	10%	0%	5	MoWR and Its agencies and MoFDM	2015	2019	90%	10%
EE 005	Institutional development and enabling environment	152	0	100	0	2	WARPO	2013	2014	0%	100%
EE 008	Institutional development and enabling environment	800	0	100	0	8	WARPO	2011	2018	19%	81%
EE 011	Institutional development and enabling environment	35	0	100	0	2	WARPO	2012	2013	0%	100%
EE 012	Institutional development and enabling environment	40	0	100	0	2	WARPO, MOEF	2014	2015	0%	100%
ID 001	Institutional development and enabling environment	170	0	100	0	2	LGD	2012	2013	0%	100%
ID 003	Institutional development and enabling environment	1300	0	85	15	6	BWDB	2012	2017	69%	31%
ID 005	Institutional development and enabling environment	12100	0	100	0	25	LGI	2013	2037	42%	58%
ID 007	Institutional development and enabling environment	365	0	100	0	5	DOE	2011	2015	0%	100%



PRO-GRAMME	INVESTMENT HEAD	CAPITAL COST (MIL-LION BDT)	PRI-VATE CON-TRIBU-TION (%)	GOB CON-TRI-BU-TION (%)	BEN-EFICI-ARY'S CON-TRIBU-TION (%)	DU-RA-TION	Agency	Pro-posed start	Pro-posed end	IF Proportion	FF Pro-portion
AW 003	Irrigation and drought Management	6125	0	85	15	15	BWDB, LGED	2015	2029	100%	0%
AW 004	Irrigation and drought Management	2200	0	85	15	10	BMDA	2013	2022	0%	100%
DM 006	Irrigation and drought Management	1041.4	0	85	15	10	DAE	2012	2021	89%	11%
MR 002	Irrigation and drought Management	4480	0	100	0	10	BWDB	2014	2023	100%	0%
MR 003	Irrigation and drought Management	50858	0	100	0	15	BWDB	2012	2026	100%	0%
MR 004	Irrigation and drought Management	15728	0	100	0	9	BWDB	2022	2030	95%	5%
MR 005	Irrigation and drought Management	86973	0	100	0	12	BWDB	2026	2037	95%	5%
MR 007	Irrigation and drought Management	8911	0	98	2	8	BWDB, LGED	2019	2026	100%	0%
MR 008	Irrigation and drought Management	2576	0	98	2	5	BWDB, LGED	2026	2030	100%	0%
MR 009	Irrigation and drought Management	12862	0	98	2	12	BWDB, LGED	2031	2042	100%	0%
T1P1	Irrigation and drought Management	5.07	14%	86%	0%	5	BRRI, BARI, NARS	2015	2019	14%	86%
T1P2	Irrigation and drought Management	1.71	25%	75%	0%	5	MoA, NARS	2015	2019	25%	75%
T1P3	Irrigation and drought Management	0.79	0%	100%	0%	10	MoA, MoWR, DAE	2015	2024	0%	100%
MC 012	Urban drainage	877	0	100	0	4	BWDB, CWASA, CCC	2013	2016	100%	0%
MC 013	Urban drainage	12000	0	100	0	15	CWASA	2015	2029	100%	0%
MC 014	Urban drainage	444	0	100	0	10	BWDB, KCC	2013	2022	100%	0%
MC 015	Urban drainage	3724	0	100	0	22	BWDB, KCC	2014	2035	100%	0%
MC 017	Urban drainage	5224	0	100	0	22	RCC, BWDB	2014	2035	100%	0%
T3P4	Urban drainage	862.86	99%	1%	0%	7	MoLGRD, RD&C, LGED, DWASA, CWASA	2020	2026	99%	1%
MC 001	Water supply and sanitation	12.5	0	100	2	2	DPHE	2011	2012	0%	100%
T1P7	Water supply and sanitation	24.55	2%	98%	0%	7	MoLGRD, RD&C, LGI, NGO	2010	2016	2%	98%
TR 003	Water supply and sanitation	44055	0	100	0	25	DPHE, CBO	2012	2036	100%	0%
TR 004	Water supply and sanitation	74234	80	20	0	25	DPHE, LGI, CBO	2011	2035	100%	0%
TR 005	Water supply and sanitation	34894	0	100	0	25	POROSHOVAS, LGI, LGED, DPHE, CBO	2012	2036	100%	0%
TR 006	Water supply and sanitation	31622	80	20	0	25	DPHE, CBO, LGI, Private sector	2011	2035	100%	0%

## ANNEX C: NWMP PORTFOLIO PROGRAMME LIST

### *Cluster: Institutional Development*

- ID 001 Local Government Needs Assessment for Water Management
- ID 002 Independent Regulatory Bodies for Water Supply and Sanitation Service Sector
- ID 003 FCD and FCD/I Management Rationalisation
- ID 004 BWDB Regional and Sub-regional Management Strengthening
- ID 005 Local Government Capacity Building for Water Management
- ID 006 WARPO Capacity Building
- ID 007 Department of Environment Capacity Building
- ID 008 Disaster Management Bureau Capacity Building
- ID 009 Department of Meteorology Capacity Building
- ID 010 BWDB Capacity Building

### *Cluster: Enabling Environment*

- EE 001 Support to the Preparation of New Legislation
- EE 002 Field Testing of Participatory Management Models
- EE 003 Water Resources Legislation – Preparation of Supporting Ordinances
- EE 004 Project Preparation Procedures – Guidelines and Manuals
- EE 005 Regulatory and Economic Instruments
- EE 006 Field Testing and Finalisation of the Guidelines for Participatory Water Management
- EE 007 NWRD Improved Data Collection and Processing Facilities
- EE 008 Water Resources Management Research and Development Studies
- EE 009 Water Resources Management Long Term Research and Development
- EE 010 Raising Public Awareness in the Wise Use and Management of Water
- EE 011 Private Sector Participation in Water Management
- EE 012 Water and Environment Funds
- EE 013 Alternative Financing Methods for Water Management

### *Cluster: Main Rivers*

- MR 001 Main Rivers Studies and Research Programmes
- MR 002 Main Rivers Abstraction Projects
- MR 003 Ganges Barrage and Ancillary Works
- MR 004 Meghna Barrage and Ancillary Works
- MR 005 Brahmaputra Barrage and Ancillary Works
- MR 006 Regional River Management and Improvement
- MR 007 Ganges Dependent Area Regional Surface Water Distribution Networks
- MR 008 North East and South East Regional Surface Water Distribution Networks
- MR 009 North Central and North West Regional Surface Water Distribution Networks
- MR 010 Main Rivers Erosion Control at Selected Locations
- MR 011 River Dredging for Navigation
- MR 012 Hydropower Development and Upgrading

### *Cluster: Towns and Rural Areas*

- TR 001 Urban Arsenic Mitigation
- TR 002 Rural Arsenic Mitigation
- TR 003 Large and Small Town Water Supply and Distribution Systems
- TR 004 Rural Water Supply and Distribution Systems
- TR 005 Large and Small Town Sanitation and Sewerage Systems
- TR 006 Rural Sanitation
- TR 007 Large and Small Town Flood Protection
- TR 008 Large and Small Town Storm water Drainage

### *Cluster: Major Cities*

- MC 001 Inventory and Asset Management Plan of the Water Supply and Sanitation Sector
- MC 002 Dhaka Bulk Water Supply and Distribution Systems
- MC 003 Chittagong Bulk Water Supply and Distribution Systems
- MC 004 Khulna Bulk Water Supply and Distribution Systems
- MC 005 Rajshahi Bulk Water Supply and Distribution Systems
- MC 006 Dhaka Sanitation and Sewerage Systems

- MC 007 Chittagong Sanitation and Sewerage Systems
- MC 008 Khulna Sanitation and Sewerage Systems
- MC 009 Rajshahi Sanitation and Sewerage Systems
- MC 010 Dhaka Flood Protection
- MC 011 Dhaka Storm water Drainage
- MC 012 Chittagong Flood Protection
- MC 013 Chittagong Storm water Drainage
- MC 014 Khulna Flood Protection
- MC 015 Khulna Storm water Drainage
- MC 016 Rajshahi Flood Protection
- MC 017 Rajshahi Storm water Drainage
- EA 004 National Fisheries Master Plan
- EA 005 National Fish Pass Programme
- EA 006 Unspecified Regional Programmes
- EA 007 Improved Water Management in the Haor Basins of the North East Region
- EA 008 Environmentally Critical Areas and Integrated Wetland Management
- EA 009 Improved Water Management and Salinity Control in the Sundarbans
- EA 010 Public Awareness Raising and Empowerment in respect of Environmental Issues

#### **Cluster: Disaster Management**

- DM 001 Cyclone Shelters and Killas
- DM 002 Bari-level Cyclone Shelters
- DM 003 Flood Proofing in the Char lands and Haor Basin
- DM 004 National, Regional and Key Feeder Roads - Flood Proofing
- DM 005 Railway Flood Proofing
- DM 006 Supplementary Irrigation and Drought Proofing of Rural Water Supplies

#### **Cluster: Agriculture and Water Management**

- AW 001 Promotion of Expanded Minor Irrigation and Improved On-farm Water Management
- AW 002 Improved Performance of Existing Public Surface Water Irrigation Schemes
- AW 003 New Public Surface Water Irrigation Schemes
- AW 004 New Public Deep Tube well Irrigation Schemes
- AW 005 Improved Water Management at Local Government Level
- AW 006 Improved Water Management at Community Level
- AW 007 Rationalisation of Existing FCD Infrastructure
- AW 008 Land Reclamation, Coastal Protection and Afforestation

#### **Cluster: Environment and Aquatic Resources**

- EA 001 National Pollution Control Plan
- EA 002 National Clean-up of Existing Industrial Pollution
- EA 003 National Water Quality Monitoring

## ANNEX D: BCCSAP PROGRAMME LIST

THEME	PROGRAMME
T1: Food security, social protection and health	P1. Institutional capacity for research towards climate resilient cultivars and their dissemination
	P2. Development of climate resilient cropping systems
	P3. Adaptation against drought
	P4. Adaptation in fisheries sector
	P5. Adaptation in livestock sector
	P6. Adaptation in health sector
	P7. Water and sanitation programme in climate vulnerable areas
	P8. Livelihood protection in ecologically fragile areas
	P9. Livelihood protection of vulnerable socio-economic groups (including women)
T2: Comprehensive Disaster Management	P1: Improvement of flood forecasting and early warning system
	P2: Improvement of cyclone and storm surge warning
	P3: Awareness raising and public education towards climate resilience
	P4: Risk management against loss on income and property
T3: Infrastructure	P1. Repair and maintenance of existing flood embankments
	P2. Repair and maintenance of cyclone shelters
	P3. Repair and maintenance of existing coastal polders
	P4. Improvement of urban drainage
	P5. Adaptation against Floods
	P6. Adaptation against tropical cyclones and storm surges
	P7. Planning and design of river training works
	P8. Planning, design and implementation of resuscitation of river and khals through dredging and de-siltation work
T4: Research and Knowledge Management	P1. Establishment of a center for knowledge management and training on climate change
	P2. Climate change modeling at national and sub-national levels
	P3. Preparatory studies for adaptation against sea level rise
	P4. Monitoring of ecosystem and biodiversity changes and their impacts
	P5. Macroeconomic and sectoral economic impacts of climate change
	P6. Monitoring of internal and external migration of adversely impacted population and providing support to them through capacity building for their rehabilitation in new environment
	P7. Monitoring of impact on various issues related to management of tourism in Bangladesh and implementation in priority action plan
T5: Mitigation and Low Carbon Development	P1. Improved energy efficiency in production and consumption of energy
	P2. Gas exploration and reservoir management
	P3. Development of coal mines and coal fired power stations
	P4. Renewable energy development
	P5. Lower emission from agricultural land
	P6. Management of urban waste
	P7. Afforestation and reforestation programme
	P8. Rapid expansion of energy saving devices
	P9. Energy and Water Efficiency in Built Environment
	P10. Improvement in energy consumption pattern in transport sector and options for mitigation

<b>T6: Capacity Building &amp; Institutional Strengthening</b>	<b>P1. Revision of sectoral policies for climate resilience</b>
	<b>P2. Main-streaming climate change in national, sectoral and spatial development programmes</b>
	<b>P3. Strengthening human resource capacity</b>
	<b>P4. Strengthening gender consideration in climate change management</b>
	<b>P5. Strengthening institutional capacity for climate change management</b>
	<b>P6. Main-streaming climate change in the Media</b>

Source: Ministry of Environment and Forest (MoEF), 2009



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