

CLIMATE CHANGE AND WATER IN BANGLADESH

INFORMATION BRIEF



Photo: IUCN / Shimanto Dipu

KEY POINTS

- Water and water resources is closely linked with climatic factors and the most damaging effects of climate change are predicted to be inland and coastal flooding, low flows and droughts, salinity intrusion, changes of the riverbed level due to sedimentation and changes in morphological processes due to seasonal variation of water level and flow and effects on groundwater.
- The impacts of climate change will be more pronounced in some regions. These regions have higher concentrations of poverty also.
- This paper highlights key policy gaps and suggests for adaption to these effects.

INTRODUCTION

Bangladesh is globally known as one of the most vulnerable countries to climate change. For Bangladesh, the most critical is the water sector. This is because water and water resources is closely linked with climatic factors and the most damaging effects of climate change are predicted to be floods, salinity intrusion, and droughts.

Analysis of climatic data from different stations in Bangladesh from 1975 onwards shows a clear sign of climate change and climate variability. It has been observed that pre and post monsoon mean temperature is rising in more than two-third of the meteorological stations and particularly in the coastal region more than 80% stations are showing rising trends in temperature.¹ Moreover, the frequency of extreme rainfall events has also increased over the recent years. The highest recorded rainfall for any month in the capital for a 24-hour period was 341 mm in September 2004. Again more recently, 448 mm rainfall was recorded during 24 hours in Dhaka on 27 July, which was the highest rainfall in the history of Dhaka. Tide gauge measurements and more recently satellite altimeter observations show a definite increase of sea level change.

According to Bates *et al.* (2008) the average rate of sea level rise was 1.7 ± 0.5 mm/yr for the 20th century, 1.8 ± 0.5 mm/yr for 1961–2003, and 3.1 ± 0.7 mm/yr for 1993–2003. Water level data from the past few decades show that, in the south western (Sunderbans) and south eastern part (Cox's Bazar) of Bangladesh there is an indication of sea level rise. In the absence of off-shore water level measuring stations data from these coastal monitoring stations can give an indication of sea level rise as these stations are situated in tidal dominated rivers and are mostly free from any sort of artificial or man-made interventions. The observed range of water level variance can be taken as 5.05 to 7.4 mm/yr.

Again the hydrological cycle and hydrological systems are closely linked with climate and climatic parameters. Climate warming strongly influences and causes changes in precipitation intensity and patterns, melting

of ice and snow, frequency of extreme climatic events, evaporation, soil moisture and runoff. Which means climate change and climate variability will have critical effects on water and water resources. Moreover, the impacts of climate change and climate variability on water and water resources will affect all aspects of lives and livelihoods and the overall growth and development of the country's economy.

Therefore understanding the impacts on climate change is crucial to assessing Bangladesh's overall vulnerability to climate change and identification of feasible adaptation measures in the water sector will play a central role in improving robustness of the overall socio-economic development processes of the country.

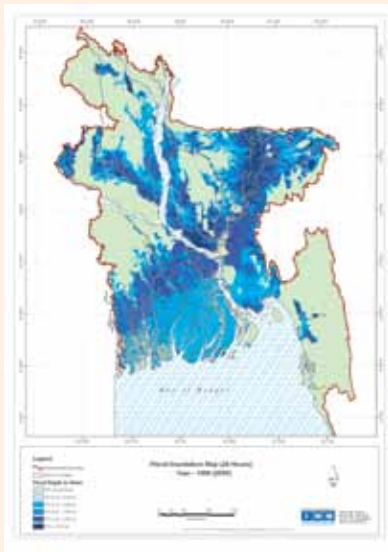
IMPACTS OF CLIMATE CHANGE ON WATER

According to the National Adaptation Programme of Action of Bangladesh², "Water related impacts of climate change will likely be the most critical for Bangladesh – largely related to coastal and riverine flooding, but also enhanced possibility of winter (dry season) drought in certain areas. The effects of increased flooding resulting from climate change will be the greatest problem faced by Bangladesh (Figure 1.2). Both coastal flooding (from sea and river water), and inland flooding (river/rain water) are expected to increase."

The key issues related to climate change impacts on water resources are inland and coastal flooding, low flows and droughts, changes of the riverbed level due to sedimentation and changes in morphological processes due to seasonal variation of water level and flow and effects on groundwater. Most of the expected impacts on the water resources will be more pronounced because of infrastructure developments, such as extension of the road communication networks and the construction of flood protection works. This implies in principle a kind of a multiplier effect, for example, by building embankments and protecting areas against increased flood levels, the flood problem is increased which requires more or higher embankments.

¹ Mukherjee, N., & Khan, M. F. (2009). *Factoring Climate Change Considerations in the Design of Padma Multipurpose Bridge*. Consultancy Report Prepared by the Center for Environmental and Geographic Information Services (CEGIS). Bangladesh Bridge Authority, Dhaka.

² MoEF. (2005). *National Adaptation Programme of Action (NAPA) Final Report*. Ministry of Environment and Forest Government of the People's Republic of Bangladesh.



Source: World Bank, 2010³

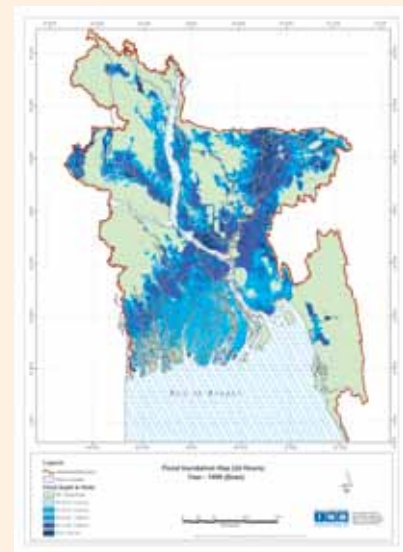
Figure 1: Peak flood flow map for base condition, 1998 flood

The risks for the water resources sector can be listed below:

- Increased intensity in flood flows due to higher peak flows, aggravated by increased drainage congestions;
- Drainage congestion, due to higher water level in the drainage systems, sea level rise and sedimentation in the flood plains;
- Increased pressure on freshwater availability, due to increased droughts (less precipitation and more evaporation) and lower rivers discharge and increased demand;
- Increased saline intrusion due to sea level rise and reduced upstream flow in dry season;
- Increased river erosion, due to higher peak flows, not fully compensated by accretion of equal quality, land elsewhere; and
- Increased intensity and frequency of cyclones and storms.

The impacts of climate change will be more pronounced in some regions. These regions have higher concentrations of poverty also. There will be variations in vulnerability within each zone, and places in areas lying beyond them will also face hazards, nevertheless the following regions are expected to be more exposed to climate change hazards,

- Flood plains adjacent to the rivers are



Source: World Bank, 2010³

Figure 2: Peak flood flow map for 2050 with climate change

subjected to riverine flood every year. Presently, flood prone area constitutes about 30% of the land mass and is spread throughout the country. The areas adjacent to major rivers and chars or riverine islands are expected to experience higher intensity flooding. In the north-eastern region the rivers are flashy in character and extremely high rain fall will cause frequent flash floods during the pre-monsoon period of April- May.

- Droughts will be prevalent in the north-west zone of Bangladesh and predicted to reach out into the mid-western region from the districts of Narail and Gopalganj in the south through Magura, Jessore, Rajbari, Faridpur and Pabna to Sirajganj, Natore, and Rajshahi in the north.
- Cyclones, floods, coastal erosion, and salinity problems may intensify and become more frequent and spatially extended in the 19 districts situated in the coastal zone of Bangladesh.
- Drainage congestion is likely to be intensified in major cities and urban areas especially located in the coastal zone of Bangladesh.

RESULTANT IMPACTS AND ECONOMIC LOSS

The consequences of changes in the water regimes on other economic and bio-physical sectors are often non-linear, complex and difficult to distil from

³ World Bank. (2010). *Bangladesh Economics of Adaptation to Climate Change*, August 23, 2010, Consultation Draft, The World Bank

anthropogenic influences. During the last decade comprehensive research, studies, information and tools on climate change and its impacts have become available and understanding of the processes, pathways and consequences has improved. Different studies show that in Bangladesh, the sectors which are predicted to be the most affected by changes in water and water resources are agriculture, health, fisheries, biodiversity and infrastructure.

Bangladesh already experiences frequent climate related disasters which lead to loss of life and economic assets, damage to infrastructure and livelihoods. However, over the last decades the intensity and frequency of natural disasters has increased exhibiting an upward trend in economic losses and costs.

Again the affects are more pronounced in specific regions or critical areas which have higher concentration of the poor. According to estimates by World Bank (2010), damages to infrastructure, livelihoods and losses from forgone production caused by natural disasters during the last decade have amounted to 0.5 to 1 percent of the GDP. This estimate will further increase if economic damage due to loss of life, impacts on health and biodiversity is added. The

same report (World Bank, 2010) projects that the net impacts of climate change will result in losses of about 3.1 percent in agricultural GDP and even larger economy-wide losses through 2050. Economic losses from severe floods are shown in Table1.

MANAGING CLIMATIC HAZARDS

The people of Bangladesh have adapted over generations to the risk of floods, droughts and cyclones. In modern Bangladesh, water resources management systems have been focused on the need to regulate and distribute water for irrigation, food production and water supply; and flood defence and drainage measures were taken to reduce flooding. But increased pressures on water resources from high population density, poor infrastructure and low resilience to economic losses are now compounded by uncertainties of climate change and climate variability. Water development and disaster management adaptation mechanisms include structural measures such as polders, embankments, cyclone shelters, cyclone-resisting housing and non-structural measures like early warning, awareness raising systems, and conjunctive use of water supply sources. However,

Table 1: Damages from Recent Serious Floods

	Monsoon Flood Year					
	1984	1987	1988	1998	2004	2007
Inundated area (km ²)	50,000	50,000	90,000	100,000	56,000	32,000
Road (km)		8,500	3,770	9,622	6,728	16,638
Rural Road (km)			3,105	29,154	19,882	
Bridges and Culverts along Roads		225	600	1,204	265	858
Railway Tracks (km)		650	1,053	349	415	
Bridges and Culverts along Railway Tracks		167	74	86	128	
Embankments (no)		2,800	3,800	4,329		
Embankment (km)			1,990	2,990	2,964	
Irrigation/ Drainage Canal (km)			283	373	752	2,243
Water Management Structures			1,465	1,031	1,041	336
River Bank Protection Works (km)			265	187	129	
Estimated Total Damage (million USD)	378	1,000	1,200	2,800	2,000	1,000

Source: World Bank, 2010⁴ and MoEF, 2009⁵

⁴ Ibid

⁵ MoEF. (2009). *Bangladesh Climate Change Strategy and Action Plan 2009*. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

present approaches and traditional methods of water resources management systems need to be reassessed.

According to Aerts and Droogers,⁶ the following elements are keys to effective adaptations to climate change in water resources management:

Flexibility and Robustness: Flexible or robust strategies and plans are imperative to adapt to changing climatic and water resources conditions. This can be done through risk-pooling, diversification and addressing a wide range of scenarios for evaluation of alternative options.

Cross-sectoral Co-operation: Bangladesh's overall adaptation to climate change should produce a coordinated response with specific cross-cutting adaptations that focus on a number of sectors. Related sectors to water resources management should include regional economic development, finance, insurance, livelihoods and poverty.

The Ability to Learn: Water resources management practices need to draw on experience and evolve as new information and perspectives come to light.

Governance: Sound governance and institutional structures in combination with structural or technical flexibility play an important role in ensuring effective adaptation of water resources systems to climate change.

It is also important to note that current approach and practices for development of water management options rely on statistical analysis which assumes "stationary" of climate. Stationary presumes the

climatic trends of the future will be similar to the climate data of the past. Therefore dynamic modelling will provide more reliable information on probable scenarios.⁷

FINANCING ADAPTATION IN THE WATER SECTOR

Effective and appropriate adaptation programme has to be supported by funding mechanisms and financial opportunities. Many of the adaptation options identified are essentially embedded into and complementary to existing national and sectoral plans and programmes. Nonetheless climate change concerns and complexities means there will be an incremental effect to the investments required to realise these programmes.

Since the 1960s the Government of Bangladesh has invested in a portfolio of water development and disaster management schemes which have significantly reduced damages and losses from extreme events over time. World Bank (2010) estimates these investments at around 10 billion USD. But even with this infrastructure in place, the Bangladesh Climate Change Study and Action Plan (2009) estimates that a 500 million programme will need to be initiated in years 1 and 2 for immediate actions such as strengthening disaster management, research and knowledge management, capacity building and public awareness programmes, and urgent investments such as cyclone shelters and drainage urgent drainage programmes. More detailed estimates are given in Table 2.

Table 2: Total Adaptation Cost to Address Increased Risk of Inland Flooding from Climate Change by 2050

Adaptation Options	Investment Cost (million USD)	Annual Recurrent Cost (million USD)
Transport – Road height enhancement	2,122	42
Transport – Road cross-drainage	5	-
Transport – Railway height enhancement	27	1
Embankment – height enhancement	96	2
Coastal Polders – cross drainage	421	8
Erosion Control Measures	-	1
Total Costs	2,671	54

Source: The World Bank, 2010⁸

⁶ Aerts, J. and P. Droogers. (2009). 'Adapting to Climate Change in the Water Sector'. In: F. Ludwig, Kabat P, van Schaik H. and M. van der Valk (eds.) *Climate Change Adaptation in the Water Sector*. Earthscan, UK.

⁷ Ludwig, F. (2009). 'Using Seasonal Climate Forecasts for Water Management.' In: F. Ludwig, Kabat P, van Schaik H. and M. van der Valk (eds.) *Climate Change Adaptation in the Water Sector*. Earthscan, UK.

⁸ World Bank. (2010). *Bangladesh Economics of Adaptation to Climate Change*. The World Bank. Pp. xvii.

The government of Bangladesh has recently established a National Climate Change Fund, with an initial capitalization of 45 million USD later raised to 100 USD, which will focus on adaptation. At the 2009 United Nations Climate Change Conference in Copenhagen, there was broad agreement that an effective response to climate change will require new investments and that developing countries will require more substantial assistance to meet the additional challenges from climate change (IMF, 2010). This is true for a developing country like Bangladesh already burdened by a poor resource base and financial constraints will not be able to address climate change issues without external technical and financial assistance.

The Green Climate Fund, established as a financial mechanism of the Copenhagen Accord predicts annual financing for developing countries rising to around \$100 billion per year by 2020, in support of developing countries to mitigate and adapt to climate change. In fact, in November 2010, Bangladesh became one of the first three countries to tap into a pilot climate change fund to help developing and highly vulnerable nations adapt to climate change. Part of this grant will help shore up the country's coastal embankment to withstand cyclones and storm surges, and also pay for water supply projects and promote farming of more resilient crops. However, these types of funds need to be administered properly with sound disbursement modalities, an appropriate governance structure and careful resource management.

POLICY AND INSTITUTIONAL ARRANGEMENTS

Policy Considerations

The national policies of relevance to climate change and water include: The National Water Policy (NWP), announced in 1999, which was the first comprehensive look at short, medium and long term perspectives for water resources in Bangladesh; followed by the National Water Management Plan (NWMP) in 2001 that looked at the implementation and investment responses to address the priorities identified in the NWP and also the Coastal Zone Policy.

The National Water Policy (NWP) was adopted in 1999 with title of with a view to guide both public and private actors to ensure optimal development and management of water sector that benefits both individuals and the society at large. Water access and

management is even a big challenge for Bangladesh as water resources are already under stress due to meteorological conditions and demand pressures from the society. Moreover, climate change is likely to pose an additional burden on water resources and their management. Keeping this in mind, following gaps have been identified in the National Water Policy.

- Risks associated with climate change and water resources are not addressed adequately in the existing water policy.
- Special provisions have not been made for flood and drought management when water bodies are shared among several regions.
- Adaptation measures for flood and drought episodes aggravated by climate change have not been addressed.
- Drainage patterns of the Ganges, Brahmaputra and Meghna region has not been included.
- Environmental flow within rivers has not been addressed.
- Filling up of flood flow zones and low land is another issue that has not been adequately addressed.

The NWP does not explicitly mention climate change, however climate change is recognised by the National Water Management Plan as one of the factors determining future water supply, including the impacts of sea level rise, which guides the implementation of the NWP. Further, many of the NWP and NWMP priorities are synergistic with climate change adaptation, such as the recommendation in the NWP for early warning and flood proofing systems. The NWMP focuses on better preparations for dealing with water related disasters including flood and drought emphasizing both structural and non-structural measures. Additionally, several planning issues including formulation of climate change scenarios and criteria for assessing vulnerability and options to reduce vulnerability have also been addressed.

The Coastal Zone Policy, formulated in 2005 provides a general guidance to all concerned for the management and development of the coastal zone in a manner so that the coastal people are able to pursue their life and livelihoods within secure and conducive environment. The Integrated Coastal Zone Management plan identifies critical impacts of climate change and sea level rise in Bangladesh are: increased drainage congestion; reduced

fresh water availability; disturbance of morphological processes; and increased intensity of extreme events and disasters. The policy gives the following directions for addressing climate change issues:

- Existing institutional arrangements for monitoring of climate change in Bangladesh will continue. Steps will be taken to support upgrading of technology and institutional strengthening for enhancing their capacity for generation of better data and more accurate long-term prediction and risk related to climate change.
- Implementation of adaptive measures identified in relation to climate change for coastal zone and resources shall be gradually undertaken.
- Efforts shall be made to continuously maintain sea-dykes along the coastline as first line of defence against predicted sea-level rise.
- An institutional framework for monitoring/detecting sea level rise shall be

made and contingency plans for coping with its impact.

Relevant policies addressing climate change also include the National Conservation Strategy (NCS), Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009 and the Poverty Reduction Strategy Paper (PRSP). Policymakers at the highest level in Bangladesh are also taking active participation in the international efforts (of IPPCC, UNFCC, COP) and plays an important role in international negotiations with a highly qualified team of negotiators backed by a national team of experts. Bangladesh has also motivated neighbouring countries to actively seek adaptation options to climate change at the regional level. This is reflected in the Sixteenth SAARC summit held in Thimphu, Bhutan in April 2010.

Institutional Arrangement for Tackling Climatic Change

Climate change is a development as well as environmental challenge. To adapt the water in the



Photo: IUCN / Abdul Quayyum

changing climate, coordination among all government and non government organization is imperative. For this reason, the institutional arrangement plays a key role for the water environmental planning and management to cope up with the changing of climate. As climate change is a cross-cutting issue a coordinated institutional response should be based on integrated planning with community participation on different levels. Again since many of the adaptation measures need to be applied at the local level effective strengthening and capacity building of local management organizations is also imperative. The Water Resources Planning Organization (WARPO) and Department of Environment (DOE) are the two apex organizations responsible for water resources and environment management in Bangladesh.

CONCLUSION AND RECOMMENDATIONS

This policy brief shows that the water sector of Bangladesh faces serious threats from climate change and climate variability; and although many of the impacts are difficult to differentiate from the climate and water management issues Bangladesh faces normally, there have been gradual and detectable

changes in the climatic conditions in the country. It highlights these key vulnerabilities and discusses practical anticipatory measures and responses in managing these impacts. This document can serve to enable a discussion for a broad consensus of planners and practitioners in Bangladesh to develop project specific guidelines.

The key issues related to climate change impacts on water resources are inland and coastal flooding, low flows and droughts, salinity intrusion, changes of the riverbed level due to sedimentation and changes in morphological processes due to seasonal variation of water level and flow and effects on groundwater. According to estimates by World Bank , damages to infrastructure, livelihoods and losses from forgone production caused by natural disasters during the last decade have amounted to 0.5 to 1 percent of the GDP. Again the affects are more pronounced in specific regions or critical areas which include flood plains adjacent major rivers, the coastal region, the north-west region and unplanned urban areas. Again many of these areas have higher concentration of the poor. This estimate will further increase if economic damage due loss of life, impacts on health and biodiversity is added.



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