

Country Paper: Bangladesh

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Introduction

Bangladesh is the worst affected and the most vulnerable country to climate change due to its geographic location, low-lying deltaic nature and flat topography, high population density, reliance of many livelihoods on climate sensitive sectors, particularly agriculture and fisheries, and inefficient institutional aspects (Huq, 2001; Nishat *et al.*, 2009; Huq and Ayers, 2007). Millions of people are affected every year, forcing people in to abject poverty and vulnerability. The anticipated adverse affects of climate change are sea level rise; higher temperatures, enhanced monsoon precipitation and an increase in cyclone intensity will impede the development of Bangladesh, particularly by reducing water and food security and damaging essential infrastructure (MoEF, 2005). The climate change will have devastating effects on almost all sectors of the economy, the environment, national development, and the people of Bangladesh (Reid and Sims, 2007; Nishat *et al.*, 2009).

Climate change is a global phenomenon and can not be solved alone. However, though negligible, Bangladesh has developed some capacity for dealing with the impacts of climate change at the national level, and policy response options have been mobilized that deal with vulnerability reduction to environmental variability in general, and more recently, to climate change in particular. In addition, Bangladesh has for some time been recognized as a particularly vulnerable country by the international community, and has received disaster management and adaptation support in several sectors.

1. Overview of Bangladesh in context to climate change

Bangladesh is the most vulnerable countries to climate change in relation to physical, social and economic conditions. It is one of the largest deltas in the world, formed by a dense network of the distributaries of the rivers Ganges, Brahmaputra, and the Meghna, and more than 230 major rivers and their tributaries and distributaries. The total land area is 147, 570 sq km and consists mostly of low, flat land. Eighty per cent of the land is floodplain, and only in the extreme northwest do elevations exceed 30 meters above mean sea level, making the majority of Bangladesh prone to flooding at least part of the year, with the floodplains of the north western, central, south central and north eastern regions subject to regular flooding. Between 30-70 per cent of the country is normally flooded each year. The extent of flooding is exacerbated by the sediment loads brought by the three major Himalayan rivers, coupled with a negligible flow gradient, which increases congestion (Agrawala, 2003).

The relevant predictions of climate change as they relate to Bangladesh include:

The projected increases in temperatures for the individual months are similar, regardless of the month;

Ten of the months have decreased precipitation quantities while two of the months have increases;

The net amount of annual precipitation is projected as virtually unchanged such that the annual amount remains almost the same but the great majority of the months have decreased precipitation quantities (Table 1).

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Table 1. Projected changes in temperature and precipitation for Bangladesh in response to climate change

| Month | Projected Temp Change in 2100 for Individual Months (°C) | Precipitation in 2000 (mm/month) | Projected Ppn in 2100 (mm/month) | Ratio Ppn (2100/ Ppn (2000)) |
|----------------------|--|----------------------------------|----------------------------------|------------------------------|
| January | 2.0 | 118 | 98 | 0.83 |
| February | 2.5 | 93 | 89 | 0.96 |
| march | 2.2 | 106 | 95 | 0.89 |
| April | 1.5 | 102 | 73 | 0.71 |
| May | 2.0 | 108 | 78 | 0.72 |
| June | 1.4 | 104 | 75 | 0.72 |
| July | 1.6 | 431 | 542 | 1.26 |
| August | 2.2 | 431 | 432 | 1.00 |
| September | 2.4 | 283 | 262 | 0.92 |
| October | 2.2 | 159 | 115 | 0.72 |
| November | 1.7 | 100 | 75 | 0.75 |
| December | 1.8 | 104 | 81 | 0.78 |
| Annual rainfall (mm) | | 2140 | 2015 | 0.86 |

Source: McBean *et al.* 2009

2. Current trends in climate Change vulnerability and its impact on agriculture and water sector

Climate change is affecting many sectors, including water resources, agriculture, food security, ecosystems, biodiversity, human health, urban areas and coastal zones.

2.1 Anticipated climate change impacts

Many of the projected impacts of climate change will reinforce the baseline environmental, socio-economic and demographic stresses already faced by Bangladesh. Climate change is likely to result in:

- Increased flooding, both in terms of extent and frequency, associated with sea level rise, greater monsoon precipitation and increased glacial melt
- Increased vulnerability to cyclone and storm surges
- Increased moisture stress during dry periods leading to increased drought
- Increased salinity intrusion
- Greater temperature extremes

2.2 General Impact of Climate Change

Bangladesh has stressed environmentally, socially and economically as a result of climate change. However, climate change induced impacts may trigger a chain of consequences due to non-climatic activities and their outcomes. The main effects of climatic change are sea level rise and increase frequencies of natural disasters (Table 2). As a result of sea level rise coastal regions of Bangladesh has experienced tremendous consequences including coastal inundation and erosion, intrusion of saline water, deforestation, loss of biodiversity and agriculture and large scale migration. According to some reports 830, 000 million hectares of arable lands is affected by various degree of salinity. About 4.56 million tons of rice was damaged due to drought and flood during 1973-1987 (Rahman *et al.*, 2009). There were 93 major natural calamities recorded during 1991 to 2000 resulting near about 0.2 million deaths and causing US \$ 5.9 billion in damage with high losses in agriculture and infrastructure.

Table 2. General impacts of climate change in Bangladesh

| Effect of climate change | | Impacts | Projection |
|--|---|--|--|
| Direct effect | More frequent and severe droughts | <ul style="list-style-type: none"> ➤ Decreased water availability ➤ Lead directly to conflict over water resources | IPCC- by the year 2050 > 1 billion people in Asia adversely affect by |
| | | Ruin harvests, leading to malnutrition and migration | IPCC- by the year 2020 75-250 million people exposed to water stress |
| | Acidification of the ocean | Hinder the formation of shells and skeletons of marine organisms, adversely affecting marine ecosystem | |
| | Sea level rise | <ul style="list-style-type: none"> ➤ Large scale people migration ➤ Increased frequency of flood, storms surges, salt water intrusion etc. ➤ Contaminate fresh water wells and aquifers | World Bank (Dasgupta <i>et al.</i> , 2007)-1 meter sea level rise would affect at least 56 million people |
| | More frequent tropical storms and fires started by lightening strikes | <ul style="list-style-type: none"> ➤ People movements from low lying areas fleeing the devastation and loss of farm lands ➤ Clean water contamination due to salt water by storm surges | Large scale people movement are highly likely to lead directly to conflict as people try to cross boarder and settle on land already claimed by others |
| | Loss of biodiversity | <ul style="list-style-type: none"> ▪ Organisms migration ▪ Lost of critical “Keystone” species | Outbreaks of cholera, Diarrhoea and other water borne diseases |
| <ul style="list-style-type: none"> ➤ Affecting human socio-economic system ➤ By agriculture and tourism, ➤ Loss of irreplaceable natural chemical compounds for pharmaceuticals and bioscience research | | | |
| Indirect | “Other” economic costs | Impact the insurance industry resulting higher premiums <ul style="list-style-type: none"> ➤ Affect energy generation companies finally this will pass caused on to consumers ➤ Make insurance unaffordable to those who previously able to afford | |
| | Higher energy cost lead | ❖ Adverse health outcomes since they increase transport, heating and electricity costs for the health sector | |
| | Donor fatigue | Increase natural disasters and conflicts, spread tropical diseases etc. will likely increase energy and other economic costs facing donor countries | Pressure on donors’ aid budgets |

Source: Rahman *et al.* (2009)

2.3 Impacts on agriculture

As noted above, the economy of Bangladesh is based on agriculture, with two thirds of the population engaged in or indirectly relying on agricultural activities, although the country is slowly moving towards industrialization.

Agriculture is one of the most sensitive sectors to climate change, particularly changes in temperature, rainfall patterns, and increased likelihood of extreme events such as droughts and floods. Although an increase in CO₂ levels could under moderate temperature increases result in an increase in cropping yields, through carbon fertilization, modeling studies suggest that increasing frequency of crop loss due to extreme events, such as droughts and heavy precipitation, may overcome any benefits of moderate temperature increases (Easterling , 2007).

In Bangladesh, the overall impact of climate change on agricultural production will be negative. While inundation to a lesser degree has had a positive impact on production, with perennial floods bringing silt and nutrients increasing the fertility of the soils, prolonged

floods have had a detrimental impact on crop yields; in two severe floods, 1974 and 1987, the shortfalls in production were about 0.8 and 1.0 Mt, respectively (Rahman and Alam, 2003). On an average during the period 1962-1988, Bangladesh lost about 0.5 Mt of rice annually as a result of floods, which accounts for nearly 30% of the country's average annual food grain imports (Paul and Rashid, 1993). Other impacts of climate change such as temperature extremes, drought, and salinity intrusion, are also causing declining crop yields in Bangladesh.

Agricultural land area of the country is declining at the rate of 200 ha/day. Significant decrease is observed in Aus cultivation production from local variety has declined. Production from high yielding variety had increased. Aus cropped area has declined over the years. In 1980, it was 3.11 Mha and became 2.11 M. ha in 1990. In 2000, it was only 1.33 Mha. Major changes noticed in northwest and central regions *Aman* cropped area has not declined significantly over the years; In 1980, it was 6.03 Mha and became 5.77 Mha in 1990. In 2000, it was only 5.71 Mha. Changes noticed in northwest and north-central regions *Boro* cropped area has increased significantly over the years; In 1980, it was 1.15 Mha and became 2.52 Mha in 1990. In 2000, it was only 3.76 M. ha. Major expansion occurs in northwest and southwest regions *Aus* cropped area under local variety has decreased significantly over the years; but high yielding variety of *Aus* has increased. *Aman* cropped area under broadcast, local transplanted pajam variety has decreased over the years; But high yielding variety of *Aman* has increased *Boro* cropped area under local and pajam variety has decreased over the years; But high yielding variety of *Boro* has increased. Irrigated area has increased about 3 times over the last 20 years Irrigated area under *Boro* Rice has increased significantly compared to other rice crops. Major increased noticed in northwest, northeast and central region.

The fisheries sector may also be adversely affected by climate change. The fisheries sector contributes to about 3.5% of the GDP in Bangladesh, and people rely on fish products to make up the majority of daily protein dietary requirements. There are 260 species of fish in Bangladesh, all of which are sensitive to particular salt and freshwater conditions (MoEF, 2005). The changes in tidal patterns, as well as increasing saline intrusion into the freshwater rivers, associated with climate change, will impact on fish populations, although the extent to which this occurs is still uncertain.

2.4 Impacts on water resources

The National Adaptation Program of Action (NAPA) highlights water related impacts of climate change to be amongst the most critical for Bangladesh, particularly in relation to riverine and coastal flooding, but also in relation to increased winter droughts in some areas. Agrawala (2003) states that future changes in precipitation in Bangladesh have four distinct implications:

- The timing of occurrence of floods may change,
- Increase precipitation in the Ganges, Brahmaputra and Meghna basins may increase the magnitude, depth and spatial extent of floods
- The timing of peaking in the major rivers may also change, and
- Increased magnitude, depth, extent and duration of floods will bring a dramatic change in land use patterns.

Other changes associated with climate change include increases in evaporation rates, reduction in dry season transboundary flows resulting in an increase in irrigation water requirements, sea level rise that will exacerbate drainage congestion, and other potential impacts such as more frequent flash floods, higher frequency of tropical cyclones, rise in storm surge depths, and slower accretion of coastal lands.

Changes to water resources and hydrology will have a major impact on Bangladesh, where people depend on the surface water for fish cultivation, navigation, industrial and other uses, and where the ground water is used for domestic purposes and irrigation. The impacts on agriculture have already been noted.

It should be noted that these problems will be further exacerbated by poor water management, both nationally and trans-boundary. For example, the effect of water diversion upstream on dry season flows and salinity levels on coastal mangroves in Bangladesh was found to be comparable, if not higher, than the impact that might be experienced several decades later as in line with climate change projections.

2.5 Impacts on coastal areas

Coastal areas in Bangladesh are on the 'front line' of climate change, directly affected by storm surges, drainage congestion, and sea level rise. Most of Bangladesh is less than 10 m above sea level, with almost 10% of the country below 1 m, making it extremely vulnerable to increasing high tides. With sea levels expected to rise by an average of 2-3 mm per year during the first part of this century (IPCC, 2007). The effects on the coastal areas will be severe, and include erosion, coastal land subsistence, siltation of river estuaries, reduced sedimentation, water-logging, and saltwater intrusion.

3. Investments in research and development to meet the challenges of climate changes

Over the last 35 years, the Government of Bangladesh, with the support of development partners, has invested over \$10 billion to make the country more climate resilient and less vulnerable to natural disasters. These investments include flood management schemes, coastal polders, cyclone and flood shelters, and the raising of roads and highways above flood level. In addition, the Government of Bangladesh has developed state-of-the-art warning systems for floods, cyclones and storm surges, and is expanding community-based disaster preparedness. Climate resilient varieties of rice and other crops have also been developed.

4. Adaptation Measures and Practices of Bangladesh

Since the 1970s, the Government of Bangladesh has taken following adaptation measures and practices:

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

5. Policies and programs designed to integrate the adaptation measures

To integrate climate risk into development plans and processes, the government, through its Department of Environment has recently launched the preparation of the Climate Change Policy and Action Plan for Bangladesh. Government established Climate Change Cell in DoE under the Ministry of Environment and Forests supports the mainstreaming of climate change into national development planning and has developed a network of 34 'focal points' in different government agencies, research and other organizations.

5.1 Mainstreaming climate change into development and national planning

The Bangladesh government is integrating climate change into sectoral plans and national policies. For example, recommendations from the World Bank on the impacts of climate change have been incorporated into coastal zone management programs and adopted in the preparation of disaster preparedness plans and a new 25 year water sector plan. In agriculture, research programs have taken place in light of climate change information, particularly drought and saline tolerant rice varieties.

5.2 Climate change policies, planning and institutions

Bangladesh is signatory to the United Nations framework Convention on Climate Change (UNFCCC). In 1992, the Government of Bangladesh signed the UNFCCC, and ratified in 1994. A National Climate Change Committee, comprised of members from all relevant government and non-government organizations was constituted in 1994 for policy and guidance and to oversee the implementation of obligations under the UNFCCC process. In addition to the Climate Change Cell, other government institutions that are relevant for climate change include: an inter-ministerial committee on climate change, headed by the Minister for Environment and Forests and with representation from relevant government ministries as well as NGOs and research institutions; and a National Environment Committee to determine environmental policies chaired by the Prime Minister with representation from MPs as well as government and civil society.

Other national policies of relevance to climate change 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.

The Climate Change Action Plan is a 10-year program (2009-2018) to build the capacity and resilience of the country to meet the challenge of climate change. The needs of the poor and vulnerable, including women and children, will be mainstreamed in all activities under the Action Plan. In the first five year period (2009-13), the program will comprise six pillars:

- Food security, social protection and health
- Comprehensive Disaster Management
- Infrastructure
- Research and knowledge management
- Mitigation and low carbon development
- Capacity building and institutional strengthening

It is estimated that a \$500 million program will need to be initiated in Years 1 and 2 (e.g., for immediate actions such as strengthening disaster management, research and knowledge management, capacity building and public awareness programs, and urgent investments such as cyclone shelters and selected drainage programs) and that the total cost of programs commencing in the first 5 years could be of the order of \$5 billion. The Government of

Bangladesh has established a National Climate Change Fund. Development partners may contribute to this fund, establish different funds or use other financing mechanisms.

6. Issues and challenges in mainstreaming adaptation

To mainstream adaptation into development planning of agricultural and water sectoral activities, the following issues and challenges should be include:

- Salinity, drought and flood (water logging) tolerant crop varieties should be invented and it should be made popular and available.
- Water conservation techniques must be developed along with new technologies (e.g. rain water harvesting).
- Grassroots communities should also be educated on the dissemination of climate information and traditional approaches to weather forecasting. For its part, the Meteorological Department should improve its weather forecasting techniques and ensure the effective dissemination of climate and weather data to the rural population especially farmers.
- Capacity building for integrating climate change in planning, designing of infrastructure, conflict-management and land water zoning for water management institutions.
- Construction of flood center, and information and assistance center to cope with enhanced recurrent floods in the major floodplains along with flood proof seed bed.
- Development of eco-specific climatic knowledge (including indigenous knowledge) on adaptation to climate variability to enhance adaptive capacity for future climatic change.
- Adaptation to fisheries in areas prone to enhanced flooding in North East and Central Region through adaptive and diversified fish culture practices.
- Promoting adaptation to coastal fisheries through culture of salt tolerant fish special in coastal areas of Bangladesh.
- Exploring options for crop insurance and other emergency preparedness measures to cope with enhanced climatic disasters.
- Government should allocate more funds for research and development of appropriate technology to encourage farmers to diversify into heat and drought-tolerant crops as well as disease-resistant livestock.
- Incorporate climate change adaptations in long-term planning and developmental programs.
- Encourage and enhance conservation and recycling of water including inter-basin transfers with more storage facilities.

7. Conclusion

To strengthen climate change adaptation mechanism in Bangladesh, sectoral research and awareness should be geared up. This will help undertake sectoral mitigation and adaptation measures. Even if the climate change of alarming magnitudes does not occur! the adaptation and mitigations options will pay in the long run to keep the future environment congenial.

The paper illustrates mostly a little information on impact of climate change in agriculture and water sectors of Bangladesh. All of informations gathered from published sources especially from National Adaptation Programs Action (NAPA). To realize the holistic situation on impact of climate change of Bangladesh, the provided information is not sufficient. It only highlights a little bit pin point on the topic due to page limitation.

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