

Introduction

Bangladesh is frequently cited as one of the most vulnerable countries to climate change [4-7] because of its disadvantageous geographic location; flat and low-lying topography; high population density; high levels of poverty; reliance of many livelihoods on climate sensitive sectors, particularly agriculture and fisheries; and inefficient institutional aspects[9]. Many of the anticipated adverse affects of climate change, such as sea level rise, higher temperatures, enhanced monsoon precipitation, and an increase in cyclone intensity, will aggravate the existing stresses that already impede development in Bangladesh, particularly by reducing water and food security and damaging essential infrastructure[10]. These impacts could be extremely detrimental to the economy, the environment, national development, and the people of Bangladesh[11].

Bangladesh has developed some capacity for dealing with the impacts of climate change at the national level, and policy response options have been mobilised 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 recognised as a particularly vulnerable country by the international community, and has received disaster management and adaptation support in several sectors.

This briefing note will begin by describing the country characteristics of Bangladesh that make it particularly vulnerable to climate change, before outlining the main climate change impacts that are of concern to Bangladesh. These impacts will then be discussed in relation to their adverse effects on different sectors. Finally, the national and international policy responses to manage these effects will be outlined, including actions that that mitigate the impacts of climate variability in general, as well as those that target climate change specifically.

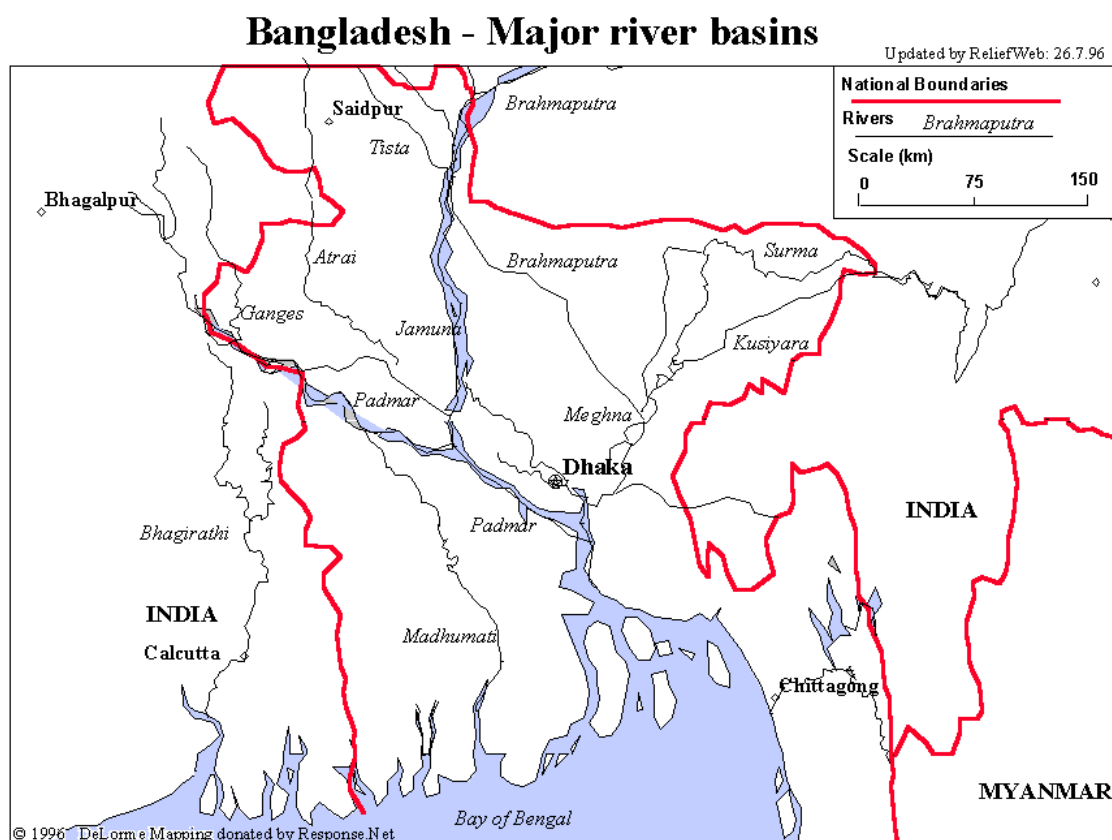
1. Context

The core elements of Bangladesh's vulnerability to climate change are contextual [12]. This section will highlight the country characteristics that increase the vulnerability of Bangladesh, and consider which impacts of climate change are likely to be most damaging in this context.

1.1. Bangladesh: Country characteristics

The physical, social and economic conditions of Bangladesh are relevant to its status as one of the most vulnerable countries to climate change.

Bangladesh 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 (see map 1). 80 per cent of the land is floodplain, and only in the extreme northwest do elevations exceed 30 metres above mean sea level, making the majority of Bangladesh (with the exception of the highlands) 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 [10]. 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 [12].



The boundaries and names shown on this map do not imply official endorsement or acceptance by the United Nations or ReliefWeb. These maps may be freely distributed. If more current information is available, please update the maps and return them to ReliefWeb for posting.

Map 1: The major rivers of Bangladesh. Source: Reliefweb www.reliefweb.int/

The societal exposure to such risks is further increased by the country's high population and population density. Bangladesh has a population of 143 million people (2002) [13] with a GDP per capita (PPP US\$) of 2,053, a life expectancy at birth of 63.1 years, and an adult literacy rate of 47.5 per cent. The recent Human Development Report ranks Bangladesh number 140 of 177 nations, with an HDI¹ value of 0.547 [14]. Bangladesh has an average annual population growth rate (2002) of 2 per cent (4.6 per cent in urban areas), 75 per cent of the population live in rural areas, and a population density (people per km sq) of 954.4 [13]. (For a comprehensive list of population, health, and human wellbeing indicators of Bangladesh, see appendix A). Bangladesh is predominantly agricultural, with two thirds of the population engaged in farming activities, although it should be noted that more than three quarters of Bangladesh's export earnings come from the garment industry [15].

In terms of climate, Bangladesh is characterised by high temperatures, heavy rainfall, high humidity, and fairly marked seasonal variations. Although over half of Bangladesh is north of the Tropics, the climate is characterised as tropical for most of the year because of the effect of the Himalayan mountain chain, with a warm, almost uniformly humid climate throughout most of the year. There are three main seasons in Bangladesh [5]:

- i. A hot summer season, with high temperatures (exceeding 40°C for up to 10 days in the West), a high rate of evaporation, and erratic but heavy rainfall from March to June;
- ii. A hot and humid monsoon season, with temperatures ranging between 20°C and 36°C with heavy rainfall from June to October. This amounts to around two thirds of the annual rainfall.
- iii. A cooler and drier winter from November to March, with temperatures ranging from 8°C to 15°C, with minimum temperatures of 5°C in the North.

1.2. Projected 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:

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

Increased flooding

Precipitation extremes will result in increased rainwater flooding, both because of the increase in monsoon rains, and also because of the increased incidences of flash floods associated with increased intensity of precipitation interrupted by sustained dry spells, increasing the surface runoff when the rains do come.

Sea level rise will directly result in increased coastal flooding, which will increase in the event of storm surges. Sea level rise in Bangladesh is higher than the mean average rate of global sea level rise over the past century, because of the effects of tectonic subsidence [5].

¹ Human Development Index (HDI) looks beyond GDP to a broader definition of well-being. The HDI provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy); being educated (measured by adult literacy and education enrolment); and having a decent standard of living (measured by purchasing power parity).

Sea level rise is also associated with increased riverine flooding, because it causes more backing up of the Ganges-Brahmaputra-Meghna rivers along the delta [12]. This will result in increased drainage congestion due to higher water levels, which will be exacerbated by other factors associated with climate change such as siltation of estuary branches in line with increased surface runoff, and higher riverbed levels.

Higher temperatures will result in increased glacier melt, increasing runoff from the neighbouring Himalayas into the Ganges and Brahmaputra rivers. The recent Intergovernmental Panel on Climate Change IPCC Fourth Assessment Report (FAR) states that glaciers in the Himalayas are receding faster than in any other part of the world, and this can be attributed primarily to global warming.[17]

Increased intensity of cyclone winds and precipitation

The IPCC conclude that there is evidence of a 5-10 per cent increase in intensity (wind speed) that would contribute to enhanced storm surges and coastal flooding, and also project a 20 per cent increase in intensity of associated precipitation that would contribute to flooding.[12] Cyclone winds are likely to increase in intensity because of the positive correlation with sea surface temperature. In November 2007, for example, the tropical cyclone Sidr, with a 100 mile long front covering the breadth of the country and with winds up to 240 km per hour, hit Bangladesh. This was noted to be an unusual occurrence given the intensity and timing of the storm, particularly given that it occurred in the same year as two recurrent floods [16]. The IPCC FAR also note that climate change will be associated with greater precipitation extremes, which includes more intense monsoonal rainfall.

Increased moisture stress during dry periods

Climate change will exacerbate drought in Bangladesh both in terms of intensity and frequency linked to higher mean temperatures and potentially reduced dry season precipitation. Monsoon rains produce 80% of Bangladesh's annual precipitation, and when this is reduced, drought is a significant problem; between 1960 and 1991, a total of 19 droughts occurred in Bangladesh[12]. The Southwest and Northwest regions are particularly susceptible to drought. Greater precipitation extremes associated with climate change also mean less rainfall in the dry season, which will increase water stress on those areas that already experience water shortages, particularly in the winter months. This will be worse for those areas that depend on glacial melt water for their main dry-season water supply, as glaciers recede with rising temperatures.

Increased salinity

The availability of freshwater will be reduced by increased salinity intrusion into fresh water sources during the low flow conditions. In the coastal regions this is brought about by sea level rise resulting in saline water intrusion in the estuaries and into the groundwater. The effects are exacerbated by greater evaporation and evapotranspiration of freshwater as temperatures increase, coupled with a greater demand for fresh water in times of water stress.

Greater temperature extremes

Climate change is associated with hotter summers and colder winters. Temperatures in Bangladesh have increased about 1°C in May and 0.5 °C in November between 1985 and 1998, and further temperature increases are expected. However, although the overall climate is warming, temperature extremes are increasing, and winter temperatures as low as 5°C have been recorded in January 2007, reportedly the lowest in 38 years [11].

2. Sectoral Impacts

The impacts of climate change on Bangladesh have significant implications for its development. These impacts will be discussed for different sectors, before considering what the IPCC refer to as the “human dimensions” of climate change impacts, including a discussion of the most vulnerable groups.

2.1. Agriculture and fisheries

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 industrialisation.

Agriculture is one of the most sensitive sectors to climate change[18], 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 fertilisation, modelling 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[19].

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 [5]. On average during the period 1962-1988, Bangladesh lost about 0.5 million tonnes of rice annually as a result of floods, which accounts for nearly 30% of the country’s average annual food grain imports [20].

Other impacts of climate change such as temperature extremes, drought, and salinity intrusion, are also causing declining crop yields in Bangladesh. Several studies have been conducted in Bangladesh to assess the vulnerability of food grain production to various climate scenarios. One such study² noted that a 4°C increase in temperature would have a severe impact on food production in Bangladesh, resulting in a 28 per cent reduction for rice and a 68 per cent reduction for wheat [5]. Temperature and rainfall changes have already affected crop production in many parts of Bangladesh, and the area of arable land has already decreased. The shortening of the winter season is resulting in a decline in production of winter crops, particularly potatoes.

The salinity intrusion experienced by the coastal area of Bangladesh is having serious implications for the quality of the soil in areas that were traditionally used for growing rice. Under a moderate climate scenario the decline in yields due to salinity intrusion could be 0.2 Mt, which increases to 0.56 Mt under more severe scenarios[5].

Increases in water stress have also affected the production of major crops, again particularly rice, which needs significant amounts of water. The IPCC FAR note that the production of rice and wheat could fall by eight per cent and 32 per cent respectively by 2050[19].

The fisheries sector may also be adversely affected by climate change. The fisheries sector contributes to about 3.5 per cent of the GDP in Bangladesh, and people rely on fish products to make up the majority of daily protein dietary requirements.

² Climate Change Country Study Bangladesh, under the United States Climate Change Study Programme, carried out by the Bangladesh Centre for Advanced Studies in 1996, in conjunction with BIDS and BUP, with support from the US Government.

There are 260 species of fish in Bangladesh, all of which are sensitive to particular salt and freshwater conditions[10]. 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.

The implications of climate change for agriculture and fisheries are extremely significant, not only because of the livelihoods implications for the majority of the population who depend on agricultural outputs and systems, but also because of the threat to Bangladesh's food security, where projections suggest that by the year 2030 food-grain requirements will be 41.6 million tonnes. To become self sufficient in food grain production by 2030, an additional 14.64 million tonnes will be required[11]. Further, about 80 per cent of animal protein intake in Bangladeshi daily diets comes from fish. The population of Bangladesh almost doubled in less than thirty years from 1961, and now stands at over 143 million. According to projections the requirement of foodgrain in the country will be 42.8 Mt by 2030[5]. Increase vulnerability to crop production makes this near impossible and with fisheries also vulnerable to climate change, food security in Bangladesh is unlikely to be achieved.

2.2. Water resources and hydrology

In Bangladesh, the effects of climate change on the surface and groundwater resources will be entirely negative[21]. The National Adaptation Programme 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[10].

In terms of flooding, a report by the OECD[5] states that future changes in precipitation in Bangladesh have four distinct implications:

- i. The timing of occurrence of floods may change, with implications for the seasonality of the hydrological cycle
- ii. Increase precipitation in the Ganges, Brahmaputra and Meghna basins may increase the magnitude, depth and spatial extent of floods
- iii. The timing of peaking in the major rivers may also change, which may in turn change the likelihood of synchronization of flood peaks of major rivers
- iv. Increased magnitude, depth, extent and duration of floods will bring a dramatic change in land use patterns in Bangladesh.

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 [12].

This highlights the interaction between climate change and the existing stresses already experienced by Bangladesh with regards to water management.

2.3. 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 ten metres above sea level, with almost ten per cent of the country below 1 metre, making it extremely vulnerable to increasing high tides. With sea levels expected to rise by an average of two to three mm per year during the first part of this century[21], the effects on the coastal areas will be severe, and include erosion, coastal land subsistence, siltation of river estuaries, reduced sedimentation, waterlogging, and saltwater intrusion.

The coastal area of Bangladesh and the Bay of Bengal are located at the tip of the northern Indian Ocean, which is frequently hit by severe cyclonic storms, generating long tidal waves that are aggravated by the shallow bay [5]. Although Bangladesh now has good early warning systems and cyclone shelters have been constructed along much of the coast, infrastructure and livelihoods are still threatened and severely affected, hampering further development of the coastal areas. 30 districts were damaged by clone Sidr for example, with the 11 districts closest to the coast damaged most severely [16].

Coastal areas will also be affected by salinity intrusion. Saltwater from the Bay of Bengal already penetrates 100 kilometres inland during the dry season [11], and climate change is likely to exacerbate this. Pressure from an increasing population and rising demand for groundwater further reduces the availability of freshwater supplies for domestic and industrial purposes

A quarter of the population live in the coastal areas, with the majority of the population reliant on or affected by coastal activities. If sea levels rises up to one metre this century, Bangladesh could lose up to 15 per cent of its landmass and up to 30 million Bangladeshis could become climate refugees [22]. In these areas, agriculture, industry, infrastructure, livelihoods, marine resources, forestry and biodiversity, human health, and utility services will all suffer. Such a scenario could lead to a decline in GDP of between 27 and 57 per cent [12].

2.4. Forestry /Biodiversity

Bangladesh has a diverse range of forest ecosystems, including savannah, bamboo, freshwater swamp forests and mangroves. The Sundarbans of Bangladesh, a world heritage sight, is the single largest mangrove area in the world, comprising an area of 577,00 ha, and housing one of the richest natural gene pools. A total of 425 species have been identified there, the most notable of which is the Bengal tiger, which is endemic to the area. Climate change will have a detrimental impact on all of the forest ecosystems in Bangladesh, and the Sundarbans are likely to be the worst affected [5]. The changes in temperature and water resources with climate change will result in direct pressure on many climate-sensitive species, and cause increased erosion and deterioration of soil quality in may upland forested areas. Increased rainfall intensity will cause enhanced erosion upstream and cause sedimentation. Saline intrusion is already a major problem in the Sundarbans, however it should be noted that climate change will also cause an increase in freshwater flows from the major distributaries with increased precipitation, and the extent to which this may offset salinity intrusion is uncertain.

The Sundarbans also offer subsistence to around 3.5 million inhabitants who live within and around the forest boundary. The inundation and intruding salinity are interrupting traditional practices in the Sundarbans.

Although opportunities for shrimp farming have accompanied increasing salinisation, shrimp farmers are encouraged to inundate their land with brackish water during times of low salinity, exacerbating damage to the forest cover. Depleting forests in waterlogged and salinated areas are putting further pressure on forest resources such as fuel wood and timber, enhancing the rate of forest depletion [12].

2.5. Human Health

Climate change affects health directly and indirectly. The most direct impacts of climate change on human health occur through extreme events, for example the floods in Bangladesh in 2004 caused 800 deaths, while the recent cyclone affected more than 8.5 million people, causing more than 3,500 deaths [16].

Climate change will also affect the distribution of climate sensitive diseases. Malaria is a frequently cited example, because its prevalence increases in line with the warmer, wetter climates that are anticipated with climate change. Incidences of malaria have increased dramatically in Bangladesh over the last 30 years, and it is now a major public health problem, with 14.7 million people in Bangladesh classified as high risk for catching the disease [11]. Other diseases such as dysentery, diarrhoea, dengue, hypertension associated with heat stress, asthma and skin diseases are also increasing in Bangladesh, particularly during the summer months. While a causative connection between climate change and these diseases is of course difficult to verify, the conditions associated with climate change (in terms of temperature, rainfall, and salinity) and the impacts on water supply, sanitation and food production, generate favourable environments for the incidence and spread of such diseases. For example, increased flooding as well as drought is resulting in a decline in the availability of clean water, for a country where water-borne diseases are already responsible for 24 per cent of all deaths [11].

2.6. Urban areas

Low lying coastal cities are at the forefront of climate change impacts, directly vulnerable to the risks of sea level rise and storms [23]. In Bangladesh, the most vulnerable cities include Dhaka and Khulna, both of which have witnessed extreme environmental stresses in recent years. Cyclone Sidr affected the infrastructure of more than half a million homes, with nearly one million all or particularly destroyed, and more than 10,000 schools all or partially destroyed. Direct impacts will occur through the increased floods, drainage congestion and water logging, as well as further infrastructure damage during extreme events. Severe flooding has already impeded the development of Dhaka significantly, but of the eight major floods that have occurred in the last 50 years, the three most recent (1988, 1998, and 2004) have been the most damaging [11]. The key sectors affected by floods in Bangladesh's cities include infrastructure, industry, trade, commerce and utility services, all of which reduce in productivity during and after major flooding, increasing the vulnerability of the urban poor. Further, as the adverse impacts of climate change on rural areas cause increased migration to urban areas in search of non-agricultural employment, putting greater pressure on scarce housing, water, sanitation, and energy services [24] and increasing the number of vulnerable urban poor who are particularly at risk from climate related disasters. Already, around 40 per cent of the population in Bangladesh live in slums and squatter settlements in the cities, which are most at risk from damage during flooding. A survey conducted during the 1998 flood found that at least one in thirteen people had been forced to change their occupation, while the floods left 27.4 per cent of people unemployed [11].

2.7. Particularly vulnerable groups

The urban poor are therefore especially vulnerable to the impacts of climate change, because of the fragility of the infrastructure of slums and squatter settlements, and the lack of employment security.

In the rural areas, those with insecure land tenure, particularly the lower Adivasi castes, and women, are also particularly vulnerable. In Bangladesh, women are more vulnerable to chronic poverty in general due to gender inequalities in various social, economic and political institutions. Land access is particularly problematic. Land is often obtained by women on a limited usufruct basis through marriage, which can leave them landless on divorce, and denies them collateral [25]. As the availability of fertile land declines under climate change, women will lose access first. In addition, women are the main users and carriers of water. As the availability and quality of water declines and resources become scarcer, women will suffer increasing work loads to collect unsalinated water to sustain their families.

When a cyclone and floods hit Bangladesh in 1991, the death rate for women was almost five times higher than for men [11]. This was because men were able to communicate with each other when they met in public spaces, but information often did not reach the household, and because many women were not allowed to leave their homes in the absence of a male relative, many waited for their male relatives to return. Further, as noted by Reid and Sims (2007), the majority of women in Bangladesh have never learnt to swim.

3. National and international policy responses to climate change in Bangladesh

3.1. National policy response options

There is no comprehensive national policy in Bangladesh that specifically targets climate change risks. However, the Bangladesh government is aware of the importance of climate change, as well as the country's historical sensitivity to climate variability in general, and there are several policy response options that exist that relate to climate change. These include: indirectly addressing the impacts of climate change through programmes that *reduce vulnerability* through for example poverty alleviation, employment generation, crop diversification; directly addressing *vulnerability to climate variability* and extreme events through disaster risk reductions and management schemes; and specifically *targeting climate change* by mainstreaming climate change into sectoral plans and national policies. A selection of policies that reduce vulnerability to climate variability, and also specifically climate change, will be discussed here.

Vulnerability Reduction

In Bangladesh ongoing projects address food insecurity and food production shortfalls by crop diversification and generation of alternative employment opportunities aimed at community development, agricultural development, credit facilities, and infrastructure improvement. Fish and shrimp production for domestic consumption and exports are promoted with special emphasis on rural poverty alleviation and employment generation. All such developmental programmes are important in enhancing the resilience of the poor. [24]

Disaster Management and Climate Risk Management

Bangladesh has a Participatory Disaster Management Programme (PDMP) with a focus on disaster management and prevention, and also adaptation to climate change. The focus is on 'soft' measures to reduce the impacts of disasters, with an emphasis on preparedness, such as: awareness raising of practical ways to reduce disaster risks and losses, to strengthen national capacity for disaster management; enhance knowledge and skills of personnel in handling disasters; establishing disaster action plans in the most disaster prone areas; promoting local-level risk reduction measures; and improving early warning systems[24].

In 2003 Bangladesh also established a Comprehensive Disaster Management Programme (CDMP) with UNDP and other donor assistance, with the aim of refocusing the government towards greater emphasis on disaster preparedness and risk reduction. CDMP has a number of disaster management components, among them to establish an integrated approach to climate change and disaster management, expanding risk reduction approaches across a broader range of hazards, with specific reference to climate change. There are three main areas of focus:

- i. Capacity building for the Ministry of Environment and the Department of Environment to coordinate and mainstream climate change into their existing activities;
- ii. Strengthening existing knowledge and information accessibility on impact prediction and adaptation;
- iii. Awareness raising, advocacy and coordination to promote climate change adaptation into development activities.

Capacity building included assisting the creation of a 'climate change cell' within the Department of Environment (DOE) to build government capacity for coordination and leadership on climate change issues. The cell coordinates awareness raising, advocacy and mechanisms to promote climate change adaptation and risk reduction in development activities, as well as strengthening existing knowledge and information accessibility on impacts and adaptation to climate change.[26]

The climate change cell is informed by another component of CDMP, the Local Disaster Risk Reduction Facility (LDRRF). LDRRF aims to improve coordination between development-orientated and disaster management aspects of the Government of Bangladesh at the local level.

Bangladesh therefore has fairly effective mechanisms in place for disaster management and climate risk management (CRM), however, there is room to improve the functioning effectiveness of this system. The UNDP suggest that an *Integrated National Framework for CRM and DRR*, broader understanding of climate change risks and impacts at all levels, as well as capacity building for assessing risks and analysing them with sectoral and cross-sectoral perspectives and implications. [6]

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 (see below) 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 [27]. Bangladesh's interim poverty reduction strategy paper (I-PSRP) recognizes the direct link between poverty and vulnerability to natural hazards, and notes that the incidence of disasters is likely to increase rather than decrease as a result of global warming. The I-PSRP has been criticised for not specifically mentioning climate change in the context of planning vulnerability measures [24]. However, in November 2007 the Government announced an initiative to formally incorporate the impacts of climate change into all development plans in PSRP revisions, proposing a draft policy and action plan by October 2008. [28]

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 NWP does not explicitly mention climate change, however climate change is recognised by the NWMP 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. Other environmental policies, including the National Environmental Management Plan (NEMAP), the National Land Use Policy, and the National Forest Policy, do not make specific reference to climate change [27].

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. The Ministry of Environment and Forest (MOEF) is responsible for coordinating the UNFCCC process in Bangladesh.

A National Climate Change Committee, comprised of members from all relevant government and non-government organisations, 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.

Through these institutions as well as independently, the Government of Bangladesh, Academic Institutes, and Research Organisations have been a number of studies on impacts, adaptation and vulnerability to climate change, and participated in a range of national efforts that seek to address climate change directly. A selection of these is presented in Box 1.

Box 1: National Efforts to Address Climate Change in Bangladesh

Extracted from “Addressing Climate Change in Bangladesh: National Efforts”. DOE 2006 (Unpublished). [2]

Bangladesh has undertaken a number of significant projects and achieved several milestones in the area of climate change:

- Signed the UNFCCC on 09.06.1992 and ratified it on 15.04.1994
- Accessed the Kyoto Protocol on 21.08.2001.
- Participated in the US Climate Change Country Study Program and prepared its emission inventory and vulnerability assessment in 1994.
- Participated in the Asia Least Cost Green House Gas Abatement Strategy (ALGAS) Study in 1995-98. The ALGAS study included the formation of the national GHG abatement strategies consistent with national development priorities, and preparation of portfolio of GHG abatement projects.
- Submitted its first National Communication to the UNFCCC in 2002. Bangladesh has taken up a project “Bangladesh: Climate Change Enabling Activity “Self Assessment Exercise” as a first step to prepare its Second National Communication in the near future.
- Completed a National Adaptation Plan of Action (NAPA) and has already submitted the NAPA to the UNFCCC in November 2005.
- Under the Clean Development Mechanism Bangladesh has established a two tier Designated National Authority (DNA). The tiers are National CDM Board and National CDM Committee. The DNA so far has approved four projects in waste and energy sectors of Bangladesh. These projects are at different stages of implementation. These projects are:
 1. Landfill Gas Extraction and Utilization at Matuail by Waste Concern.
 2. Composting Project at Gazipur and Kanchpur by Waste Concern
 3. Installation of 30,000 Solar Home Systems (SHS) in rural households by Grameen Shakti and BCAS
 4. Promotion of Energy Efficient Compact Florescent Lamp (CFL) in Rural Bangladesh (100,000 incandescent lamps to be replaced by CFL) by Grameen Shakti and BCAS.

Notable among these efforts in relation to climate change impacts is that Bangladesh was the first country to complete a National Adaptation Programmes of Action (NAPAs), which are documents produced by the Least Developed Countries for the UNFCCC to identify immediate and urgent needs for adaptation to climate change. Bangladesh successfully completed the NAPA in 2005.

The NAPA Document focuses on six sectors but in reality more sectors are covered:

- i. Forestry, Biodiversity and Land-Use
- ii. Agriculture, Fisheries and Livestock
- iii. Water, Coastal Areas, Natural Disaster and Health
- iv. Livelihood, Gender, Local Governance and Food Security
- v. Industry and Infrastructure
- vi. Institutional and Policy Issues

3.2. International policy response options

This section will discuss the role of the United Nations Framework Convention on Climate Change (UNFCCC) as well as selected donor initiatives, in supporting climate change impacts responses in Bangladesh.

The United Nations Framework Convention on Climate change

The UNFCCC is an international treaty that came of United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro in 1992. The UNFCCC addresses what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. There are approximately 40 Annex-1 and 150 Annex-2 Parties and Observers to the convention [29]. The UNFCCC supports adaptation to the impacts of climate change primarily through four funds (see box 2):

Box 2: Adaptation Funding under the UNFCCC[1]

There are currently four funds for adaptation:

1. Least Developed Countries Fund (LDCF), established under the UNFCCC to help developing countries prepare and implement their National Adaptation Programmes of Action (NAPAs).
2. Special Climate Change Fund (SCCF), also established under the UNFCCC to support a number of climate change activities such mitigation and technology transfer, but place top priority on adaptation.
3. GEF Trust Fund's Strategic Priority for Adaptation (SPA) which pilots 'operational approaches' to adaptation.
4. Adaptation Fund (AF) which was established under the Kyoto Protocol and is intended to assist developing countries carry out 'concrete' adaptation activities.

The LDCF, SCCF and Trust Fund are based on voluntary pledges and contributions from donors. As of April 2007, the LDCF and SCCF amounted to around US\$114 million in received allocations [3]. All three funds are managed by the Washington-based Global Environment Facility (GEF) under the guidance of the UNFCCC. To carry out work under the funds the GEF works with its three Implementing Agencies, the World Bank, United Nations Environment Programme (UNEP), and the United Nations Development Programme (UNDP).

The AF fund is funded by a 2% levy on CDM transactions¹. The 2% share of credits from the CDM transactions is collected directly by an international body – the CDM Executive Board – and transferred to the AF for monetisation. The World Bank has estimated that the levy could generate funding in the range of US\$100-500 million through to 2012 [World Bank, 8]. The management of the Adaptation Fund was finalised at the thirteenth Conference of the Parties (COP 13) in Bali in December 2007, and will be operationalised in 2008.

The UNFCCC funding streams for adaptation have been criticised for being financially and technically inadequate to meet the adaptation needs of developing countries[30]. Oxfam estimates that the true monetary cost of adaptation could be in excess of \$50 billion annually, yet in 2007 the three GEF funds received pledges of approximately US \$200 million [31], and although the World Bank estimates that the amount of money available under the Adaptation Fund may amount to US \$100-500 million by 2012, this still falls significantly short of the estimated cost of adaptation.

Bangladesh's completion of the NAPA took place with financial assistance from the UNFCCC through the Least Developed Countries Fund (LCCF). However, because the preparation of full project design documents was not funded through the NAPA process, additional resources are still required to prepare full project documentation before implementation can take place.

Other relevant UNFCCC policies include the Nairobi Framework on Impacts, Vulnerability and Adaptation, that shall assist all countries but developing countries, the Least Developed Countries, and Small Island States, to improve their understanding on impacts, vulnerability and adaptation actions and measures to respond to climate change. The Nairobi Work Programme does not engage in implementation of concrete adaptation activities, but rather calls for a series of workshops and reports over the coming two years to share and analyse information on topics relevant to climate change adaptation.

Climate change activities in selected donor strategies

Bangladesh received over one billion USD of Official Development Assistance annually. Analysis of donor portfolios in Bangladesh carried out by the OECD in 2005 [27] revealed that between 22 and 53 per cent of development assistance of aid amount, and 22 to 37 per cent of aid-funded projects, are in sectors potentially affected by climate risks. As early as 1996 the World Bank's 2002 Long-run Perspective Study for Bangladesh raised the issue of climate change, particularly the potential for the economic impacts of sea-level rise. In response, the World Bank sponsored the Bangladesh Climate Change and Sustainable Development Study (2000) which analysed the possible impacts of climate change, identified physical and institutional adaptation options, and reviewed a number of development projects and the National Water Management Plan, with the aim of mainstreaming adaptation in the regular development strategies and operations in Bangladesh.

The OECD notes that donor country strategies and project documents generally lack explicit attention to climate change [27]. However, more recently and in line with increasing international attention to climate change, donors are increasing their focus on climate change in Bangladesh. For example, DfID Bangladesh has mainstreamed climate change activities into its development programmes; and also now provides direct support for programmes that reduce vulnerability to climate variability and climate change. DfID has screened its projects in Bangladesh based on profiles of climate and future hazard and vulnerability, and disaster risk reduction and climate change adaptation recommendations have been integrated into programme activities. The pilot programme for mainstreaming began in Bangladesh in 2006, and has now finished.

On the basis of this assessment, DfID Bangladesh is taking forward a variety of options and several have already started to put aside money for concrete adaptation measures:

- Improving infrastructure, such as enforcing road building standards through more rigorous monitoring and evaluation to increase the resilience of roads during flooding
- Non-structural measures such as integrating climate change and disaster management awareness into education programmes
- Further research and data collection on impacts of climate related hazards.

DfID also provides funding for adaptation directly, for example through bilateral support for specific work on disaster management and climate change under the CDMP, described above. DfID is providing a total of £5.7 million over 5 years supporting a range of sub-elements in the programme, among them establishing an integrated approach to climate change and disaster management.[32] Part of DfID's funding went towards two positions in the climate change cell, one of which specialises in climate change adaptation.

Other examples of donor projects that incorporate climate change include: the GEF/UNDP Coastal and Wetland Biodiversity management at Cox' Bazar and Hakaluki Haor (2000 – 2007), which notes the potential effect of sea-level rise. [27]

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