Synthesis: A Future for Bangladesh Under a Changing Climate: Policy Strategies for Adaptation and Resilience

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Chapter 13
Synthesis: A Future for Bangladesh Under a Changing Climate

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Abstract Due to its geophysical and socioeconomic characteristics, Bangladesh is particularly vulnerable to the harmful impacts of climate change. The contributors to this volume generally agree that climate projects should prioritize reducing exposure to loss and damage for the most at-risk populations, infrastructure, and assets. These include women, migrants, and the landless poor, whom would benefit from local-level projects that address their specific vulnerabilities. There are also a range of aspects, such as more robust monitoring, reporting, and evaluation, which require additional government commitment and policy integration. Confronting climate change will need to be continually responsive and adaptive to somewhat unpredictable future circumstances. With its experience and knowledge, Bangladesh has an important role to play as an example to the rest of the developing world.

Keywords Climate change · Bangladesh impacts · Future · Projections

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13.1 Climate Change Impacts on Bangladesh

Bangladesh (20–26° N, 88–92° E) has geographical characteristics that render it one of the countries in the world most vulnerable to climate change-related damages. Most of the country is low-elevation and comprised of alluvial delta, with floodplains occupying 80% of its area (Agrawala et al. 2003). Located at the end of the Ganges-Brahmaputra-Meghna (GBM) river system, Bangladesh acts as a drainage outlet for cross-border runoff generated from China, Nepal, India, and Bhutan (Mirza 2005). The climate can be separated into four seasons: dry winter (December-February), pre-monsoon (March-May), monsoon (June-September), and post-monsoon (October-November) (Alamgir et al. 2015). Due to the high ratio of monsoon to dry season runoff, the country experiences an abundance of water during the monsoon season while also facing surface water scarcity in the dry season. Consequently, annual monsoon floods typically inundate one fifth to one third of the country (Faruque/Ali 2005)—and up to 70% in extreme years (Mirza 2003)—affecting both rural and densely populated urban areas. Occurring between June and September, these floods coincide with the main growing season when two-thirds of the total annual staple rice crop is produced. Although past severe floods fall within the range of historical variability, a warmer climate will likely increase precipitation and Himalayan glacier melt, resulting in greater frequency, magnitude, and extent of flooding and causing extensive damage to lives, property, and staple crops (Agrawala et al. 2003; Mirza 2011).

Despite being a flood-prone country, hydrological droughts are also common, particularly in northern and northwestern Bangladesh (Mirza 2005; Shahid/Behrawan 2008; Alamgir et al. 2015). Dry season and pre-monsoon droughts typically affect the winter rice and wheat crops, resulting in greater irrigation demand (Faruque/Ali 2005). Drought can also occur when monsoon rains, which normally produce 80% of Bangladesh's annual precipitation, are significantly reduced or delayed, which severely impacts annual rice production (Agrawala et al. 2003; Faruque/Ali 2005). Though climate models generally predict an increase in monsoon and annual precipitation, increased drought during the dry winter season, exacerbated by higher evapotranspiration due to rising temperatures, remains a possibility.

The coastal zone in particular is extremely prone to flooding, as well as salinity intrusion, storm surges, and rapid geomorphological changes (Ali 1996, 1999; Brammer 2014). Bangladesh receives the brunt of cyclones, which originate in the Indian Ocean and funnel northward through the Bay of Bengal, where shallow waters contribute to tidal surges up to 15 m in height (Agrawala et al. 2003). While the intense precipitation generates inland and riverine flooding, storm surges cause most of the damage from tropical storms in Bangladesh, as surges that hit coastal areas propagate long distances inland along rivers (Ali 1996). Besides causing loss of life and damage to infrastructure, the storm surges ruin crops and aquaculture operations, which cannot tolerate saltwater intrusion. Coastal soil salinity is also exacerbated by high spring tides which inundate coastal areas and tidal flooding during the monsoon season (Karim et al. 1999; Haque 2006). Tropical storm surges —alongside heavy discharge currents through the GBM river system and wave action created by strong southwest monsoon winds—also contribute to coastal erosion (Ali 1999). Between 1973 and 2010, the Sundarbans coastline in southwestern Bangladesh underwent net erosion of approximately 6290 square km (Rahman et al. 2011), whereas to the east, the Tentulia, Meghna, and Feni River estuaries and nearby deltaic islands experienced about 2363 square km of accretion and 1337 square km of erosion during the same period (Chow 2017). Forming in warmer oceans, wind speed and precipitation from tropical cyclones are projected to intensify with climate change, increasing the damages caused by storm surge, floods, erosion, and salinity (IPCC 2013). Sea level rise—currently about 1.06 to 1.75 mm per year in the North Indian Ocean (Unnikrishnan/Shankar 2007), but up to 10.7 mm per year along the Bangladesh coast due to subsidence (Khan et al. 2000)—will aggravate these impacts, resulting in dramatically larger storm surge risk areas and flood depths over the course of the next century (Karim/Mimura 2008). As population growth results in more settlements and pressures on natural resources in the coastal zone, people and infrastructure will be increasingly exposed to climate hazards, especially among the poor (Brouwer et al. 2007; Brammer 2014).

Bangladesh's socioeconomic condition amplifies its vulnerability to climate impacts. Bangladesh is economically underdeveloped, with about a third of its population living in poverty, the highest rate in all South Asia (ADB 2017). Between 1991 and 2000, Bangladesh experienced 93 major natural disasters resulting in nearly 200,000 deaths and causing US$5.9 billion in damages with high losses in agriculture and infrastructure (MoEF GoB 2005). Although disaster-induced morbidity and mortality—often disproportionately affecting women (Neumayer/Plümber 2007)—have declined substantially over the last several decades thanks to improved early warning systems and shelters, economic losses may be increasing as the economy develops (Penning-Rowsell et al. 2013). Additionally, Bangladesh is an agrarian country primarily dependent on rice cultivation (BBS 2015), whose yields can be depressed by higher temperatures (Sarker et al. 2012; Chowdhury/Khan 2015), severe flooding (Paul/Rasid 1993; Banerjee 2010), and salinity (Dasgupta et al. 2014). Salinity in drinking water also results in public health problems, such as adverse maternal and fetal outcomes where pregnant women consume sodium well in excess of WHO-FAO recommended levels (Khan et al. 2011). Other possible long term health risks from climate change include greater incidences of heat-related mortality, water-borne infections, and vector-borne diseases (McMicheal et al. 2006). Heat and humidity extremes are expected to approach or exceed human survivability thresholds for some parts of Bangladesh by the late 21st century (Im et al. 2017). Thus, climate change may have severe consequences for public health, especially in light of the country's poor healthcare and sanitation infrastructure (Shadid 2010). Moreover, the temporary displacement and migration, which often follow climate disasters—as the landless poor seek shelter and employment away from their homes—are frequently accompanied by diminished livelihood opportunities and weakened social bonds (Penning-Rowsell et al. 2013).

13.2 Confronting Climate Change

Due to the range of adverse climate impacts, confronting climate change in Bangladesh has required actions across many diverse sectors. The Ministry of Environment and Forests (MoEF) within the Government of Bangladesh first outlined its adaptation strategy in its National Adaptation Programme of Action in 2005, which proposed mainstreaming adaptation into sectors ranging from education to infrastructure to forestry, while focusing particularly on disaster management, water, agriculture, and industry (MoEF GoB 2005). In 2009, the MoEF published the Bangladesh Climate Change Strategy and Action Plan (MoEF GoB 2009), which organized its climate change mitigation and adaptation goals into six pillars: food security; social protection and health; comprehensive disaster management; infrastructure; mitigation and low carbon development; research and knowledge management; and capacity building and institutional strengthening. The MoEF has also produced the Climate Change and Gender Action Plan (CCGAP), which integrates gender issues into the first four pillars and sets objectives to reduce the climate vulnerability of women (MoEF GoB 2013). Each of the six pillars emphasizes a strategic cross-sectoral approach. For example, Bangladesh intends to reduce greenhouse gas emissions not only through adopting low-carbon energy technology, but also by increasing carbon sequestration via community forestry. Alongside government efforts, local civil society organizations have also begun to contribute to adaptation planning.

As reviewed by Pervin et al. within this volume, adaptation programs are primarily undertaken by the public sector, with finance sourced from the Government of Bangladesh, multilateral development banks, and other sovereign donors. This funding is channeled through several windows, mainly the Pilot Program for Climate Resilience, the Bangladesh Climate Change Trust Fund, and the Bangladesh Climate Change Resilience Fund, which have allocated more than US $1.2 billion for over 400 projects across Bangladesh. The Government of Bangladesh has drafted a country investment plan to link the environment, forestry, and climate change sectors to the financing required for successful implementation (GoB 2017). This framework estimates US$4.9 billion in total funding is required for mitigation, adaptation, and resilience projects from 2016 to 2022, compared to the US$2.9 billion currently available.

Adaptations to protect food production from salinity and submergence, reviewed in this volume by Mondal et al., have required developing and promoting new, salt- and flood-resistant varietals of rice and non-rice crops, and bolstering infrastructure including embankments, drainage structures, and irrigation pumps and canals. Bangladesh has also explored innovative practices that reduce vulnerability by accommodating new inundation regimes, such as vertical horticulture, short-duration cropping, and alternating rotations of fish and crop cultivation. Some of these strategies are ecosystem-based, such that they incorporate biodiversity and ecosystem services into the adaptation program in ways that substitute or complement infrastructure and technology-based methods. In this volume, Saroar et al. identify key ecosystem-based adaptations for food production, which include rehabilitating natural canals and wetlands to enhance drainage and irrigation, as well as floating hydroponic agriculture and ditch-and-dyke schemes that integrate flood management with agriculture and aquaculture. Ecosystem-based adaptations may have multiple benefits, as well. For example, according to Chow et al. (this volume), the Government of Bangladesh has been implementing coastal mangrove conservation and afforestation not only to mitigate tropical storm surges and salinity intrusion, but also to use the binding properties of vegetation roots to reduce coastal erosion and enhance land accretion. Similarly, hillside afforestation has also been undertaken in order to mitigate slope erosion and landslides.

As reviewed by Mukherjee et al. in this volume, flood control, drainage, and irrigation have been the main goals of infrastructural adaptations implemented across Bangladesh. These have been utilized to reduce loss and damage from monsoon flooding in the north-west and north central region, tidal flooding in the eastern region, coastal flooding and storm surge in the southern coastal region, and water scarcity in the northwest and southwest regions. To reduce flood hazards for urban residents and infrastructure in the city of Dhaka, Bangladesh has invested heavily in river embankments, flood walls, pumping stations, sluice gates, as well as storm water drainage systems. As described by Rahman and Islam in this collection, the city established this protective infrastructure after a catastrophic flood in 1998, and continues to construct additional embankments and drainage works. Mitigating flooding has allowed former agricultural land in the urban fringe to be converted to residential zones. As Dhaka's population continues to grow, further non-structural measures have become necessary. Polyethylene bags have been banned in order to reduce congestion in the drainage system. Building codes and regulations now identify flood-prone areas and restrict large-scale developments in flood flow zones. However, illegal construction and settlements persist, and can impede drainage and endanger vulnerable residents, who tend to be poor.

Within the public health sector, the government, private sector, NGOs, and donor agencies have been working to improve access to healthcare services, as well as promote sanitary latrines. These organizations have also deployed various technologies and strategies for providing safe drinking water. Described by Rana in this volume, these include arsenic testing of groundwater, rainwater harvesting systems, pond sand filtration systems, and desalinization panels.

Bangladesh has also bolstered its communication systems for warning populations of hazardous climatic events such as floods and tropical storms. Within this collection, Afroz et al. discuss how telecasts of information from the Storm Warning Center have facilitated evacuations and reduced mortality. Rahman and Islam also describe the Flood Forecast and Warning Center, which provides live updates of river water levels and warnings when river water rises above safe levels, though this information is directed more towards decision-makers than the general public. The government has also increased general awareness of climate change through media campaigns and public education curricula and textbooks. Community-based organizations and NGOs play an important role in spreading climate knowledge and facilitating disaster preparedness in vulnerable areas.

In order to improve lives in Bangladesh's vulnerable rural areas, where two-thirds of the population lack access to grid electricity, a consortium comprised of the Government of Bangladesh, international donor agencies, NGOs, and private companies has been working to equip households with home solar electricity systems. More than 3 million systems have been installed, covering about 12 million people; however, this constitutes only a tenth of the rural population that could benefit from this technology. According to Muzammil and Ahmed (this volume), solar power adoption not only enhances household productivity and climate resilience, but also constitutes a low-carbon development strategy that reduces air pollution from the burning of kerosene.

As Reggers points out in her chapter, Bangladesh has made significant development gains in recent decades, doubling its Human Development Index score since 1980 and decreasing its poverty rate from 56.6% in 1991 to 31.5% in 2013. Despite the strides Bangladesh has made, there remain institutional and operational impediments that hinder the dissemination and adoption of adaptation strategies. Lack of adherence to flood zoning regulations and other governance failures result in a greater number of lives at risk. Insufficient investment capital and funding resources, a lack of knowledge, and coordination failures between government agencies, NGOs, and other stakeholders often render programs unsustainable. As discussed by Rana in this volume, health providers in particular often lack the funding and staff to ensure that comprehensive and specialized services are available to climate-vulnerable communities. There may be communication failures across institutions, since, as Afroz et al. mention in their chapter, the strategic framework for government ministries to interact on climate change is not clearly articulated in the Bangladesh Climate Change Strategic Action Plan. As Pervin et al. point out, civil society organizations often insufficiently communicate with each other and with public sector institutions, reducing their influence and constraining knowledge sharing. As a result, individual initiatives may be piecemeal and too narrowly focused on specific outcomes, when coordination and integration with other agencies and programs could potentially increase their effectiveness and probability of success. Some projects are also implemented in a top-down manner, disregarding consultations and input from local communities, and thus fail to account for their livelihood needs. One example, mentioned by Saroar et al. in this volume, is the Tidal River Management project, which has facilitated coastal land stabilization by retaining sediment, but has also reduced some fishing and cultivation opportunities for the local inhabitants.

While Bangladesh has been the recipient of myriad adaptation programs—making the country a laboratory for testing potential strategies—there has been a lack of rigorous follow-up evaluation. Consequently, program effectiveness often cannot be evaluated despite considerable uncertainty due to their frequently experimental nature. For example, Chow et al. point out within their chapter that the necessary tree plantation area or density to provide more than trivial mitigation of storm surges or landslides are largely unknown, and the paucity of reliable and systematic baseline data complicates ex post facto assessments. Well-intentioned projects in some cases may have immediate benefits but turn out to be maladaptive in the long run. As noted by Mukherjee et al., river embankments mitigate flood risks in the short term, but may over time trap sediments in the river bed, which reduces the replenishment of topsoil nutrients and increases future flood depth. Moreover, upstream flood embankments may increase geomorphological instability and flood risks downstream. Careful empirical analysis, research, monitoring, and evaluation are therefore necessary to determine the optimal deployment and management of adaptation strategies.

13.3 A Path Forward

To overcome these barriers, Bangladesh must develop long-term strategic plans, which build upon existing and potential synergies and avoid parallel and uncoordinated systems among all affected sectors. For instance, Saroar et al. recommend that ecosystem-based adaptation strategies must horizontally integrate forestry, fisheries, agriculture, and water resources in order to fully account for uncertainty and risk. Mukherjee et al. suggest that a single river basin is the appropriate unit of management and that one-size-fits-all, country-wide interventions that ignore local circumstances ought to be avoided. Thus, vertical coordination is essential as well, so that climate projects foster sustainability across various levels of implementation, while still taking into consideration the needs and practices of local communities, the private sector, and other relevant stakeholders. According to Pervin et al, finance mechanisms also could be more coordinated through the establishment of horizontal and vertical feedback systems and central information sharing hubs, in order to strengthen capacity, improve efficiency, and ensure future access to climate funds. Muzammil and Ahmed offer the example of solar home systems promotion in Bangladesh, which utilizes a holistic finance model that starts with public funding and policy, but also incorporates market development incentives, access to private capital, the establishment of delivery networks, after-sales services, and institutional support for partner organizations and small-scale enterprises.

There is general consensus among the contributors to this volume that climate projects should prioritize reducing the loss and damage exposure for the most at-risk populations, infrastructure, and assets. Such populations include women, migrants, and the landless poor, who would benefit from community-specific, local-level projects designed to address their particular vulnerabilities. More effective early warning systems and greater availability of disaster shelters can reduce loss of life, and local officials and media bear a responsibility to communicate with vulnerable people in order to improve hazard mitigation and response. Due to the heterogeneous characteristics of communities across Bangladesh, national strategies must anticipate and allow for flexible guidelines that are tailored to meet specific local needs. Local institutions such as village governments and NGOs ought to be afforded sufficient capacity, resources, and the authority to meaningfully contribute to adaptation projects within their jurisdictions.

Despite the considerable attention that has been given to adaptation in Bangladesh, there are aspects which require additional commitment by governments and integration into policy frameworks. Some impacts that span multiple jurisdictions, such as migration, displacement, and the disproportionate effect of climate change on women, merit greater attention and mainstreaming within national development plans. For example, Reggers reports that the CCGAP has yet to be implemented in any meaningful way at both national and local levels. Moreover, the dialogue concerning gender has focused almost exclusively on mitigating vulnerabilities, leaving inequality largely unaddressed. In urban areas, considerations of flood risks need to be embedded into city planning processes, since inadequate infrastructural maintenance, lack of enforcement against illegal settlements and commercial developments, and paucity of flood shelters place vulnerable populations at more risk, according to Rahman and Islam.

Stronger monitoring, evaluation, and reporting mechanisms are essential not only for transparent evaluation of climate projects, but also to review the performance of governance and finance. Afroz et al. also suggest that participatory monitoring could help increase resilience by spreading awareness of climate change, and that local communities can play an important role in identifying gaps. Moreover, robust evaluation would allow policy- and decision-makers to place more emphasis on effective strategies and to reduce support for ineffective ones, increasing the efficiency of climate fund expenditures. Increased confidence in the effectiveness of public financing could help encourage more private investment into climate projects, which would spread the responsibility and risks across a greater number of stakeholders. Mukherjee et al. suggest that one way of potentially increasing the cost-effectiveness of interventions would be to focus on projects with multiple, complementary benefits, particularly those that have both a emissions mitigation and adaptation effect. The elimination of ineffective strategies would also help avoid engendering a false sense of security among vulnerable populations. However, robust monitoring and evaluation would in many cases require long-term impact studies for which available data may be scarce. Scholars within academic institutions and NGOs have an important role to play in the rigorous and independent implementation of this research.

With decades of experience grappling with natural disasters that will increase in frequency and intensity due to climate change, Bangladesh has an important role to play as an exemplar to the rest of the developing world. Even if certain programs are unsuccessful in their initially defined adaptation or mitigation goals, analyzing the reasons for these failures may nevertheless offer lessons learned for future actions, improving climate strategies in the long run. If strategies prove to be cost-effective successes, then they help Bangladesh serve as a model for environmentally sound, socially responsible, and economically sustainable development in the face of climate change. Rigorous empirical evaluations are therefore vital, and are only possible if the Government of Bangladesh and other stakeholders are committed to transparency, large sample data collection, and most importantly knowledge sharing—the goal of this volume. Climate change-induced environmental hazards will only increase for the foreseeable future, against the backdrop of rapidly evolving socioeconomic conditions in Bangladesh. Confronting climate change in Bangladesh is therefore a task without determinable conclusions, and will need to be continually responsive and adaptive to somewhat unpredictable future circumstances.

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