

The Anthropocene: Politik—Economics—Society—Science

Saleemul Huq
Jeffrey Chow · Adrian Fenton
Clare Stott · Julia Taub
Helena Wright *Editors*

Confronting Climate Change in Bangladesh

Policy Strategies for
Adaptation and Resilience



The Anthropocene: Politik—Economics— Society—Science

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Chapter 1

Introduction: Bangladesh Responds to Climate Change



Helena Wright, Adrian Fenton, Saleemul Huq, Clare Stott, Julia Taub and Jeffrey Chow

Abstract Bangladesh is a country that is highly vulnerable to the impacts of climate change, and a broad range of practices have emerged to adapt to these impacts. The book presents a range of sectors that are affected by the impacts of climate change, such as agriculture, water and health, as well as covering thematic areas relating to responses to climate change, such as governance and finance, communication and gender. Measures to adapt to climate impacts in the agricultural sector range from hard engineering measures like construction of polders, to soft socio-economic measures, such as changes in cropping patterns. In the water sector, non-structural approaches to risk reduction include community-based disaster management initiatives. Across all practice areas there are barriers and challenges to confronting the impacts of climate change, including knowledge gaps. The chapters of this book emerged as part of the Gobeshona initiative in Bangladesh, a knowledge sharing platform for climate change research on Bangladesh.

Keywords Bangladesh · Adaptation · Climate · Impacts · Poverty

Bangladesh is a low-lying agrarian country located in the Ganges-Brahmaputra Delta, which is highly vulnerable to the impacts of climate change. A broad range of practices have been identified to adapt to these impacts, some of which are already taking place. The chapters of this book, which emerged out of the

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Gobeshona initiative, present a range of sectors affected by climate change as well as thematic areas relating to responses to climate change in Bangladesh. In particular, agriculture is a sector which is affected by increased temperature and unpredictable rainfall patterns in Bangladesh (Mondal et al. 2012). As explained in Chap. 2, the agricultural sector employs around half of the civilian workers in Bangladesh and plays an important role in poverty reduction. The range of measures to adapt to climate impacts in the agricultural sector identified by Mondal et al. in this volume range from hard engineering measures like construction of polders, to soft socio-economic measures, such as changes in cropping patterns. Mondal et al. (2012) find that the majority of the identified adaptation practices in agriculture are for the purpose of implementing actions which reduce hazards, enhance production, and bring direct, tangible benefits. However, the agriculture chapter outlines a number of barriers in relation to these practices including a lack of capital, lack of access to resources, lack of knowledge and information, and lack of institutional capacity. In the coastal zone, the government is the primary provider of the identified agricultural adaptations, while Mondal et al. (2012) explain that the role of the private sector as an adaptation provider is not studied or well documented within adaptation literature.

The water sector and availability of freshwater both face the threat of loss and damage due to current and expected climate change impacts. As outlined in Chap. 3, Bangladesh's population of nearly 160 million relies heavily upon its hydrological systems and is therefore vulnerable to events that will be exacerbated by climate change, such as floods, storm surges, drought, sea level rise, and salinity intrusion, as well as loss of fish spawning grounds and reductions in agricultural production due to changes in the hydrological regime. As Mukherjee et al. explain in Chap. 3, the wetland systems of Bangladesh – known as “haor” regional rivers are susceptible to flash flooding which can affect harvests, and during the 2004 flood, more than two thirds of the boro production was lost due to an early flash flood event coinciding with the harvest (CEGIS 2012). However, while efforts have been made to adapt, it is noted in this volume that some initiatives may be maladaptive despite having claimed benefits over the short term. For instance, while river embankments have been constructed as adaptation measures these can also restrict the sediment inflow to the flood plain, reducing the nutrient availability of the topsoil (Brouwer et al. 2007). Mukherjee et al. explain that other non-structural approaches to risk reduction include early warning systems and community-based disaster management initiatives.

In Bangladesh, forests and wetlands are at risk from climate impacts, but protecting forests can also be considered as an opportunity to respond to climate change. As outlined in Chap. 4, mangrove forests are coastal forests that can help reduce damage from sea level rise and erosion (FAO 2007). However, as detailed by Chow et al. (in this volume) greenbelts can only provide the role of protecting against intense storms if they are appropriately designed and managed. The forest chapter describes major adaptation initiatives which have taken place for the conservation of the Sundarbans forest, which is the largest contiguous mangrove ecosystem in the world and is a UNESCO World Heritage Site. As explained by

Chow et al. (in this volume), many important knowledge gaps remain that require continued investigation; for example, we do not know the width of mangrove plantation that will provide adequate storm protection, as currently these plantation widths are set almost arbitrarily. This demonstrates that further research is required to enhance the impacts of forests and wetlands for adaptation. Relatedly, plantation of mangroves can be considered as an example of *ecosystem-based adaptation* (EbA), which refers to the use of biodiversity and ecosystem services as part of a climate change adaptation strategy, as examined in Chap. 5. Among other ecosystem services, Saroar et al. explain in this volume that mangroves can provide a line of defence against cyclonic storm surges, erosion, and salinity intrusion for coastal communities, infrastructure, and livelihood assets, and can also provide pollution control, water purification, and improvement of drainage.

The chapter on Governance and Finance in this volume explains that in the initial stages, policy concerns for environmental protection in Bangladesh were reflected for the first time in the Fourth Five Year Plan (1990–1995), and have been included in other five-year plans since then. Since the signing of the Kyoto Protocol, Pervin et al. (in this volume) explain that the governance of climate change in Bangladesh has been characterised by specific interventions, such as the creation of policy provisions, research and technological innovations, and the establishment of funding entities. Bangladesh was the one of the few *Least Developed Countries* (LDCs) to develop a National Adaptation Programme of Action (NAPA) in 2005, and this was then revised in 2009. The Government of Bangladesh also unveiled the *Bangladesh Climate Change Strategy and Action Plan* (BCCSAP) in 2008. The chapter describes the various funding windows in Bangladesh including the *Bangladesh Climate Change Trust Fund* (BCCTF) established in 2009, the *Bangladesh Climate Change Resilience Fund* (BCCRF) established in 2010, and the *Pilot Programme for Climate Resilience* (PPCR).

Chapter 7 explains that media and education systems can play an important role in alerting and preparing people for climate-related disasters as well as empowering them to minimise risks, which means that raising public awareness and understanding of climatic risks through disseminating accurate information is an important part of building long-term resilience. At the global level, the Sendai Framework for Disaster Risk Reduction emphasises the utilisation and strengthening of all kinds of media to support successful disaster risk communication. The chapter on media and communication provides examples of different forms of communication interventions which are relevant to adaptation in Bangladesh. For example, in 2007 before the powerful Cyclone Sidr struck Bangladesh, the Bangladesh Government began to broadcast warnings five days in advance on radio and television (Paul/Dutt 2010). Emergency evacuation orders were also issued almost twenty-seven hours before landfall of the cyclone, which the authors argue helped reduce the death toll. The Government of Bangladesh has recognised the role of the media in the National Broadcasting Policy of 2014 (GoB 2014), which makes a provision for telecasting emergency weather bulletins and producing climate change awareness programmes, as Afroz et al. (in this volume) explain in this volume. Chapter 7 explains that there is a wealth of traditional knowledge that has

been preserved for generations alongside locally adaptive mechanisms for survival, so this local knowledge can be being integrated within media interventions to appropriately support resilience.

Gender inequalities in Bangladesh often mean that women are more affected by climate change than male counterparts. The gender chapter highlights a few of these gender inequalities from the perspective of rights. It begins with a boxed text outlining international gender and climate change policy, followed by a section on the Bangladesh context and specific gender inequalities and discriminations that contribute to women's vulnerability. For example, a study by Neumayer/Plümper (2007) found that women and children are 14 times more likely to die or be injured in a disaster than men. Reggers explains in Chap. 8 that the decision-making over resource use, as well as buying and selling of land before or after climate-related events often rests with men. Finally, Reggers notes that women's relative lack of mobility in public spaces can result in women not receiving early warning signals before cyclones. The author finishes by providing examples of national and community level efforts to address the gender dimensions of climate change.

The health sector is another sector particularly affected by climate change in Bangladesh. The Intergovernmental Panel on Climate Change (IPCC 2014), cited in Chap. 9, affirms that "recent decades have seen warming air and ocean temperatures, changing rainfall patterns, variations in the frequency and intensity of several extreme events including droughts, floods and storms and rising sea levels" and that the changing climate will adversely affect the health of human populations. The chapter explains the three basic pathways by which climate change affects health: primary or direct impacts (such as heat stress), secondary or indirect impacts (such as shifts in diseases), and tertiary or long-term implications (mediated by social, political and economic systems). Rahaman et al. argue in this volume (Chap. 9) that the increasing frequency of extreme climatic events such as floods can affect health infrastructure like hospitals, clinics and healthcare facilities, while climatic events that result in reduced food production can affect nutrition due to the declining food quality and quantity. As for other impacts, women, children and the elderly are often particularly vulnerable.

Chapter 10 explains that climate-related events such as cyclones, land erosion and flooding can also contribute to displacement and human migration. In the context of Bangladesh this can either lead to increased risk or create new opportunities. As Saha et al. explain in this volume, those who are forced to leave their homes often take shelter in places where they lack legal rights or social services, but there are also examples where settling in a new location offers opportunities for coping and resilience. Internal displacement and migration in Bangladesh is also linked to the movement of people to cities. Urban areas are also expanding in Bangladesh, partly in response to rural environmental and climate hazards. Taking the case of Dhaka, Chap. 11 finds that flooding poses a significant threat and the city lacks proper mechanisms to counter flooding, due to the combination of Dhaka's climatic and geographical conditions, as well as weak political and economic capacity to address the situation. Unregulated housing developments in low-lying areas can exacerbate the problem by preventing natural drainage

(Morshed 2013). The authors identify solutions such as the need for flood warning systems and well-managed and equipped flood shelters.

Finally, in the energy sector, solar home systems have emerged as a widespread technology enabling electrification to reach remote rural communities. As Muzammil and Ahmed explain in Chap. 12, the Solar Home System (SHS) programme in Bangladesh has grown to be one of the largest off-grid electrification initiatives in the world, and has also been described by the World Bank as the fastest growing SHS programme in the world (World Bank 2014). The final chapter reflects on the benefits of solar home systems for low carbon, resilient development opportunities in Bangladesh, as well identifying emerging challenges and lessons for other countries. It is noted that the SHS programme in Bangladesh benefitted largely from a strong pre-existing network of competitive microfinance institutions with a broad reach in rural areas (Sadeque et al. 2014). Overall, Muzammil and Ahmed note that increased support from donors allowed the programme to reach the poor, as well as enhance market development and catalyse finance for smaller players, providing an innovative funding model with lessons for other countries.

The chapters of this book all emerged as part of the Gobeshona initiative in Bangladesh, a knowledge sharing platform for climate change research on Bangladesh that aims to bring together the national and international research community to encourage sharing, enhance research quality and make climate change research on Bangladesh more effective (ICCCAD 2017). Some chapters address sectors that are particularly vulnerable to climate change, including agricultural, coastal zones, water, while others address particular thematic issues of relevance to adaptation in Bangladesh, including governance, communication and gender. The aim is to connect researchers with other stakeholders, with the hope that the resulting publications can be used in response to climatic impacts in Bangladesh.

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Chapter 2

Agricultural Adaptation Practices to Climate Change Impacts in Coastal Bangladesh



M. Shahjahan Mondal, Mohammad Towheedul Islam, Debanjali Saha, Muhammad Shahriar Shafayet Hossain, Prodip Kumar Das and Rezaur Rahman

Abstract Bangladesh is an agrarian country and about one-third of its cultivable lands are in coastal and offshore areas which are highly vulnerable to climate change impacts. To adapt to such impacts, a number of policies, plans and adaptation measures have been suggested. However, it is not clear how many of these potential adaptation measures are actually in practice. In this study, we carry out an inventory of agricultural adaptation practices in the coastal zone of Bangladesh and present a synthesis of the inventory. The inventory is developed by recording multiple dimensions of adaptations. It records the purpose, geographic location, provider/beneficiary, timing, drivers, barriers to adaptation, gender aspects and sustainability issues of the adaptation practices. The findings of the study indicate that about 85 agricultural adaptations are now in practice, the majority of which are infrastructural-technological in scope. Almost all the adaptations are deliberate actions which come with a tangible aim of taking action/implementing change. The majority of the adaptations have been in response to long-term chronic stresses, such as salinity. Lack of capital, access to resources, knowledge and information, and centralised decision-making process appear to be some of the barriers to taking up the adaptations. The current evidence suggests that Bangladesh has embraced a

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mix of adaptations for agricultural development, though there are still areas for improvement.

Keywords Adaptation practice · Agriculture · Coastal area · Adaptation inventory
Gaps between policy and practice

2.1 Introduction

Bangladesh is a small country with a large population of about 160 million. About 32% of its population live below the upper poverty line and 18% below the lower poverty line (BBS 2013). The per capita net cropped area available in the country is less than 0.05 ha. Bangladesh is an agrarian country, and about 53% of households have farmland holdings and 48% of civilian workers are employed in the agriculture sector (BBS 2011, 2013). Being a predominantly deltaic country, about 57% of its total area is cultivable. There are three overlapping crop seasons (Rabi, Kharif-I and Kharif-II) and rice is the single most dominant crop cultivated in all these seasons, with about 77% coverage of the total cropped area. Jute, potato, wheat, maize, oilseeds, pulses, vegetables and spices are among the major non-rice crops. Agriculture plays an important role in rural employment and poverty reduction. Irrigated agriculture in particular plays a significant role in enhancing agricultural production and income, which contribute to the reduction of poverty and improvement in living conditions (Saleh/Mondal 2009). However, the agriculture sector is highly vulnerable to climate change impacts induced by global warming. Increased temperature, erratic and unpredictable rainfall, shortening of winter, foggy weather, sea level rise, increased flooding, and increased cyclones and storm surges are among the hydro-climatic factors which affect the country's agriculture sector (Mondal et al. 2012).

About one-third of the cultivable land in Bangladesh lies in the coastal and offshore areas. These areas are even more vulnerable to the effects of climate change due to their proximity to the sea, low land topography, the confluence of the mighty Ganges-Brahmaputra-Meghna rivers, reduced freshwater supplies from upstream, and fragile agro-ecosystems. About 37% of the cultivable coastal land is already affected by varying degrees of soil salinity (Mondal et al. 2015). The spatial extent of such area is increasing over time. Between 1973 and 2009, the salt-affected coastal and offshore areas increased by about 27% (SRDI 2012). Apart from salinity, cyclones, storm surges, tidal flooding, waterlogging and erosion are among the major hazards in the coastal areas. The frequency and intensity of these hazards are expected to increase, and their adverse impacts are likely to intensify under the changing climatic and environmental conditions in the future. In addition, the relatively high incidence of poverty and the high proportion of people dependent on ecosystems for their livelihoods further add to the vulnerability of coastal people to climate change impacts. To mitigate the adverse effects of climate change, adaptation is seen as a practical strategy in both policy and practice.

A number of studies have been conducted on agricultural adaptations in Bangladesh. However, most of these studies have been on potential adaptation options rather than on adaptation practices. For example, different kinds of studies were recommended in Brammer et al. (1993) to improve knowledge about the probable impacts of climate change on plant growth and yield, and to monitor environmental changes as they occur. Adoption of hybrid rice, development of pest and disease-resistant, stress-tolerant and short-duration crop cultivars, and development of crop varieties with low-transpiration ratios were postulated as potential adaptation options under a changed climate (Karim et al. 1998). Awareness building, infra-structural development, disaster preparedness, post-disaster rehabilitation, crop varietal development, improvement in agricultural management practices, development of agricultural extension services, promotion of agro-processing techniques, market infrastructure development, improved irrigation and water management, and integrated coastal zone management were identified as adaptation options by Karim (2011). Seventeen rice varieties have been developed in Bangladesh to withstand adverse climatic and environmental conditions (Rabbani et al. 2015). Two of them are submergence-tolerant, nine are salt-tolerant and the remaining varieties are drought-resistant. Other studies on potential adaptation options relate to crop agriculture (Ericksen et al. 1993; Ali 1999; World Bank 2000, 2011; Faruque/Ali 2005; Ahmed 2006; Asaduzzaman et al. 2010; Rawlani/Sovacool 2011; Asia Foundation 2012; Dev 2013). In contrast, there are relatively fewer studies on adaptation practices, i.e., on evidence of adaptations (Younus et al. 2005; Oxfam International 2009; Ahmed 2010; Sterrett 2011; Abedin/Shaw 2013). Also, there is no systematic study on such practices in Bangladesh from a holistic perspective, i.e., answering questions like which groups are adapting and benefiting, what have been the major drivers of adaptation, what are the ultimate aims of adaptations, in which geographical locations are adaptations occurring, whether the gender dimension is taken into account, etc. These holistic studies are also not available in the international arena with the exception of the one done for the UK by Tompkins et al. (2010). Such a study would help inform where Bangladesh stands in terms of adapting to climate change, identifying successful and unsuccessful adaptations, and designing better climate change policies and actions in the future.

2.2 Methodology

This study was conducted in the coastal zone of Bangladesh, as it represents the most vulnerable part of the country. Since there are a number of definitions of climate change adaptation, we draw on the IPCC (2014) definition: “The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities”. The study looks at adaptation to climate stressors, which include exposure to sudden-onset shocks, such as floods, and/or to slow-onset stresses, such as changes in temperature and rainfall. Adaptation in this study also refers only to adjustments made by humans.

Following this definition, an inventory of adaptation practices in the coastal zone of Bangladesh was prepared in order to collate the literature. To prepare the inventory, a protocol was first developed to collect evidence of adaptation to climate change. Currently observed and documented agricultural adaptations were within the purview of the protocol. The experience in developing the UK inventory of observed adaptations (Tompkins et al. 2009) helped in the formulation of the protocol for this inventory. Though agriculture broadly encompasses crop, live-stock, forestry and fishery sectors in some countries, only crop agriculture was considered in this study, as the agriculture ministry in Bangladesh is responsible solely for the crop sector and there are separate ministries and statistics available for others. Published literature – both peer-reviewed and grey – was collated in a universal spreadsheet template. No distinction was made between peer-reviewed and grey literature to qualify for the inventory except that the grey literature must contain authors/institutions, content with evidence of adaptation and year of publication. The template had 43 columns recording inter alia the purpose, geographic location, provider/beneficiary, timing, drivers, barriers to participation, gender issues, current and future damaging aspects, and long-term sustainability of the adaptation practices.

We collected literature available in both printed and electronic copies. Printed literature available from different national government agencies, non-governmental organisations, and academic and research institutes was collected. *The Bangladesh Climate Change Trust Fund* (BCCTF) has funded 219 projects since 2009–10 and the *Bangladesh Climate Change Resilience Fund* (BCCRF) has funded 13 projects. The documents available on these projects were collected and included in the inventory. For electronic literature, we searched in a number of online sources including academic databases (ScienceDirect, Springer, Wiley, OARE, etc.) and organizational web pages. The databases were searched with a number of relevant keywords, such as *adapt, resilient, vulnerab, climat, chang, variab, extreme, weather, disaster, risk, cop, recover, rehabilitat, repair, migrat, displac, hazard, insurance*, etc. and their appropriate combinations using Boolean and truncation operators. In addition, formal letters were sent to about 30 government, non-government and private organisations with a request to share available adaptation related documents. After sending the letters, the organisations were also contacted over telephone or in person. A few more documents were received through these processes and included in the inventory. One limitation of this approach was that only those practices which have been documented and defined as ‘adaptations’ were qualified to be included in the inventory. Many autonomous or spontaneous adaptations could be occurring in the coastal zones without proper documentation. Also, we did not attempt to identify to what extent the adaptations were in reaction to climatic impacts caused by global climate change or by other contextual factors, as that was beyond the scope of the study.

A half-day national workshop was arranged in Dhaka in 2015 to share and validate the findings of the inventory. The workshop was well attended by adaptation practitioners, professionals, implementers, academics, and researchers from different government and non-government organisations.

2.3 Analysis of Adaptation Practices

The inventory that we have prepared records many aspects of adaptation practices. These aspects were analysed using simple statistics, such as frequency of the practices, and are presented in this section. After describing the different adaptations that are in practice and their spatial distribution in the next two subsections, we will discuss the different forms, drivers, providers and beneficiaries of the adaptations, and barriers to the adaptation practices. Gender issues as reflected in the adaptation documents, and the various adaptation-linked policies and plans as formulated in the country, are highlighted in the final two subsections. The statistics are presented in terms of number of practices rather than by number of documents.

2.3.1 *Adaptation Practices*

About 85 different adaptations related to crop agriculture were identified as being currently practiced in the coastal region of Bangladesh. These range from hard engineering measures such as construction of polder, to soft socio-economic measures such as changes in cropping pattern, to technological innovations such as cultivation of stress-tolerant crops. Of the total practices, 53 are found to be infrastructural-technological in scope and 31 are socio-economic. Infrastructural adaptations typically characterise physical structures such as polders, regulators, sluices, culvert, canals, storage reservoirs, tube wells, pumps, and revetments; while technological adaptations include farm machineries, crop varietal development, irrigation canal lining, and new irrigation techniques.

The major adaptation practices have been the construction of polders to protect agricultural lands from flooding, construction of drainage infrastructures to alleviate waterlogging, innovation in crop technologies such as stress tolerant and short duration crop varieties, agricultural mechanisation to ease post-harvest activities and reduce operation time between successive crops, and introduction of integrated farming practices and cropping pattern changes. In addition to these practices, innovations in vegetable gardening such as floating beds and hanging gardens, rainwater harvesting for irrigation, dyke cropping to incorporate vegetables and other crops in a single season, and relay cropping were among the emerging adaptation practices. Some research in innovative agricultural practices, training and knowledge dissemination, and policy formulation were also found among the agricultural adaptation practices.