

Review Article

Climate change and water environment: Impacts on Bangladesh and highlights of policy gap

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Received: 24 June 2022; Revised: 21 October 2022; Accepted: 13 November 2022

Abstract

As a result of climate change, water resources and human well-being are being impacted in a variety of ways. Studies show that a rise in temperature, a rise in the sea level, and an increase in the number of natural disasters could cause pain for millions of people. Climate change has a significant influence on Bangladesh's water resources, which are examined in this review study. An increase in water-borne disease transmission, significant shifts in aquatic biodiversity, hindrance to blue economic growth and more severe natural catastrophes are all consequences of climate change impacts in the water sector. Programs taken by Bangladesh government have often failed to reduce the impacts of climate change. Recommendations for better policy in decision making, enforcement of environmental legislation, improvement of institutional capacity, and public awareness to safeguard the water environment and biodiversity, have been highlighted in this study. Experts and policymakers will benefit from the information that is shared through this medium.

Keywords: climate change, water environment, water borne disease, natural disaster, policy enforcement

1. Introduction

In the previous two centuries, the scientific understanding of climate change has expanded globally. There has been a lot of political debate about global warming and climate change in recent years. Many people, as well as the media, are divided on the issue of global warming's veracity (some call it a hoax). But climate experts, after looking at the evidence and facts have come to the conclusion that the earth is warming. There is now more evidence than ever before that the majority of the warming in the previous 50 years is due to human activity. In the last decade, we have seen a significant acceleration in all indicators of global warming (Rosen, 2021). Today's debate is not on the existence of global warming but on the extent to which people contribute to it and may thus mitigate its effects. Climate change, as defined by the United Nations Framework Convention on Climate Change (UNFCCC), is any change in the weather that can be connected in some way to human activity that modifies the

global atmosphere's chemical makeup (UNFCCC, 2011). Human-caused increases in atmospheric concentrations of greenhouse gases are most likely to blame for recent global warming. IPCC report finds that it is expected that the global temperature will reach or exceed 1.5 degrees Celsius of warming over the next 20 years on average. New climate model simulations, new analyses, and methods that combine multiple lines of evidence help us learn more about how humans affect a broader spectrum of climatic parameters, such as temperature and precipitation extremes (IPCC, 2021).

Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (NO), and water vapor are collectively referred to as "greenhouse gases" because they absorb infrared radiation and contribute to the greenhouse effect by trapping heat in the atmosphere. In 2021, carbon dioxide concentrations hit 421 parts per million for the first time in history (Figure 1). The amount of carbon dioxide in the air has increased by half due to human activity in less than 200 years (NOAA, 2022).

When it comes to the effects of global warming, the water industry is particularly at risk. One of the most dramatic effects of climate change is the rising level of the ocean. The average level of the sea around the world reached a new all-time high in the year 2020 rising 91.3 millimeters above its

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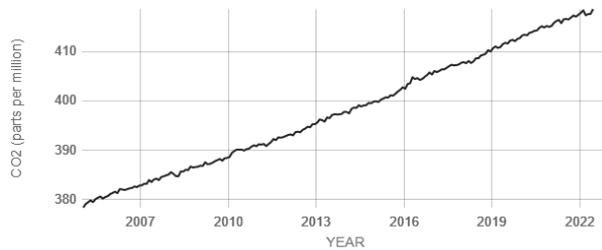


Figure 1. Rising trend of carbon dioxide (NOAA, 2022)

level in 1993, for a rate of 3.6 millimeters per year (Lindsey, 2022).

The impact of climate change on people's ability to acquire water is already being seen around the world, leading to increasingly severe droughts and floods. The rise in average global temperature causes greater quantities of water to evaporate into the atmosphere, which in turn will create higher concentrations of water vapor in the atmosphere and, in the years to come, precipitation that is more frequent, heavy, and severe. Scientists who study climate predict that this change would result in an increase in the number of floods that occur because more water will fall than the flora and soil can absorb. Coral bleaching, a mass death of coral reefs, reached record levels in 2015 because of the strongest El Niño (Pacific warming) climate cycle in a century and already high sea temperatures caused by climate change (Bradbury, 2012).

As a result of its location, low GDP, and reliance on climate-sensitive sectors, Bangladesh is one of the world's most at risk nations from the consequences of climate change. Bangladesh's primary economic driver is the water industry. We may anticipate a rise in the severity and frequency of natural catastrophes like tropical storms, river erosion, floods, landslides, and droughts that currently wreak havoc on the country. These, along with climate change's many other negative effects, will have serious consequences for the country's economy and its future. Bangladesh Government takes different initiatives including structural and non-structural measures to manage climate change, but it cannot be fully controlled. Bangladesh has several laws and strategies in place to deal with the effects of climate change, but these have so far been unsuccessful.

To understand the effects of climate change and how to put policies into place, we need to find answers to a lot of questions. These are: To what extent will climate change affect the Bangladesh's regional water environment in future? What will be the impacts of climate change in our blue economy? What further future steps should be taken by the government to tackle climate change?

The purpose of this assessment is to help policymakers in Bangladesh implement policies that are both pragmatic and prudent in order to address this issue. Discussion of various facets of the influence of climate change on Bangladesh's water resources has been made possible by the availability of data from a wide range of sources. The fact that this research relied solely on secondary sources to get the data and information it needed is the most significant limitation of this work.

2. Impacts of Climate Change on Bangladesh's Water Sector

According to Germanwatch's 2021 Global Climate Risk Index, Bangladesh comes in at number seven on the list of nations that are most at risk from the damaging effects of climate change (CRI). The results of this study provide a preliminary glance at the effects and provide policymakers strategies for adapting to them.

3. Water Availability

Everyone has the right to water. Every year, millions of people all over the world drink dirty water that gives them parasites, typhoid, cholera, and diarrhea (Elliot, 2010). Bangladesh has a problem with getting access to water because of water pollution caused by climate induced floods, salt intrusion, groundwater depletion, salinity, and drought (Abedin, Collins, Habiba, & Shaw, 2019; Water Aid, 2012). Since around two to three decades ago, the upland region of the Northwestern section of Bangladesh known as the Barind has been suffering from drought conditions. Due to rising temperatures and reduced precipitation, this area is already considered to be among the most vulnerable to severe drought (Figure 2) as a direct result of climate change. These factors are responsible for the decreasing water availability in these places. By 2050, the anticipated climatic changes include more unpredictable rainfall, leading to emergence of droughts, especially in the drier northern and western portions of the country (MOEF, 2008). According to the WHO, nearly all of Bangladesh's population has access to clean drinking water, whereas just 40 percent have basic sanitation. The country is in jeopardy as a result of the stunning fact that 60 percent of the population has to cope with contaminated water. Lack of access to or availability of water has many bad effects on people's ways of making a living, especially on women in rural areas of developing countries. Women notice climate change more than men (Hunter, Mac - Donald, & Carter, 2010; IPCC, 2013). In Bangladesh and other low-income nations, for instance, women are responsible for providing water and energy for their households. However, climate-related droughts can make this job harder because water and wood for fuel need to be gathered from farther away (Levy & Patz, 2015). Water shortage conditions caused by drought or by submerged well water during floods force women to carry water over long distances. This problem could make rape and physical harm more likely, and pregnant women are more likely to get sick from water and bugs (Levy & Patz, 2015; Liana, Clemens, & Peter, 2013).

4. Water Related Diseases

Extreme temperature and precipitation spread water and food borne diseases, which is further accelerated by climate change. In general, higher temperatures make it much easier for bacterial pathogens to multiply, stick around, survive, and propagate. Parasites can also get into our body through water and food when the temperature is high. Overall, more rain is linked to more bacteria, viruses, and parasites that

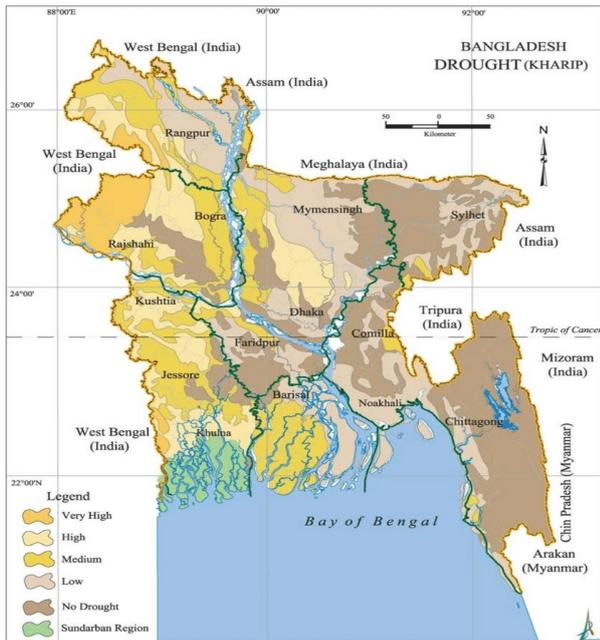


Figure 2. Drought prone areas in Bangladesh (Banglapedia, 2018)

cause illness. Pathogenic organisms’ growth and proliferation can be accelerated by high temperatures in their environments. Rainfall can also play a role in how quickly cholera spreads. During a study in Bangladesh, researchers discovered that the frequency of cholera cases rose by 14% when rainfall exceeded a threshold. Multiple pieces of research have pointed to a connection between rising average temperatures and an increase in the number of diarrhea-causing *E. coli* cases. An increase in relative humidity of only 1% decreases the risk of waterborne diseases by 1.6%, whereas an increase in mean temperature of just 1°C reduces the risk of respiratory infections by 4.2% (Mahmud, Raza, & Hossain, 2021).

Dengue is expected to get worse in Dhaka as the weather changes to more suitable for it (Figure 3). From 1976 to 2019, weather records show that Dhaka is getting less humid, getting warmer, and getting more rain in the summer. Together with things like urbanization, these raise the risk of dengue in Dhaka city (World Bank, 2021). The graph shows how many cases of dengue there were each month from 2008 to 2019. Climate change or variability, rapid urbanization that wasn’t planned, high population densities, and lack of public health infrastructure and poor vector-control programs, all make dengue outbreaks in Bangladesh bigger and worse (Hsan *et al.*, 2019). This area is expected to see an increase in mosquitoes and dengue transmission as an outcome of climate change. Dengue cases in Dhaka would soar if the IPCC’s predicted temperature rise of 3.3 degrees Celsius by 2100 comes to fruition (Banu *et al.*, 2014).

5. Impacts on Aquatic Biodiversity

Climate change and the biodiversity are closely linked. The 13th meeting of the Conference of the Parties (COP 13) to the Convention on Biological Diversity (CBD) took place in Mexico in 2002, where a number of important commitments were made about biodiversity like “life below

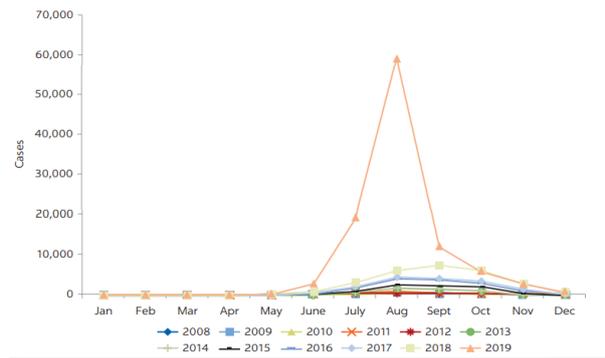


Figure 3. Distribution of Dengue fever cases in Bangladesh from 2008-19 (Mamum *et al.*, 2019)

water,” (Goal 14) and “life on land” (Goal 15). These goals show how important it is to protect biodiversity and ecosystems in the ocean and on land. Bangladesh is on the IUCN’s “Red List” that was recently updated by The International Union for Conservation of Nature and Natural Resources (IUCN). This list shows that 390 animal species in Bangladesh are in danger of going extinct (Sirazoom, 2017). The reproduction, migration, and survival of fish are all impacted by changes to marine ecosystems brought on by climate change. The yield of Hilsa from inland waters has decreased by around 20 percent over the past two decades, whereas the yield from marine water has increased by a factor of three (DoF, 2016). Recent studies show that 96% of the Sundarbans tiger habitat would be lost if the sea level rises by 28 cm (Payo *et al.*, 2016). This would result in the loss of cultural, biological, and fishery resources. On the positive side, floods may reconnect rivers with shallow lakes, disseminate biota and seeds, and make it simpler for native fish to reproduce and have offspring (Prusty, Chandra, & Azeez, 2017).

6. Increasing Water Related Disaster

Bangladesh’s location renders it particularly susceptible to floods, droughts, cyclones, and the effects of rising sea levels. One in seven individuals in Bangladesh would be compelled to leave their home by 2050 due to the effects of climate change. About 11 percent of Bangladesh’s land might be lost by 2100 if the sea level rises as anticipated by 19.6 inches (50 cm), forcing as many as 18 million people to relocate (Figure 4). In addition to the effects of rising sea levels, salt intrusion in the coastal zone has emerged as one of the most pressing issues confronting the country today. The amount of land impacted by salinity keeps growing. By the year 2050, it is anticipated that the average salinity would have increased by 26%. (Figure 5).

As a direct effect of climate change, mega floods are expected to become more intense and more frequent. According to the worst-case scenario forecasts, flood damage across the country would increase by a significant margin by the year 2050. With the sea level rising from the base period in 2005, the amount of flooding may increase by up to 6% in the central area of the coastal zone by 2050 and by 8% by 2100. This is based on a hypothetical situation in which severe weather occurs (CEGIS, 2010).

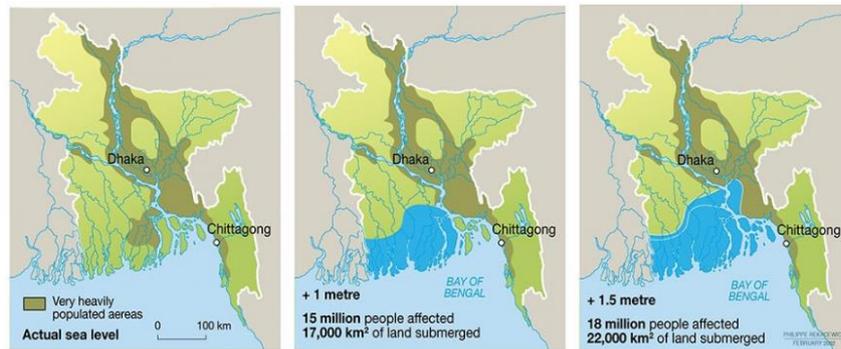


Figure 4. Sea level rise in Bangladesh (UCAR, 2018)

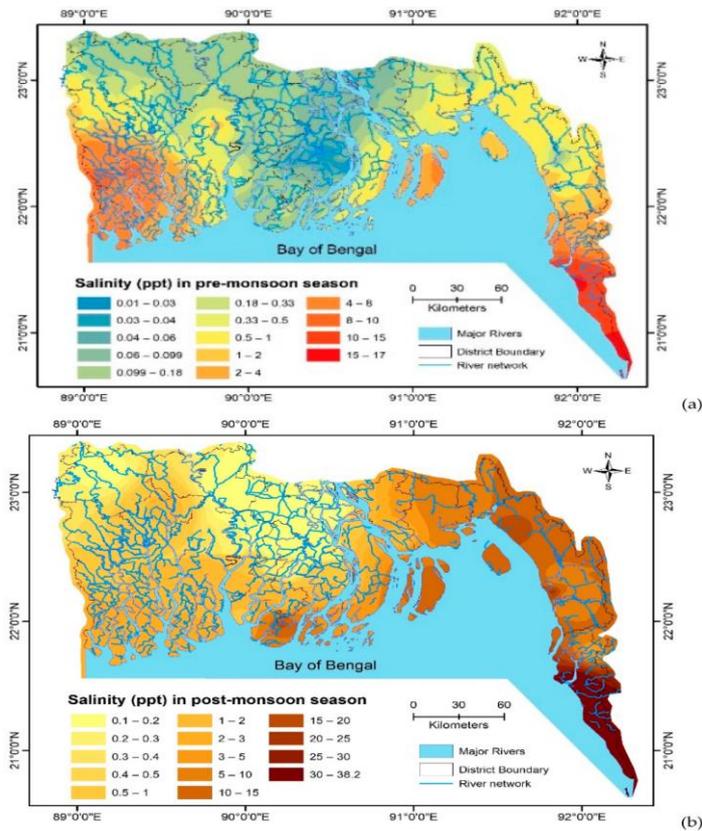


Figure 5. Salinity intrusion map in Bangladesh (Shammi *et al.*, 2019)

Natural catastrophes displaced 700,000 Bangladeshis every year during the previous decade (McDonnell, 2019). Cyclones represent a major threat to life and property in Bangladesh’s coastal zone, which is particularly vulnerable to cyclones in low-lying regions. Early summer (April–May) or late rainy season (September–October) are the most common times for cyclones to strike the country’s coastal areas (October–November) as shown in Table 1.

7. Impacts on Blue Economy

The occurrence of extreme weather events, which is linked to climate change, is also making coastal and marine resources more susceptible, which might impede the uninterrupted growth of the Blue Economy in Bangladesh.

The process of photosynthesis in marine plants and algae might be hindered by rising sea levels, which would also alter the way mangrove ecosystems work. The biodiversity of St. Martin’s Coral Island could be hurt by ocean acidification in a big way. Sedimentation, storm surges, and coastal erosion pose the greatest danger to coral reefs. A rise in surface temperature due to coral bleaching reduces seabird mating and population growth. Heat and water stress have a significant impact on the reproductive growth of coconut trees. Crabs and shrimp will lose their breeding grounds as a result of sea level rise. Climate change is affecting marine ecosystems and the commodities and services they offer, which might impair our capacity to meet the SDGs. The fundamental idea behind Sustainable Development Goal 14 (SDG-14) is to help Bangladesh create a blue economy that can thrive long after

Table 1. Impacts of cyclones in Bangladesh (Wikipedia, 2022)

Year	Cyclone name	Deaths	Economic loss (\$)
2007	Sidr	3447	\$ 1.8 billion (2010 USD)
2009	Aila	109	\$ 552.6 million (2009 USD)
2020	Amphan	20	\$1.5 billion (2020 USD)
2021	Yaas	03	\$3.0 billion (2021 USD)

2030. Experts from around the world predicted that the impacts of climate change on the services provided by marine ecosystems would have a significant and adverse effect on all of the Sustainable Development Goals (SDGs), with the goal of ending hunger being among those that would be most directly impacted (Haque, 2020).

8. Plan and Policies to Address Climate Change in Bangladesh

Bangladesh's "Ministry of Environment and Forest" (MoEF) is in charge of protecting the environment first and foremost. In the sections that follow, we will briefly describe and synthesize national-level policy and institutional factors in connection to climate change.

1. National Water Policy: The Ministry of Water Resources (MoWR) of Bangladesh developed a comprehensive plan for the country's water system in 1999 called the National Water Policy. This policy addresses issues such as users' rights, water quality, decentralization, privatization, siltation, and erosion. While the water industry is one of the most susceptible to climate change, policymakers hardly touched on the subject in this document.
2. National Water Management Plan: The National Water Management Plan of 2001 is a framework for the ministries to establish approaches; organizations, departments, and government municipalities to create programs and a course of action for individuals in charge of water related function provision and direct investment in Bangladesh. This framework, in contrast to the National Water policy, has to give due consideration to the impact that climate change would have on water resources in Bangladesh.
3. The Coastal Zone Policy: The Ministry of Water Resources (MoWR) developed the Coastal Zone Policy 2005 to serve as a guide for the many government entities responsible for protecting and enhancing the coastline. It lists a number of goals, some of which are as follows: the establishment of sustainable livelihoods; the intensification of the coverage of clean drinking water infrastructure; the minimization of hazards (including vulnerability to climate change) and the narrowing of the gender gap.
4. National Adaptation Programmes of Action (NAPA): In response to a decision made at the 7th Conference of the Parties (COP 7) of the UNFCCC, the Ministry of Environment and Forests of Bangladesh formulated the National Adaptation Programme of Action (NAPA) 2005.

The initial purpose of NAPA formulation for Bangladesh is to lead the coordination and implementation of adaptation strategies in the state using a paradigm that is both inclusive and fosters synergies with other relevant environmental and related initiatives. It will also provide a personalized, priority-based action plan for coping with climate change.

5. Bangladesh Climate Change Strategy and Action Plan (BCCSAP): In 2008, Bangladesh's government produced the Bangladesh Climate Change Strategy and Action Plan (BCCSAP). With a variety of programs, the BCCSAP tackles six elements of climate change (Table 2). Bangladesh Climate Change Strategy and Action Strategy (BCCSAP) is a 10-year plan (2009-2018) to prepare the country for climate change.

Further, in October 2011, the Prime Minister signed the Climate Change Trust Act into law. The primary goal is to provide a framework for institutionalizing the development of climate change resilience. Water and food security, economic growth, and a stable climate are just some of the goals of the recently enacted, all-encompassing "Delta Plan 2100," which the government unveiled. A key part of this strategy is to be flexible and open to change. The plan's immediate actions will be taken by 2030, its intermediate steps by 2050, and its final, far-reaching steps by 2100.

The major gaps of these policies are in addressing environmental technologies and methods for making an integrated single policy to combat climate change. Planners should add environmental database in action plan and informal and formal education is very necessary for the people to be aware regarding the impacts of climate change. This legislative framework lacks the necessary environmental technology and unified approach to combating climate change. The process of implementing environmental policy in Bangladesh does not include official or informal talks between government agencies, especially the MoEF and DoE, and polluters. No acceptable level of institutional capability exists within the relevant ministries to carry out the different action steps. A lack of institutional capacities, unskilled human capital, an unawareness about legislation, limited community involvement in strategic planning, a lack of knowledge and failure of coordination among different stakeholders all appear to be to blame for Bangladesh's poor environmental governance. Nongovernmental organizations (NGOs) are employing pro-poor strategies in order to work with low-income people, particularly women and members of marginalized communities. Many non-governmental organizations do not have enough access to the Bangladesh Climate Change Trust Fund (BCCTF) and the Bangladesh Climate Resilient Fund (BCCRF) resources, which are both sponsored by donors and development partners in Bangladesh. Weakness in rules, laws, and policies pertaining to climate adaptation impedes their execution. There now exist no clear norms for such cross-sector cooperation. There has been a delay in developing effective courses of action as a result. It is not uncommon for political pressure to cause government entities to violate environmental protection laws (Rahman, 2015).

Table 2. The six topical areas under which BCCSAP initiatives in Bangladesh are being carried out (Huq *et al.*, 2012)

Thematic area	Budget (US\$ in Million)	% of total investment
Food security, social protection and health	4.5	9
Comprehensive disaster management	10.5	21
Infrastructure	9.5	19
Research and knowledge management	6.5	13
Mitigation and low carbon development	16	32
Capacity building and institutional strengthening	1.6	3.2

9. The Way Forward

To guarantee the success of all national policies relating to the environment, the Ministry of the Environment and the Department of the Environment (MoEF and DoE) must adopt a mitigation and adaptation plan to establish a centralized database and management information system (MIS). Climate change vulnerability analysis calls for a revamp of current environmental policies. For political decisions to have more of an impact, institutional, administrative, and organizational changes would have to be made. The services necessary to achieve governance for environmental protection would be promoted and institutionalized if they were better coordinated and integrated across many sectorial departments. It is important that efforts be directed toward discovering viable ways ahead to assure liability and proficiency in the management of natural resources like harnessing renewable energy by the government. The gathering and transmission of information is a key component of streamlining environmental governance, and relevant stakeholders should play a significant part in this process. Above all else, the system of the United Nations, which includes universal finance and involvement delegation, as well as all intergovernmental organizations and forums, need to, in collaboration with non-governmental organizations, finalize the endeavors of the government of Bangladesh to speed the implementation of laws related to environmental governance. This should be done in conjunction with the United Nations.

10. Conclusions

The impacts of climate change on Bangladesh's ecology and environment have been devastating. By 2025, almost two-thirds of the world's population, or more than 1.8 billion people, will be at danger of water stress due to a lack of access to clean water in their homes or communities. Increasing floods and drought make water inaccessible to people. This report is one of the few that provides an overview of consequences and recommendations for filling the policy void in Bangladesh. Water shortage is becoming an increasingly critical problem in Bangladesh as the country's population grows and consumes water in numerous ways. In the dry season, saline intrusion, drought, and floods threaten freshwater supplies, making it difficult to provide people with safe drinking water. Dengue pandemics in Dhaka have been blamed on the climate change-induced conducive environment in recent years. It is easier to see the effects of extreme weather, widespread floods, or other natural catastrophes in certain areas than in others. These areas include flood plains surrounding river basins, coastal areas, the northwestern

region, and disorganized urban centers. Although Bangladesh government has an action plan to combat climate change, enforcement of these strategies is very weak with corruption, lack of coordination, lack of institutional cooperation, intersectoral coordination, inequity, or injudicious use of natural resources being the main driving factors. The processes of planning, policy formation, and putting into action adaption plans for climate change are still in their infancy. Both the Bangladeshi government and the Bangladeshi community are now fully aware of extreme events that are caused by climate change and the potential impacts that these events may have, and they are now working actively toward mitigating the effects of these extreme events. The government has built efficient and comprehensive institutional systems, as well as dedicated money derived from the government's own resources, in order to take actions to adapt to and mitigate the effects of climate change. But there is a pressing need for an all-encompassing plan to keep resources in a sustainable state as a way to slow the process of environmental deterioration and to assure general development by mitigating the effects of climate change. We may conclude that Bangladesh is one of the most vulnerable countries to the effects of climate change, and that these effects will have far-reaching consequences in the not-too-distant future.

Acknowledgements

We would thankfully acknowledge the editor and anonymous reviewers for their constructive feedback that improved greatly the manuscript.

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