

Bangladesh

1. Country overview

Bangladesh is located in South Asia in a low-lying delta region formed at the junction of the Ganges and Brahmaputra River systems. The country shares borders with India to the north, east and west, and Myanmar in the south-east. Bangladesh's land is mostly low and flat, with some hilly regions in the north-east and south-east, and crisscrossed by more than 230 rivers and their tributaries (Food and Agriculture Organization of the United Nations (FAO) 2016). The majority of coastal cities in Bangladesh are at an average elevation of 1,2 – 1,5 metre above sea level and 10 per cent of the country is below 1 metre (m) above sea level (Rahman 2015).

An estimated 164 million people live in Bangladesh – 40 per cent of whom live in urban areas. Since 2005, Bangladesh's economy has grown around 6 per cent per year. The majority of the country's gross domestic product (GDP) comes from the service sector, but more than half the population works in the agriculture sector. Additionally, roughly 40 per cent of the population is underemployed, working only a few hours a week for low wages (Central Intelligence Agency (CIA) 2020).

Bangladesh ranks 162 out of 181 countries in the Notre Dame Global Adaptation Initiative (ND-GAIN) index. The ND-GAIN index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. This ranking indicates that Bangladesh has high vulnerability levels, and medium to low levels of readiness to adapt to climate change (ND-GAIN n.d.).



Figure 1: Map of Bangladesh

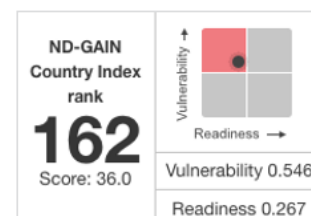


Figure 2: Bangladesh's ND-GAIN Ranking (ND-GAIN 2021).

1.1 Climate

Bangladesh experiences a subtropical monsoon climate with a wide seasonal variation in rainfall. The country has three climatological seasons characterized as follows (Smilebangladesh 2019):

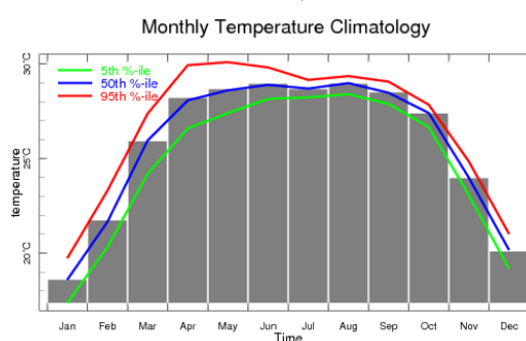
1. Summer (March to June): hot and humid weather
2. Rainy or Monsoon (June to October): hot and rainy weather
3. Winter (October to March): cooler and dry weather

There are three major drivers of Bangladesh's climate variability (shifts from year to year). The first is the El Niño Southern Oscillation (ENSO), including La Niña. El Niño and La Niña events occur every 2–7 years. During El Niño periods, Bangladesh typically experiences drier conditions during June to September and during La Niña periods, wetter than usual conditions typically occur (International Research Institute for Climate and Society (IRI) 2014; IRI 2015). Additional drivers include the South Asian Monsoon, South-East Trade Winds and the Indian Ocean Dipole (World Bank 2021b).

Temperature

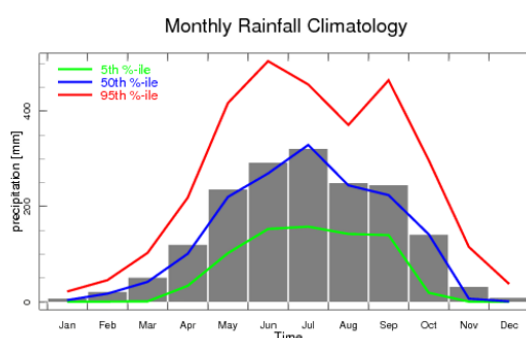
The climatological average temperature is around 26,1°C, but this varies seasonally between roughly 15°C and 34°C, with colder extremes in the mountainous North and the highest extremes around capital city Dhaka. The warmest temperatures tend to accompany the summer rainy monsoon season from March to September (World Bank 2021a).

Figure 2: Monthly temperature climatology (1981–2007) Observations for [90.25E–90.5E, 23.75N–24N] (Source: IRI Map Room 2020)



Precipitation

Bangladesh is one of the wettest countries in the world with most regions experiencing at least 1.5m of precipitation annually and some receiving upwards of 5.8m. The majority of this rainfall is associated with the South Asian Monsoon, which brings warm and moist air from the Indian Ocean (World Bank 2021a).



Cyclones

Originating from the Bay of Bengal, Bangladesh experiences extensive cyclonic activity, with many of these events concentrated in November and May. All coastal and adjacent inland areas of Bangladesh are at risk from the impacts of tropical cyclones, especially severe flooding of coastal cities and damage of essential infrastructure. In addition to coastal impacts, tropical cyclones can cause heavy precipitation, landslides and heavy wind far from the coast (Rahman 2015; World Bank 2021b).

1.2 Climate change

Historical climate

Temperature

Since the 1960s, surface air temperature has increased by around 0.3°C during the early monsoon season (June–August), and approximately 0.5°C in the late monsoon season (September–November).

Relatedly, the number of ‘hot’ days (defined by the temperature exceeded on 10 per cent of days or nights in the currently defined climate of that region and season) increased by 26 days per year from 1960–2003. This warming is also mostly seen in the early monsoon season (McSweeney 2010).

Projected Climate

The average temperature in Bangladesh is projected to increase by 1.4°C and 2.4°C by 2050 and 2100 respectively, with much of the warming happening during the winter months (December–February) (World Bank 2021c).

The number of ‘hot’ days and nights are projected to increase across the country, with ‘hot’ nights occurring on 26–37 per cent of nights by the 2060s, and 30–50 per cent of nights by the 2090s (McSweeney 2010).

Precipitation and water

While overall trends in mean annual rainfall are unclear, there has been a shift in rain distribution since 1960 with increases in March–May rainfall and decreases in June–August rains (USAID 2015). Extreme rainfall events became slightly less frequent and intense, although few of these trends are significant (USAID 2015).

Approximately one-quarter of the land area in Bangladesh is inundated every year. Up to two-thirds of Bangladesh is inundated by floods every three to five years (World Bank and GFDRR 2011). The frequency of above-normal floods has increased since the 1950s (World Bank 2011).

Cyclone activity has significantly increased in the Bay of Bengal in May and November (World Bank 2021c). Over 70 cyclones have affected Bangladesh in the past 200 years (Minar *et al.* 2013).

Projections for overall rainfall suggest a slight increase in total precipitation (McSweeney 2010). However, this is due to a projected increase in extreme precipitation events (peak 5-day rainfall intensity) and an increase in the amount of time between rainy days (World Bank 2021c).

Glacial melt, especially in the Himalayas, is likely to affect river flows in the important Ganges–Brahmaputra–Meghna Basin. Early indications of this impact are likely a contributing factor to recent historic flood events (United States Agency for International Development (USAID) 2018).

The frequency and intensity of cyclonic activity in the Bay of Bengal is also likely to increase. Sea level rise of up to 27 centimetres (cm) by 2050 (World Bank 2021c) will further exacerbate cyclone-induced storm surges.

2. Humanitarian sectors and climate change

2.1 Water and habitat

Water and sanitation systems

As a low-lying, coastal nation with significant monsoon and cyclone seasons, much has been written about water management and infrastructure in Bangladesh. Many of the country's coastal cities sit below 1–1.5m above sea level, exposing these areas to rising seas and hydro-climatic extreme weather events such as cyclones, storm surges and tidal floods. In turn, this puts water resources in these communities at risk of contamination and salinization (Rahman 2015).

Drinking salinized water, and the accompanying increased sodium intake, can have adverse health effects; including a range of significant maternal health risks, notably leading to dangerous levels of hypertension in pregnant women (Khan *et al.* 2011).

In 2016, the World Bank highlighted a range of water-quality issues and trends in Bangladesh, including (World Bank 2016):

1. Arsenic contamination in 22 per cent of tube wells, the discovery of which closed wells and reduced coverage to below 80 per cent of the population (from around 100 per cent coverage in previous years)
2. Sanitation improvements are slow. As of 2016 the sanitation rate was 61 per cent, with a 1.1 per cent annual increase.
3. There is no city with a significant sewer system. Only the capital city of Dhaka has a sewer system, and that system serves just 18 per cent of the city's population.
4. UN programmes, microfinancing and government sanitation projects are attempting to improve these metrics.

In 2017, an estimated 22 per cent of the population did not have access to water at home. While just under 90 per cent of Bangladeshis have access to at least some basic services of clean water near their homes, approximately 45 per cent, or 73 million people, use contaminated water (WaterAid n.d.).

Bangladesh's water and sanitation sectors have increased coverage over the last several decades; however, hygiene promotion/education and the quality of water and sanitation facilities are in need of improvement (Mahmud and Mbuya 2016).

Each of these water-quality issues exacerbate vulnerability to a changing climate and the associated impacts of more intense rainfall, more frequent flooding, more frequent droughts and increased cyclone intensity.

Municipal power

Bangladesh's energy consumption is extremely low at just 220 kilowatt-hours (kWh) per year (89 kilogrammes of oil equivalent (kgoe) / capita), producing less than 0.2 per cent of the world's total greenhouse gas (GHG) emissions. This is due, in part, to the low production capacity and existing grid infrastructure, resulting in a growing energy crisis with deficits in supply, leading to fuel poverty. As a result, only 31.2 per cent of the population is connected to the grid – 80 per cent of whom are urban dwellers (Ministry of the Environment, Forest and Climate Change 2011).

Already existing and projected increases in the frequency and severity of extreme weather events puts the country's energy sector under heightened risk. The infrastructure is not only at risk of damage from weather events including high winds, flooding or salt intrusion, but climatic and environmental changes shift demand patterns. During heatwaves and droughts, the high temperatures increase the demand for electricity from users, puts pressure on the power infrastructure's cooling systems, and affects wind power potential (Shahid 2012). Inadequate access to emergency cooling, whether due to accessibility issues or power outages, can have dire consequences during extreme heat events.

Infrastructure

Bangladesh's capital Dhaka is one of the most densely populated cities in the world at 41,000 people per square kilometre. In Dhaka, 4 million people live in informal settlements (Habitat for Humanity n.d.) characterized by inadequate housing and services along with a range of high vulnerability indicators, which make these communities particularly at risk of climate-related shocks.

Monsoon-proof buildings are part of Bangladesh's vernacular architecture, but the importance of this knowledge is being reemphasized with recent demographic and environmental changes. Bangladesh has explored innovative ways to provide infrastructure and services within the context of flooding and monsoons, including the use of floating hospitals that expand the reach of medical services to coastal communities impacted by rising sea levels (Sampath 2017).

2.2 Economic Security

Bangladesh has experienced steady economic growth (a rate of 5.8 percent annually) during the last decade, with relatively low inflation and stable domestic debt alongside improvements in nutrition and health outcomes (Mahmud and Mbuya 2016). However, Bangladesh's economic stability is vulnerable to climate impacts across many sectors. World Bank research suggests higher temperatures and shifting precipitation patterns will reduce living standards in Bangladesh in the near future (Mani *et al.* 2018).

Agriculture and food security

In 2005, agriculture represented 20 per cent of Bangladesh's GDP and provided work to about 52 per cent of the labour force. The agricultural sector produces 12 per cent of GDP alone, with rice being the most important crop (Sikder and Xiaoying 2014).

Bangladesh's agriculture sector is vulnerable to climate impacts including flooding, storms and cyclones, heatwaves and droughts as well as saline intrusions. Rice production is particularly vulnerable to a range of climatic changes and weather stressors, and anthropogenic climate change has been projected to decrease rice production in Bangladesh by 7.4 per cent every year between 2005–2050 (Sikder and Xiaoying 2014).

Researchers and governments have raised the alarm about the sector's vulnerability to environmental changes, and interventions such as wage subsidies have been developed in the hope of mitigating some of the damage (Sikder and Xiaoying 2014). Research suggests, however, that given sufficient irrigation infrastructure, rising temperatures could have a positive impact on general crop production. A 1 millimetre (mm) increase in rain and 1°C increase in temperature could lead to about a 4–15 US dollars increase in net crop income per hectare (with a wide range of variance) (Hossain 2019). This is an active area of research, but general consensus is that increasing climatic variability, salinization, more frequent inundation and temperatures above critical thresholds will decrease rice and other crop production (Ministry of Foreign Affairs of the Netherlands 2019).

Saline intrusion is a major worry as rice production in coastal rice fields decreased by 69 per cent (1,151 metric tons) in 2005, compared to 1985 (Ali 2006). Inundation from coastal flooding in the Bay of Bengal is projected to increase, with 17 per cent of land inundated by 2050. This inundation will drastically decrease Bangladesh's cultivable land as 30 per cent of the workable farmland is along the coast. Although food security in Bangladesh has improved, the country is still considered food insecure with 60 million people consuming less than daily recommended calories in 2010 (Ismail 2016).

Fisheries and livestock

Fisheries contribute around 5 per cent of Bangladesh's GDP and livestock around 6 per cent; but both sectors are crucial to food security and employment. Due to climate change and other anthropogenic impacts, fisheries are at risk of loss of habitat, habitat degradation, ocean acidification and changing reproduction patterns among different species of fish (Barange *et al.* 2018). Similarly, the livestock sector is at risk of reductions in grazing lands and increased heat-related mortality and diseases among farm animals. As a result, livelihoods that depend on fisheries and livestock are under increased threat, which in turn impacts national food security as the country is highly dependent on these activities. Projections show that these trends will lead to further unemployment, poverty and malnutrition (Ministry of the Environment, Forest and Climate Change n.d.).

Nutrition

Bangladesh's nutrition is highly dependent on the agricultural and livestock sectors; and, as such, is significantly impacted by climate change. Since the 1990s, rates of undernutrition have declined, but prevalence remains high with 38.7 per cent of under five-year-olds 'short for their age' and 35 per cent underweight (Mahmud and Mbuya 2016).

2.3 Health

Direct impacts of climate change on health in Bangladesh include increased mortality and morbidity caused by storms, tropical cyclones, heatwaves and droughts. Indirectly, climate change also impacts health by reducing water quality and increasing food insecurity through saline intrusions, destruction of habitats, low precipitation and increases in pathogens and viruses (Rahman *et al.* 2019).

Extreme precipitation and flooding events put the population at risk by contaminating drinking water with salt, human waste or other biohazards. Droughts pose a similar risk as reductions in water availability may force individuals to use contaminated water sources. Population displacement from events like droughts are linked to increases in communicable diseases and poor nutritional status from overcrowding as well as a lack of potable water and food and shelter. Heatwaves and temperature affect the elderly and vulnerable populations first and can have widespread and sustained impacts on health and well-being (ICCCAD 2014; Ministry of Foreign Affairs of the Netherlands 2019; Ministry of Environment and Forests 2008).

A study on climate change and health in Bangladesh revealed that the mean annual health care expenditure of study participants was 6,555 Bangladeshi Taka (BDT). Hazards and disasters like extreme flooding or cyclones often result in public health emergencies. During and after extreme weather events, health expenditure increases significantly from the associated costs of treating increases in waterborne and water-associated diseases (like malaria, dengue fever and diarrhoea), injuries from land- or mudslides and displacement or homelessness (Kabir *et al.* 2016).

These risks are compounded by lack of access to proper sanitation facilities, a weak health sector and limited healthcare provision available in Bangladesh. The healthcare system itself is threatened by physical climate impacts, with limited infrastructure and ability to respond during an extreme weather event (Shahid 2010).

2.4 Protection

The United Nations High Commissioner for Refugees (UNHCR) estimates the refugee population in Bangladesh is approximately 855,000 people (UNHCR 2020). This population is predominantly Rohingya communities who have been forcibly displaced from Myanmar. Displaced people, including those who have been displaced internally (IDPs) and refugees, are often particularly vulnerable to climate extremes. This includes flood and cyclone events that can quickly destroy the limited infrastructure in camps, as well as heatwaves that leave people with few options for cooling and shelter. In June 2019, for example, over 28,000 refugees in Cox's Bazar in south-eastern Bangladesh were affected by heavy monsoon rains, with over 10,000 people being displaced due to floods and landslides (ReliefWeb 2019).

Within Bangladesh, rural to urban migration and displacement is occurring increasingly due to climate change and extreme weather impacts in coastal areas which include cyclones, storm surges, erosion and saline intrusions or droughts destroying arable land and livelihoods (Salaudhin 2012). This internal displacement has significant long-term impacts on people's lives and livelihoods: increasing unemployment and leading to a lack of housing and access to local public services as well as health problems (Islam *et al.* 2016; Ismail 2016). A public health study

in Dhaka shows that the children in these communities are substantially more at risk of diarrhoea and asthma than the non-migrant population, leading to lower life-expectancy (Molla *et al.* 2014).

With ever-increasing climate risk, it is projected that internal and external climate displacement and migration will also increase. By 2009, an estimated quarter of the population had been displaced by flooding since 1970 (Aker 2009). That number could be as high as 50 per cent today. Research suggests permanent inundation of coastal regions through sea level rise may directly displace 0.9 million people in the south of Bangladesh by 2050 (Davis *et al.* 2018).

In addition to internal migration and displacement, climate-motivated migration from Bangladesh to India is increasing, and could potentially cause socioeconomic tensions between the countries, destabilization of politics, and a range of economic and environmental impacts. The protection of climate-motivated migrants and understanding these migration patterns are essential to properly address this issue bi-nationally (Panda 2010).

Climate migration, within Bangladesh, has both a socioeconomic and a gender component as climate impacts disproportionately affect individuals of lower economic status and women. In Bangladesh, women are more vulnerable to shocks for socioeconomic reasons, with less resources to adapt, and are more likely to be killed or injured during extreme weather events (Parvin *et al.* 2013; Cannon 2002). Globally, disasters exacerbate gender inequality; and, within Bangladesh, where pre-disaster conditions are already poor, and disasters often occur at the same time or in sequence, this effect is magnified (Rahman 2013).

Finally, around the world, people in detention frequently have heightened vulnerability to natural disasters due to: spatial marginalization, resulting from prison locations on hazard-prone land and/or isolation from emergency evacuation services; limited to no connections to social networks, which are crucial aspects to hazard resilience; and political marginalization, including a lack of policies and services to prevent disaster impacts on imprisoned populations (Gaillard and Navizet 2012). These vulnerabilities, coupled with more frequent and intense disasters due to climate change, may leave prison populations in especially high-risk positions to the impacts of extreme heat, extreme cold, floods and cyclones.

2.5 Policy

Bangladesh has ratified the UN Convention on Biological Diversity, UN Convention to Combat Desertification, UN Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and the 2015 Paris Agreement. Alongside these ratifications, Bangladesh elaborated a National Biodiversity Strategy and Action Plan in 2004 and prepared two national communications for the UNFCCC as well as a National Adaptation Programme for Action (NAPA). Only one NAPA project that focused on coastal afforestation was funded (Ministry of Foreign Affairs of the Netherlands 2019).

In 2008 (updated in 2009), many of the strategies of the NAPA were adapted into the Bangladesh Climate Change Strategy and Action Plan (Ministry of Foreign Affairs of the Netherlands 2019; Ministry of Environment and Forests 2008) – a cross-sectoral 10-year programme to build resilience to climate change impacts. It established 44 short-, medium- and long-term goals across six areas:

1. Food security, social protection and health
2. Comprehensive disaster management
3. Infrastructure
4. Research and knowledge management
5. Mitigation and low carbon development
6. Capacity building and institutional strengthening

Bangladesh's 2015 Intended Nationally Determined Contributions (INDC) include the mitigation contributions of unconditionally “reducing GHG emissions by 5 per cent from Business-as-Usual levels by 2030 in the power, transport and industry sectors, based on existing resources” as well further conditional contributions. The INDC also includes adaptation priorities such as: improved early warning systems for cyclones, floods and drought; storm surge protection and flood-proofing measures; urban resilience, drainage, housing and infrastructure; biodiversity conservation; health; and capacity building of individuals and institutions (UNFCCC 2015; Ministry of Environment and Forests 2008; Ministry of the Environment, Forest and Climate Change 2009). To enhance community resilience, especially in coastal regions, collaborations between government, NGOs, local actors, and academic actors need to be strengthened. Efforts are focused on capacity building of actors on the ground to improve coordination and the inclusion of enhancing resilience into local programs (Bollettino *et al.* 2020).

Bangladesh has been an active participant in international policy as well as with internal policymaking; however, the effectiveness of in-country institutions is often diminished by limited resources and capacity (ICCCAD 2014; Ministry of Foreign Affairs of the Netherlands 2019).

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