Chapter 2

Background to Natural Hazards

The previous section provides an introduction to the problem of natural disasters in Bangladesh, and this chapter presents analyses of three key disasters: floods, earthquakes, and landslides. Floods are the most common and occur annually with low casualty levels but great economic losses. Earthquakes are of great concern, even more so now after a performance evaluation of search and rescue operations following the collapse of two buildings in Dhaka. Landslides are not recognised as hazards by the Government of Bangladesh. In this chapter, before discussing hazards in Bangladesh, an overview is given of the characteristics of floods, earthquakes, and landslides in Bangladesh (Table 1). Other than these hazards, cyclones, tornadoes, and river bank erosion also occur, but these are outside the remit of the current report.

Table 1: **Selected natural hazards by key characteristics**

Types of hazard	Scale of impact	Frequency, likelihood, and return period	Impact		
			Casualties/ fatalities	Local economy	National economy
Floods	National	• Annual, sometimes a number of floods per year • The intensity and frequency is changing in the context of climate change. Currently, the return period of major floods is likely to change from 10-20 years to six years. • Flash floods occur almost annually in the northeast part of Bangladesh.	Low	Very high	Very high
Earthquakes	National (though there is no scientific prediction about scale and location)	Low, but probability is high and vulnerability is high	Likely to be very high	Likely to be very high	Likely to be very high
Landslides	Local	Low	Low	Low	Low

Floods and flooding

Among all the disasters in Bangladesh, floods are the most frequent and cause the people heavy economic hardship, with negative impacts on the national economy. Floods occur almost every year, with more than one flood event a year at times. Brammer (2004), rightly distinguished between floods and flooding: flooding is normal seasonal submergence of some flood plains, valleys, and terraces and to which people's traditional settlements and livelihoods are well adapted. Farmers in Bangladesh accommodate to seasonal flooding so well that they manage to feed one of the densest populations on earth (James 1998). Floods, on the other hand, represent unwanted and abnormal inundation having a heavy negative impact on people's lives and livelihoods, whereas flooding is good for the flood plains in terms of agriculture and soil fertility (James 1998). Normal annual flooding may inundate about 20% of the country, whereas disastrous floods may cause submergence of over 60% of the area for three to four weeks.

Current trends in floods in Bangladesh

- The frequency of floods continues to increase[3]; serious floods causing extensive crop damage occur on an average every three to five years. Catastrophic floods, on the scale of those in 1974, 1987, 1988, 1998, and 2004 occur on average every 10-20 years (Brammer 2004).
- Floods have become much more unpredictable than before, in terms of both onset and scale (Alam 2007).
- The sources of vulnerability have changed and are no longer purely related to hydro-meteorology but rather to social, political, cultural, and economic factors such as faulty design, collapse of embankments and drainage congestion due to unplanned structure contribute greatly to vulnerability to natural and man-made hazards.
- Flood-related fatalities have been reduced and the impact on the economy has increased. A pluralistic, institutional environment has developed in which diverse public and private actors engage in preparedness and post-disaster services. Floods stay for longer periods than before and hence flood plains are extended (catchment areas).

Flood problems in Bangladesh should be understood not from a country perspective but from a wider regional perspective, because the country is located in the Ganges, Brahmaputra and Meghna (GBM) basin. Apart from these three major rivers, 54 medium and small cross-boundary rivers enter Bangladesh and drain into the intricate river network, most of which flows into the Bay of Bengal through a single outlet called

[3] Author's note: further work should be carried out on how the frequency and return periods of floods are changing. Since floods occur every year, the key problem with trend analysis is the lack of an agreed classification of floods. The oldest flood research was carried out by a Professor Mahalanabis (Report on Rainfall and Floods in North Bengal 1870-1922) and puts the return period as moderate floods once in 2 years and severe floods once in 6-7 years.

the Lower Meghna. The Bangladesh section of the catchment is about seven to eight per cent of the total drainage area, whereas about 93% of the catchment lies beyond its territorial confines. This has deprived Bangladesh of control of the rivers and their huge flows in its terrain. The massive cross-boundary river flows combined with runoff generated by local monsoon (June-September) precipitation do not drain out smoothly due to flatness of the land and tidal factors. Rather, high tides cause backwater effects inland through estuarine creeks. Consequently, rivers overspill the levées, resulting in inundation of large areas caused by drainage congestion. These factors, singly or in combination, cause flooding every year. The extent of flooding depends on the coincidence of hydrometeorological events.

About 80% of Bangladesh is rather flat with tidal and riverine floodplains, about 14% in the southeastern region in four districts (Chittagong, Bandarban, Khagrachhari,and Rangamati) has some hillocks, and about five per cent, in the northeast in Sylhet, Sunamganj, Moulvibazar, and Habiganj districts has smaller hillocks. In these areas the land surface undulates with steeper gradients than the rest of the country. These two regions are termed hilly areas, and they are a continuation of the foothills of the northeastern Indian states of Assam, Meghalaya, and Tripura.

Based on geographical characteristics, floods can be classified into the following four broad categories.

- Riverine floods on plains caused by the gradual rise of river levels during monsoon.
- Tidal floods in coastal areas caused by high tides.
- Flash floods caused by sudden onrushes of water from hilly torrents after heavy rainfall in the Khasia-Jaintia, Garo, and Tripura hills bordering Bangladesh.
- Floods caused by water logging as a result of structural faults. Southwest Bangladesh suffers such floods on a regular basis.

Gently rising riverine floods are still a major concern in Bangladesh. Floods have occurred as long as people can remember and the mitigation measures undertaken by local people were sufficient when the population was small, almost less than half of what it is today. On the contrary, people used to reap the beneficial effects of normal, annual flooding in terms of replenishment of soil moisture, groundwater recharge, flushing, enhanced navigation, and open water fishing. The normal flood becomes a disaster when standing crops are totally damaged, communication is disrupted, and people are forced out of their homes due to submergence by deeper and longer duration of flood waters than previously experienced. With the population boom, human settlements have encroached on flood plains, aggravating drainage congestion. With economic growth, more infrastructure and assets are created and, apart from agriculture which is the mainstay of the economy, more and more people, assets, and infrastructure become vulnerable to floods over time. Thus riverine floods take their toll not only in the

short term but also in the long term, and the uncertainty and threat of floods impact the real development potential.

Tidal floods are limited to coastal areas only. Earlier, they used to damage the standing summer rice in the lowlands with saline inundation, but, since the 1950s, about 130 polders have been built (till date) by installing embankments, closures, and sluices to prevent the entry of sea water during high tide and to drain it during low tide. The total area protected is estimated at 1.4 million hectares.

Flash floods

Flash floods occur mostly in the northeast (Kishoreganj, Netrokona, Sunamgonj, Sylhet, and Moulvibazar districts) and southeast (Chittagong, Bandarban, Khagrachhari, Rangamati districts) regions of Bangladesh and are caused by heavy rainfall in bordering hilly regions of northeast India. Because of the steeper gradients in hilly areas, flash floods have less travel time and are violent and short-lived. The southeastern region is even hillier with fewer plains and enormous runoffs in the form of flash floods which flow down the gorges scarcely affecting agriculture or other economic activities and flatten and slope down towards large saucer-shaped depressions called *haors*. During flash floods the violent inflow from the hills overspills the river banks in flatter reaches, washing away infrastructure and crops on both sides.

The depressed basins receive the flash floods which sometimes occur in late March to April during the early spring rains. With the onset of and during monsoon, the basins are filled completely and each 'haor' looks like an inland sea. The depth is such that even deep water floating rice cannot be grown. For seven months (April to October) of the year no agricultural crop is cultivated in these areas, but they host a wide variety of fish species. Agriculture is possible only five months of the year (November to March). Flash floods sometimes occur in the northwestern (parts of greater Rajshahi, Dinajpur, and Rangpur districts) region due to heavy, localised rainfall in an area with steep gradients. Box 2 gives an account of a flash flood occurring in Sunagami in April 2002.

Landslides

Landslides are not a common hazard in Bangladesh. There is no reliable study or record of landslides in Bangladesh. Some news items in local dailies in Chittagong district claim there are local landslides, but these news' items fail to attract the Government of Bangladesh (GoB); neither are these records observed in the Disaster Management Bureau (DMB) nor in the Directorate of Relief and Rehabilitation (DRR). As stated in Section 2.1, Bangladesh consists, to a great extent, of a flat delta with some undulating topography composed of small hillocks in the northeastern and southeastern regions. Occasional mudflows occur in the southeastern region because of soil erosion of hill slopes. These flow down the gorges and receive scanty media coverage as they

Box 2: Case study of a flash flood in Sunamganj district

Sunamganj region has the highest rainfall in Bangladesh; it lies close to Cherapunja in Assam, the location of the world's heaviest amounts of rainfall. It is famous for numerous water bodies, locally called haor, and is rich in wild fisheries and natural habitats.

The area has a predominantly subsistence economy, and both harvests and income are dependent on floods. Around 48% of land remains under water up to seven months a year. Farmers can only grow a single rice crop, boro, the major source of income for the district. Land distribution is uneven, with 57% of virtually landless inhabitants owning only 0.062% of the land. While 80% of the population are sharecroppers, as much as 48% of people's primary income depends on wages from daily labour. Between 2000 and 2004, farmers in Sunamganj lost harvests three times because of flash floods caused by embankment breaches.

The flash floods occur because a large amount of water flows down from the hills in a short time with limited warning – a common characteristic of the district. As harvest and flooding times overlap, submersible embankments are built by the Bangladesh Water Development Board (BWDB) to divert water away from the fields. The fate of farmers is thus dependent on the embankments' efficiency and quality. However, research carried out by the NGO ActionAid and its partners has clearly shown that these embankments are neither adequately constructed nor maintained.

In April 2002, several embankments collapsed just before the annual harvest. An estimated 1.4 million people were affected, with loss of about 20% of crops as well as damage to infrastructure. The local people blamed the water board officials for the disaster; in fact a group of farmers had marched on the government offices demanding repairs long before the floods. A local leader said, "We took a letter to them in January protesting about the poor management and corruption. We warned them of the risk to our homes and crops if they did not make repairs. We were ignored." In response, the BWDB pointed to "… the recent cuts in public funds for essential repair work and the late arrival of funds as allocated."

hardly affect economic activity. Mudflows are so insignificant that hardly any literature is available. The enormous silt load (1.6-2.4 billion tons per year) carried by the rivers to the Bay of Bengal originates for the most part in upper catchments outside Bangladesh.

Earthquakes

Bangladesh lies in an active tectonic zone which extends throughout the Himalayan, Shillong plateau and Rakan-Yoma region and into parts of the adjoining Indo-Ganges flood plains (Brammer 2004). India, Bangladesh, and Pakistan more or less comprise what geologists call a tectonic plate.

Between 1869 and 1950, seven major earthquakes with magnitudes exceeding seven on the Richter scale occurred in the region and had some impact on Bangladesh (Table 2). The Indian plate is moving northwards at about five centimetres a year, a

Table 2: **Major earthquakes in Bangladesh and neighbouring areas (1869-1950)**

Date	Name	Magnitude (Richter)	Distance of epicentre from Dhaka (km)
January 10,1869	Cachhar Earthquake	7.5	250
July 14, 1885	Bengal Earthquake	7.0	170
June 12,1897	Great Indian Earthquake	8.7	230
July 8,1918	Srimangal Earthquake	7.6	150
July 2, 1930	Dhubri Earthquake	7.1	250
January 15,1934	Bihar-Nepal Earthquake	8.3	510
August 15,1950	Assam Earthquake	8.5	780

(Source: Choudhury 2005)

force that also contributes to the formation of the Himalayas. The movement of the Indian plate also caused the Sumatra-Andaman earthquake earlier this year.

Of the seven events, only two (1885 and 1918) had their epicentres within Bangladesh. According to the records the consequent damage is as presented below.

- 1869 – major damage occurred only in the eastern parts of greater Sylhet district but the tremor was felt all over the country.
- 1885 – it caused considerable damage in the Sirajganj-Bogra areas and perhaps more damage in the Jamalpur-Sherpur-Mymensingh areas.
- 1897 – the damage was very severe in Sylhet, northern Mymensingh, and eastern Rangpur and minor throughout the rest of the country with 545 casualties in Sylhet (see Box 3 also).
- 1918 – a large amount of damage occurred in Srimangal but, due to the shallow focal depth, the intensity rapidly decreased and only minor effects were observed in Dhaka.
- 1930 – major damage occurred in eastern parts of Rangpur district.
- 1934 – minor damage was observed in the northwestern parts of Bangladesh.
- 1950 – the tremor was felt all over the country but no damage was reported.

The great earthquake of 1897 had its epicentre in the Shillong Plateau of India (Megha) and caused widespread damage in adjacent areas of what was then known as Bengal.

In 2005, an earthquake with a magnitude of 7.3 on the Richter scale occurred in the Indian region near Bangladesh. Seismologists at the United States Geological Survey (USGS) have indicated that this earthquake was an aftershock of the 9.0 earthquake that had occurred just a few hours earlier, 305 km (190 miles) away in the Indian Ocean near Sumatra, Indonesia. The Bangladesh Meteorological Department (BMD) issued a statement that the quake had struck Chittagong, a southern port that is the second largest city in Bangladesh.

Although tremors have been felt in different parts of the country during the last six years, four events caused considerable damage, and these are given below (Box 4).

The low incidence of severe earthquakes in the last 100 years has led to a situation in which earthquakes are not perceived as a menacing hazard. The emphasis on recurrent floods and cyclones has often helped overlook the real risk of earthquakes. Though there are several local studies and vulnerability analyses, earthquake risks and vulnerability are well researched in Bangladesh. The earthquake in Gujarat in 2001 was a milestone that changed perspectives among NGO actors, but key donor agencies were still reluctant to fund earthquake projects. The earthquake that occurred in the hilly districts of Rangamati in the Chittagong Hill Tracts (CHT) was the point at which awareness among public officials started to grow and eventually lead to serious 'consideration' after the Indian Ocean earthquake.

The city of Dhaka, which is expected to grow to a population of 21.1 million (Freeman 2003) (4th largest in the world) by 2015, is among the cities most vulnerable to earthquakes. With increasing construction of bridges, buildings, and industrial

Box 3: The great Indian earthquake of 1897 and its impact

"At 5.15 pm on the 12th of June in 1897, a great earthquake hit Bengal, Assam, and Bihar and shocks lasted around 5 minutes. There was a loud rumbling noise from the east. The earthquake caused a great change in the country's river system. The epicentre was located on the Shillong Plateau, Rangpur district, and the northern and Sylhet districts in the northeast were severely damaged. The current district headquarters was located in Mahiganja, which was completely destroyed, including the king's palace in which he died. Sylhet town was completely levelled to the ground, causing 545 deaths."
Casualties were not so great because of the limited number of buildings at that time, as rural people used to live in 'katcha' structures.

Box 4: Recent earthquakes in Bangladesh (1997-2003)

- May 8, 1997 Sylhet earthquake – with a magnitude of 5.6 it caused fractures in several buildings in and around Sylhet.
- Nov 21, 1997 Bandarban earthquake – with a magnitude of 6.0 it caused damage to a number of buildings in Chittagong region while a building collapsed in Chittagong city leading to the deaths of about 20 people.
- July 22, 1999 Moheskhali earthquake – with a magnitude of 5.1 it led to the collapse of a number of mud-walled houses and cracks in some 'pucca' buildings.
- July 27, 2003 Barkal (Rangamati) earthquake – with a magnitude of 5.6 it resulted in cracking in a number of buildings, collapse of about 500 mud-walled houses, deaths of 2,and injuries to about 100 persons. The tremor was also felt in Chittagong city with development of cracks in a number of buildings. The major shock was followed by 14 lasting aftershocks until August 13, 2006.

infrastructure in the last two decades, assessment of seismicity in different regions is receiving considerable attention. The earthquake of July 2003 with a magnitude of 5.6 that affected the hilly district of Rangamati in the southeastern region and was felt in Chittagong city received wide coverage in the national media. The recent, severe earthquake near Sumatra, Indonesia, in December 2004 with a magnitude of 9, and the tsunami generated by it that affected many countries, have resulted in greater awareness in South Asia, South East Asia, and Africa. Earthquakes have now become a subject of grave concern to members of the public, researchers, and planners.