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UNDERSTANDING THE PAST PERSPECTIVE OF RIVERINE FLOODING IN BANGLADESH; CHARACTERISTICS AND CHALLENGE IN PRESENT ERA

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ABSTRACT

Flooding is a regular catastrophic event in Bangladesh as it causes severe social and economic losses and damages in the different parts of the country in every year. Bangladesh is a flat delta with many abandoned channels inside the country and many depressions known as beels, baors and haors. The geographic location of Bangladesh with the Indian Ocean to the South, the Himalayas to the North and the prevailing monsoons, has made it one of the wettest countries of the world. The flatness of the land surface gives a minimal gradient to the flood producing rivers. During flood time, the average slope of the Brahmaputra is of the order of 6 cm/km and the Ganges and the Meghna have even smaller gradients. The heavy monsoon downpour and synchronization of flood-peaks of the major rivers are generally considered to be the main causes of the floods. Some primary factors also deserve serious consideration as possible contributors to the recent floods: alteration in the base level of the rivers due to local sea level rise and subsidence, inadequate sediment accumulation on flood plains, a possible increase in the watershed area due to seismic and neotectonic events in the region, river bed aggradation due to siltation and damming of rivers, soil erosion due to imprudent tilling practices, deforestation in the upstream area, and excessive development and population growth. Despite its recurrent nature and devastation, the comprehensive research on flood modelling, forecasting and management in Bangladesh has been limited and less emphasized. This study of research will help the authorities to have an overview of important aspects of flood during planning of mitigation measures and management projects.

KEYWORDS: Riverine Flood, Characteristics, Challenge, Bangladesh.

INTRODUCTION

Bangladesh is situated in the delta of the Ganges and the Brahmaputra in the North-eastern part of the Indian Subcontinent located between 23º34´ and 26º38´ North Latitude and 88º01´ and 92º41´ East Longitude. It is bordered by India on the West, North and East; shares a border with Myanmar on the Southeast, and the Bay of Bengal on the South.[1-4] A flat,[5] low-lying topography,[6] is the most characteristic geomorphological feature,[7] in where 60% of the area lies less than 6 metres above sea level[8]. The average river gradient in the delta is as small as 6 cm/km.[1,5] Bangladesh and the Ganga–Brahmaputra–Meghna basin as a whole are dominated by the Asian monsoon system.[2,4] In the summer months Bangladesh is a ‘‘water country’’: rivers, ponds, rising groundwater tables and the sea are interlinked and form large water bodies.[9,10] Deepwater rice floats in the water, jute is harvested and a wide range of country boats ensure communication.[10] In the winter season Bangladesh is a ‘‘dry country’’, with large sand bars, dry river courses and vast areas of irrigated agriculture.[9-11] Floods are more or less a recurring phenomenon in Bangladesh and often have been within tolerable limits.[12] But occasionally they become devastating.[11,12] Each year in Bangladesh about 26,000 sq. km, 18% of the country is flooded.[1-10] During severe floods, the affected area may exceed 55% of the total area of the country.[13] In an average year, 844,000 million cubic metre of water flows into the country during the humid period (May to October) through the three main rivers the Ganges, the Brahmaputra-Jamuna and the Meghna.[13,14] This volume is 95% of the total annual inflow. By comparison only about 187,000 million cu m of streamflow is generated by rainfall inside the country during the same period.[15,17]

Ancient History of Flood

The monsoon phenomenon and flood have been mentioned in The Holy Ramayana and Mahabharata and other Vedic books. In the book Artha-Shastra [Artha-

Shastra] written during the reign of Chandragupta Maurya (321-296 BC) by his minister Kautilaya, there is mention of the amount of rain at different places indicating that they had knowledge of rainfall measurements. The astronomer Barahamihira (505-587 AD) used to predict rain and flood. Astronomers Arya Bhatta and Brahmagupta also studied the monsoon. Kalidasa, the famous sanskrit poet composed poems on monsoon clouds and flood in his Meghdut and Ritusamahara. However, during the ancient times a lady named Khana made most of the predictions on meteorology and agrometeorology. Even to this day the farmers of Bangladesh remember her verses. The Arabs used the knowledge of the changing pattern of monsoon winds very profitably for trade with India. The term 'monsoon' is derived from the Arabic word 'Mausam' meaning season. The first comprehensive report of Professor Pc Mahalanabish on floods in Bengal between 1870 and 1922 shows that moderate floods have occurred once in two years on an average, while severe floods have occurred once in 6-7 years on an average.[18]

Types of Flood in Bangladesh

While the issue of flooding and the ongoing efforts to limit its damages are prevalent throughout the entire country, several types of floods have recently occurred regularly, affecting different areas in their own distinct way. These flood types include.[19]

1. **Flash floods in hilly areas:** water increases and decreases suddenly, generally happens in the valleys of the hilly areas.
2. **Monsoon floods during monsoon season:** seasonal, increases slowly and decreases slowly, inundates vast areas and causes huge losses to life and property.
3. **Normal bank floods:** from the major rivers, Brahmaputra, Ganges and Meghna.
4. **Rain-fed floods**
5. **Tidal flood: s**hort duration, height is generally 3m to 6m, blocks inland flood drainage

Factors Causing Flood in Bangladesh

The factors for causing floods in Bangladesh are.[7,9,10,12]

(a) General low topography of the country with major rivers draining through Bangladesh including a congested river network system. The geographic location of Bangladesh in the downstream section of the Ganges–Brahmaputra–Meghna (GBM) Basin along with the flat topographic nature of the terrain makes it extremely vulnerable to floods. Bangladesh is located at the lower part of the entire GBM River Basin and provides the outlet of the basin into the Bay of Bengal. Bangladesh is on the floodway of an immense area of the GBM Basins.

(b) Rainfall in the upstream country or in the mainland; The climate of Bangladesh is tropical monsoonal and as a result Bangladesh catches an enormous rainfall which compounds the flooding. A long duration of heavy rainfall associated with ‘nor wester’ thunderstorms is very common in Bangladesh, creating local floods in flood prone areas. The local rainfall runoff augments the incoming flood of the international GBM Rivers. Due to unplanned drainage congestion, local rainfall runoff creates flood havoc in a comparatively small area.

(c) Snow-melt in the Himalayas and glacial displacement (natural); Global warming is contributing to a rapid melting of the Himalayan glaciers. Between 1970 and 2000, 9% of their ice volume was lost. In the period from 2003 to 2009, they lost about 170 gigatons of water often leading to catastrophic flooding throughout the Indus, the Ganges and the Brahmaputra regions. The melting of the Himalayan glaciers will also affect river flows downstream, the volume of water in dams and the level of their electricity production. Some rivers will be more affected than others by this phenomenon, although we do not yet know how to measure the scope of the effects.

(d) River siltation/lateral river contraction/landslides: Rivers of Bangladesh are alluvial in type and erosion and siltation are a nonstop process. Literature refers that the gradual siltation of many channels, reduced the water flow areas and at the same time decreased the depth of the river-bed and thus reducing their water containing capacity. This siltation can accelerate the severity of floods.

(e) Synchronisation of major river peaks and influences of one river on the other: The compound flood has been considered as an alarming threat over the years due to climate change. River flood synchronization acts as a compound event which is mainly occurred at the downstream of the large river confluence zones. When multiple rivers become flooded at the same time, the resultant flood magnitude and flood duration at their confluences zone raise drastically. Only a few previous researches addressed synchronized flood risk at a local scale, where simply yearly peak synchronization has been considered to avoid the complexity of detecting multiple peaks. However, several rivers occasionally show significant multiple peaks in a single year and sometimes yearly peak stays much below the flood limit.

(f) Human intervention of the environment: The flood control projects in Bangladesh such as the Brahmaputra right bank embankment and “Chalan beel” embankment project has protected the project area from floods, but it has increased the intensity of floods outside the protected area. Damming of a river decreases the velocity of water flow downstream from the dam. As a result of reduced velocity, the sediments carried by the river start to settle down faster on the riverbed causing riverbed aggradation and in turn reducing the water carrying capacity of the river. The Farakka Barrage on the Ganges has already caused tremendous damage to the agriculture, navigation, environment and hydrodynamic equilibrium in Bangladesh.

(g) Tidal and wind effects on slowing down the river outflow (backwater effect): A moderately strong semi-diurnal tide with two high waters and two low waters over a period of twenty-four hours affects the coast of Bangladesh. Backwater effects of tides, from the Bay of Bengal, particularly spring tides, prevent efficient drainage of flood waters causing flooding in the low-lying coastal areas. For example, flooding of the areas of Sylhet and Mymensingh is also affected by the tidal effect as it hampers drainage of water of the river Meghna at Chandpur.

(h) Construction of barrages and protective works along the banks of the river - some are very close to both the banks - in the upper reaches thus making the passage of water flow downstream increasingly narrower and resulting in greater acceleration of water flow downstream presently than before.

(i) Deforestation in the upper reaches of the rivers is not only leading acceleration of water flow downstream but also lead deposition of loads in the river beds, resulting in reduced channel flow and consequent overland runoff water. Deforestation of steep slopes is assumed to lead to accelerated soil erosion and landslides during monsoon precipitations. This in turn is believed to contribute to devastating floods in the downstream regions such as in Bangladesh.

(j) Tectonic anomalies (earthquake) those change in river flow/morphology: Bangladesh lies on the Indian lithospheric plate which is pushing against the Asian plate, causing growth of the Himalayas and occasional earthquakes in the region. It causes movement of the land and this can change the topography of the region and alter the water movement of river. A sudden change in a river course can cause substantial flooding. Even though the cause and effect relationship between floods and earthquakes is not very clear, historic records suggest a relationship between these two phenomena.

Historical and Environmental Overview of Flood in Bangladesh (1781-2020)

Flooding in Bangladesh is a recurring phenomenon. Recurrent floods between 1781 and 1830 changed the old course of the Brahmaputra. After a major flood in northern Bengal in 1922, a Flood Committee was formed and a report was published in 1927 on the north Bengal floods between 1870 and 1922. Statistical analysis of available records revealed that severe floods can occur every 7 years, and catastrophic floods every 33-50 years. Some severe monsoon floods of this region starting from the late 18th century are described in Table 01 chronologically.[2,5,6,8,11,12,15,17,18,19]

Impacts of Flood in Bangladesh

Bangladesh is recognized as one of the most susceptible countries to flood disasters in the world. Flood causes destruction of country's physical and social infrastructure, transport network, assets, crop production, loss of lives etc. Flood not only declines the social lives of people but also the economy as a whole as below.

Social: Displacement from one's home, loss of property, and disruption to business and social affairs can cause continual psychological stress, even if one’s current situation is relatively sustainable. Emotional weight (e.g. stress, anxiety), disruption to living, loss of community and cultural structures or buildings, and resource loss are all deficits that are not easily replaced, even if one were in the possession of funds.[9]

Economic: Disruption to industry leads to people being unable to work, which thus leads to people having ineffectual paying power and them having to sustain themselves on the few belongings and food they have. Loss of land value (e.g. from the destruction of crops) in the floodplains leave communities economically vulnerable and unable to recover.[9]

Health: Damage to infrastructure can further increase the spread of waterborne disease, as disruptions to supplies of clean water and wastewater treatment leave large quantities of water contaminated, preventing industries such as those involved in making steel from operating.[9,20]

Environmental: In Bangladesh, floods play an important role in maintaining key ecosystem functions and biodiversity. They link the river with the land surrounding it, recharge groundwater systems, fill wetlands, increase the connectivity between aquatic habitats, and move both sediment and nutrients around the landscape, and into the marine environment. For many species, floods trigger breeding events, migration, and dispersal. These natural systems are resilient to the effects of all but the largest floods.[21]

Political: Public schools and mosques are built with a view to their potential use as shelters. Mobile phones (exceeding 100 million, despite poverty) have turned into an important tool for conveying information during a calamity. Bangladesh’s government is quick to deploy the army, with soldiers being best equipped to reach remote villages and help with evacuation.[20,21]

Personal security: In Bangladesh, the major impact of floods is death caused by drowning, water-borne diseases, diarrhea and snakebites. Loss of life is considered to be the most important loss type in the public perception of disasters. Snake bites is considered as a significant cause of death after drowning and contributed to more deaths than even diarrheal and respiratory diseases. Many people change their jobs and residential location changes because of flood. Violence and injuries are under-reported in developing countries, especially during natural disasters such as floods. In our country Child and woman violence and injuries occurred in flood affected area.

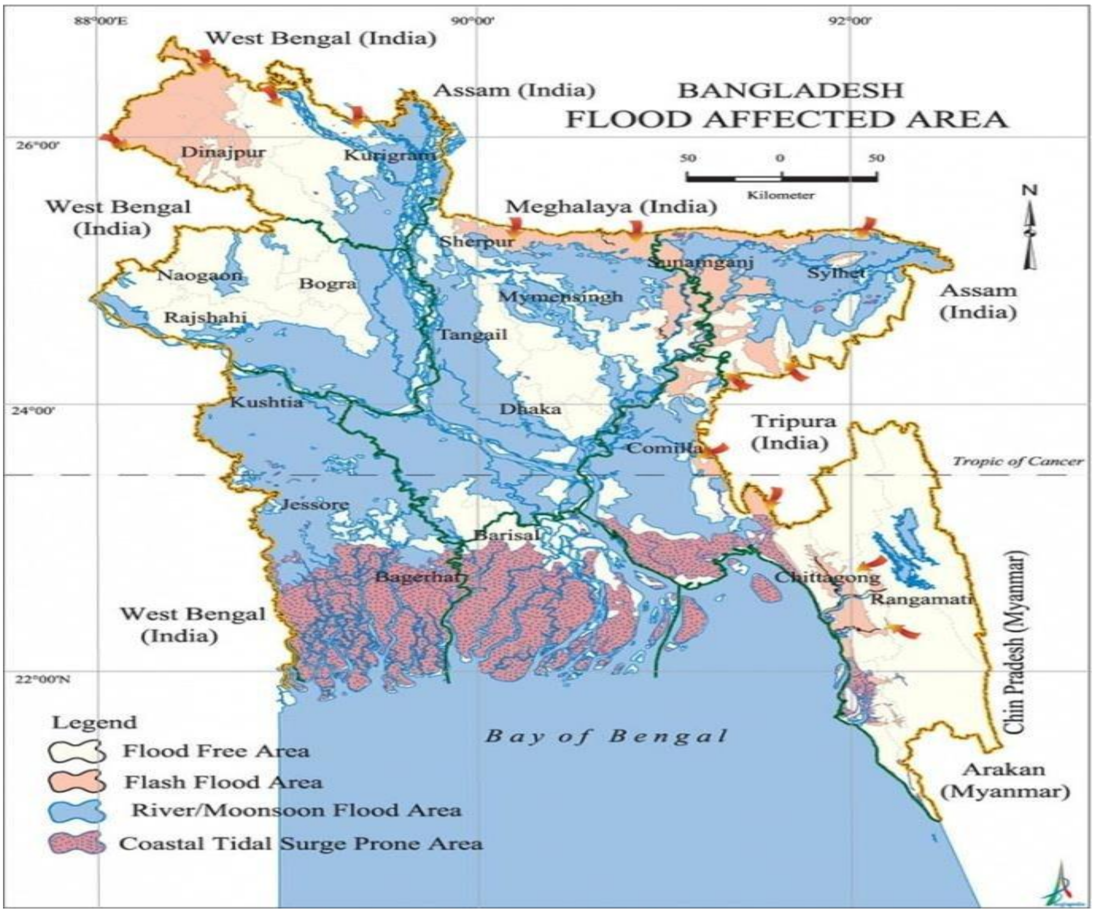

Figure 1: Flood affected area of Bangladesh.

Table 01: Historical and environmental overview of flood in Bangladesh (1781-2020).

Year	Duration	Causes	Area Inundated (sq.km)	Cost of damage (million Tk)	Population affected (million)	Deaths
1781	-	Heavy rainfall	-	-	-	-
1786	-	-	-	-	-	-
1794	-	-	-	-	-	-
1822	April and July	Flash Floods	-	130	-	39,940
1825	June and July	Heavy rainfall	-	-	-	-
1838	April and July	Heavy rainfall	-	-	-	-
1853	April and July	Heavy rainfall	-	-	-	-
1864	-	-	-	-	-	-
1865	August	-	-	-	-	-
1867	June and July	Heavy rainfall	-	-	-	-
1871	-	-	-	-		-
1876	May	Flash Floods	-	-	-	215,000
1879	April and July	-	-	-	-	-
1890	June and July	Flash Floods	-	-	-	-
1900	-	-	-	-	-	-
1902	May	Heavy rainfall	-	-	-	-
1904	August	-	-	-	-	-
1953	September	Heavy rainfall	-	-	-	-
1954	June and July	Flash Floods	36,920	1.200.00	30	112
1955	-	-	50,700	1,290.00	-	129
1956	-	-	35,620	900.00	-	-
1962	-	-	37,440	560.00	-	117
1963	-	-	43,180	580.00	-	-
1966	September				12	39

1968	-	-	37,300	1,160.00	70	126
1970	August	Monsoon Rain	42,640	1,100.00	30	87
1971	April and July	Heavy Rain	36,475	-	-	120
1974	-	Monsoon Rain	52,720	28,490.00	30	1,987
1984	May	Heavy Rain	28,314	4,500.00	20	553
1987	July and August	Monsoon Rain	57,491	35,000.00	30	1,657
1988	August and September	Monsoon Rain	89,970	100,000.00	47	2,379
1998	August and September	Monsoon Rain	100,000	120,000.00	55	1,050
1999	July and September	Monsoon Rain	100,000	70400.00	30	918
2004	August and September	Monsoon Rain	58,000	200,000.00	36	750
2007	July and September	Heavy Rain	32,000	72,535.00	16	3363
2008	September	-	3,394	-	1	7
2010	June	Floods and Landslides	-	-	-	56
2012	June	Floods and Landslides	230,000	-	5	139
2019	July	Floods and Landslides	17,173	-	5	-
**2020	July and August	Heavy Rain	150,000	73,200.00	5.4	217

****Up to 09 August, 2020**

Flood Management

Flood control and drainage projects heavily depended on dredging, embankments, polder and gravity drainage. Heavy dependence on structural means to manage floods, together with the effects of such other structures as roads, highways and railroads that obstruct flow of water in some cases aggravate the flood situation. Despite huge amounts of investment in flood control and drainage projects, the benefits have been less than satisfactory. However, an alternative strategy for mitigating flood hazard, the concept of social adjustment, also known as non-structural measures can be important. These include.[9,12,18,20]

(a) Dissemination of meteorological forecasts, short and long range warning system including the height to which the flood water is likely to rise in the next few hours or so and a programme of speedy evacuation.

(b) Land management for reduction of runoff water. In this case a programme of afforestation and reforestation together with animal grazing controls to increase absorption and reduction of runoff water could be undertaken.

(c) Land use change and enactment of building codes, diversification of agricultural production, that is, identification and planting of flood resistant crops and adjustment of planting season.

(d) Floodplain zoning, involving land use zoning to control development and restrictive development regulations, should ensure that any development meets certain standards and that they take into consideration the threat to a site.

(e) Structural solutions are in practice on a limited scale in Bangladesh as part of a flood control project. Structural solutions call for the engineering of structures such as embankments along rivers, dams, drains, reservoirs and other structures designed to control the natural flow of rivers. Structural solutions treat the problem section of a river basin in isolation and generally do not take into account the possible geologic consequences.

CONCLUSION

Monsoon-related floods have devastated millions of people in South and East Asia almost every year. One of the country's most severely affected has been Bangladesh in 2020. Government officials tried to prepare for monsoon season, but recent COVID-19 pandemic disasters in the country made planning difficult. Many flood protection structures, such as embankments and dykes, were already damaged from monsoon floods in recent years; the typical recovery cycle is usually three to five years. Community based prioritise susceptibility and adaptation issues need to be immediately addressed, and structural and non-structural flood management methods, which the Government is emphasising in recent policy, need to be implemented together in order to reduce future flood vulnerability under the probable climate change regimes. But, without regional cooperation among the co-riparian nations any major interbasin flood control activity is considered to be almost impossible. The country is also recovering from Cyclone Amphan, which hit the country's coast in May 2020 and the COVID-19 pandemic has constrained response efforts.

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