Lecture-1

EWCE 461
River Engineering and Flood Management
3 Credit Hour

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Lecturer

Department of Environmental, Water Resources and Coastal Engineering

Sec-B: Flood Management- 1.0 Credit



Syllabus of Sec-A: 2.0 Credit

- Behavior of alluvial rivers
- River channel pattern and fluvial processes
- Aggradations and degradation
- Local scours
- River training and bank protection works
- Navigation and dredging of sediment movement in river channels
- Bed form and flow regimes
- Case studies



Syllabus of Sec-B: 1.0 Credit

- **Flood and its causes**
- Flood process in urban and rural area
- Flood management measures: structural and non-structural measures such as dams, reservoirs
- Diversion channels and floodways
- Improvement of channel capacity by dredging
- Land management, Flood proofing, Flood zoning, Flood hazard mapping
- Flood forecasting and warning, Flood damage assessment



Course Outcome (CO)

CO1	Be able to explain the relationships of river planforms with the river Morphological parameters
CO2	Be proficient in calculating and estimating sediment distribution and sediment load of a river
CO3	Be able to apply different engineering perceptions to estimating the scour depth.
CO4	Be familiar with different bank protection and river training work and understand the dredging and navigation processes
CO5	Apply knowledge of flood processes and management strategies to analyze and assess flood risk.

Reference Books

- Any book on Flood Management and Mitigation
- **Water Resources Engineering by R. K. Linsley, J. B. Franzini, D. L. Freyberg and G. Techobanojlous**
- Fluvial Processes in River Engineering (1992) by H. H. Chang
- **Flood Control and Drainage Engineering, Fourth Edition, S.N. Ghosh**
- Urban Flood Management; by Chris Zevenbergen (Author), Adrian Cashman (Author), Niki Evelpidou (Author), Erik Pasche (Author), Stephen Garvin (Author), Richard Ashley (Author)
- Flood Risk: Planning, Design and Management of Flood Defence Infrastructure, By: Paul Sayers
- Vulnerability and Adaptation to Climate Change in Bangladesh: Processes, Assessment and Effects by MD



Lecture 1

Overview of Flood, Types and Causes of Flood

Overview of Flood Risk

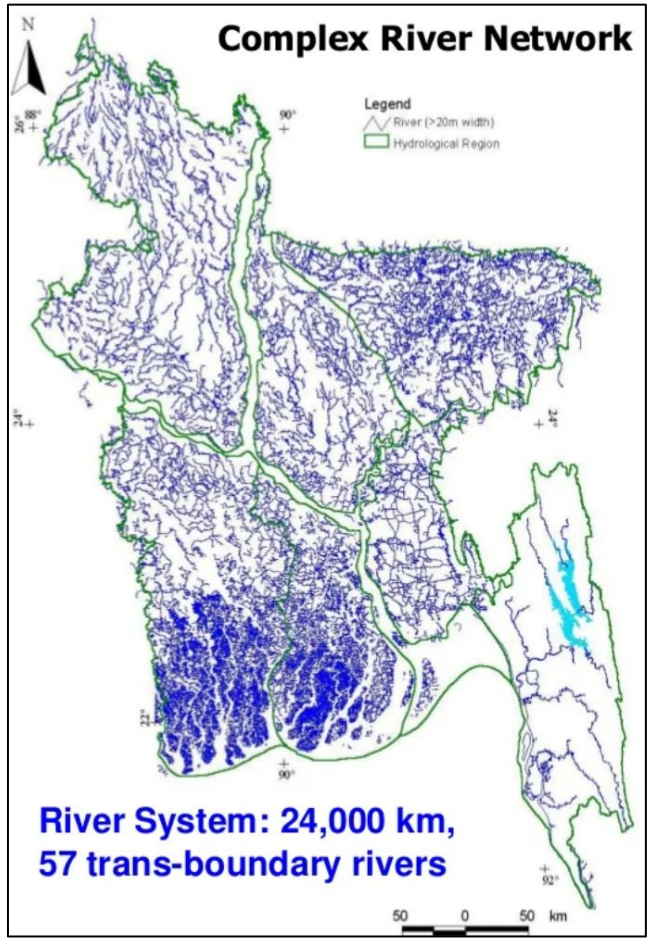
- Deltaic Country located at the lower part of GBM basins
- Most flood prone areas of the world-
  - Unique Geographic Setting
  - Physiographic features
- $1/5^{th}$ to $1/3^{rd}$ of the country is annually flooded by overflowing river during monsoon (June-Sept)
- Rainfall within the country is also very high



Geographic Location of Bangladesh

Overview of Flood Risk

" Any flow which is relatively high, and which overtops the natural and artificial banks in any reach of a river may be called a flood"



In rainy season, when **heavy rainfall occurs in the catchment area, the flow of the river is increased and sometimes it exceeds the normal carrying capacity of the river.** Then the surplus water overtops the banks of the rivers and submerges the surrounding areas consisting of village, agricultural land etc. **This phenomenon is called as Flood.**



Overview of Flood Risk

- Normal Floods are blessing- **provide vital moisture and fertility to the soil through alluvial silt deposition in floodplains.**
- Moderate to extrema flood are of great concern- **inundate large areas (more than 60% of the country). Widespread damage to crops and properties.**
- Flood hazards are already difficult for Bangladesh to cope up with considering its socio-economic conditions.
- Since mid 1960s flood control interventions were practiced/ implemented.
- Later new insights have been gained and consequently new concepts of flood management have evolved.

Types of Flood

- Riverine Flooding
  - Overbank flooding
  - Flash flood
  - Dam and levee break
  - Ice jam flood
- Urban flooding
  - Storm water drainage system
- Mud-flood
  - Subsidence
- Coastal Flood
  - Storm surges

Types of Flood



Overbank flooding

Types of Flood



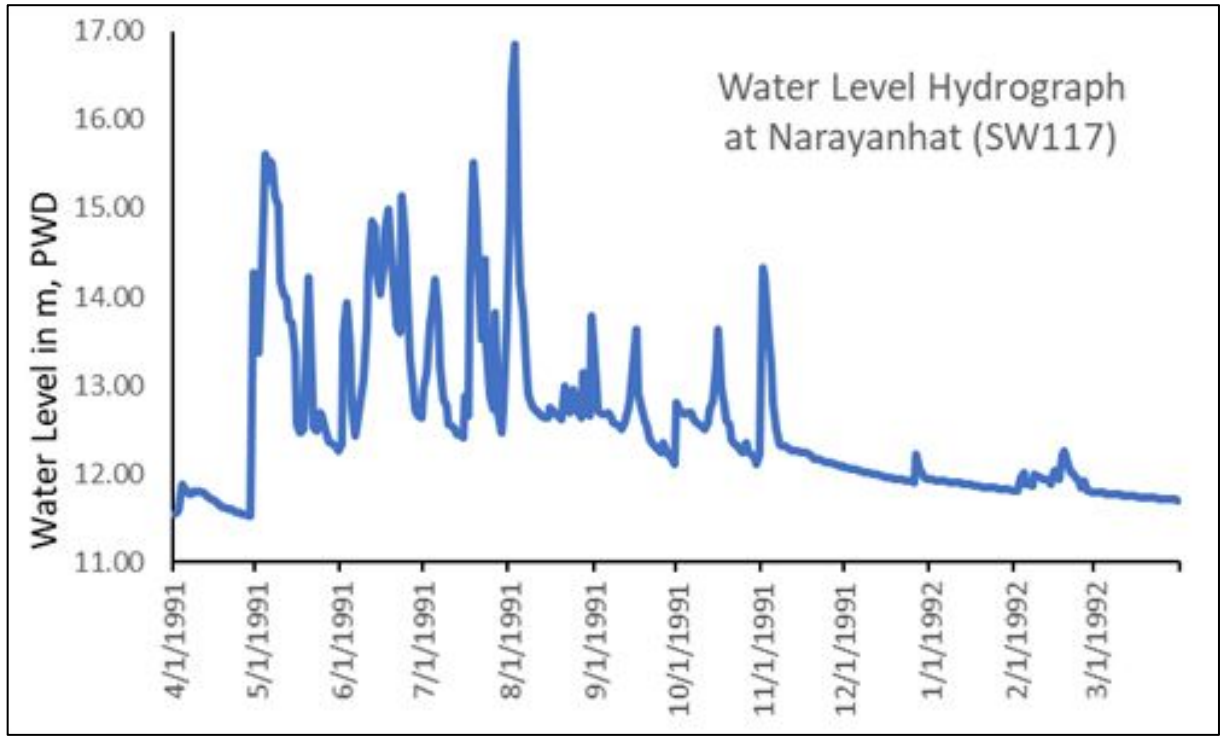
Flash flood

Types of Flood

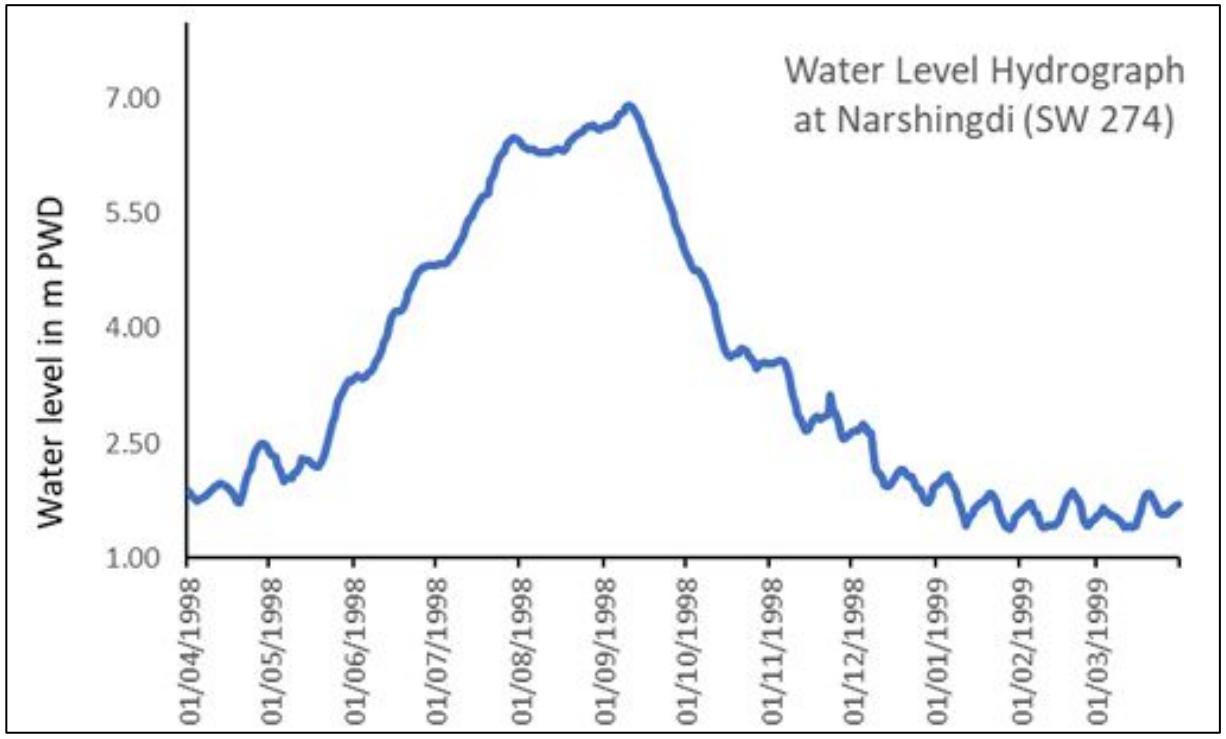


Flash flood

Types of Flood



Flash flood



Annual flood

Types of Flood



Dam Break

Types of Flood



Dam Break

Types of Flood



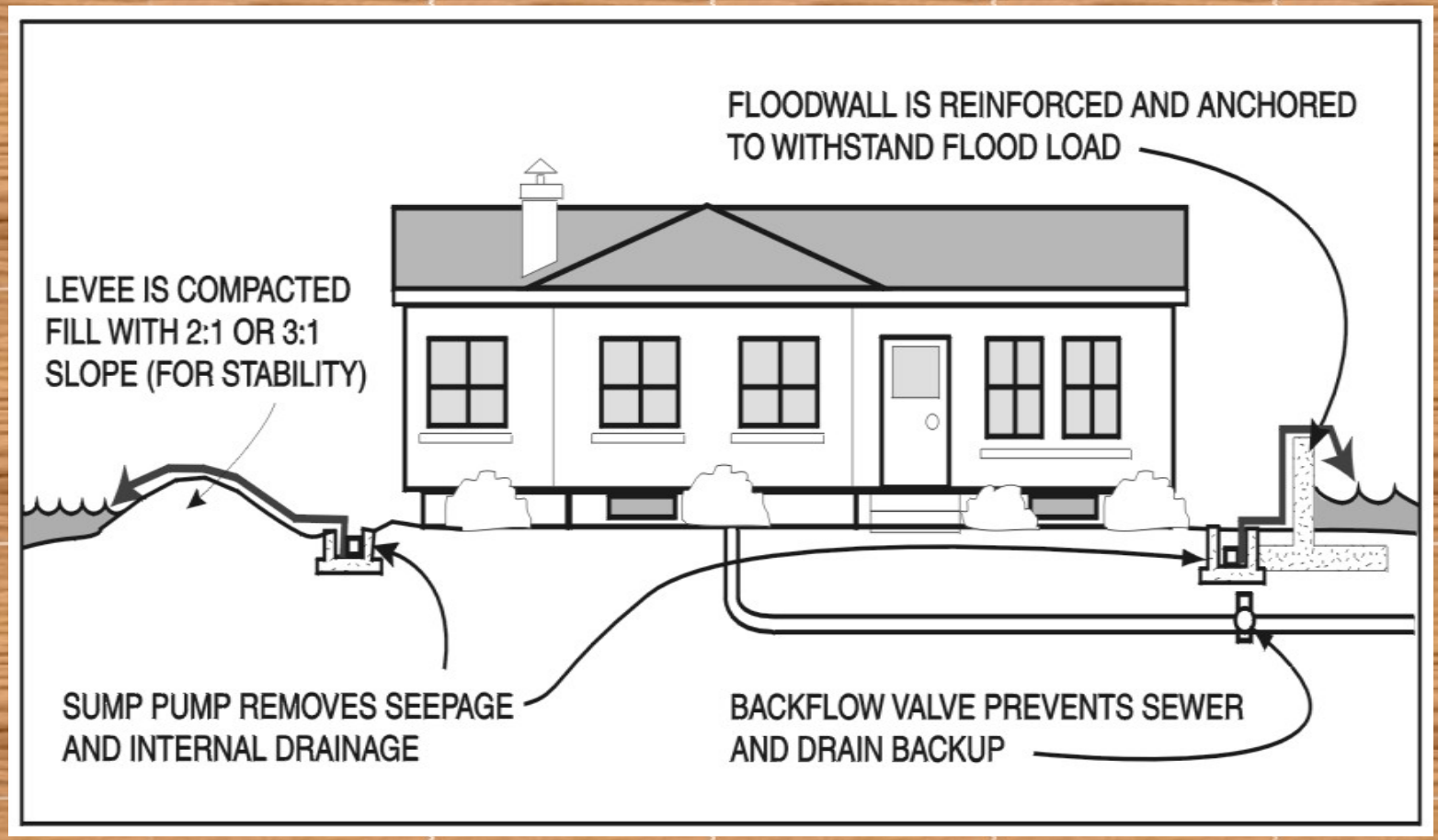
Levee Break

Types of Flood



Levee Break

Levees and Floodwalls



Types of Flood



Ice jam

Types of Flood



Ice jam

Types of Flood





Urban Flood

Types of Flood





Mood Flow

Types of Flood

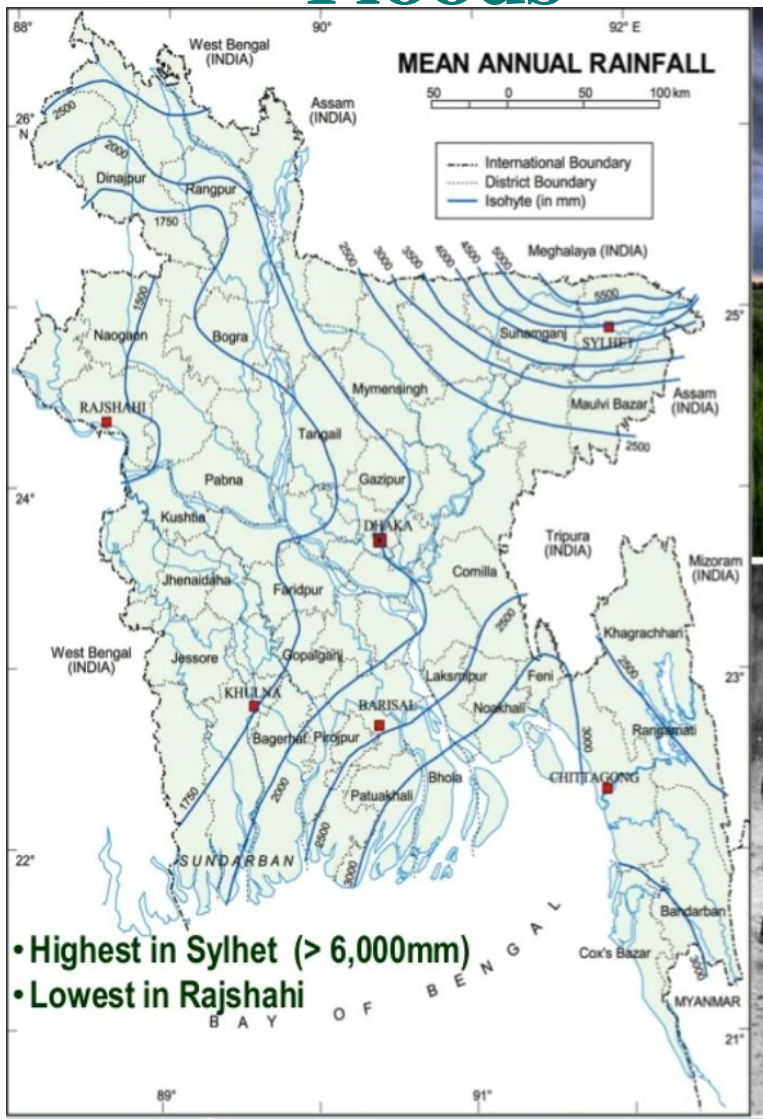




Coastal flood

Geographical, Physiographic and Hydro-Meteorological Factors responsible for Floods

- *Surrounded by Mountains*
- *Lower Riparian Country*
- *Floodplain Country*
- *Unique Hydro-Meteorological System*



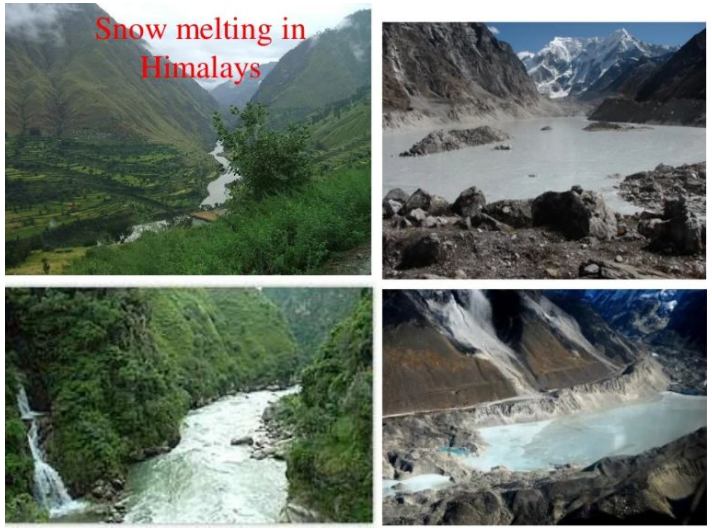


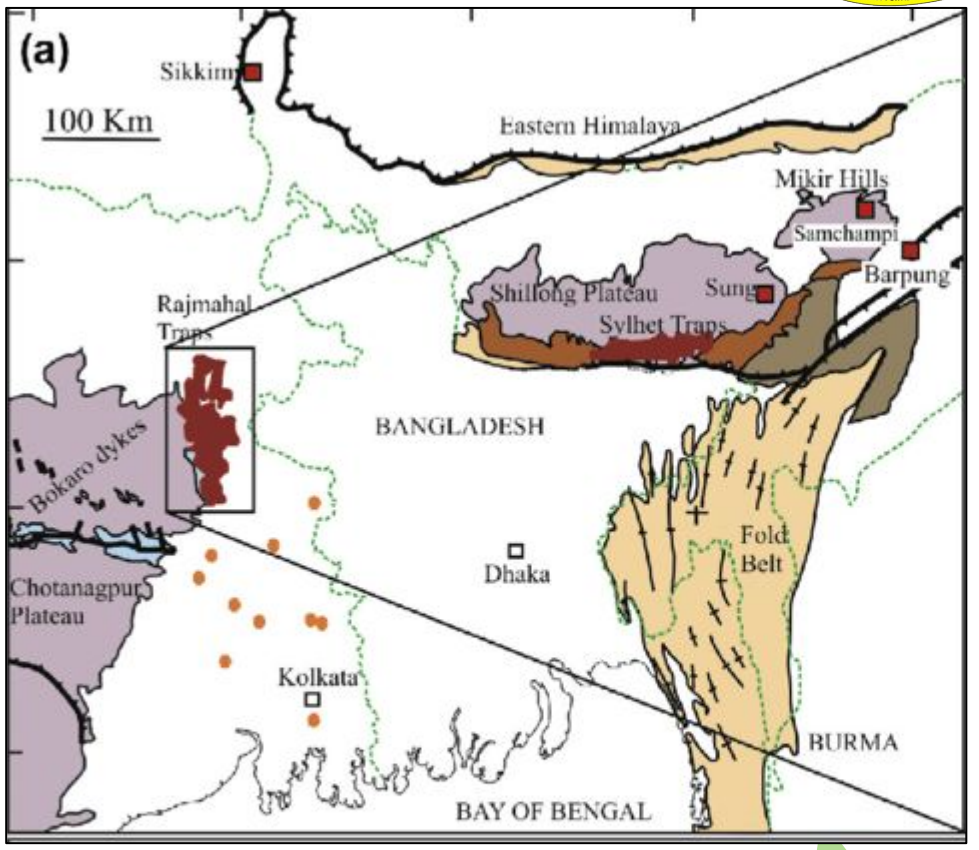


Factors responsible for Floods- Surrounded by Mountains

- West-Rajmahal Hills
- North- Himalaya and Meghalaya Plateau Hills
- East-Tripura-Chittagong Hills







Rainfall Runoff+ Snowmelt in the Himalaya

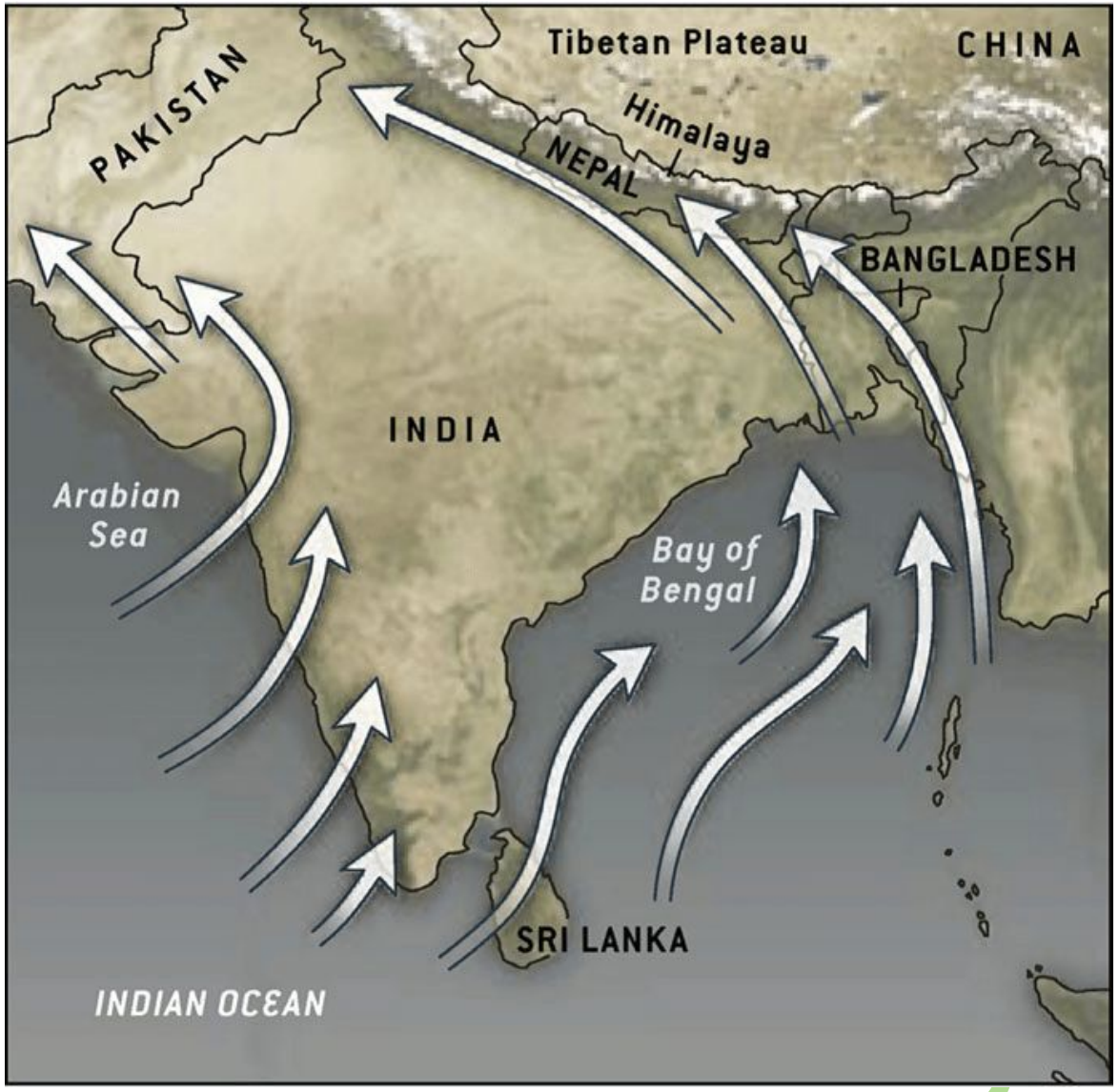
Huge inflow of water to BD during wet monsoon

Factors responsible for Floods- Surrounded by Mountains

From ***June to October*** large quantities of warm moist air travel from Indian ocean north over Bangladesh and then to the Himalayan slopes as ***monsoon winds.***

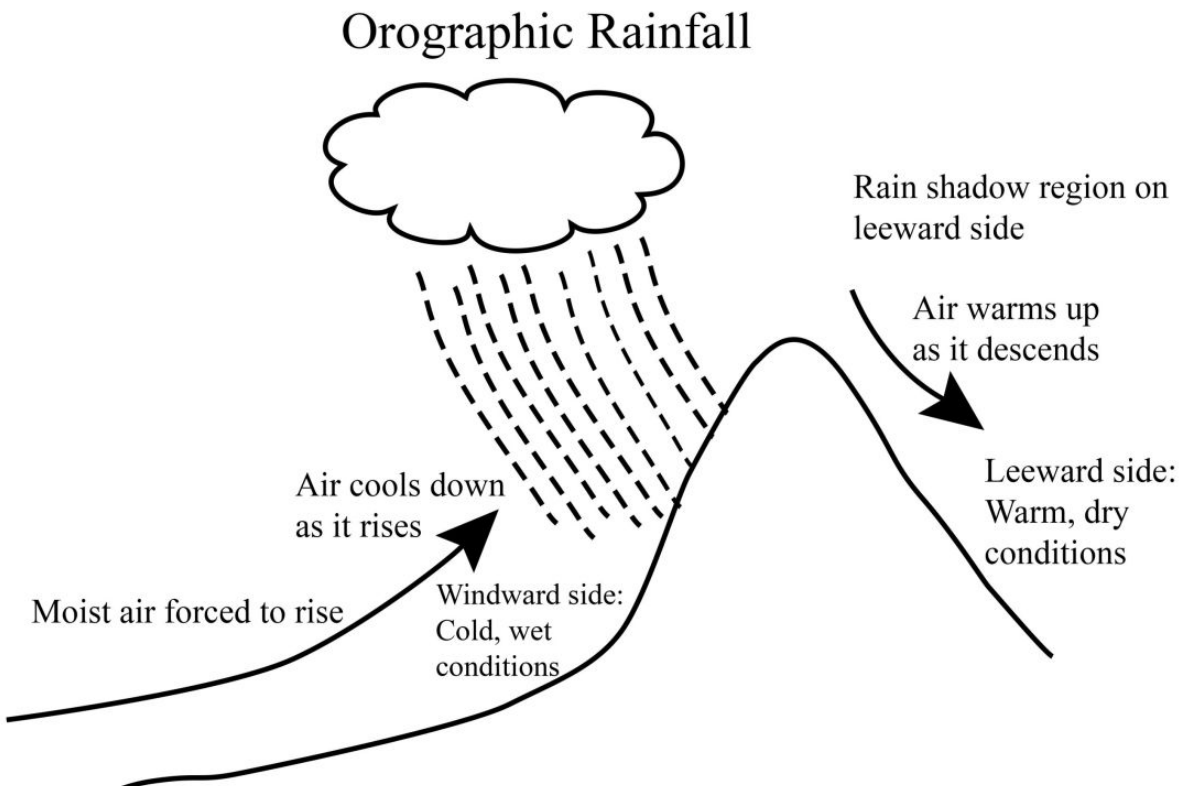
Upper air turbulence and the long mountainous barriers stretching east-west make this moist air rise and as a result cool off and bring about enormous amounts of **orographic rains**.

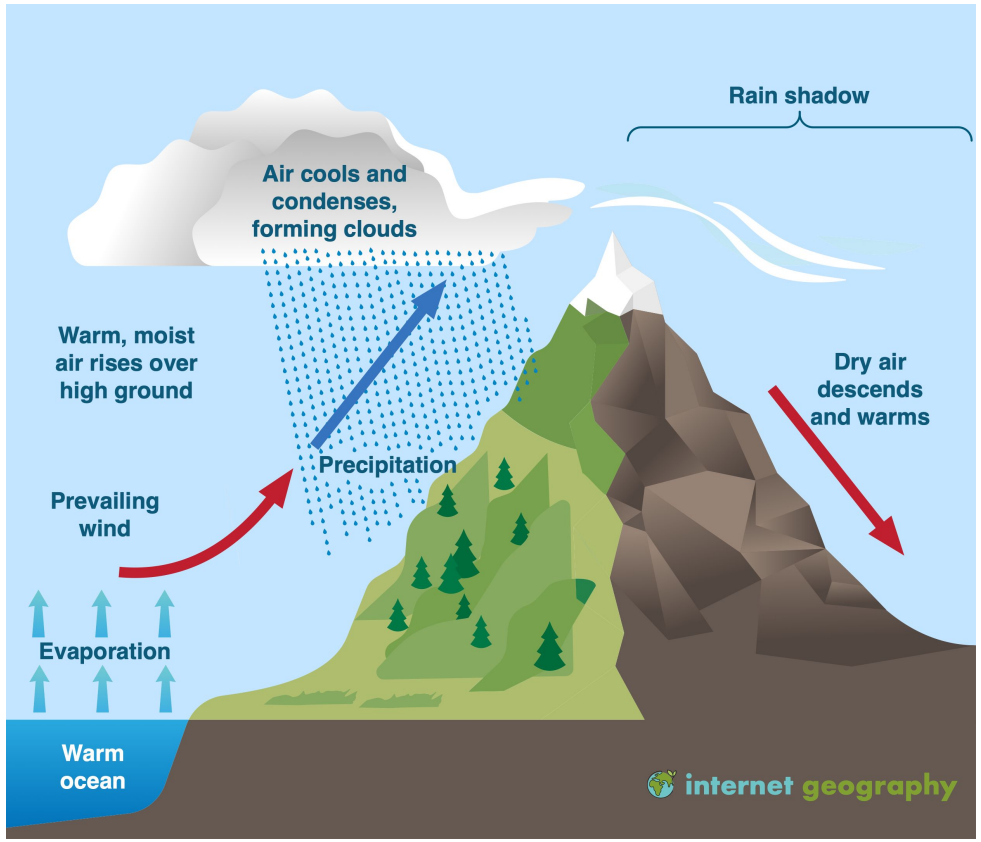
Which enter BD territory in the form of runoff (Rashid 1991*)*



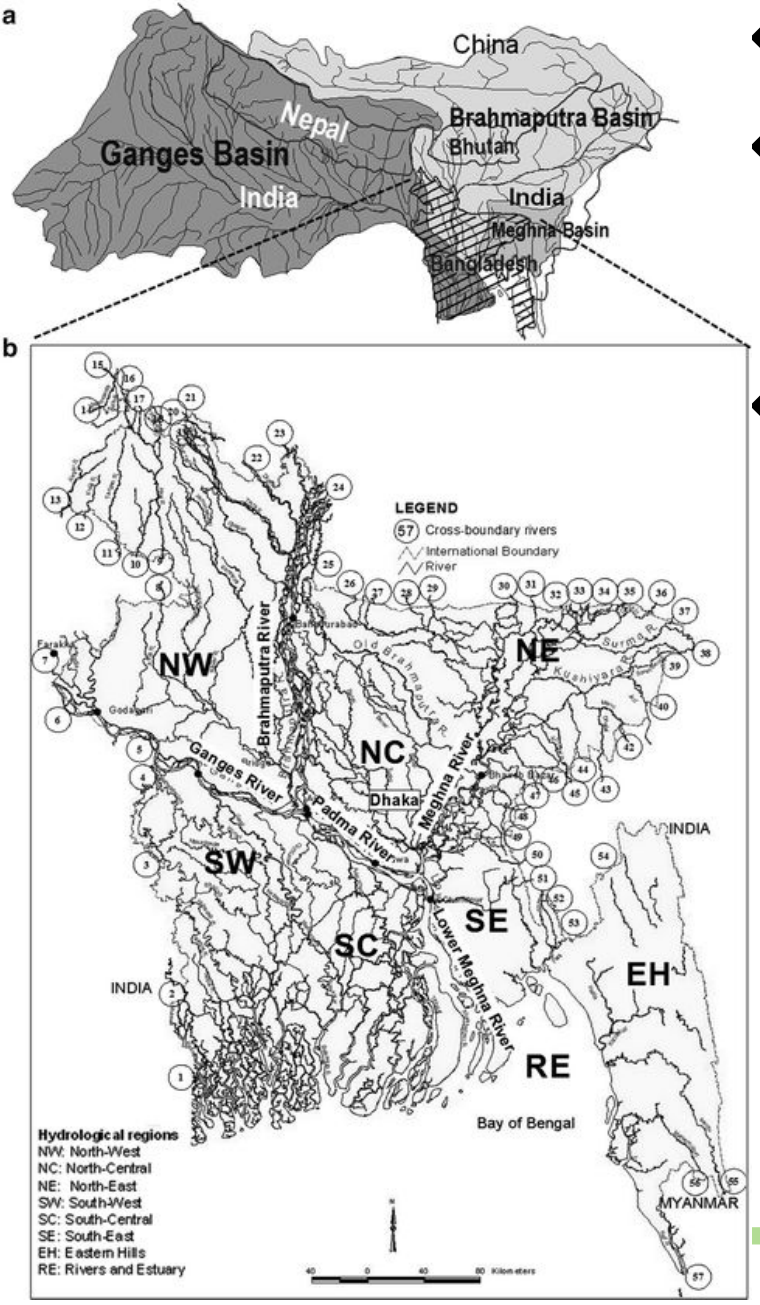
Factors responsible for Floods- Surrounded by Mountains

Orographic precipitation, rain, snow, or other precipitation produced when moist air is lifted as it moves over a mountain range. As the air rises and cools, orographic clouds form and serve as the source of the precipitation, most of which falls upwind of the mountain ridge.





Factors responsible for Floods- Lower Riparian Country

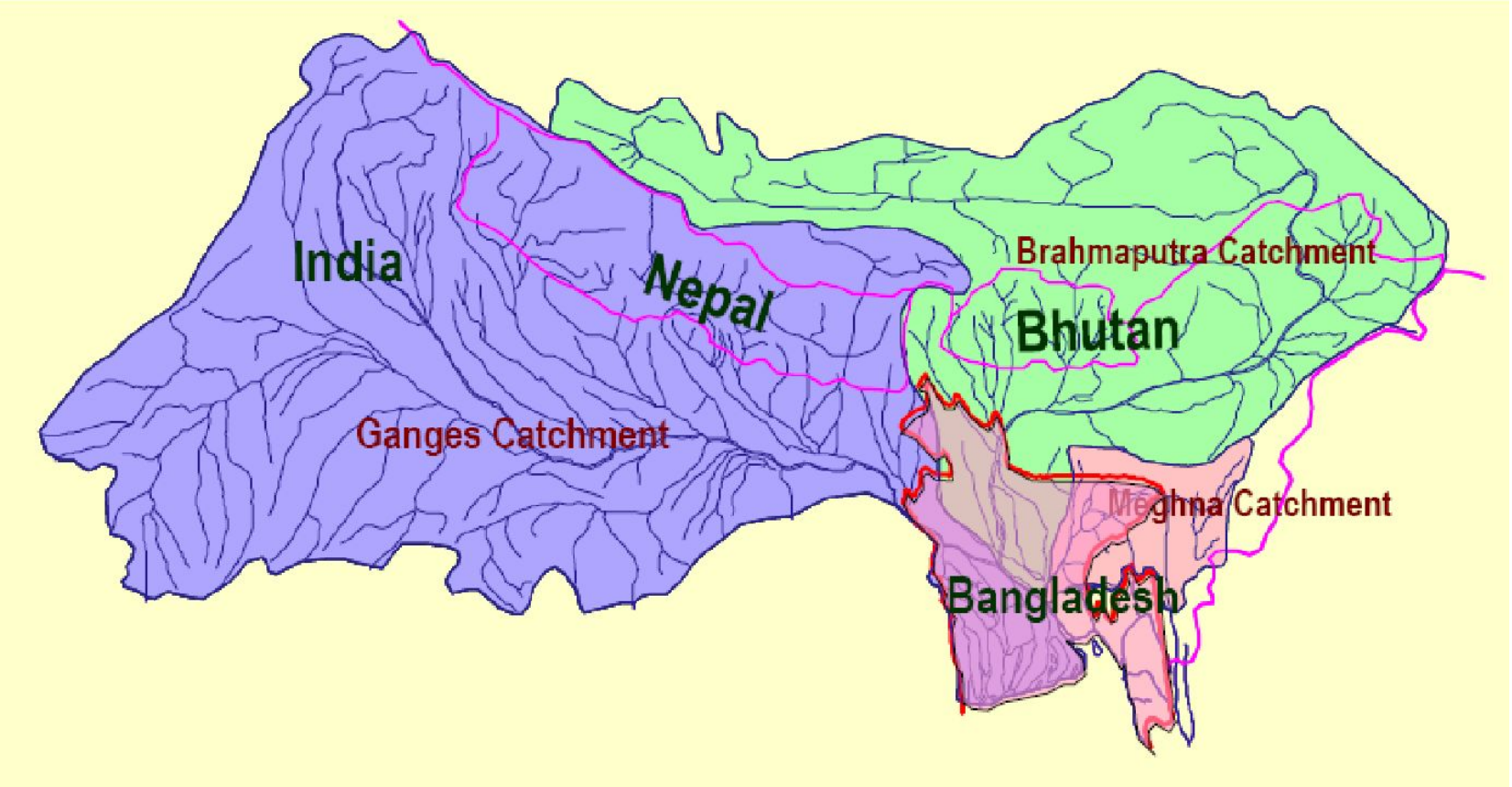


- Located at the lower part of GBM basins
- Total area of GBM Basins- 1.75 million km² (**India, Nepal, Bhutan, The Tibetan region of China and Bangladesh**)
- 7% of total area lies within Bangladesh.

Country areas in the Ganges-Brahmaputra-Meghna river basin (Source: Joint Rivers Commission Bangladesh)

Basin	Area km²	Area % of Southeast Asia	Countries included	Area of country in basin (km²)	As % of total area of the basin	As % of total are of the country
Ganges	1 087 300	5.2	India	860 000	79	26
			China	33 500	3	0.3
			Nepal	147 500	14	100
			Bangladesh	46 300	4	32
			Bhutan	-	-	-
Brahmaputra	543 400	2.7	India	195 000	36	6
			China	270 900	50	3
			Nepal	-	-	-
			Bangladesh	39 100	7	27
			Bhutan	38 400	7	100
Meghna	82 000	0.4	India	47 000	57	1
			China	-	-	-
			Nepal	-	-	-
			Bangladesh	35 000	43	24
			Bhutan	-	-	-
Total	1 712 700	8.3	India	1 102 000	64	33
			China	304 400	18	3
			Nepal	147 500	8	100
			Bangladesh	120 400	7	83
			Bhutan	38 400	3	100

Factors responsible for Floods- Lower Riparian Country



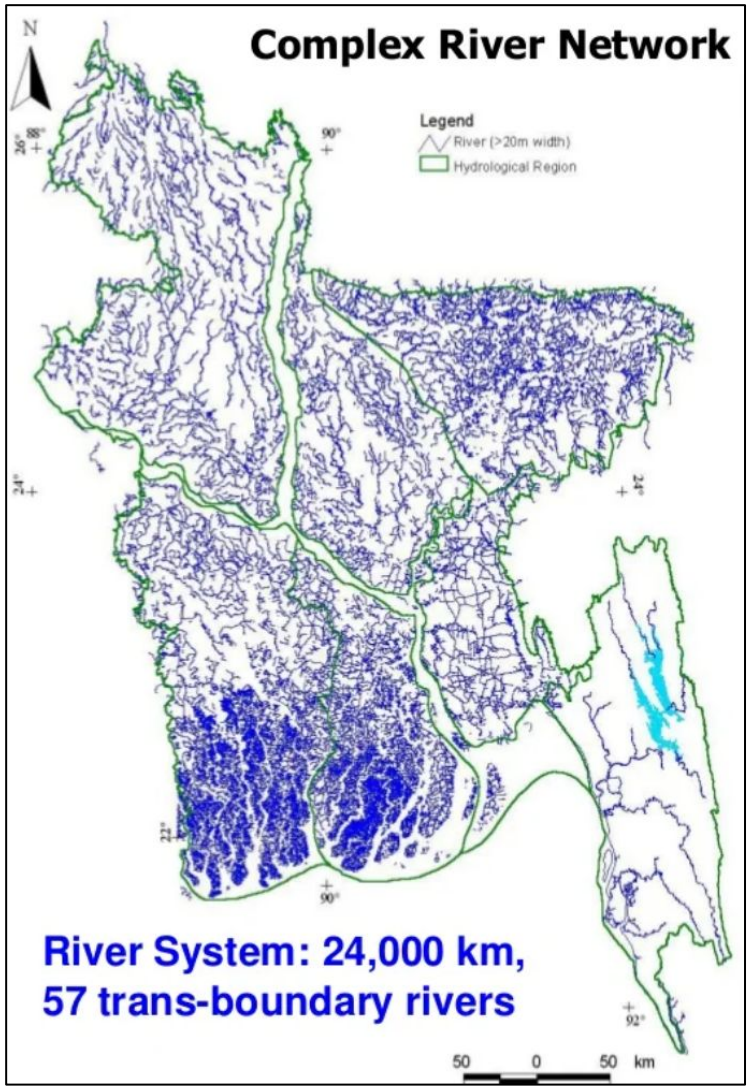
Ganges-Brahmaputra-Meghna Basin

1.76 Million sq. km

Distributed among:

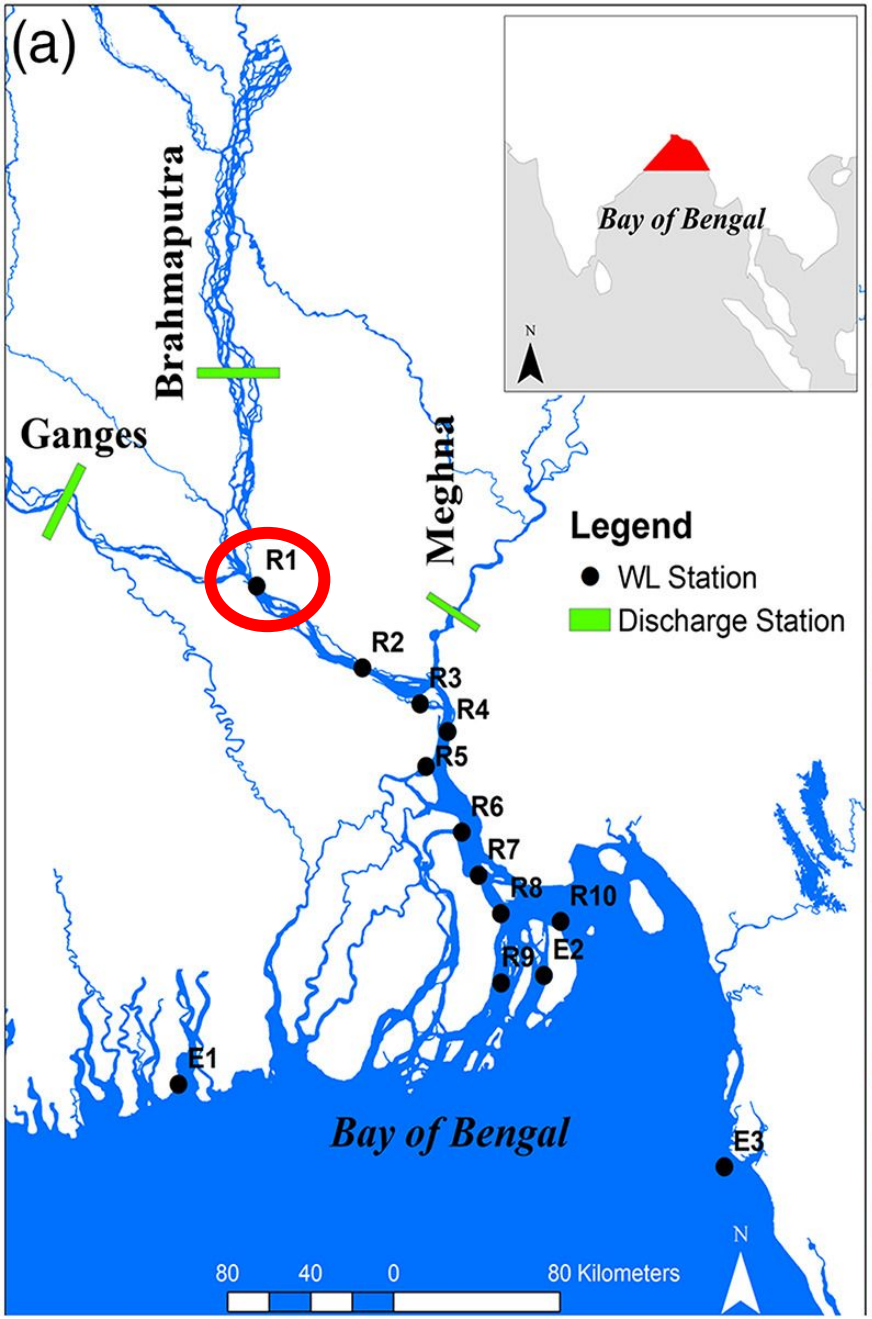
- India (64%)
- China (18%)
- Nepal (9%)
- Bangladesh (7%)
- Bhutan (3%)

Factors responsible for Floods- Lower Riparian Country



- Excessive Rainfall in these three river basins is the principal cause of riverine floods in Bangladesh.
- 57 rivers originated outside the boundary of Bangladesh.
- 1.18 trillion cubic meters of water flows annually to the sea, of which 1.07 trillion cubic meters or 91% enters Bangladesh from upstream catchment
- Rest contributed by total internal rainfall.

Factors responsible for Floods- Lower Riparian Country



The annual volume of flow past Baruria just below the confluence of the Brahmaputra and the Ganges is

795,000 million m³

Equivalent to 5.52 m of depth over 14.40 million ha of land area of Bangladesh.

In contrast, the annual average rainfall for the country in 2320 mm .

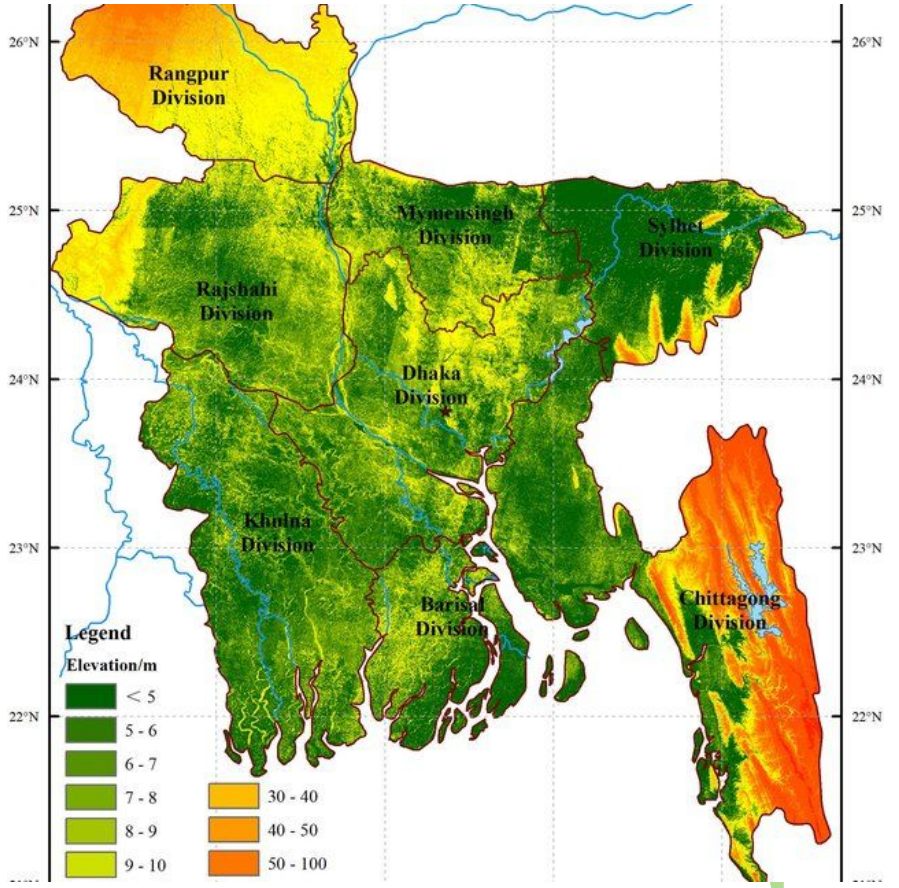
Factors responsible for Floods- Floodplain Country

- Unique Physiographic feature- low-lying and extremely flat floodplain of the major rivers and their tributaries and distributaries.

- Floodplains cover 80% of the country

- Mean elevation 1m on tidal floodplains, 1-3 m on the main river and estuarine floodplains, up to 6 m in the Sylhet basin in the north-east.

- Dhaka which is 225 km from the coast is within 8m above the mean sea level.



River has minimum gradient (flatness).

Relatively small increase in flood level results in inundation of a wide area in the floodplain

Factors responsible for Floods- Hydro-Meteorological System

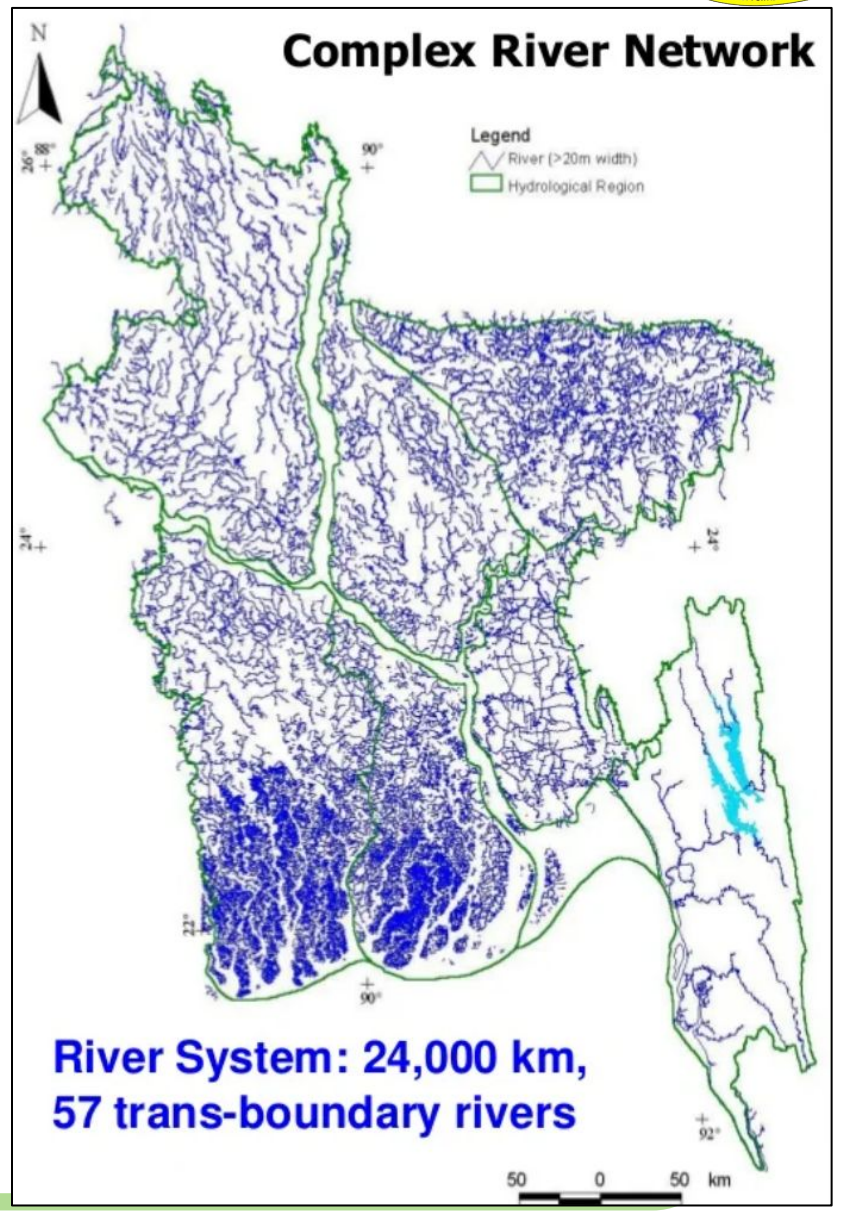
- Spatial variation of rainfall in the GBM basins
- Highly skewed temporal variation of rainfall (80% of rainfall occurs from May to September)
- Unlike other deltas, the seasonal variation in the river flow is highly skewed (abundant water during monsoon and very small flow during dry season)
- **Two major hazards:** Flood during the wet season and scarcity of water during the dry season
- Hydrodynamic characteristics during flood flow in alluvial rivers in Bangladesh are quite different from that during low flows

Factors responsible for Floods- Hydro-Meteorological System

- Crisscrossed with around 230 rivers
- Are hydraulically linked to each other (except those of the Chittagong sub-region).
- That is all rivers are either tributaries or distributaries of three major rivers.

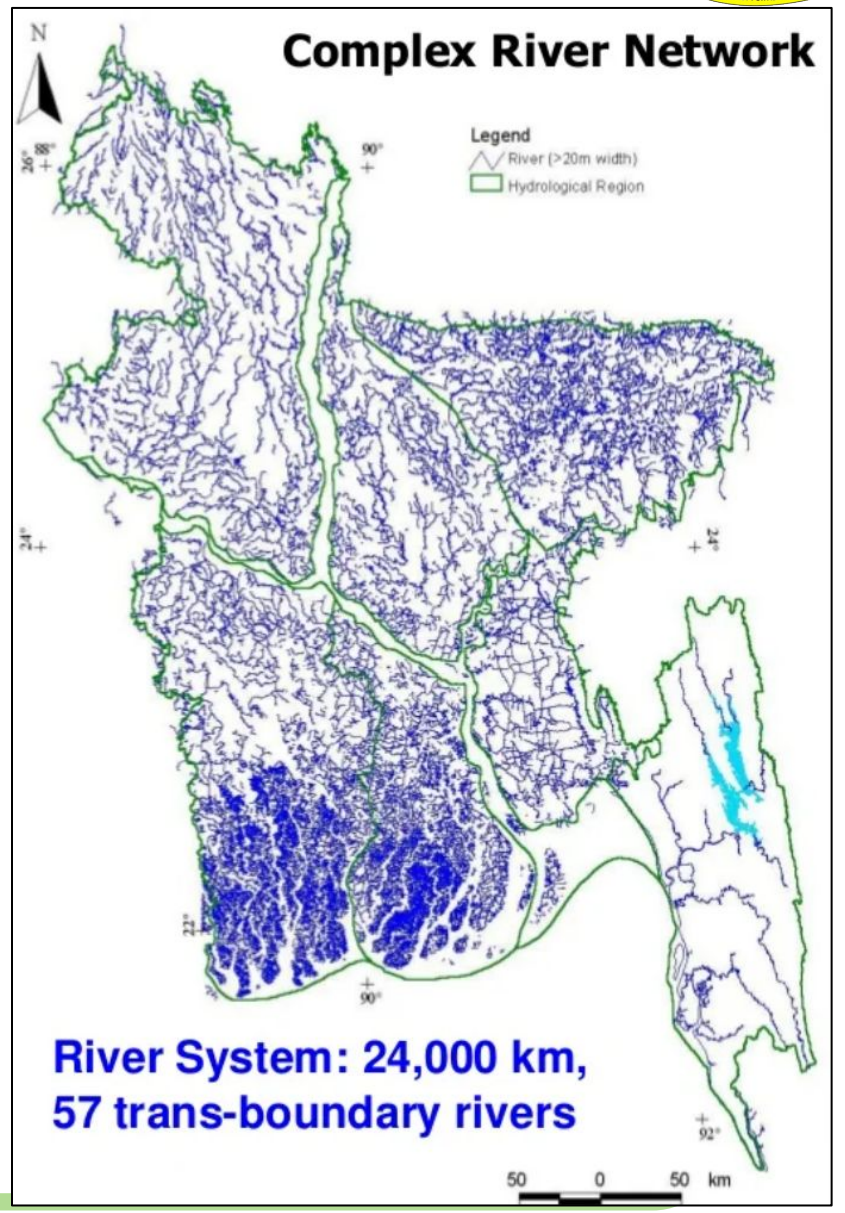
❑ Tributaries- Freshwater stream that feeds into a larger stream or river
❑ Distributaries- Stream that branches off and flows away from a mainstream channel.

- High water level of the Major rivers slows down the flow of their tributaries resulting in backing up of water in the tributaries.



Factors responsible for Floods- Hydro-Meteorological System

- GBM rivers discharge about 142,000 m^3/s into BoB during high flow period
- B-G carry about 85% of flood flow that enter Bangladesh
- Flood Flow ration is B:G:M = 4.4:2.5:1
- As far as area flooded concerned, flow in the Brahmaputra has the strongest correlation with the extent of flooding in Bangladesh.



Key Determinants of Extent of Flooding

- Magnitude
- Synchronization of Peaks

} Amount of Rainfall in the upstream catchments

- Duration of Floods in the major rivers.



Downstream control provide by coast in the form of **Spring tide** and **monsoon wind** set-up in the Bay of Bengal (BoB)

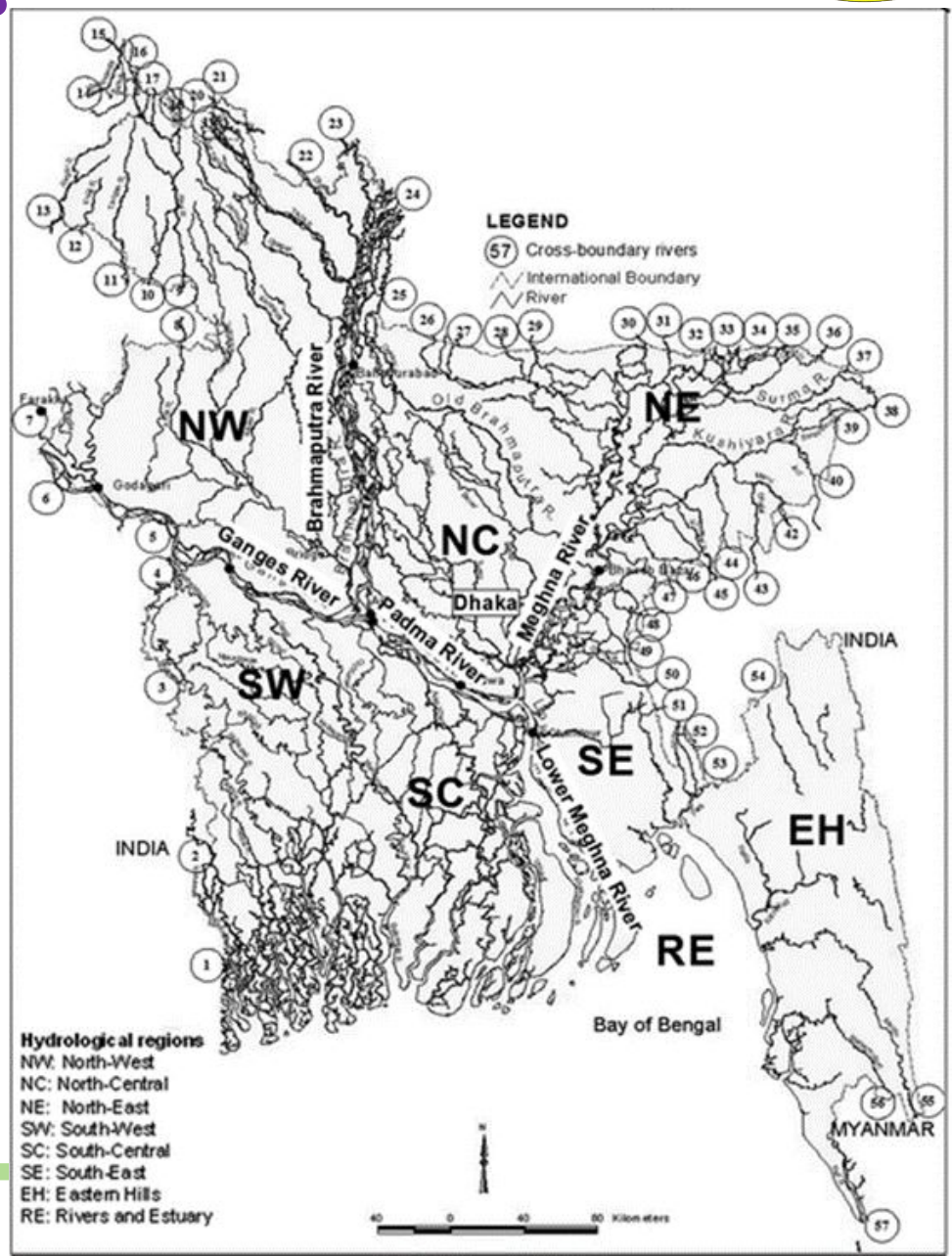
Key Determinants of Extent of Flooding

Duration of Floods

- Downstream control is offered by the lower Meghna
- Act as single drainage outlet
- Spring tide and monsoon wind setup in the BoB cause strong back water effect in the lower Meghna

Slow down drainage building up high water level and cause increase and severity of flood.

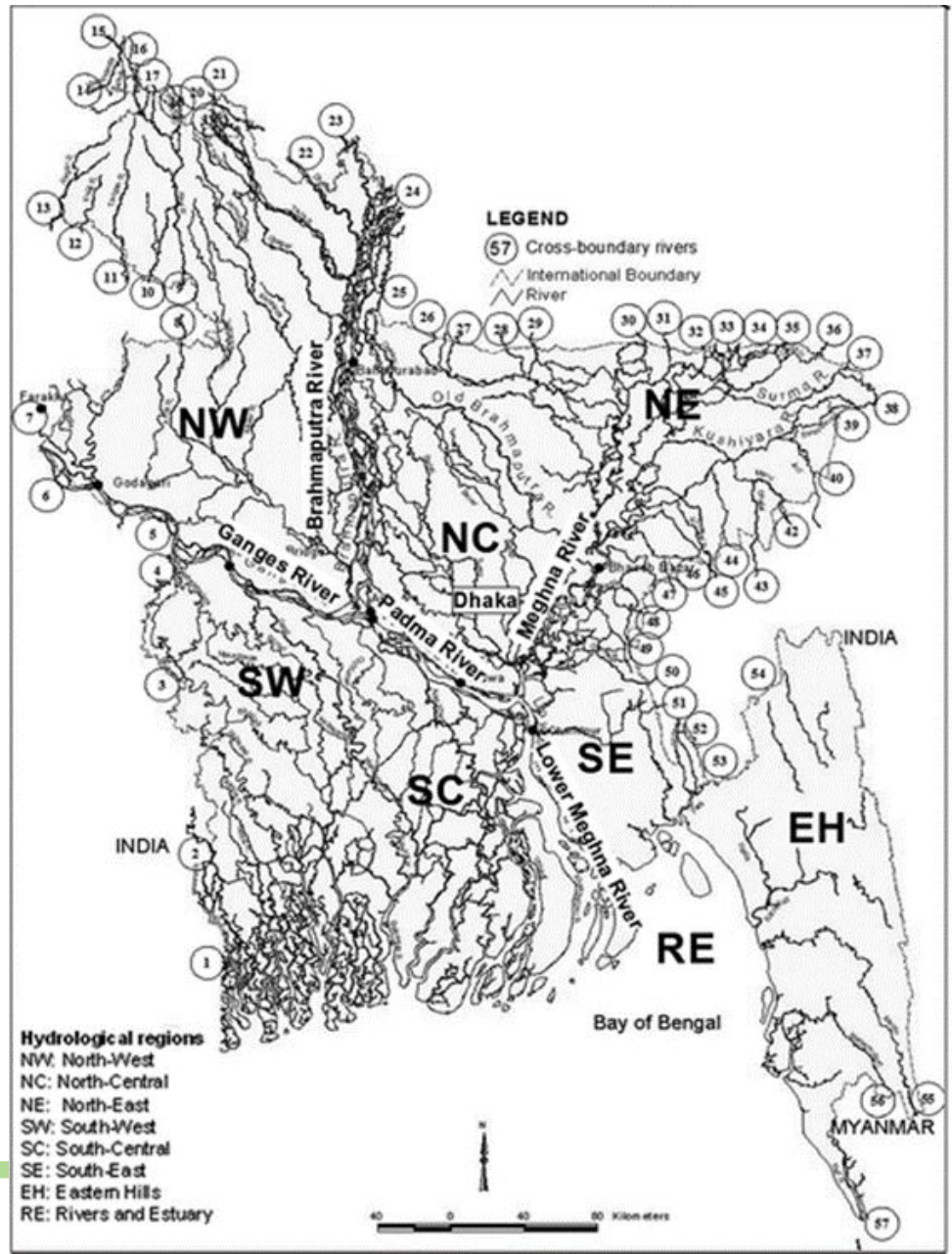
1998 and 2004 flood



Key Determinants of Extent of Flooding

Peak Flows

- Synchronization of peak flow in the Brahmaputra and Ganges is a major determinant of the extent of flooding in BD.
- When the peaks of the two rivers coincide, severe flooding occurs.
- 1998, 2004 .



Floods in Bangladesh

The major types of flood can be classified as:

- flash flood (in the foot-hill region);
- flood due to drainage congestion (including urban flood);
- monsoon floods from major rivers;
- floods due to storm surges in the coastal belts.

Floods in Bangladesh

Causes of Flood in Bangladesh:

- excessive rainfall leading to run-off in excess of safe channel conveyance capacity;
- deterioration of drainage channel by natural siltation, shoal formation, or obstructions;
- drainage congestions due to faulty or unplanned development activities and encroachment on flood plains;
- effect of construction of embankments, causing increases in flooding elsewhere;
- deforestation in upper catchment areas;
- flat topography of the country which slows drainage rate;
- rise in sea level due to monsoon wind;
- coincidence of peak flow of major rivers causing congestion at confluences;
- failure of water retaining structures, dams etc.;
- tidal surges and sea waves; and
- Global climate change.



Thank You!