

**Delta Alliance Bangladesh Wing (DABW)**

Workshop on

**Sediment and Salinity in the Coastal  
Areas of Bangladesh**

Presented by

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# Bangladesh:

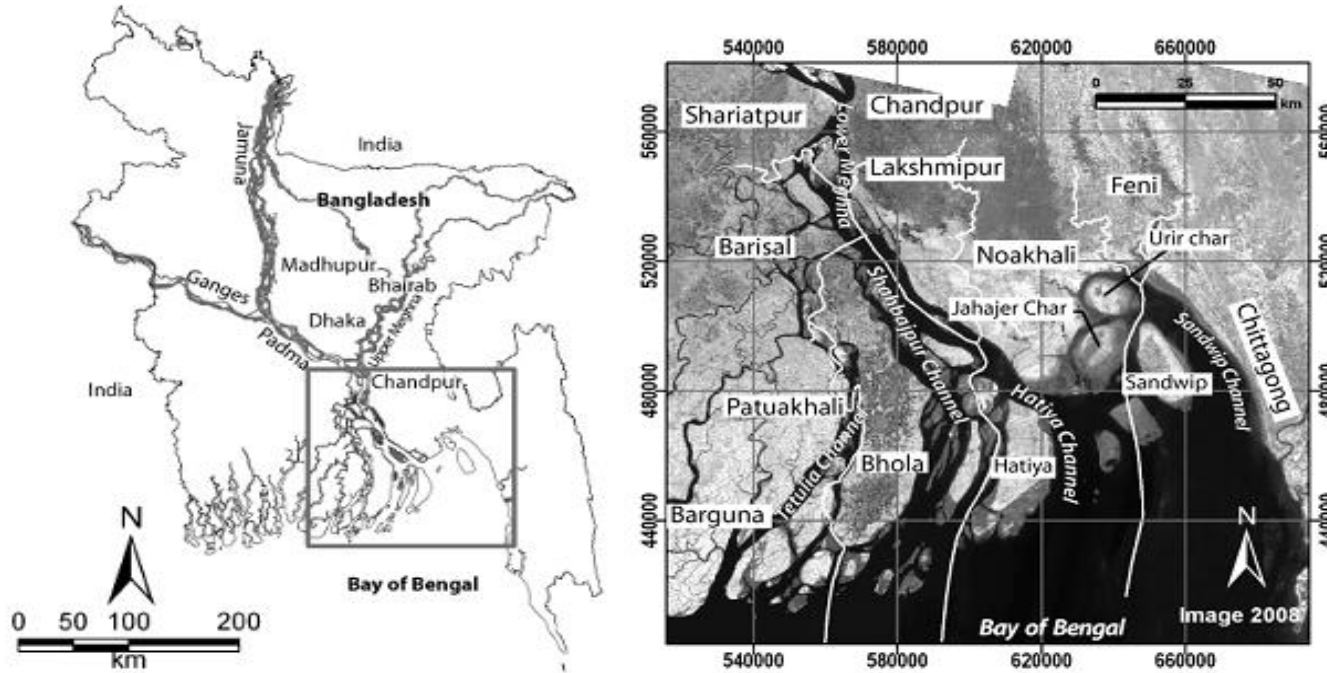
***What is a Delta:*** According to Fookes et al., 2007, Deltas are a large accumulation of both fluvial and marine sediments which have in filled river mouths and extended onto the continental shelf.

***What do a Delta do:*** Deltas are generally associated with large catchments with high sediment yields and low nearshore gradients.

***The GBM Delta:*** The great rivers, the Brahmaputra and the Ganges with their huge sediment loads derived from the Himalayas and tectonic interactions have formed this delta. The Meghna forms from the eastern side of India and contribute to the other two rivers to form the lower delta.

***Bangladesh, a part of this process:*** A large part of this delta lies within Bangladesh, covering a land area of 144 000 km<sup>2</sup> and most of the country is formed by a low lying plain with a gentle slope from north to south, where the land meets the Bay of Bengal (Elahi, 1991).

# Result of Active Sediment Movement



Satellite Image (2010) shows the Meghna Estuary Area (Source: Sarker et al., 2011)

Now a days, delta building is taking place within the Meghna Estuary area.

Each year the Ganges, Jamuna and Meghna Rivers of Bangladesh transport more than one billion tonnes of sediment from their catchments in India, China, Nepal and Bhutan to this delta region.

# Sediment Movement

According to the long-term sediment budget for the delta predicted by Goodbred & Kuehl (2000):

- one third of the sediment carried by these rivers is deposited on the flood plain and tidal plain,
- one third is trapped in the sub-aqueous delta, causing vertical accretion and lateral progression of the sub-aqueous delta, and
- Goodbred & Kuehl (2000) were unable to assess the destination of the remaining sediment and concluded that it is probably transported to the deep ocean floor.

# Sediment Movement

High sediment input from upstream and high tidal energy, Meghna Estuary itself is very dynamic in nature and characterized by erosion and accretion on the scale of several thousand hectares of land per year.

Due to its low and flat terrain, it is suspected that Bangladesh would be one of the worst victims of climate change (Ahmed, 2006).

Although accretion is the dominant process, several thousands of people in the densely populated tidal plains become landless and homeless every year due to erosion (Sarker et al., 2011).

Sediment management, based on a sound knowledge of the processes of sediment dispersal in the estuary and along the coasts are the effects of large events in the recent past, could be instrumental in combating sea level rise.

***Up-to-date knowledge and identification of related issues may help in formulating the most effective adaptive approach.***

# Sediment Related Studies

After the late 1970s

**Land Reclamation Project (LRP)**

**Meghna Estuary Studies (MES)**

**Estuary Development Programme (EDP)**

Carried out by Bangladesh Water Development Board (BWDB) with the financial support from the Netherlands Government

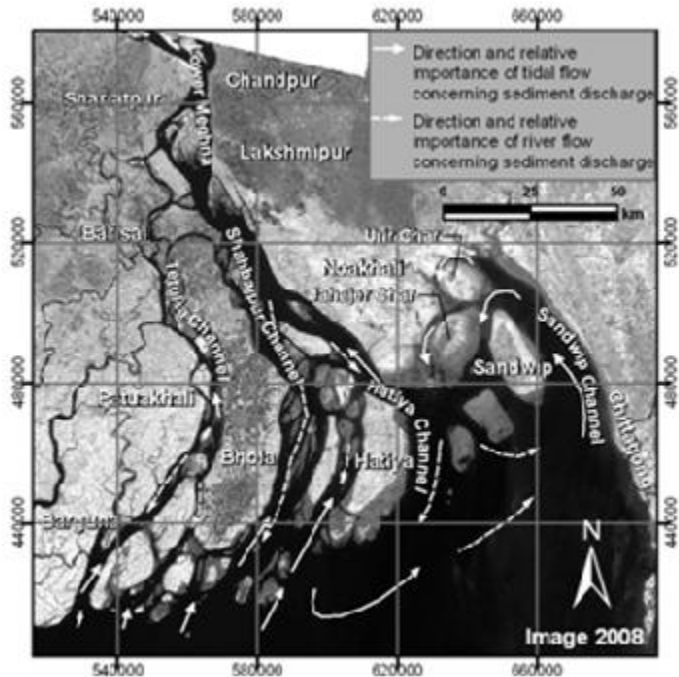
Data have been analyzed to understand the land formation and sediment dispersion processes, and

To assess the impact of exogenic factors and human intervention.

These studies greatly increased knowledge and understanding of the physical processes of sediment transport, erosion and accretion.

**Bangladesh Delta Plan 2100.....**

# Results of Sediment Movement



The direction and relative importance of river and tidal flows in influencing sediment discharge (Source: Sarker et al., 2011).

Sediment supply, waves and tides exert important controls on the formation of the delta planform.

High tide energy results in tide dominated deltas like the Meghna Estuary, where distributary channels with linear river mouth bars are present (Fookes et al., 2007).

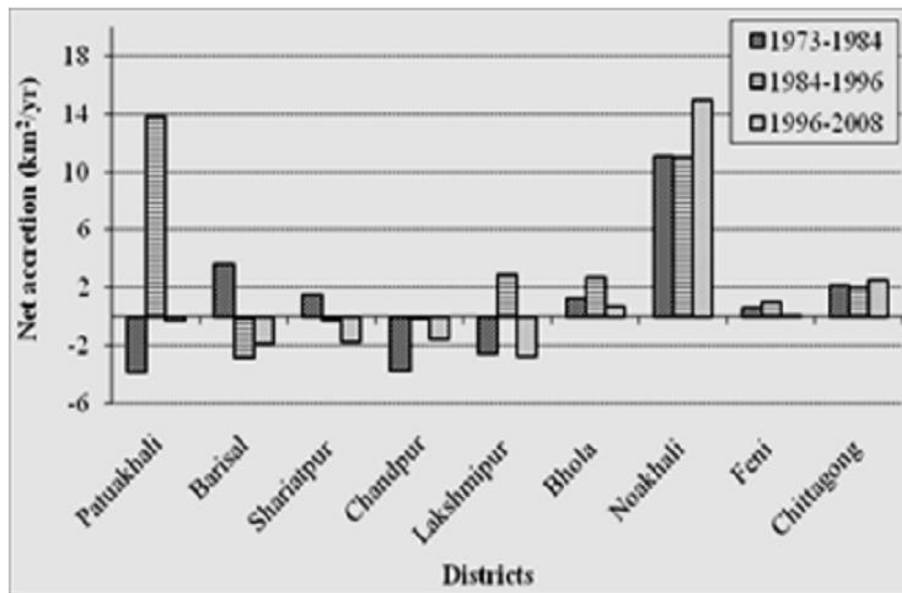
Seasonal variation of the fresh water input into the estuary ranges from 20 to 30 times, a similar range to that of sediment input.

In tide dominated deltas, sediments are re-worked and re-deposited (Hori and Saito, 2007).

# Results of Sediment Movement

Comparison of erosion and accretion rates from different studies (MES, 2001)

Length of study period (years)	Period of study	Net change for period (km <sup>2</sup> )	Rate of change (km <sup>2</sup> year <sup>-1</sup> )	Reference
220	1776–1996	+2187	9.9	EGIS (1997)
192	1792–1984	+1346	7.0	Allison (1998)
144	1840–1984	+638	4.4	Allison (1998)
23	1940–1963	+279	12.1	Eysink (1983)



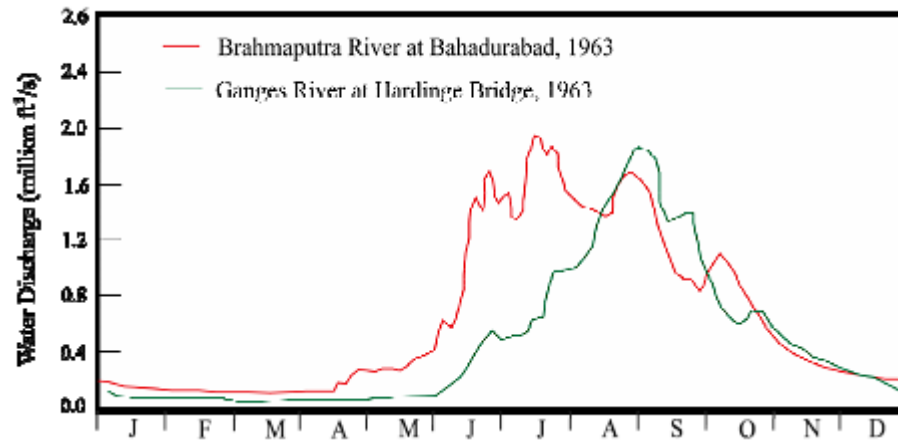
The spatial distribution of erosion and accretion in the erosion/accretion process (Source: Sarker et. al., 2011)

Every year about  $1 \times 10^{12} \text{m}^3$  of fresh water is brought into the Meghna Estuary by the three major rivers: the Ganges, the Jamuna and the Upper Meghna.

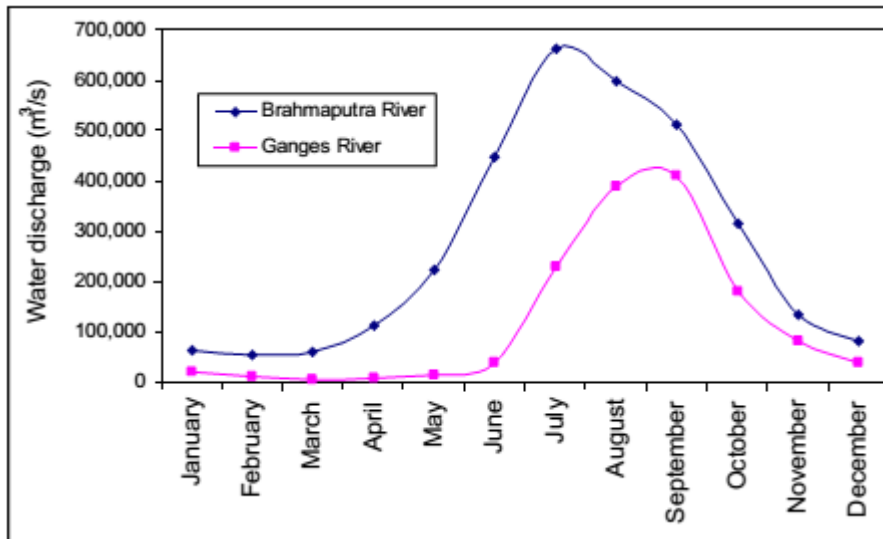
The temporary storage of sediment during the monsoon in the zone of the turbidity maximum is the main source of sediment redistribution during the dry season.



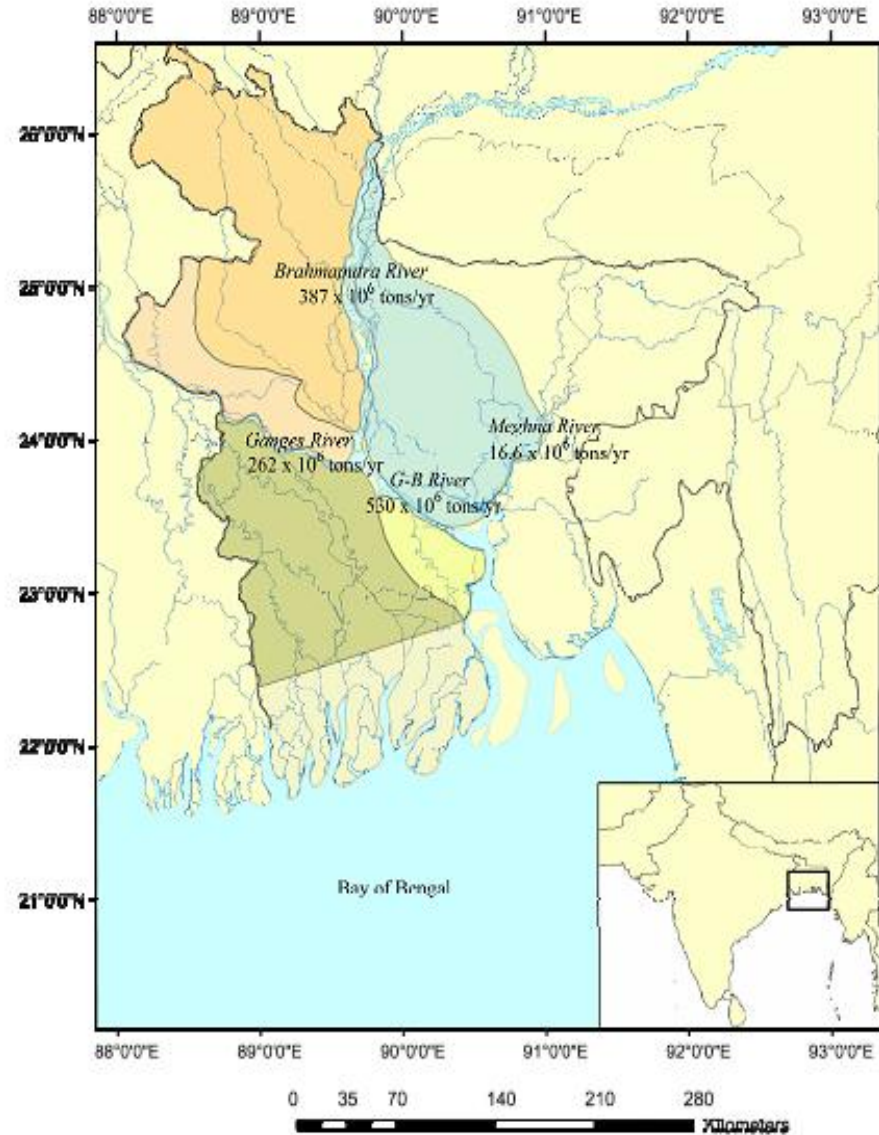
# Suspended Sediment Movement



Flood hydrograph for the Ganges and Brahmaputra Rivers for 1963 (Source: Rice, 2007; modified from Coleman, 1969)

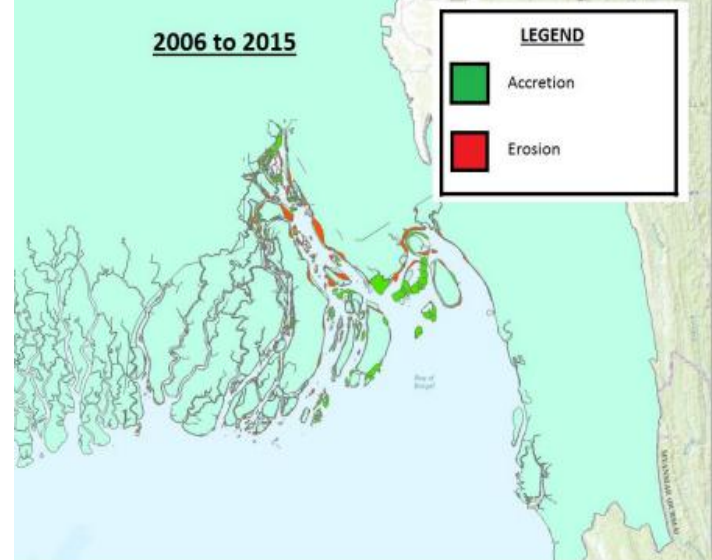
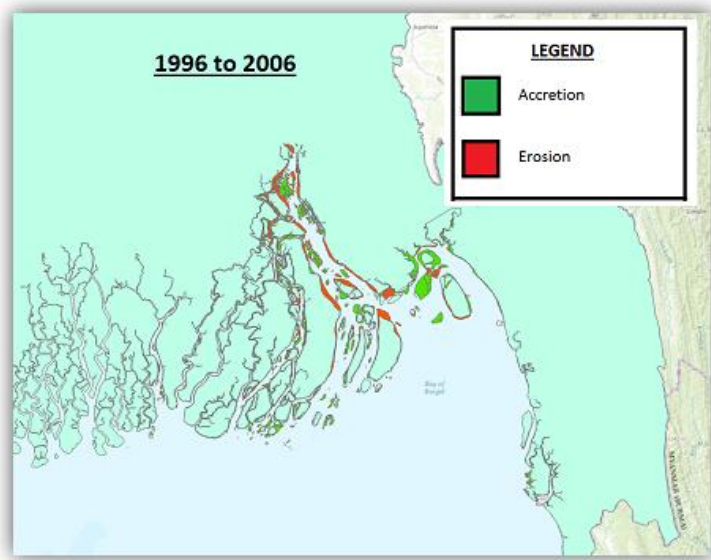
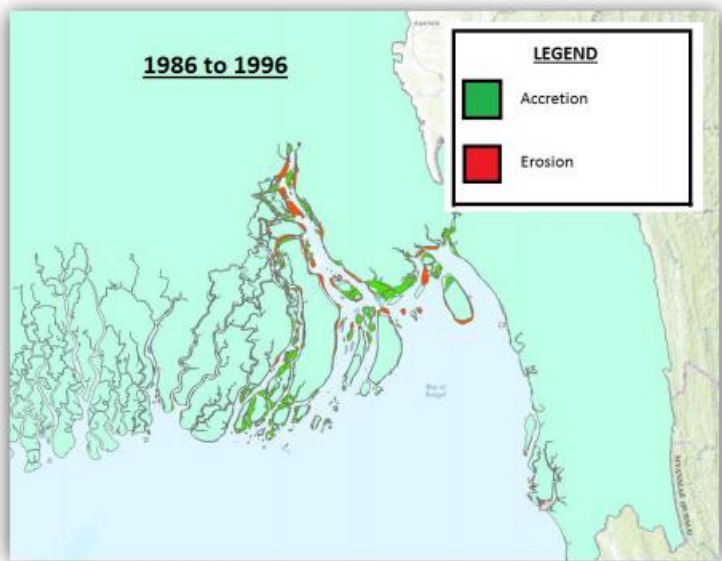
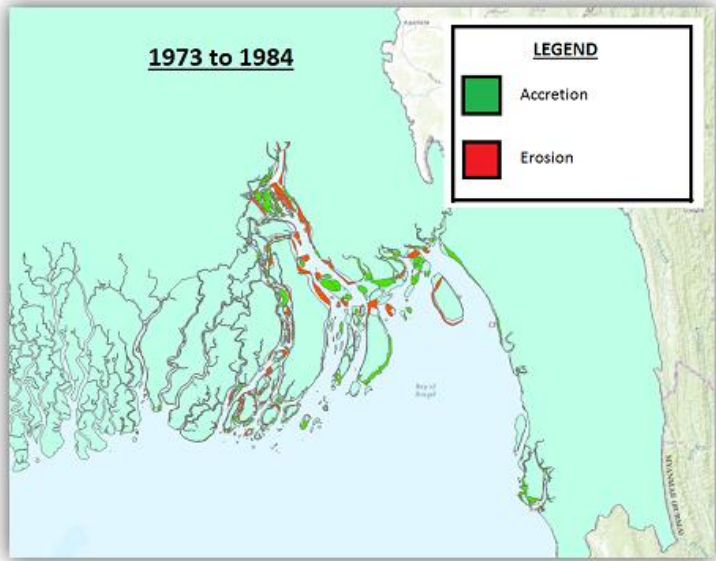


Flood hydrograph for the Ganges and Brahmaputra Rivers. Monthly averages from 1990 to 2003 (Source: Rice, 2007)



Calculated annual sediment loads from the Ganges, the Brahmaputra and the Meghna (Source: Rice, 2007)

# Erosion and Accretion Process



Source:  
Hasan, 2016

Based on related studies and findings, it is high time to set up the priorities in coastal zone based on the sediment movement, erosion and accretion process in that area

# Salinity

## How to define saline water?

When water contains significant quantities of dissolved salts, especially sodium chloride (NaCl), we call this saline water.

The amount of salt in water is often expressed as concentration in milligrams of chloride per liter of water (mg Cl<sup>-</sup>/l) or in its equivalent; parts per million (ppm).

Another standard way of measuring salinity is milligrams TDS per liter, where TDS is Total Dissolved Solids. It can also be expressed using the Electrical Conductivity (in reference to 25° Celcius) often expressed either in milliSiemens per centimeter (mS/cm) or microSiemens per centimeter (μS/cm).

Classification of water as a function of salinity (Souce: DeltaRES, 2015)

Type	mS/cm	mg TDS/l	Drinking- or irrigation water
Non-saline or fresh water	<0.8	<600	Drinking and irrigation water
Slightly saline	0.8 - 2	600-1.500	Irrigation water
Moderately saline	2-10	1.500-7.000	Primary drainage water and groundwater
Highly saline	10-25	7.000-15.000	Secondary drainage water and groundwater
Very highly saline	25 - 45	15.000-35.000	Seawater is 35000 TDS mg/l
Brine	>45	>45.000	

# Salinity in the Coastal Area of Bangladesh

Salinity intrusion from the sea through the estuaries in low-lying tide-dominated deltas is a serious threat.

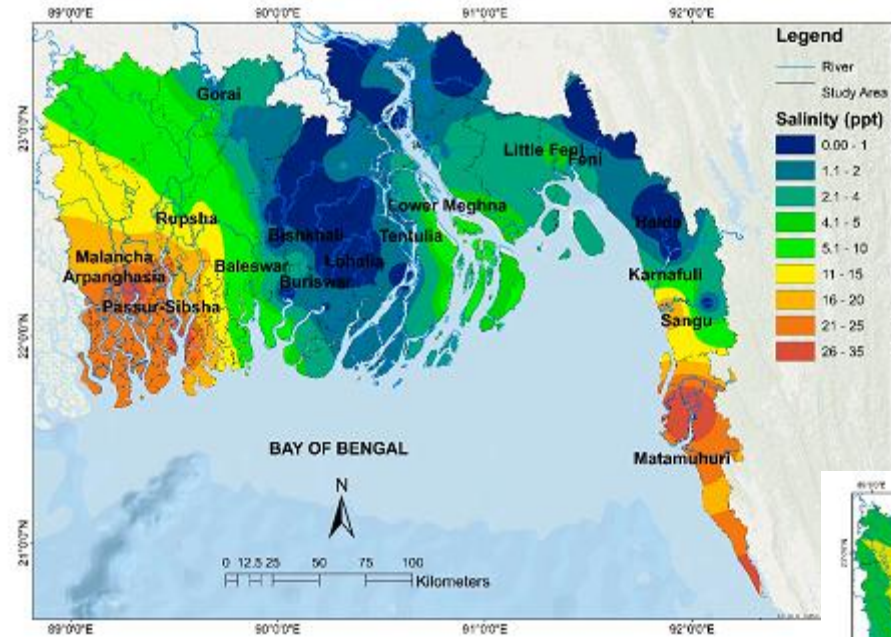
It is expected to worsen in changing climatic conditions and with sea level rise.

The effects of the reduced upstream discharge, sea level rise and cyclones cause different levels of impacts in the Ganges-Brahmaputra-Meghna (GBM) delta along the coast of Bangladesh.



# Salinity in the Coastal Area of Bangladesh

Reduced upstream discharge causes an increased saltwater intrusion in the entire region.



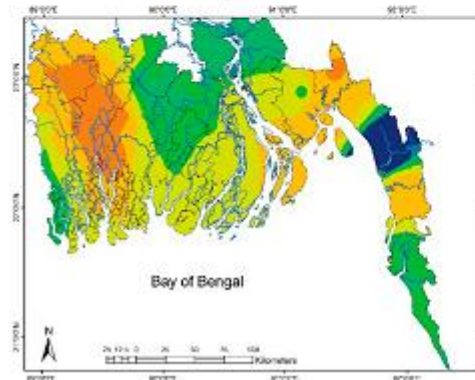
Base salinity, 2011 from measurement  
(Source: Akter et al., 2019)



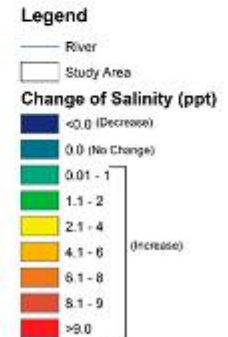
Q1



Q2

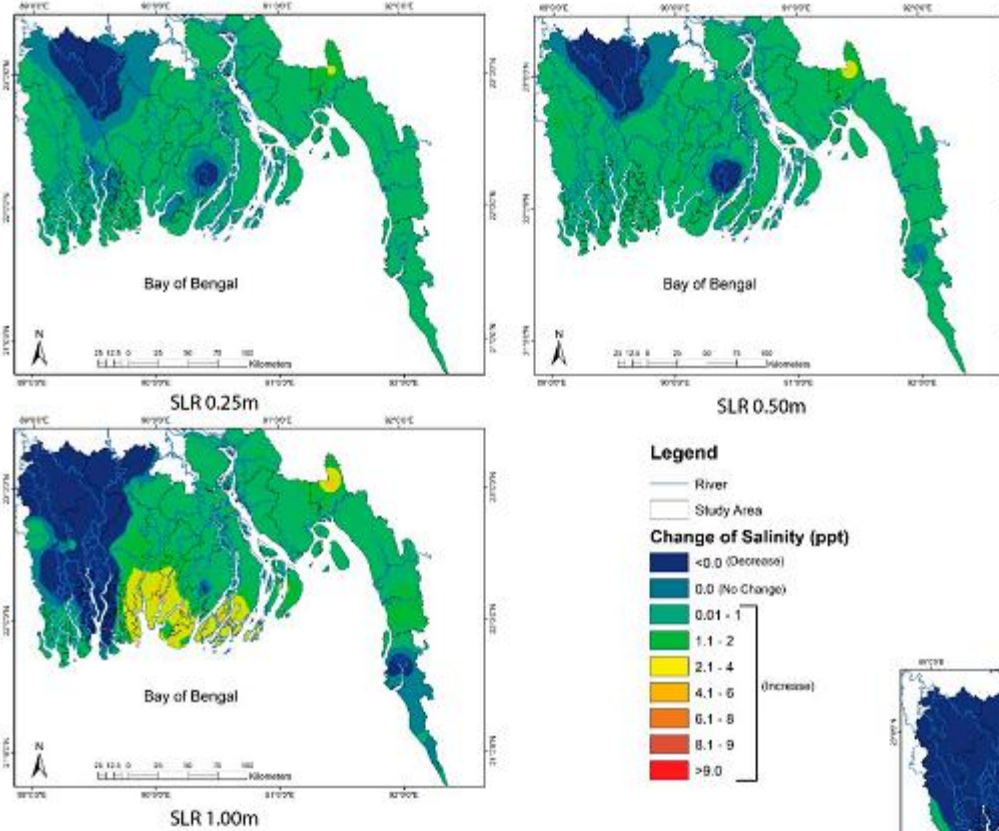


Q3



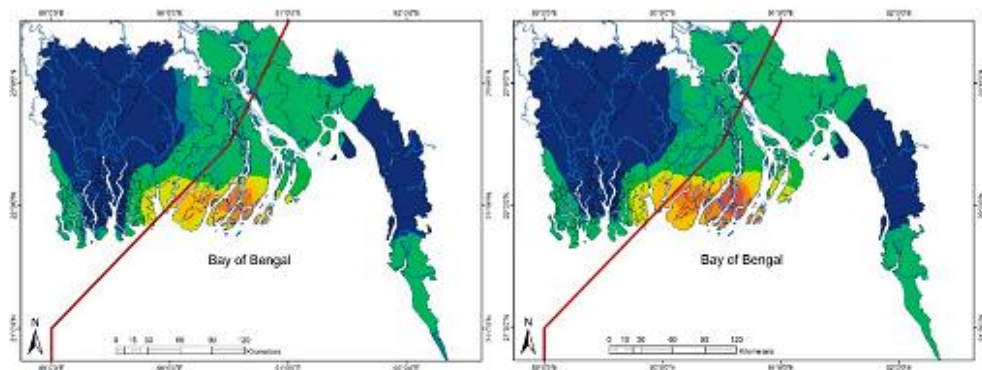
Change in salinity magnitude with reduced discharge (Source: Akter et al., 2019)

# Salinity in the Coastal Area of Bangladesh



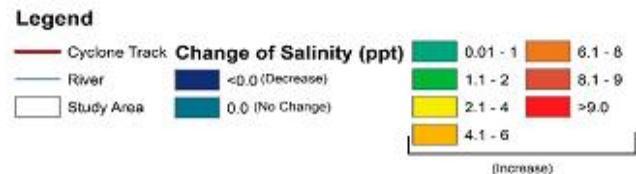
The cyclonic impact on saltwater intrusion is confined within the landfall zone.

Change in salinity magnitude Base Cyclone and the Cyc-Scenario (Source: Akter et al., 2019)



Base Cyclone

Cyc-Scenario



Change in salinity magnitude with SLR (Source: Akter et al., 2019)

A rising sea level causes increased salinity in the shallower coast.

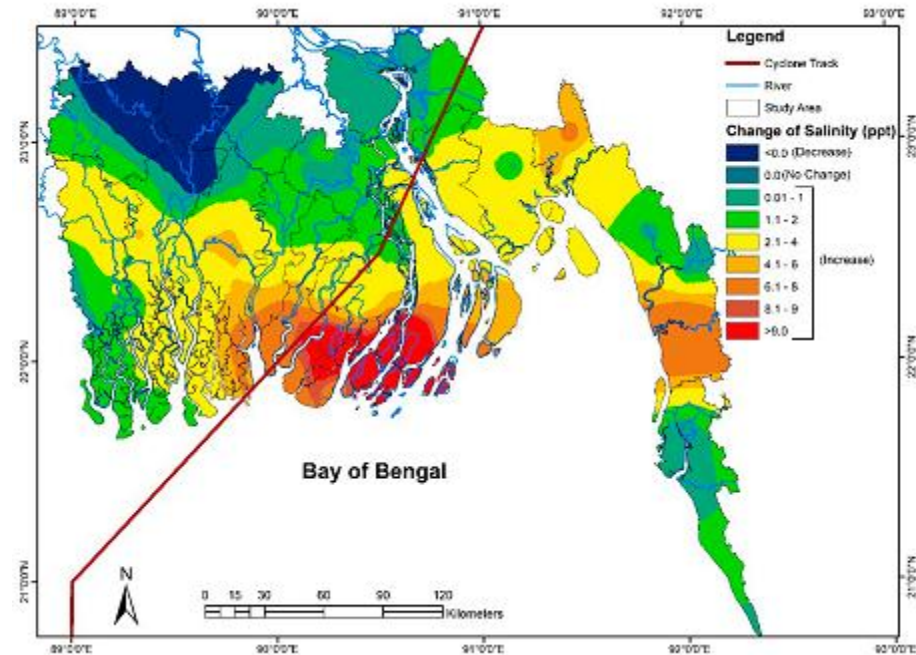
# Salinity in the Coastal Area of Bangladesh

For a tide dominated delta, if a sea level rise (SLR) or cyclone occurred, the impact would be conditional and local.

The impact of SLR is more prominent in a relatively shallower coast.

Salinity intrusion due to cyclonic scenarios is confined close to the cyclone landfall location.

However, if the upstream discharge reduces, the impact would be gradual and along the entire coast.

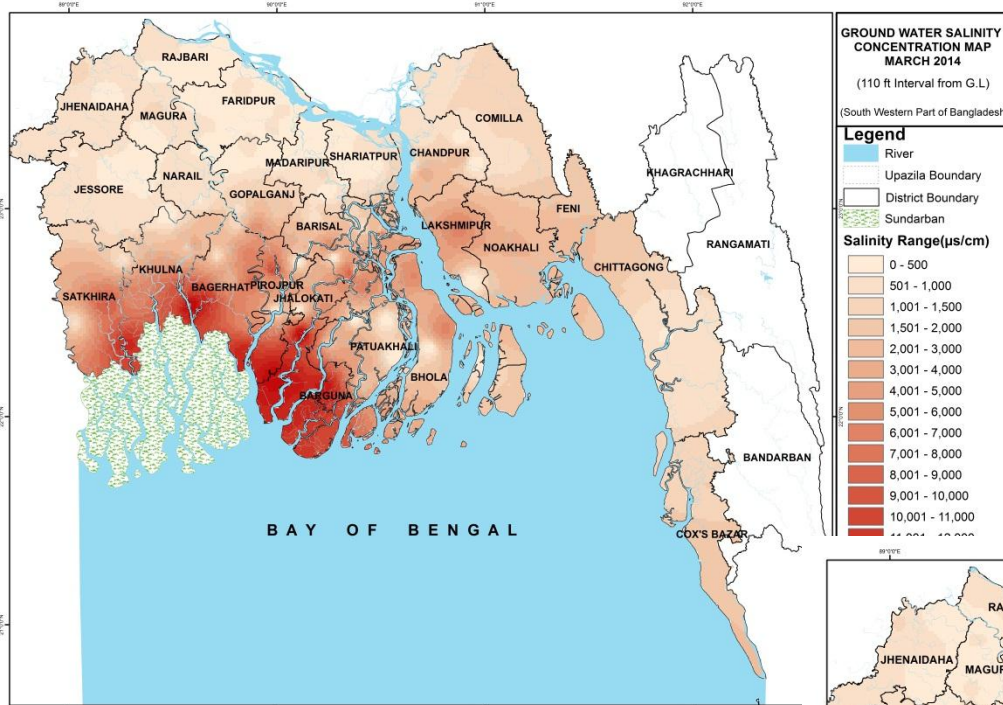


Change of salinity magnitude for an extremely severe climatic condition (Source: Akter et al., 2019)

**The reduced discharge causes an increase of salinity in all types of coast.**

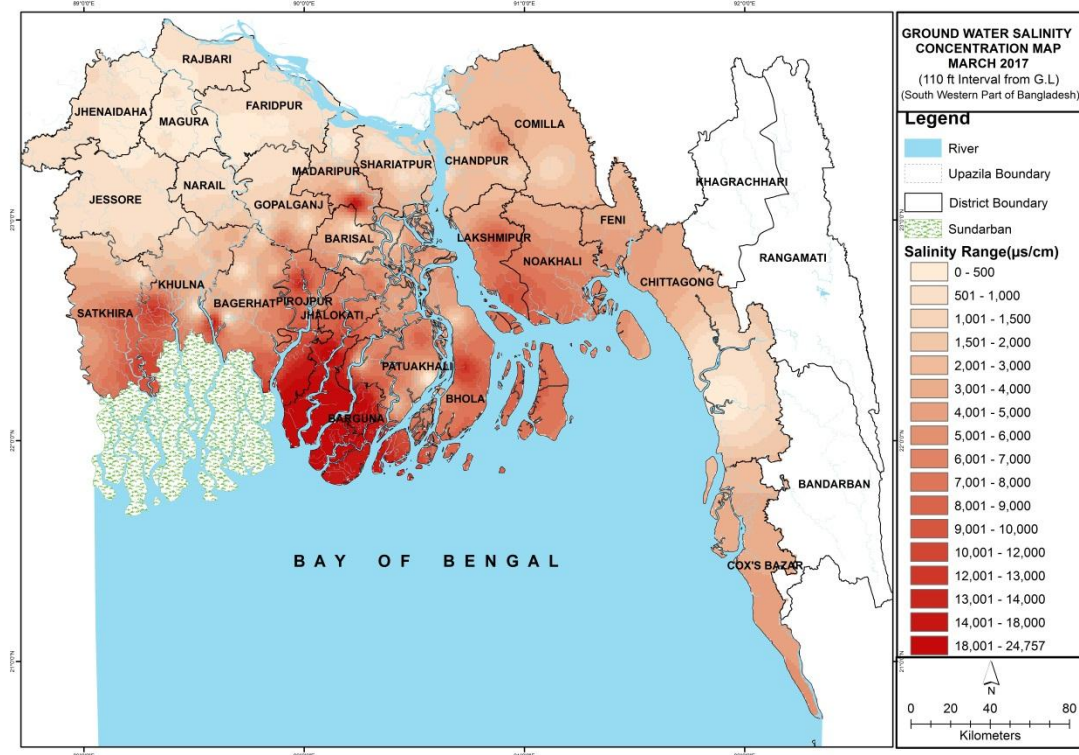


# Ground Water Salinity in the Coastal Area of Bangladesh



**Ground water salinity concentration map, March 2014 [110ft interval from the GL] (Source: BADC)**

**Ground water salinity concentration map, March 2017 [110ft interval from the GL] (Source: BADC)**





# Human Sufferings from Salinity



According to Anderson (2013), human sufferings can be - physical sufferings, mental sufferings, economic sufferings and social sufferings. With the accretive salinity intrusion in the coastal belt, people's hardship is becoming a momentous issue.

Paul and Javed (2018) describes human sufferings as:

- 1. Physical sufferings:** The major health problems are Hair loss, Diarrhea, Gastroenteritis, kidney and Skin Diseases.
- 2. Mental sufferings:** Fear, distress, and hopelessness among the affected people. Salinity affected people are in fear of probable major illnesses as they drink saline water.
- 3. Economic sufferings:** People need to buy container with fresh water for drinking purposes or cooking purposes. Need to walk long distances to collect water.
- 4. Social sufferings:** Direct social suffering is unemployment which has been caused by the prevalence of salinity. However, the indirect social sufferings are discrimination by others to the salinity affected people and incapability of salinity attacked people to migrate elsewhere.

Thank You