Investigation of sedimentation process and stability of the area around the cross-dams in the Meghna Estuary

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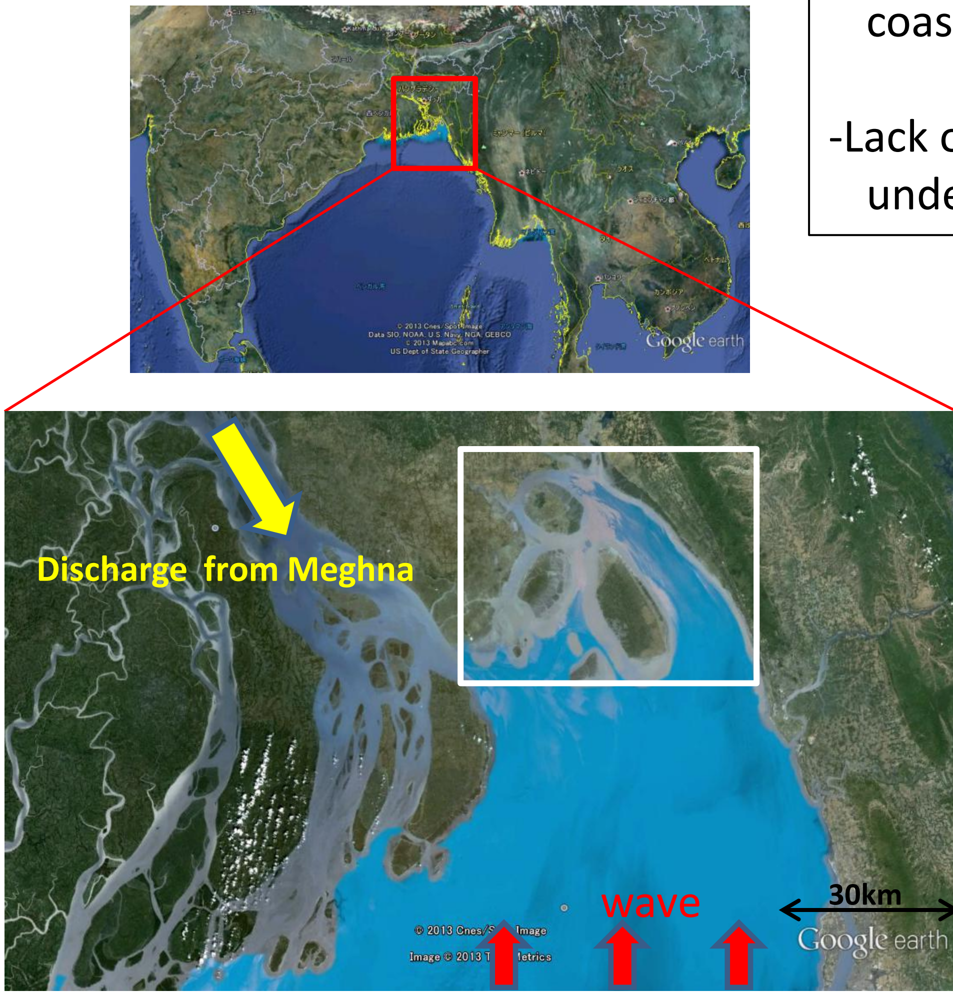
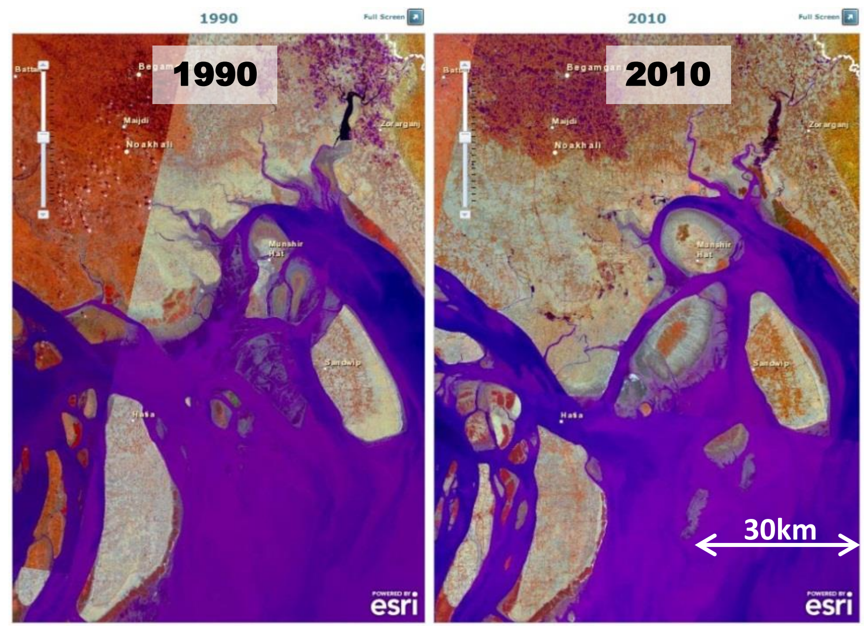
Background

- -Significant and dynamic coastal morphology change has strong impacts on development of coastal area in Bangladesh

- -Lack of measured data makes it difficult to fully understand the phenomena.





Objectives of this Research Work

The overall objective of the research work is to develop a monitoring system for large scale morphology change around the Meghna Estuary (MES) of Bangladesh

The specific objectives are:

- Analyze satellite data to identify the historic and recent morphology changes in the MES area as well as to distinguish the impact of cross dams.
- Obtain hydrodynamic data and investigate the relationship between hydrodynamic events and observed morphology changes.
- Apply numerical models to analyze morphological changes.
- Assess impact of climate change on the morphology changes of MES area.

Kickoff Meeting in Bangladesh July 2012

Participants: LGED, BUET, UT, AIT, JAXA, BWDB, WARPO,IWM, CEGIS, BIWTA, GSB, SoB, SPARSO

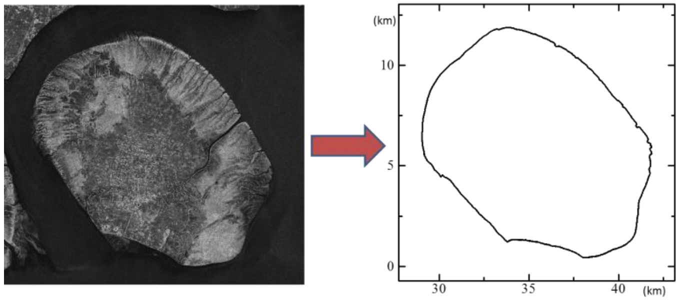
Field Survey July 2012

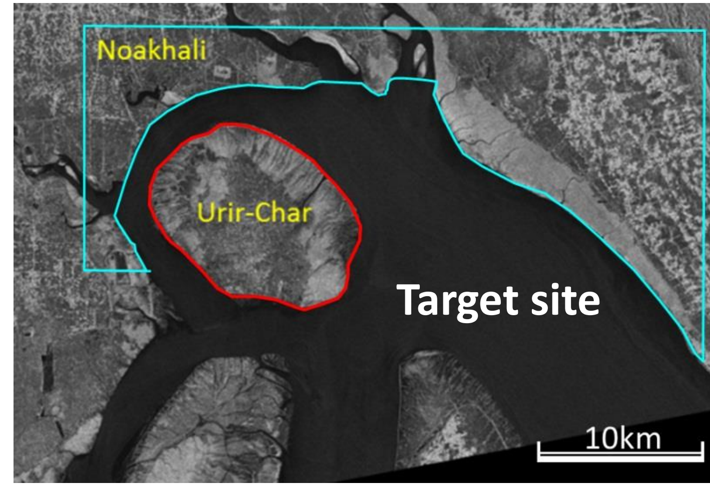
Field Survey December 2012

Analysis of PALSAR imagery

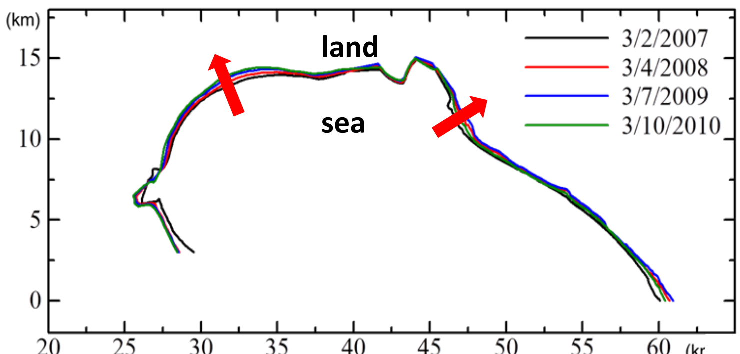
21 images from Jan.2007 to Apr 2011

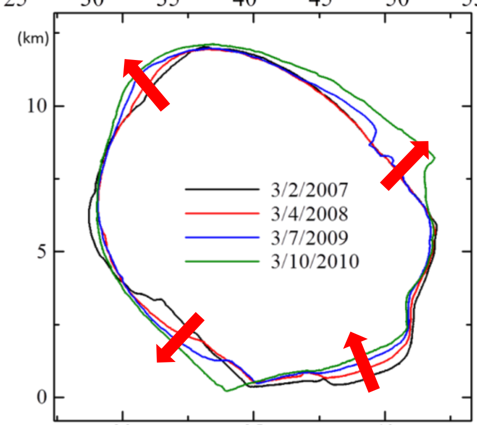
Shoreline extraction based on local XY coordinates



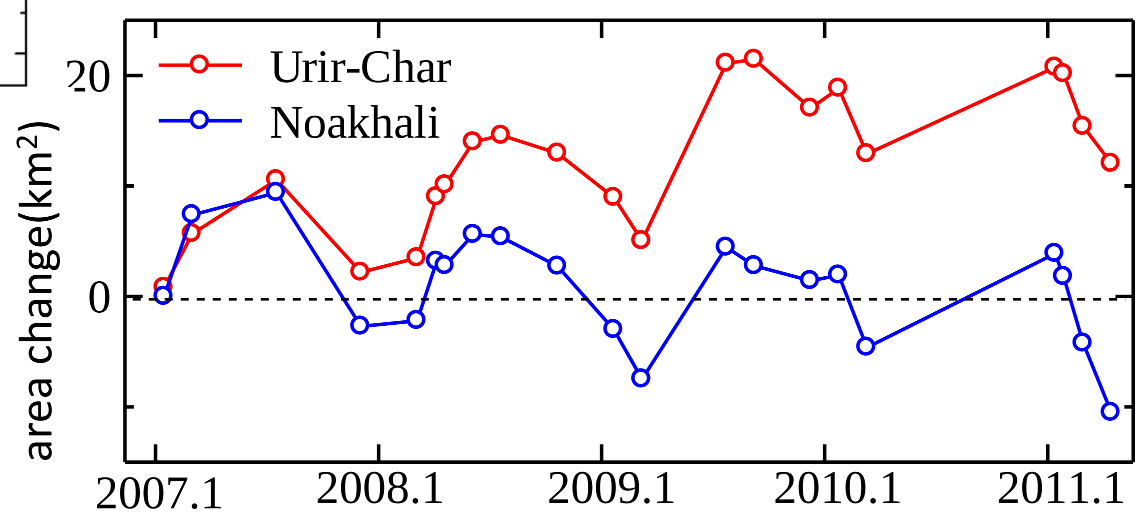


Extracted shoreline change





Time-series of observed land area



Challenge of this study

- Observed shoreline change includes the change due to morphology change (erosion-accretion) and temporal shoreline change due to the difference in tidal water level when the PALSAR image was recorded.
- Many parts of the target site has tidal flat and nearshore coast with very mild slopes.
- Primary factors of the actual morphology change should be: (i) wind waves; (ii) tidal currents; (iii) sediment discharges from the river.
- Most of these hydrodynamic data is not obtained around the target site.

→ This study combines numerical model and available data for estimations of time-varying hydrodynamic conditions.

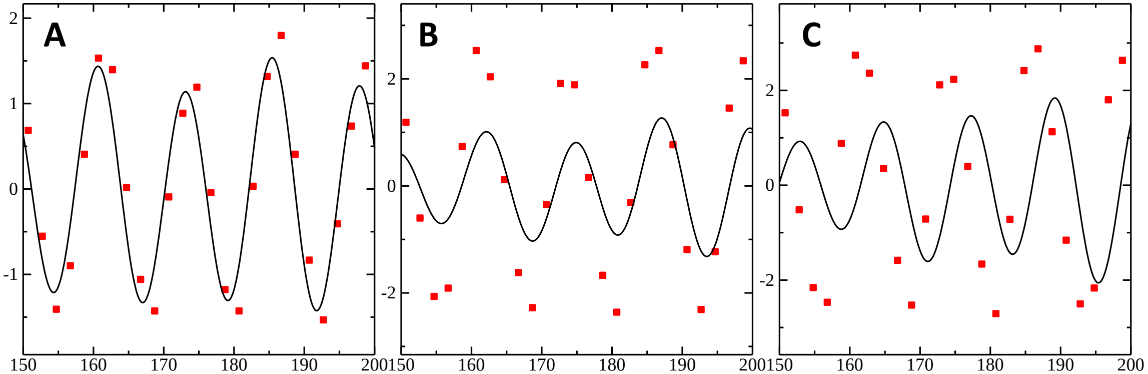
Tidal flat around Urir Char

Typical shoreline of Noakhali and Urir-Char

Tide

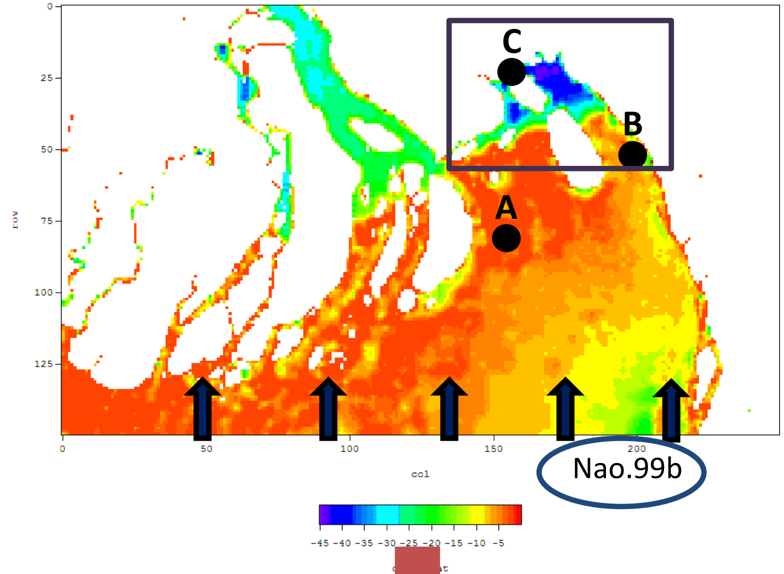
Ocean tide model + non-linear shallow water model

Ocean tide model(Nao.99b)
-Assimilated to TOPEX/POSEIDON and provides accurate predictions of tides at arbitrary locations in the open ocean
-Influence of nearshore bathymetry is not accounted for and thus loses accuracy near the shore

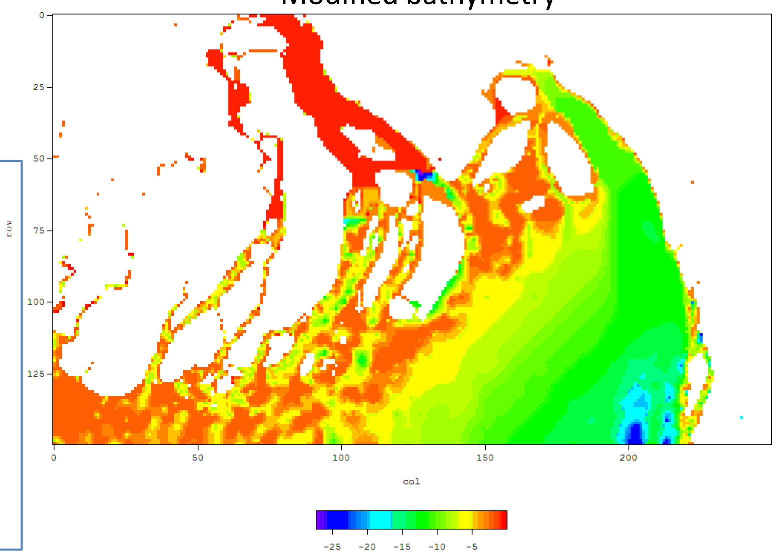


comparisons of Nao.99b (black line) and measured (red dot) tides at st. A, B and C

Bathymetry: GEBCO(original)



Modified bathymetry



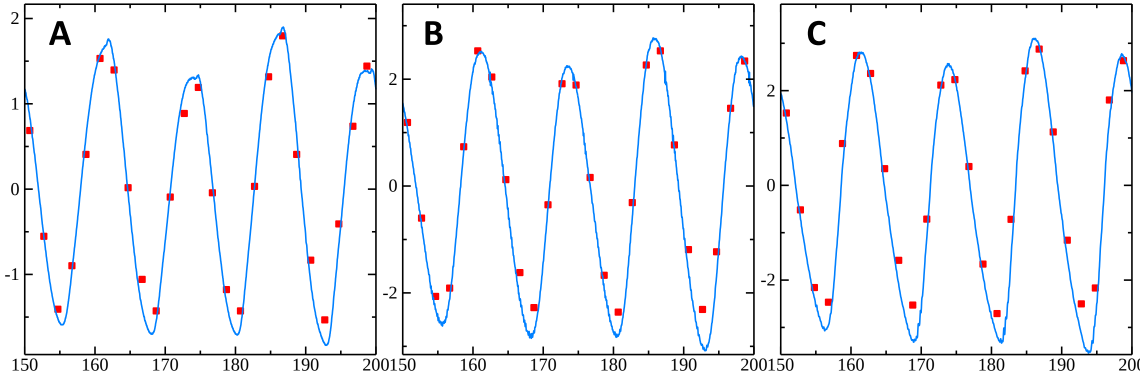
➡ Use Nao.99b to specify offshore BC and compute tidal response by non-linear wave model

Bathymetry:
Based on General Bathymetric Chart of Oceans (GEBCO). Modifications were needed for nearshore water depth and land-ocean boundaries.

- PALSAR and J-SER were used to update the shorelines.
- Unrealistic nearshore water depth was corrected so that it yields better predictive skills of tides. Modified bathymetry was consistent with previously measured bathymetry.

Tide

Ocean tide model + non-linear shallow water model



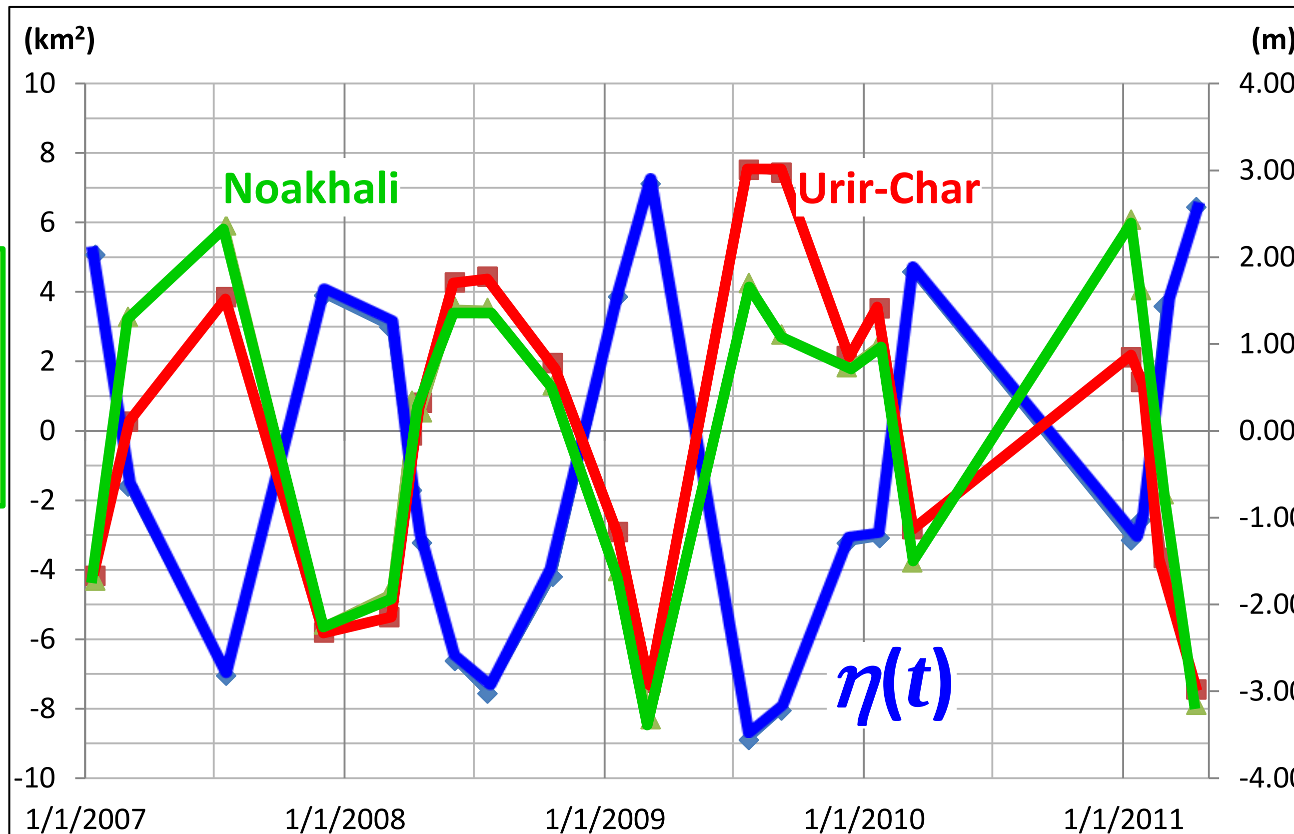
red dot : meas.
blue line : present model

Excellent predictive skills of nearshore tides around the target site!

Predicted tide when PALSAR was recorded

predicted tide, $\eta(t)$

Area change after removal of linear regression trend
Urir-Char
Noakhali



"Seasonal" trend of tide in recording timing of PALSAR

Tide and area change has strong correlations.

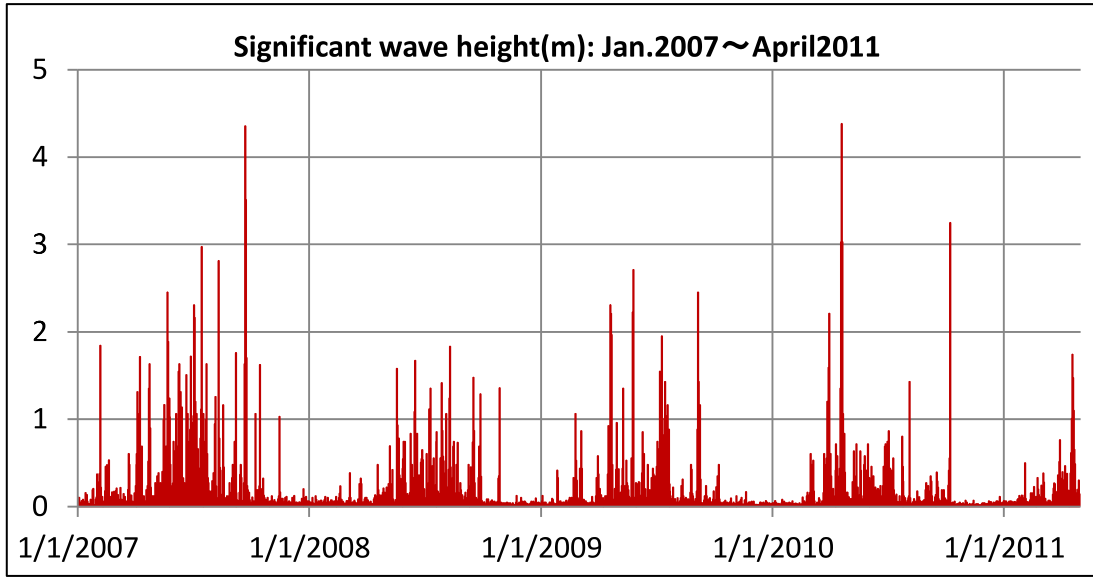
wave and river discharge

SMB curve

$$\frac{gH_{1/3}}{U_{10}^2} = 0.30\left[1-\left\{1+0.004\left(\frac{gF}{U_{10}^2}\right)^{1/2}\right\}^{-2}\right]$$

$$\frac{gT_{1/3}}{2\pi U_{10}} = 1.37\left[1-\left\{1+0.008\left(\frac{gF}{U_{10}^2}\right)^{1/3}\right\}^{-5}\right]$$

SMB curves were used for estimations of wave properties based on the wind data.



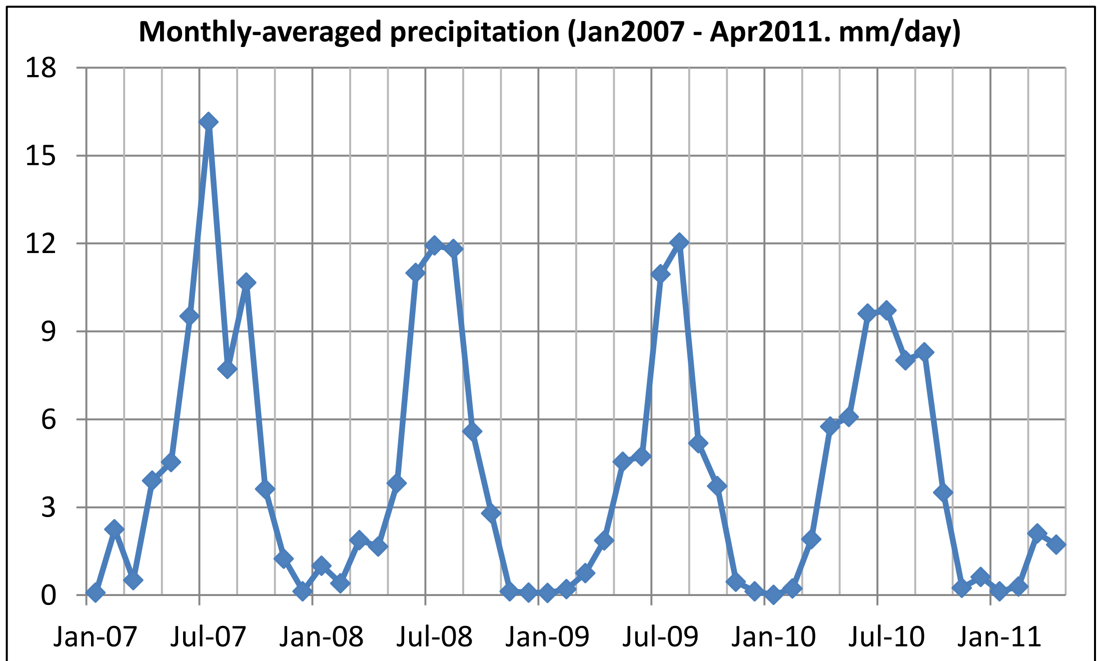
River Discharge

-River discharge was related to the total precipitation over the catchment area of the Meghna River.

- CMAP monthly-averaged precipitation was used.

-There should be a time lag among: (i) instantaneous precipitation; (ii) resulting discharge at the river mouth and (iii) sedimentation around the target site.

- Time lag was accounted for as one of calibration parameters of the following fitting curves of the observed area change.



Impact of various factors on observed area change

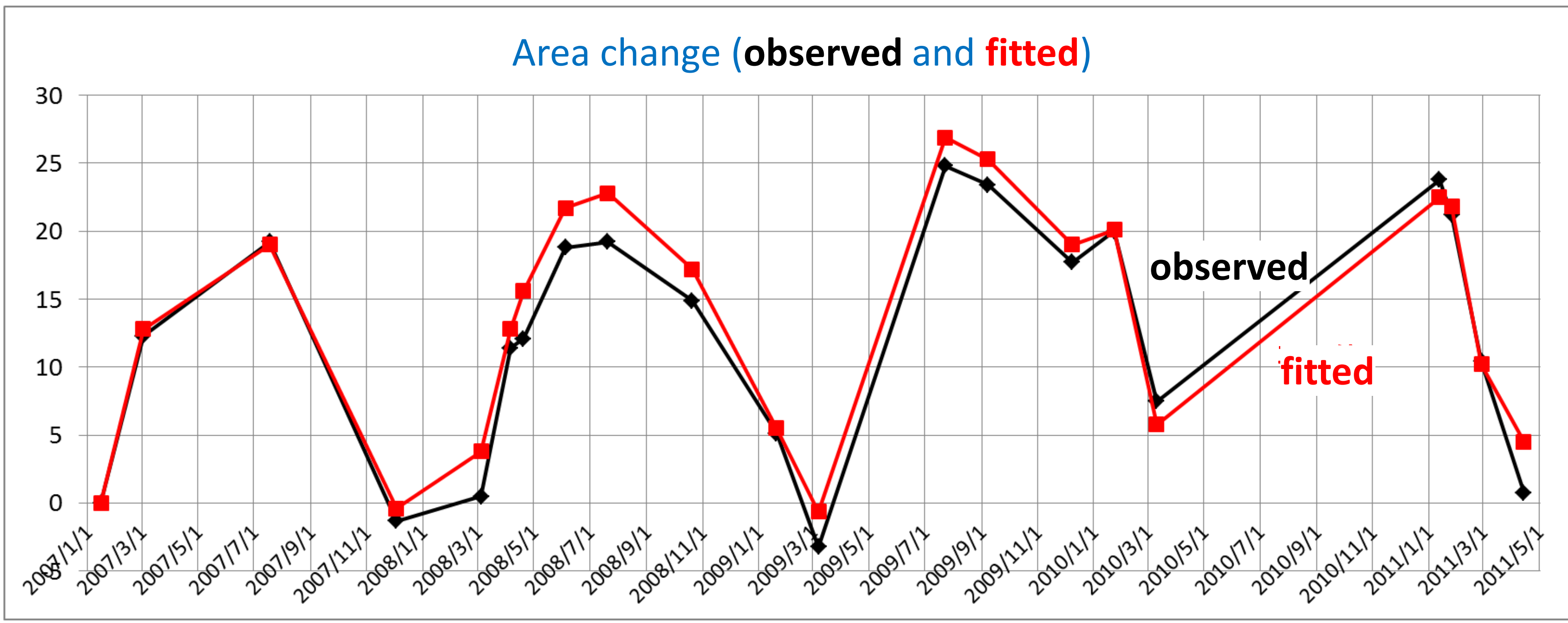
Fitting curve of the observed area change was proposed as functions of estimated parameters.

$$A(t) = A_0 + a_1\eta(t) + a_2\int_0^t Q(t-\varphi)dt + a_3\int_0^t H\,(t)dt + a_4\int_0^t H^2(t)dt$$

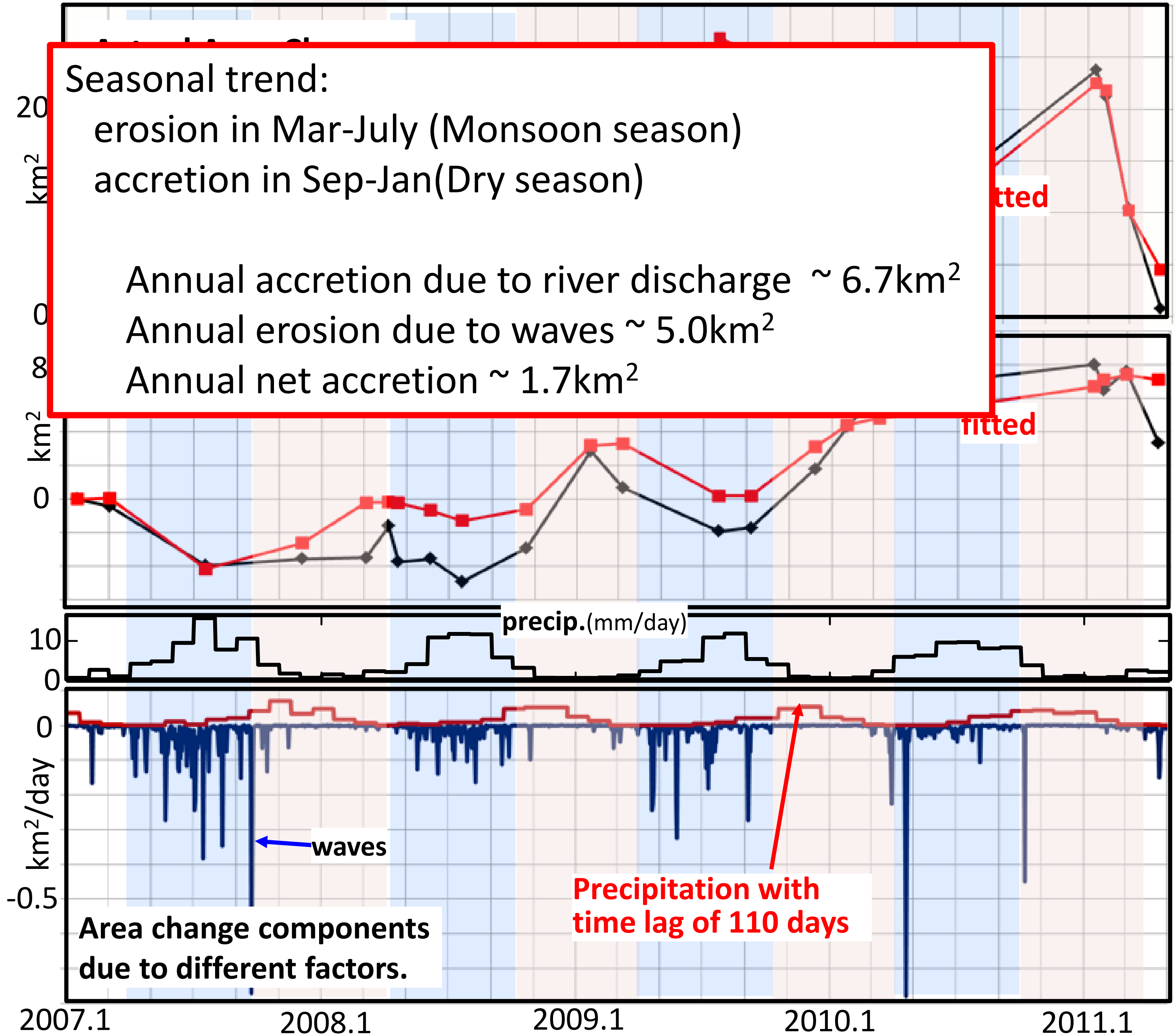
A(t): Area change of Urir-Char and Noakhali

$\eta(t)$: tide, Q(t): precipitation, φ: time lag, H(t): wave height

- Least-square method was applied for estimation of the best-fit parameters of a1 ~ a4.
- Time lag, φ was fixed in each analysis but the values of φ was altered within 80< φ(days) <120.
- Time lag of φ = 110days yielded the best fit curve.



Impacts of waves and precipitations on observed area change



Seasonal trend:

erosion in Mar-July (Monsoon season)

accretion in Sep-Jan(Dry season)

Annual accretion due to river discharge ~ 6.7km^2

Annual erosion due to waves ~ 5.0km^2

Annual net accretion ~ 1.7km^2

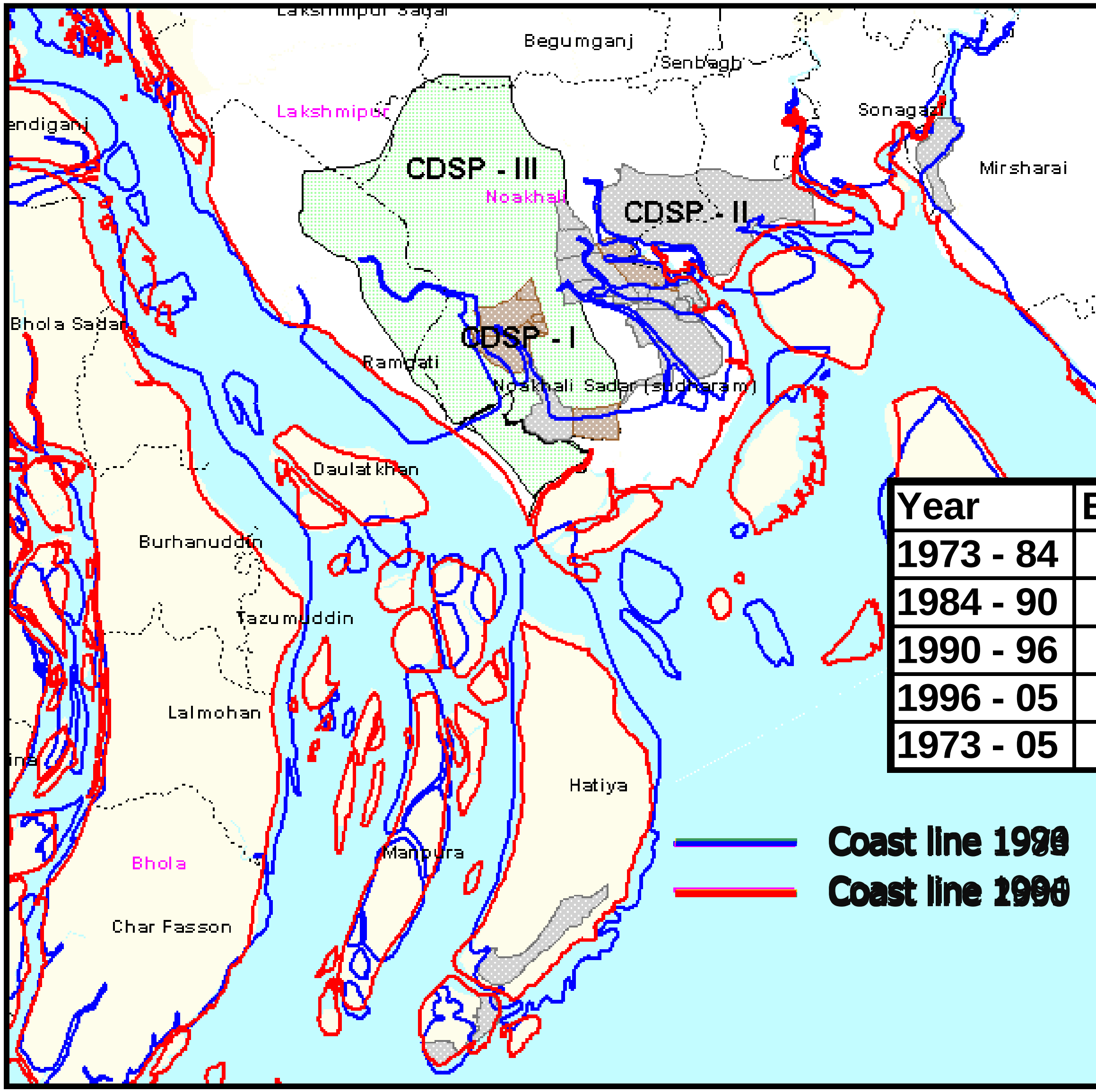
Conclusions and plans in 2013

1. Seasonal shoreline changes were quantitatively extracted from PALSAR.
2. Instantaneous tide has significant impact on the shoreline change and the newly applied numerical model was found to yield reasonable predictions of time-varying tides around target site.
3. Observed area change was fitted as functions of tide, wave and precipitations.
4. Trend of erosion due to waves and accretion due to precipitations were observed.
5. Time lag between accretion and precipitation was about 110 days.

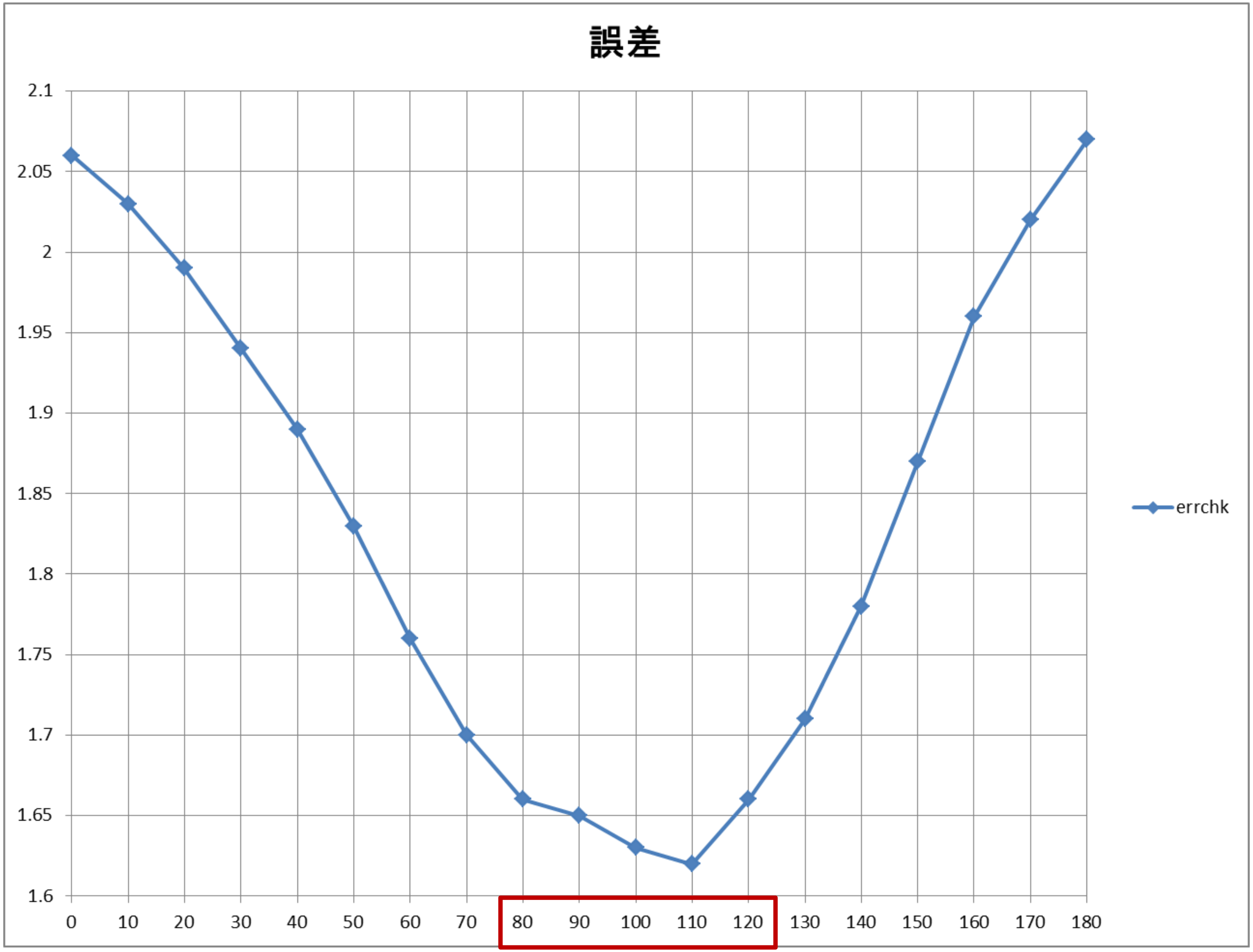
1. Applications of flux model for estimations of sediment budget around the target site.
2. Analysis of the impact of cross dams around the target site.
3. Field survey and workshops in Bangladesh (in October).
4. Stake holder meeting during Spring of 2014.


Thank you for your attention
07 12 2012

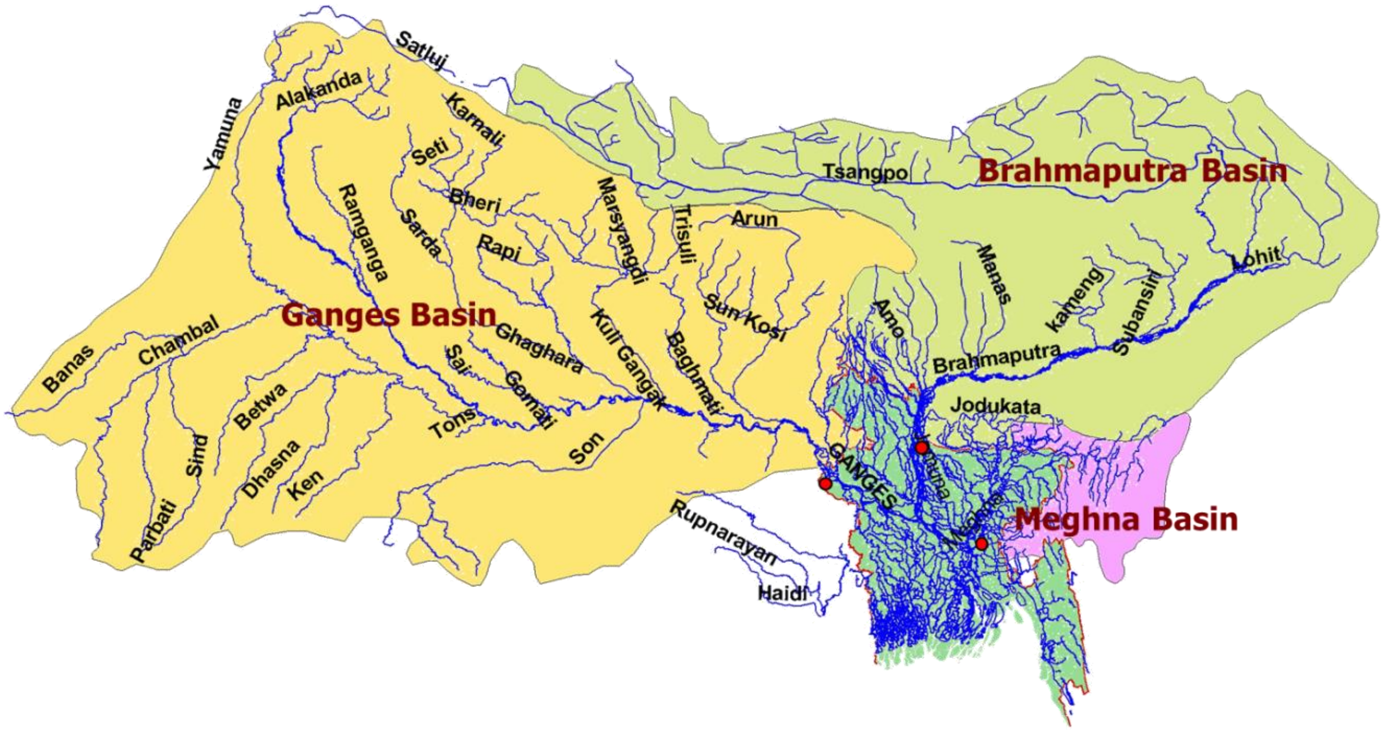
Dynamic Change of Coastline in the Meghna Estuary



Year	Erosion (SqKm)	Accretion (SqKm)
1973 - 84	692	859
1984 - 90	569	616
1990 - 96	347	609
1996 - 05	604	724
1973 - 05	1039	1792



誤差
2.1
2.05
2
1.95
1.9
1.85
1.8
1.75
1.7
1.65
1.6
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
errchk


Ganges Basin
Brahmaputra Basin
Meghna Basin
Satluj
Alakanda
Yamuna
Karnali
Seti
Bheri
Ramganga
Sarda
Rapi
Marsyangdi
Trisuli
Arun
Tsangpo
Manas
Lohit
kameng
Subansiri
Amo
Brahmaputra
Jodukata
Sun Kosi
Baghmati
Kuli Gangak
Ghaghara
Sai
Gomati
Tons
Son
Chambal
Banas
Betwa
Sind
Dhasna
Ken
Parbati
GANGES
Rupnarayan
Haidi