Modeling sediment transport to the Ganga-Brahmaputra-Meghna Delta

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1. Introduction

This study uses a climate-driven hydrological and sediment transport model to quantify changes of sediment delivery rates to the Ganga-Brahmaputra-Meghna Delta (GBM). We investigate effects of sub-catchment delineation and potential infrastructure.

India is currently engaging in a project that will transfer 174 Bm^3/y of water from the mountainous water-rich north to the water-scarce south and west. Short-term benefits include increased water resources for irrigation and decreased flooding in the east during the monsoon season. Long-term consequences may include decreased sedimentation to the GBM Delta which can contribute to delta subsidence. India's National River Linking Project may have future political, economic, and social impacts on the neighboring country of Bangladesh.

2. Study Area

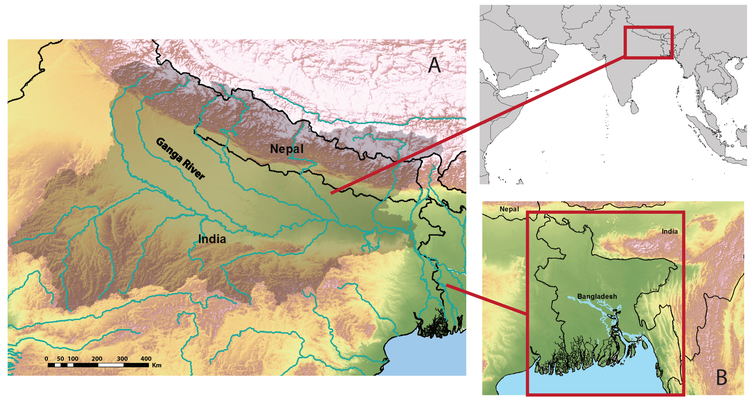


Figure 1: A) India's Ganga Basin (shaded) **B)** Country of Bangladesh located in Ganga-Brahmaputra-Meghna Delta.

- Ganga River originates from the Gangorti glaciers near the Tibet-Indian border in the Himalayas
- Flows south-east across India and Bangladesh and discharges into Bay of Bengal
- Ganga River is 2500 km long with drainage area of ~ 980,000 km^2
- Range of climates: semi-arid, tropical wet and dry, and alpine
- The GBM delta has a population of ~144 million people
- The GBM delta has an aggradation rate of ~1-2 cm/y while global mean sea level is rising at 0.03 cm/y

3. Sub-catchment Delineation

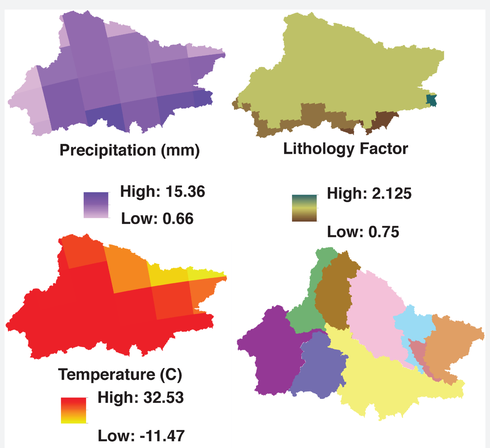
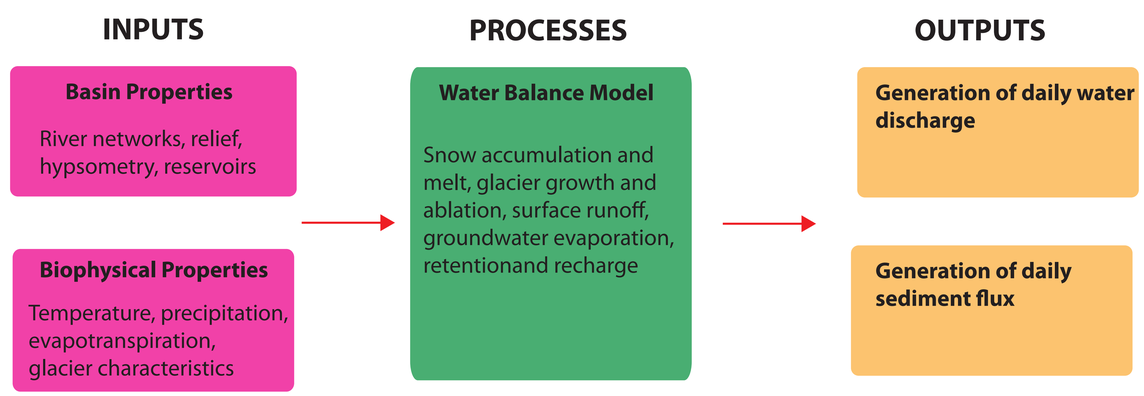


Figure 3: A) Overall basin homogeneity in temperature (ºC), precipitation (mm), and lithology factor. **B)** Sub-catchment delineations based on basin characteristics

4. HydroTrend v.3.0



5. Results: Simulated Water Discharge and Sediment Load

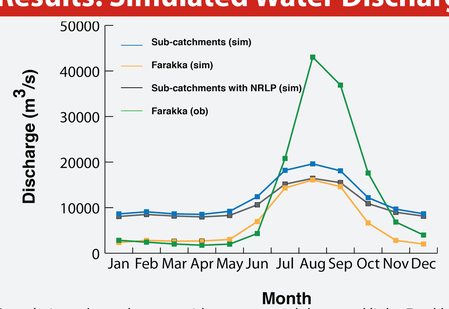


Figure 4A: Cumulative sub-catchments without proposed dams and links, Farakka, cumulative sub-catchments with proposed dams and links, and observed Farakka Barrage discharge for the period of 1982-2012

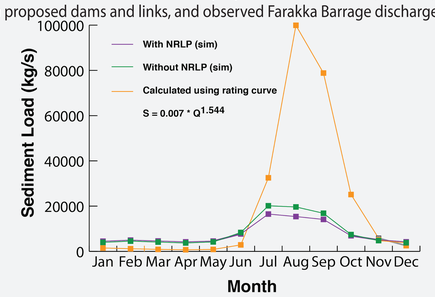


Figure 4B: Simulated sediment fluxes with NRLP (solid green) and without NRLP (solid orange line) for the period of 1982-2012. Rating curve of $S = 0.007 * Q^{1.544}$ used to calculate suspended sediment flux based on observed Farakka Barrage discharge.

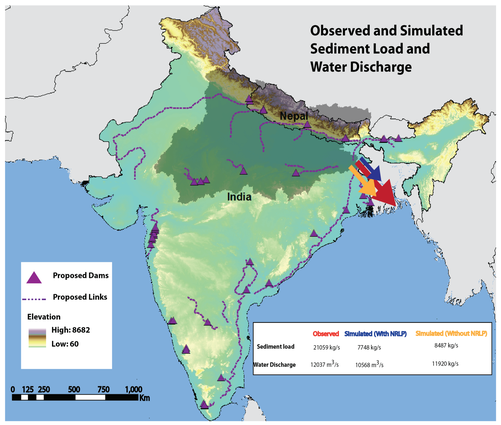


Figure 5: Simulated sediment load and water discharge (Blue) as affected by NRLP proposed dams and links in comparison to observed values (Red). NRLP proposed structures decrease water discharge and sediment load by 11% and 63% respectively

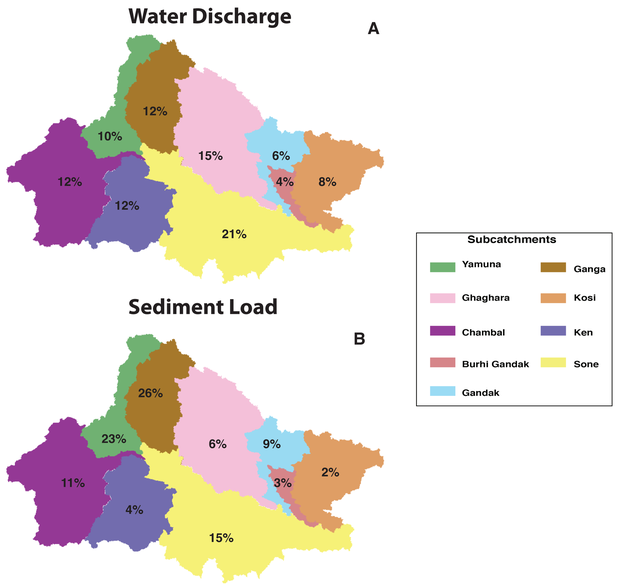


Figure 6: Source of Ganga River (Yamuna and Ganga sub-catchments) display higher contribution to cumulative sediment load. Higher precipitation in Sone sub-catchment results in higher

Discussion

- Basin averaged values impact the accuracy of water discharge and sediment flux values in large-scale basins
- Result of heterogeneous basin characteristics (Fig 3A,3B,3C)
- HydroTrend overpredicts water discharge during the winter months but underpredicts water discharge during the monsoon season (Fig 4A)
- 60% difference between simulated sediment flux and calculated sediment flux is due to underprediction of water discharge during the monsoon season (Fig 4B)
- There is more accuracy when the basin is delineated into sub-catchments because the model simulates more water during the monsoon season in comparison to total-basin simulations allowing for closer values to observed data (Fig 4A)

Key Findings

- Results show that sub-catchment delineation in large-scale heterogenous basins provide more accurate water discharge and sediment load values
- HydroTrend underpredicts water discharge during monsoonal events
- NRLP structures decrease sediment delivery by 9%
- Future work should look at how combined sedimentation by Ganga, Brahmaputra, Meghna Rivers to the GBM is afffected by NRLP

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