Sustainable management of sedimentation risks in coastal rivers in southwest Bangladesh

Story of change: Key findings & emerging impacts

Summary

- 1.3 million people in coastal Bangladesh are affected by severe waterlogging due to riverbed sedimentation
- Work on sedimentation and river morphology has provided new insights onto waterlogging processes, and how these can be addressed in the short and longer term
- Recommendations include increasing freshwater flows by restoring upstream river-river and river-floodplain connectivity and reducing "repeated dredging" of the same area
- Increased flow and revised dredging practices have reduced waterlogging and increased agricultural productivity in Bhadabah
- The Bangladesh Water Development Board continues to partner with the Bangladesh University of Engineering and Technology to understand the river system and develop long-term system-wide solutions to the problem

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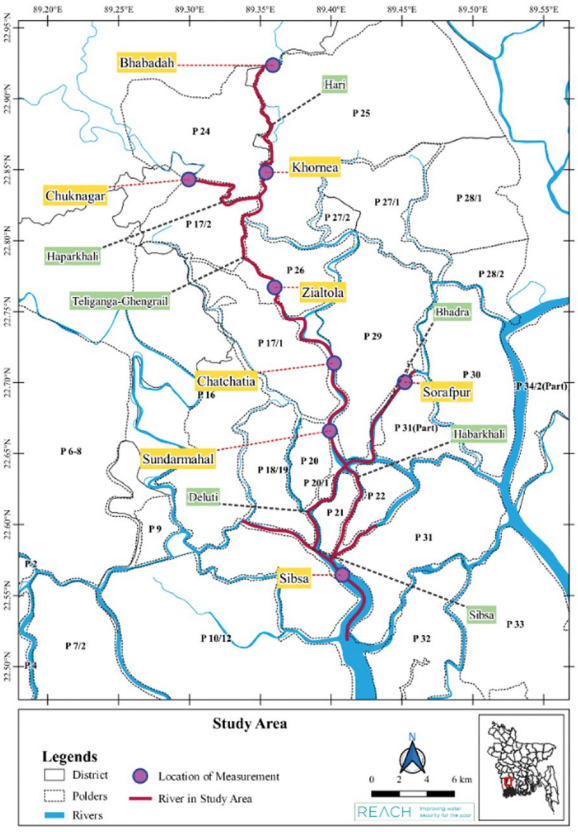
Figure 1: Study area. In the coastal zone, many polders (enclosed coastal embankments) have been constructed, affecting geomorphological and hydrological processes.



Introduction

Bangladesh's Delta Plan 2100 identified river sedimentation and associated water-logging as one of Coastal Bangladesh's main water security issues. 1.3 million people in Coastal Bangladesh have been impacted by severe waterlogging since the early 1990s, restricting key livelihood activities, reducing agricultural yields, and affecting drinking water quality.

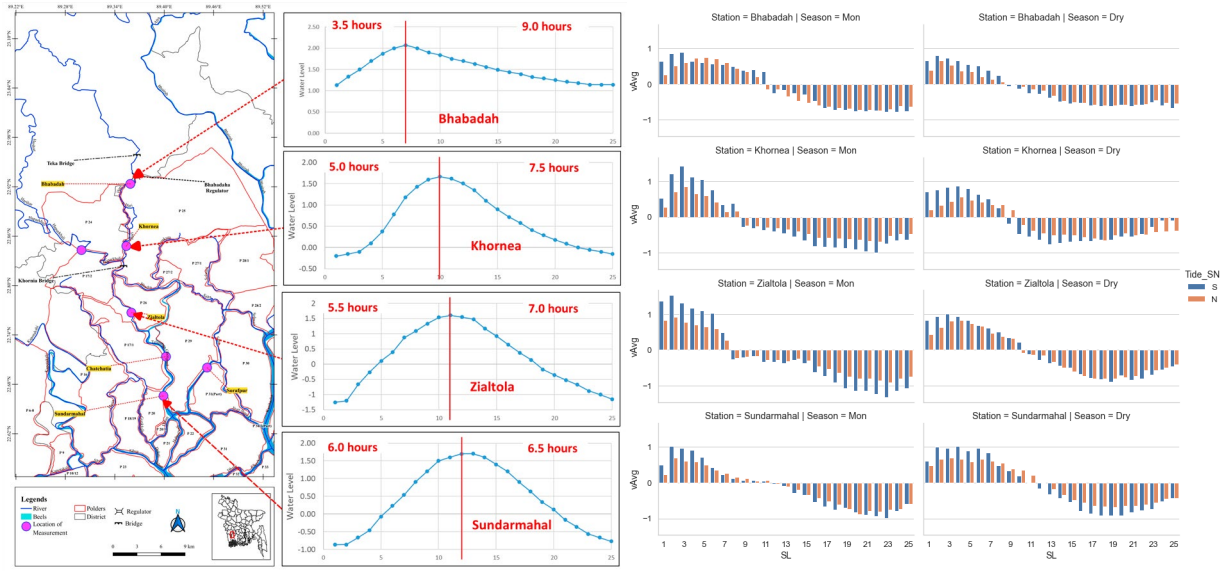
The Bangladesh Water Development Board (BWDB) has led a number of initiatives to reduce waterlogging, including Tidal River Management (TRM), and dredging of rivers in critical areas. However, failure to fully understand sedimentation processes and the lack of systematic hydro- and morpho-dynamic data along the coastal rivers of southwest Bangladesh have posed major barriers to effective management.

Figure 2: Field data measurement

As part of the REACH programme, a research team from the Bangladesh University of Engineering and Technology and the Bangladesh Water Development Board (BWDB) have characterized hydrodynamic processes and sediment transport dynamics in the area, with potential implications for different types of interventions.

An extensive hydraulic and morpho-dynamic research campaign gathered data on water level, velocity, discharge, and sediment concentration along a 70 km reach of the Hari-Ghengrail-Sibsa river system from Bhabadah in the north to Garkhali in the south, at different spatial and temporal (seasonal, spring-neap and diurnal) scales (Figures 1 and 2). The Bhabadha region has historically suffered extreme waterlogging affecting crop production, transportation and economic development. Poorer households relying on agriculture for their livelihoods often live in the areas most prone to water-logging.

Figure 3: Formation of tidal asymmetry along the Pussur estuary



REACH programme research on sedimentation and river morphology has provided new insights into waterlogging processes and how these can be addressed in the short and longer term. The findings have supported BWDB in developing more effective interventions to improve coastal resilience in the region, with early but promising results in reducing waterlogging through sediment flushing.

Key findings

Sedimentation risk in rivers is driven by a range of critical factors, in particular the spatio-temporal variation of tidal and sediment dynamics.

Sedimentation risks increase when seawater enters the river system over a short period of time and remains in the river for a long period before flowing back to the sea. This provides more opportunity for sediments in the water column to deposit onto the riverbed.

In scientific terms, tidal asymmetry (the ratio between the flood tide period and the ebb tide period), which gradually increases in the upstream direction and usually reaches a peak during spring tides, is a major phenomenon in river system of southwest Bangladesh.

Sediments are usually deposited onto riverbeds at and near places where tidal asymmetry is high (Figure 3).

The higher the tidal asymmetry, the longer the water remains stagnant when the flood tide turns.

The spatiotemporal variation of sediment dynamics determines the locations of critical sedimentation zones, which will largely determine the location and type of interventions (Figure 4).

The REACH research identified that sediment concentration increases in the upstream direction and peaks ten kilometres downstream of Bhabadah.

Sedimentation levels are almost three time higher in the dry season, as compared to the wet season, even though the sediment concentration entering this reach of the river during the monsoon season is three and a half times higher than during the dry season. That is because:

- the difference between the flood and ebb tide durations is more prominent during the dry season;

- there is less resuspension of sediments and hence less flushing of sediments, i.e., less sediments are carried back downstream due to lower freshwater flow from upstream. Flushing of sediments is also hampered in the monsoon, albeit to a lesser degree compared to the dry season, because of non-functioning river-floodplain connectivity.

Scientific impacts

Major scientific impacts of this work include:

- Improved understanding of riverbed sedimentation risk and associated waterlogging issues in the southwest coastal area - and of the interventions required to address sedimentation.
- Generation of an extensive hydraulic and morpho-dynamic database of an important coastal river system.

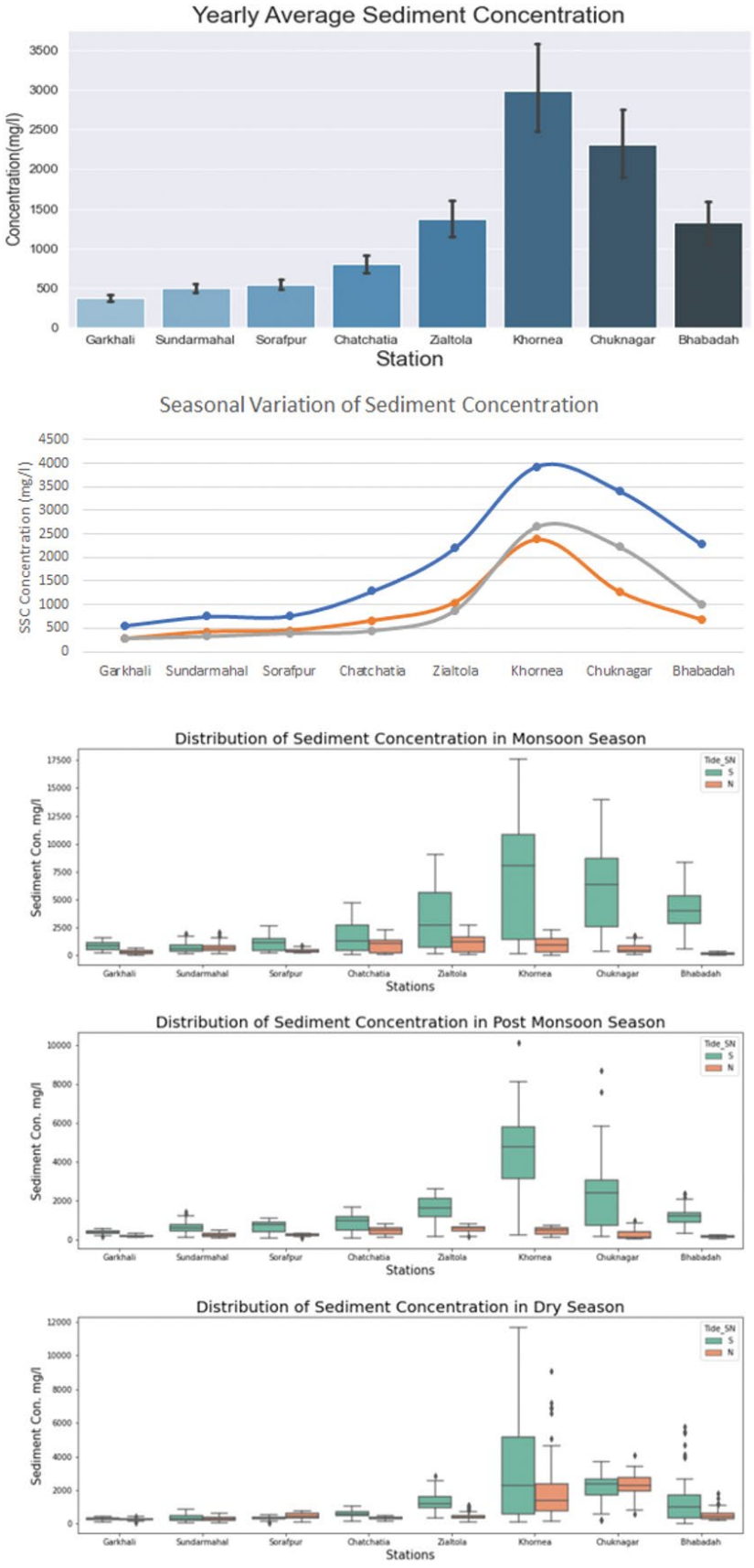
The findings presented above have direct implications for interventions implemented or planned to solve riverbed sedimentation risks and associated waterlogging problems in the polders. Recommendations regarding interventions include:

- Excavating sediments from the riverbed along the critical zone (from Khornea to Bhabadah), as carried out by BWDB on a regular basis, cannot be sustainable because of the unique hydro- and morpho-dynamics of the system. Excavation over only a few kilometres of length creates a pond-like feature in the riverbed, promoting sedimentation and filling up quickly.
- Instead of confining interventions to specific sedimentation risk zones, a system-wide approach is necessary for an effective and sustainable solution. Interventions need to be considered with a view to reducing critical sedimentation zones and distributing the sedimentation over a wider reach, thus minimizing the sedimentation problem for the whole system.
- Increasing freshwater flow from upstream, via restoring upstream river-river and river-floodplain connectivity, during the dry and monsoon seasons will help ease the problem in the short-term by allowing enhanced flushing of the sediments.

REACH seminar at BWDB, July 2021.

Special session on sediment: Source to sink. Organized by REACH in IPWE 2023 conference, January 2023.

Figure 4: Spatiotemporal variation of sediment concentration



- For a long-term solution, instead of focusing on dredging in the critical sedimentation zones and implementing TRM in areas with insufficient sediment transport and deposition capacity onto the waterbodies within the polders, a system-wide understanding (through numerical simulation followed by validation) is required to examine the implementation potential and sustainability of different solutions such as regulators, closures, TRM and dredging (**this is now an on-going activity under** the REACH programme).

Policy and practice impact

This research has been led by REACH PhD scholar Mr. Md. Saif Uddin at the Bangladesh University of Engineering and Technology, under the supervision Professor Rezaur Raman. In 2020, he was promoted to Superintending Engineer and in-charge of the Design Circle-8 (Southwest Region) of BWDB.

In his new role he has been able to discuss short and long-term management options with the BWDB Chief Engineer and Director General. The BWDB has acknowledged the research findings, which were published in their November 2022 newsletter, and has made the following interventions:

- They have stopped 'repeated dredging' of the river in the critical sedimentation area, and instead have intervened to increase flow in the system by using a number of pumps drawing water from upstream areas.
- They have taken up priority projects to improve river-river and river-floodplain connectivity. The research is now also informing the design and planning of polder rehabilitation works.

These changes in practices have already been associated with reduced waterlogging and increased agricultural productivity, with farmers in Bhabadah harvesting 30 million metric tons of rice by cultivating 2100 thousand hectares of land over the past year.

Authorities claim that if these changes are implemented in all waterbodies, 2600 hectares of land will be cultivable.

BWDB continues to collaborate with BUET in understanding the system-wide behaviour of the coastal rivers, with a goal of finding long-term, system-wide solutions. BUET's long-term strategic partnership with BWDB has been strengthened through the REACH programme.

Dr. Uddin has also presented his work at the following events:

- Workshop on Risk of Sedimentation in Tidal Rivers of Southwest Bangladesh at the Bangladesh Water Development Board, (BWDB) addressing a key gap in the Bangladesh Delta Plan 2100. The workshop included practitioners from BWDB, WARPO (Water Resource Planning Organisation) and more, with Mr. Kabir Bin Anwar, senior secretary of the Ministry of Water Resources, as the chief guest.
- Keynote at a Special Session on Sediment (Source to Sink) in the 11th International Perspective on Water Resources and the Environment (IPWE-2023) Conference, co-organized by IWFM, BUET and the Environment and Water Resources Institute (EWRI) of the American Society of Civil Engineers (ASCE) (4-6 January 2023).

Outputs

Uddin, M.S., Rahman, R. and Salehin, M. 2022. Sustainable management of sedimentation risks in coastal rivers in southwest Bangladesh: Findings from REACH Khulna Observatory. REACH Policy Brief.

Uddin, M.S. 2018. REACH Early-Career Researcher Feature: Understanding water-logging issues in coastal Bangladesh.

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Story of change themes

- Groundwater
- Land
- Coasts
- Gender
- Schools
- Services
- Health
- Climate
- Cities
- Basins