Chapter 2
Tidal River Management in the Southwest Region of Bangladesh Using Mathematical Modelling

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ABSTRACT

In the low-lying coastal areas of Bangladesh, a series of embankments, also known as polders, were built in the 1960s to protect these areas from tidal floods. However, these polders have adversely impacted social and coastal ecosystems by causing excessive siltation in rivers. To solve this problem, an initiative known as tidal river management (TRM) has been implemented since the 1990s. With this initiative, polder embankments are periodically cut in selected locations to allow the sediment-laden water to reach the polders, allowing sedimentation to occur. Subsequently, these cuts are closed. The authors assessed the suitability of the TRM initiative for the polder in East Beel Kuksia. The research was carried out using coupled 1D and 2D hydrodynamic models, built with the software tool MIKE11 and coupled with MIKE21. Erosion was calculated based on information on bed shear stress from the hydrodynamic model and erosional critical shear stress. With the implementation of TRM, the drainage capacity of the rivers downstream of the studied polder consequently increased.

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INTRODUCTION

The coastal region of Bangladesh is enriched with vast natural resources and is home to 36.8 million people who depend on these resources for their livelihoods (Islam and Gnauck, 2017). The estuarine environment of the coastal region, which is composed of mangroves, salt marshes, seagrass, and seaweeds, serves as the feeding, breeding and nursery grounds for a variety of fish, birds, and animals. The ecology of the area depends on the upland freshwater and downstream tidal flows (Khan et al., 2011). Due to the presence of flat topography, the region is highly vulnerable to coastal flooding and sea level rise (Rose and Bhaskaran, 2016). Sixty percent of the Sundarbans, the world's largest mangrove forest, which has an area of 1 million hectares, is in the Bangladesh delta, and the remainder lies in India (Rahman and Salehin, 2013). The Meghna Estuary is the habitat of 53 fish species and the largest estuarine ecosystem in coastal Bangladesh (Hossain et al., 2012b).

The southwest coastal region of Bangladesh is characterized by numerous morphologically active tidal rivers, which comprise the main drainage network of the low-altitude Land and low-lying water bodies (known as beels) in the region (**Figure 1**). The main climatic disasters that occur are due to cyclones, storm surges, riverine floods, tidal floods, and salinity intrusions (Mondal et al., 2006). Moreover, the increasing population, in addition to environmental hazards, puts pressure on Land and water resources (Brammer, 2014). To increase the amount of arable land free from waterlogging, the Bangladesh Water Development Board took up the Coastal Embankment Project (CEP) to build a series of embankments during the 1960s and early 1970s that enclosed low-lying coastal areas which led to the formation of the so-called polders. After the development of the polders, area inhabitants enjoyed the benefits for many years. Sedimentation in rivers and waterlogging on adjoining lands are major concerns in the entire southwestern region. The entire river system of the southwest region is vulnerable to excessive sedimentation due to silts that come in with the high coastal tides, especially during the dry season. Despite increasing food production, polders in the southwest coastal region of Bangladesh have failed to deliver the intended results due to a lack of understanding of the regional hydro-morphology as well as improper maintenance and a lack of consideration of the social and cultural roles of the area inhabitants (Nowreen et al., 2016). The river morphology of the area is characterized by the active deposition of sediment and silt, which is carried into the area by high tides. The presence of the polders has aggravated the sedimentation process in rivers. This occurred as the polders restricted tidal flows to low-lying areas and prevented the deposition of sediment in these low-lying areas. As a result, the silt carried upstream by tides was gradually deposited on riverbeds and near the outlets of drainage sluices. On the other hand, the freshwater flow from upstream during the dry season has reduced over the past few decades, which has expedited the siltation process. Because of this continuing sedimentation process over the years, many of the rivers/channels/canals in the area lost their conveyance, which led to severe drainage congestion in the polders.

In the late 1980s, the problem of drainage congestion became very acute in the coastal districts of Khulna and Jessore. Dredging of rivers to solve the sedimentation and drainage congestion problems was not effective since the backfilling rate was quite significant, which led to 100% siltation within 3 to 4 months. Siltation in rivers due to *polderization* caused the rise of riverbeds, and polders became waterlogged (Talchabhadel et al., 2016). The lack of silt removal from canals, reduction of freshwater supply to canals and encroachment of canals are the main causes of waterlogging (Alam et al., 2017). Waterlogging problems in the coastal region resulted in damage to crops, which eventually affected the livelihoods of the coastal people (Alam et al., 2017). The implementation of existing management

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