



Original Articles

Sustainability impacts of tidal river management: Towards a conceptual framework

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ABSTRACT

The Southwest Coastal people of Bangladesh have introduced Tidal River Management (TRM) as an environmentally acceptable water resource management practice based on their indigenous knowledge of water logging of low lying coastal land. TRM helps to address problems resulting from different anthropogenic and structural development activities, and it has been successful in helping coastal communities to adapt to climate change and rising sea level vulnerability by forming new land in Tidal Basins. Hence, it is essential to measure sustainability impacts of TRM from the environmental, socio-economic and institutional perspectives. Therefore, firstly, the study identifies sustainability indicators of TRM considering ecosystem services and secondly, develops an inclusive conceptual framework to understand the important impacts of each indicator at various spatial and temporal scales. The conceptual framework is followed by the construction of a Sustainability Index of Tidal River Management (SITRM). It has advantages over the Ramsar Convention framework (2007) and the World Meteorological Organization (WMO) framework (2012) to measure water sustainability as it includes a sustainable model to project future vulnerability of the community, river and Tidal Basin, emphasizing on climate change issues. It also involves trade-offs analysis, livelihood analysis and SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis for a complete impact assessment to enable decision-makers to focus on those services most likely to be of risks and weaknesses or opportunities and strengths for the sustainability of TRM. Moreover, the framework is a useful guide for policymakers in identifying the sustainability impacts of TRM so that they can choose best coping strategies for coastal people to effectively deal with adverse effects of water-logging and undesired climatic events as well as environmental and socio-economic changes in coastal areas.

1. Introduction

1.1. What is tidal river management (TRM)?

TRM is one of the forms of water management, developed from indigenous practices of coastal community people, to create ecologically sustainable, water-logged free environment in the Southwest region of Bangladesh (Tutu, 2005; Kibria, 2011; Paul et al., 2013). TRM introduces a temporary cross-dam (the dam is opened in rainy season

and closed in summer and winter for every year during TRM) to the upper stream and joins the tidal River with a *Beel*¹ which is called a Tidal Basin where the sediment-carrying tidal water comes from the sea through the lower stream two times in a day (Sterrett, 2011). The *Beel* should have to require 600–800 hectares of land or more/less depend on tidal prism for perfectly operation of TRM, and it must be surrounded by an embankment (village protection dam) in an enclosed TRM. The tidal water enters during high tide and over time, it deposits sediment to aggregate in the *Beel* (Fig. 1). Besides, during low tide, the

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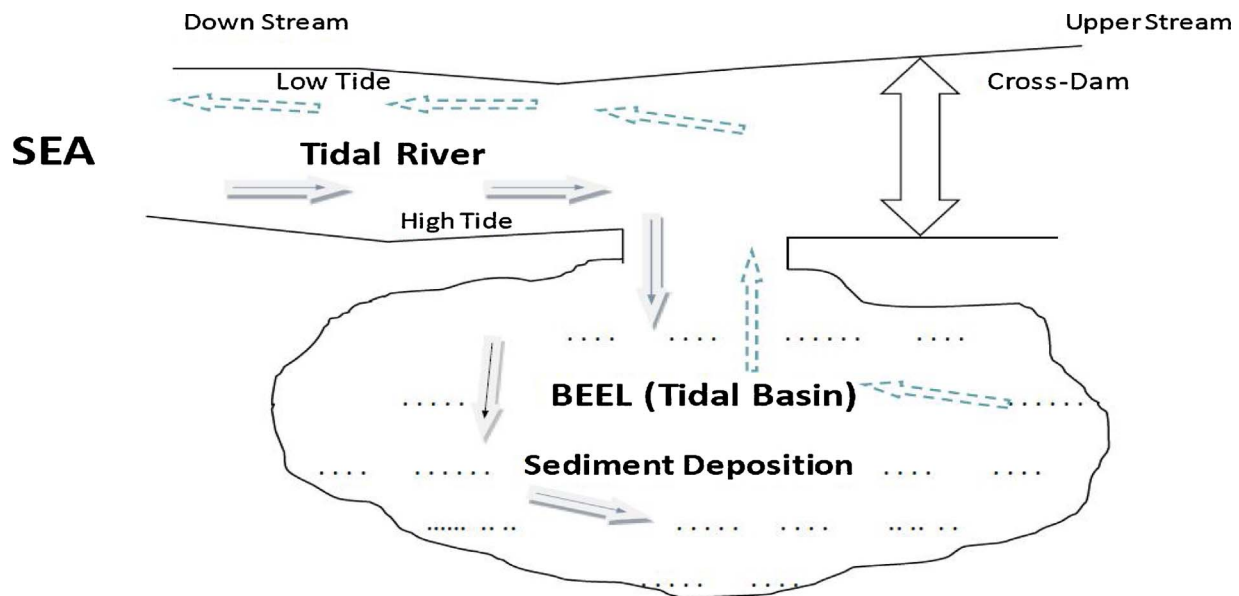


Fig. 1. The TRM (Adapted from Paul et al., 2013).

outgoing strong current water erodes the river bed and intensifies the drainage capacity (Sterrett, 2011; Kibria, 2011; Paul et al., 2013). In this process, community people of the TRM *Beel* and its surrounding *Beels* which are occupied by River Basin are freed from water-logging due to enlarging drainage capacity of the river. During TRM, the Tidal Basin is not suitable for practicing any agriculture but its surrounding 20–25 *Beels* go under agricultural production properly with favorable ecological conditions like TRM in *Beel Bhaina* and TRM in *East Beel Khukshia* (De Die, 2013; Gain et al., 2017). The people of TRM *Beel* mainly depend on natural fisheries of this tidal wetland. It is in fact a soft engineering process of natural water management. Eventually, the expecting results will come by the strong participation of stakeholders and consensus among them with a great deal of sacrificing their swamped agricultural land (*Beel*) for a specific period (3–5 years or more) depending on how much water comes into the *Beel* (Ullah and Rahman, 2002; Gain et al., 2017) and demanding new land formation. Moreover, TRM has been implemented by the government agency, Bangladesh Water Development Board (BWDB) since 2002 with the support of stakeholders, NGOs and line department of GOs in several *Beels* and Rivers of the coastal region (De Die, 2013).

Importance of TRM has been captured in terms of increased drainage capacity of river with sediment management (Khadim et al., 2013), removing water-logging from *Beel* (Tutu, 2005; Paul et al., 2013; Jakarya et al., 2016), raising land from 1 to 2 m with sediment deposition in *Beel* and combating climate change induced sea level rise (Sterrett, 2011; Paul et al., 2013; Jakarya et al., 2016), extending agriculture and fisheries and eventual increase in livelihood options (Tutu, 2005; Khadim et al., 2013), growing biodiversity with strengthening environment and finally, improving socio-economic conditions of the coastal people (CEGIS, 2003a,b; Paul et al., 2013). The above mentioned benefits of TRM may be outweighed by several economic and environmental problems coupled with institutional complexities. These are riverbank erosion, increase in salinity in varying degree, disruption of local road networks, inundation of agricultural land, weak coordination between government and community people, complexity of compensation process or low rate of compensation/subsidy to land owners by government (Paul et al., 2013; Gain et al., 2017). As positive outcome of TRM become visible even after several years, non-acceptance of TRM may trigger conflicts among different stakeholders to carry it on from one *Beel* to another *Beel* (Kibria, 2011; De Die, 2013; Gain et al., 2017).

Among 35 *Beels* in the South west region of Bangladesh (Khulna-

Jessore-Satkhira districts), TRM has already been implemented in 12 *Beels* (Gain et al., 2017). TRM has gradually been accepted and acknowledged as an effective tool to remove water-logging problem by the local communities and afterwards by public bodies. TRM, as the indigenous engineering technique has few advantages over other techniques, such as excavating of the river bed and resultant increase in drainage capacity. This process entails the removal of sediment from the river beds by excavator machine and deposits those sediments on the bank of the river and makes the river narrow. Besides, the deposited sediments by excavating again fall into the river through runoff in a rainy season. Therefore, this technique is not eco-friendly and cost effective and is more time consuming to manage the huge drainage congestion in the study area. Unlike excavating, TRM is more eco-friendly, cost effective (it does not need any large scale engineering tool), less time consuming (and perfectly deposits sediments in the Tidal Basin with protecting runoff) as it can increase drainage capacity to a long distance up to 20 km of the lower stream at a single intervention from the place of TRM implementation.

Reflecting back to the history of TRM implementation, it is noticed that TRM was initially a community driven approach, later being taken over and managed by BWDB. For example, the Tidal Basin- *Beel Dakatia* (1991–1994) and *Beel Vayenia* (1997–2001) were selected for TRM operation by local community; the Tidal Basin- *Beel Kaderia* (2002–2004) and *East Beel Khukshia* (2006–2013) were initiated and managed by BWDB. Available evidence and recent literature only shed light on the success and failure of TRM implementation in the floodplain area. Assessing the sustainability impact of TRM is of prime importance due to its acceptance as a dynamic and context-specific process (Gain et al., 2017). Major challenge in this case is the absence of a well-defined and recognized set of indicators, which may provide a benchmark to measure the derived and potential benefits of TRM. The present study tries to overcome this barrier by developing a conceptual framework of Sustainability Index of Tidal River Management (SITRM).

Firstly, this paper summarizes the standards for identifying the primary set of components and indicators for measuring the impact of TRM. After that, on the basis of identification, a detailed justification for choosing each component and indicator is presented. The study has involved four important water sustainability indices including Water Poverty Index (WPI), Canadian Water Sustainability Index (CWSI), Watershed Sustainability Index (WSI) and West Java Water Sustainability Index (WJWSI) that were effectively recognized in the field of water resources management (Plummer et al., 2012; Vollmer

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