



Review

Existing strategies for managing mangrove dominated muddy coasts: Knowledge gaps and recommendations



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ABSTRACT

Mangrove dominated muddy coasts (MDMCs) throughout the world have been made vulnerable to erosion by human induced and natural factors. Meanwhile, their management has not been clearly identified in the literature. This study uses a comprehensive literature review to describe strategies, specifically designed to manage MDMCs for effectiveness, and provides recommendations for sustainable management of these coasts. Only a small percentage of previous studies deals with real-world management of MDMCs. Two approaches that are specifically designed to manage MDMCs are science-based approaches and local knowledge-based approaches. Both approaches, each having advantages, have had limited success in effectively managing MDMCs, with a low level of local involvement, and a minimal integration of the different knowledge systems. MDMCs and their management should be distinguished from other types of coasts to avoid possible confusion in the literature. Mechanisms are needed for integrating different knowledge systems for effectively managing MDMCs. These mechanisms should promote a high level of integration of local and scientific knowledge, local ownership, and sustainability.

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1. Introduction

Mangrove dominated muddy coasts (MDMCs) throughout the

world have been made vulnerable to erosion by human induced and natural factors. A mangrove dominated muddy coast is a sub-category of global muddy coasts (Wang et al., 2002). In Southeast Asia, muddy coasts in general and MDMCs in particular have been over-exploited for agriculture, aquaculture, industry and settlements (Han, 2002; Primavera, 2006; Ramesh et al., 2011). This over-exploitation has caused adverse direct and indirect impacts (Valiela

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et al., 2001; Bhandari and Nakamura, 2004; Thampanya et al., 2006; Ramesh et al., 2011; Siple and Donahue, 2013; Anthony et al., 2014). These impacts include loss of important coastal habitats, breeding grounds for both marine and terrestrial animals, vegetation, and erosion (Han, 2002; Thampanya et al., 2006; Ramesh et al., 2011).

The world's coastlines, including MDMCs, have become increasingly vulnerable to climate change, especially sea level rise (Intergovernmental Panel on Climate Change (IPCC) 2007; IPCC 2010a,b). Coastal erosion can be caused by sea level rise (Asian Development Bank, 2010). Erosion of MDMCs in places has caused significant economic loss, ecological damage, and social unrest (Ramesh et al., 2011).

Effective management strategies for MDMCs have not been clearly distinguished in the literature. The world's coastlines, including MDMCs, have been managed with similar broad strategies: administrative coastal management and planning techniques, technical approaches, and integrated coastal zone management techniques (Kay and Alder, 2005). A review of the literature shows that the majority of the relevant papers use general terms 'coast' or 'coastal' rather than specific terms 'muddy coastal' or 'mangrove dominated muddy coastal'.

Taking into consideration adverse effects on MDMCs, uncertainties about climate change and its possible effects on these coasts, and their management status as presented in the literature, this study aims to review strategies, specifically designed to manage MDMCs, and considers the requirements to progress toward more effective management of these coasts.

2. Methods

Both published materials and technical reports were critically reviewed to understand existing practices for the management of MDMCs. The review was undertaken using articles downloaded from ScienceDirect Journals and SpringerLink Contemporary (1997 – Present). ScienceDirect Journals and SpringerLink Contemporary (1997 – Present) are two comprehensive online journal archives that provide access to millions of research documents. Additional relevant books/proceedings and technical reports, which have not been published online, were also reviewed.

Two terms used to search the literature were "muddy coast management" and "management of mangrove dominated muddy coasts". The authors limited the review to papers and reports that specifically discussed MDMCs rather than including coasts generally. The authors acknowledge that papers might have been missed by using these specific search terms. However, the limited degree of the search allowed for providing more specific recommendations for practice.

On ScienceDirect Journals, a search was limited using the filters provided by ScienceDirect Journal, which were mangrove, coastal, and estuary. As a result, 112 out of 690 hits were used in this review. Another search was undertaken on SpringerLink Contemporary (1997 – Present) using English, environmental sciences, forestry pollution, remediation, nature conservation, biodiversity, and environmental management, which were the filters provided by SpringerLink Contemporary. The search resulted in 21 articles, 9 of which were used. In addition, proceedings and technical reports, which discussed issues specifically related to muddy coasts or practically managing MDMCs, were reviewed. Likewise, projects or programs, which the authors were involved in or familiar with, were also included in this review.

All hits, relevant proceedings, and relevant technical reports were classified using thematic analysis (Ayres, 2008) in relation to content and method. Two classifications, science-based approaches and local knowledge-based approaches, were critically reviewed to

evaluate their effectiveness, and provide recommendations for effective management of MDMCs in the future (Fig. 1).

3. Results

3.1. Overview of the literature in relation to the management of MDMCs

The literature review resulted in 290 articles from two sources: hard copies of technical reports and books and professionally published digital articles. The majority of the empirical studies were laboratory based or inventory driven. Approximately 26% were studies which dealt with real-world management of MDMCs (Fig. 2).

3.2. Science-based approaches

Science-based approaches were subdivided into four main themes including specialist knowledge tools, establishment of coastal mangrove protected areas, integrated muddy coastline management, and strategic policies for managing MDMCs.

a) Specialist knowledge tools

Specialist knowledge tools use conceptual, analytical and numerical models, and inventory methods e.g. mapping, data acquisition techniques using high quality imageries to understand muddy coastal fine sediment dynamics, muddy coastal processes, and resource management in environments of MDMCs. In muddy coastal fine sediment dynamics, studies of hydrodynamics, sediment budgets, primary production, nutrient fluxes, and mineralisation, sediment transport, and sediment geochemistry included Nguyen et al. (2000); Xue et al. (2010); Chant (2011); Asian Development Bank (2011); Stokes and Harris (2015); Todd et al. (2014); Unverricht et al. (2014); Loisel et al. (2014); Nardin et al. (2016); and Hu et al. (2016). Representative studies of biochemical factors influencing deposition and erosion, natural biological processes and controls were Delafontaine et al. (2000); Wang et al. (2000); Simenstad and Yanagi (2011); Nguyen et al. (2013); Karditsa et al. (2014); Brunier et al. (2014); and Sun et al. (2015). Leading studies of effects of human and natural factors on muddy coasts (resource management) included Han et al. (2000); Wang et al. (2000); Bao and Healy (2002); Anthony et al. (2014); Van et al. (2015); and Mackenzie et al. (2016) (Fig. 3).

The tools are laboratory based or inventory driven. Despite being useful tools for specialists working in the field of muddy coast management and management of MDMCs, they may not encourage community participation, or integrate traditional knowledge, and culture. There are also challenges in determining how the data and information from these tools are retrieved and processed, and integrated into decision making processes (Stojanovic et al., 2010).

b) Establishment of coastal mangrove protected areas

Coastal mangrove protected areas have been established to protect mangroves and muddy coasts from erosion and other climate change effects (Schmitt and Duke, 2015), or to legally protect a range of coastal and marine biodiversity such as mangroves, corals, sea grasses, and benthic organisms (IUCN, 2008). These protected areas are normally classified as 'no take' zones or strictly protected areas, with interventions in these protected areas needing permission from the relevant government agencies. Examples include the Kien Giang Coastal Mangrove Protected Area and Special Use Forests (Kien Giang Provincial People's Committee (Kien Giang PPC) 2005; Kien Giang PPC, 2011) and the Ben Tre

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