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Ecosystem-based coastal zone management: A comprehensive assessment of coastal ecosystems in the Yangtze Estuary coastal zone



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ABSTRACT

The comprehensive assessment of ecosystems is highlighted as one of the most important parts of ecosystem-based management (EBM) that must be addressed. In this paper, taking Chongming Dongtan coastal zone in the Yangtze Estuary as a case study, an example of the EBM approach to the assessment of ecosystem quality and degradation response to human impacts was presented. The spatio-temporal dynamics of the coastal ecosystems in the study area during the period 1990–2008 were analysed. The three main ecosystem types in the region: the natural wetland ecosystem, the agricultural ecosystem and the suburban ecosystem, were assessed for the period 2000–2008 through the application of an index of ecosystem degradation (EDI). The results indicated that large-scale reclamation and the invasion of an exotic plant *Spartina alterniflora* had threatened the ecosystem health of the natural wetland and caused its degradation. The production structure in agriculture needed to be improved and the amount of chemical fertilizer and pesticide application needed to be reduced, because they caused the degradation in the agricultural ecosystem. The area and population of the suburban ecosystem had grown substantially, which could not keep a pace with a healthy working and living environment. Based on these results, management strategies were proposed to minimize and/or reduce future degradation and impact. The methodology developed in this study is applicable elsewhere where coastal zones are under pressure.

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1. Introduction

Coastal zones are vital economic hubs in terms of settlement, industry, agriculture, trade and tourism, as well as being of great environmental significance. At the same time, human activities exert pressure on coastal ecosystems and cause coastal ecosystem degeneration and consequent decreases in ecosystem services (MA, 2005; Nobre and Ferreira, 2009; Nobre et al., 2010). With the aim of promoting coastal zone management in a sustainable way, ecosystem-based management (EBM) is an emerging scientific consensus that is complementary to the concept of Integrated Coastal Zone Management (ICZM) (Nobre et al., 2010). EBM is an integrated approach that considers the entire ecosystem, including

humans (POC, 2003; USCOP, 2004; McLeod et al., 2005; Leslie and McLeod, 2007). It is of great value in understanding the causal relationships between environmental and socio-economic systems and the cumulative impacts of the range of human activities found in coastal ecosystems, and the management of coastal resources and biodiversity (POC, 2003; USCOP, 2004; Nobre et al., 2010).

In recent years, many studies on a working framework, methodologies and implementation of EBM for coastal and marine zones have been completed (Christensen et al., 1996; Rauscher et al., 2000; Belfiore et al., 2006; Leslie and McLeod, 2007; Douvere and Ehler, 2011; Katsanevakis et al., 2011). The working framework of EBM for coastal zones can be summarized as follows: (1) Delineation of the management boundary, including both determination of the management area in the coastal zone and identification of the range and types of ecosystems and related stakeholders; (2) Setting of management goals based on management needs and functions of coastal ecosystems; (3) Assessment of coastal ecosystems, involving a comprehensive assessment of coastal ecosystems, which should be carried out at a range of temporal and spatial scales; (4) Formulation of management strategies and actions

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based on comprehensive assessment and analysis of varying scenarios for coastal ecosystems; (5) Implementation of coastal zone EBM actions through engagement of stakeholders; (6) Monitoring and assessment of coastal zone EBM processes, focussing on the evaluation of the effectiveness of the EBM plan; (7) Promoting adaptive adjustment, including changes that are likely to improve the likelihood of successful management in future.

The comprehensive assessment of coastal ecosystems is highlighted as one of the most important parts of coastal EBM that must be addressed with some urgency (Jeftic, 1996; Nobre et al., 2010). Comprehensive assessment of coastal ecosystems includes structure analysis, function evaluation and the assessment of ecosystem health or degeneration. Such comprehensive assessment is a prerequisite of the formulation of effective management strategies for sustainable coastal ecosystems (Jeftic, 1996; Crowder and Norse, 2008; Fan et al., 2010; Katsanevakis et al., 2011).

Located adjacent to the Yangtze Delta, the coastal zone of Shanghai provides an opportunity for an illustrative case study, given that Shanghai is now the fastest developing region of all major Chinese cities. The population increased from 5.2 million in 1949, to more than 20 million in 2010, which has brought great challenges for the achievement and maintenance of sustainable social-economic development, while at the same time protecting and conserving healthy coastal ecosystems (Zhang, 2004). As an island county of Shanghai located in the Yangtze Estuary, Chongming Island is facing great challenges for the fast socio-economic development and urbanization after the construction of the bridge and tunnel connecting the island to the mainland of the metropolis Shanghai in 2010. While the Shanghai municipal government has recently formulated a master plan for Chongming Eco-Island Development, with priority on environment and ecology (Zhang et al., 2012). As an emerging paradigm, the EBM approach could greatly facilitate the implementation of Chongming Eco-Island Development. However, to adopt an EBM approach and develop integrative tools that promote coastal zone management in

a sustainable way, is at an early stage in the Chinese coastal zone, and there are only a few such research (Nobre et al., 2010; Fan et al., 2010). In order to contribute to this development, we show how to adopt an EBM approach to the coastal zone in the region. Taking the Chongming Dongtan coastal zone in the suburban of Shanghai as a study area, the specific objectives of this work were to: (1) analyse the spatio-temporal dynamics of the ecosystems in the Chongming Dongtan coastal zone; (2) develop a set of ecosystem degradation indicators and assess quantitatively the spatio-temporal degradation in these ecosystems; (3) propose management strategies that minimize and/or reduce future degradation and impact.

2. Study area and methods

2.1. Study area

The study area is located at the eastern end of Chongming Island in the Yangtze Estuary, between $31^{\circ}25' \sim 31^{\circ}38'N$, $121^{\circ}46' \sim 122^{\circ}06'E$ (Fig. 1). The total area covers 476 km², including a national nature reserve (253 km²) at the eastern boundary, three state farms and a Chenjia township (223 km²) with 21 villages and population of ca. 60 000 (SBCC, 2008). Chongming Dongtan coastal zone has extensive natural wetlands characterized by bare mudflats and shallow sea water with an elevation of less than 2 m, the saltmarshes of *Scirpus mariqueter* community with an elevation between 2.0 and 2.9 m, *Phragmites australis* and *Spartina alterniflora* communities above an elevation 2.9 m. These wetlands are at the middle range of the eastern bird migratory routes of the Asia and Pacific region and listed in the Chinese Protected Wetlands Report in 1992, and were designated as internationally important under the Ramsar Wetlands Convention in 2001. A municipal nature reserve was established after a large-scale reclamation in 1998 and became a national nature reserve in 2005 (Zhang et al., 2012).

Chongming Dongtan has a northern sub-tropical monsoon climate, with an average annual temperature of 15.3 °C, summer

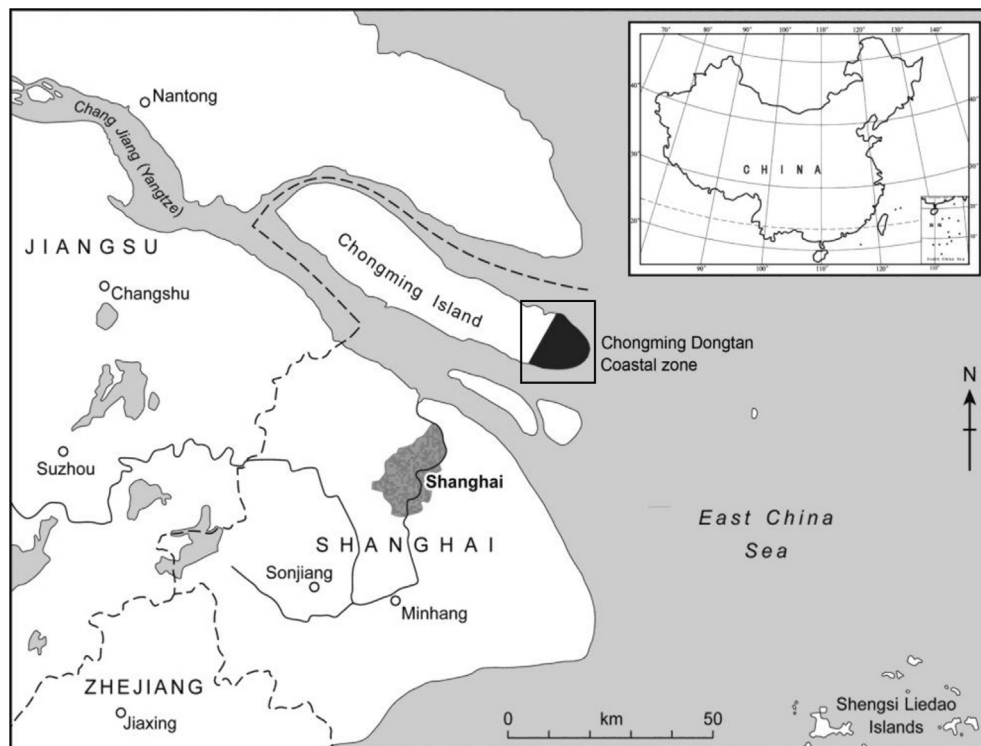


Fig. 1. The location of the Chongming Dongtan coastal zone study area.

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