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An approach of habitat degradation assessment for characterization on coastal habitat conservation tendency

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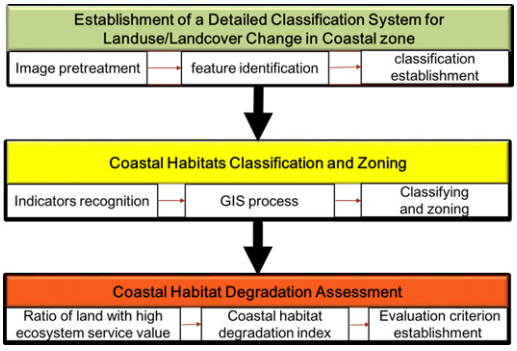
HIGHLIGHTS

- An integrated framework of coastal habitat degradation assessment was established.
- Coastal habitat classifying and zoning was achieved according to geographic characteristic.
- The evaluation criterion of habitat degradation through internal comparison was established.
- Coastal habitat degradation index could distinguish the human disturbances intensity.

GRAPHICAL ABSTRACT



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ABSTRACT

Coastal zones are population and economy highly intensity regions all over the world, and coastal habitat supports the sustainable development of human society. The accurate assessment of coastal habitat degradation is the essential prerequisite for coastal zone protection. In this study, an integrated framework of coastal habitat degradation assessment including landuse classification, habitat classifying and zoning, evaluation criterion of coastal habitat degradation and coastal habitat degradation index has been established for better regional coastal habitat assessment. Through establishment of detailed three-class landuse classification, the fine landscape change is revealed, the evaluation criterion of coastal habitat degradation through internal comparison based on the results of habitat classifying and zoning could indicate the levels of habitat degradation and distinguish the intensity of human disturbances in different habitat subareas under the same habitat classification. Finally, the results of coastal habitat degradation assessment could be achieved through coastal habitat degradation index (CHI). A case study of the framework is carried out in the Circum-Bohai-Sea-Coast, China, and the main results show the following: (1) The accuracy of all land use classes are above 90%, which indicates a satisfactory accuracy for the classification map. (2) The Circum-Bohai-Sea-Coast is divided into 3 kinds of habitats and 5 subareas. (3) In the five subareas of the Circum-Bohai-Sea-Coast, the levels of coastal habitat degradation own significant difference. The whole Circum-Bohai-Sea-Coast generally is in a worse state according to area weighting of each habitat subarea. This assessment framework of coastal habitat degradation would characterize the landuse change trend, realize better coastal habitat degradation assessment, reveal the habitat conservation tendency and distinguish intensity of human disturbances. Furthermore, it would support for accurate coastal zone protection measures for the specific coastal area.

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1. Introduction

The world's 2/3 major cities and 60% population are located in coastal areas, and a portion of economic activities are concentrated in these cities, and it induces great pressure on the coastal environment (Lotze et al., 2006; Jackson et al., 2001). Coastal habitat supports the sustainable development of human society (Hopkins et al., 2012; Rönnbäck et al., 2002; Fujita et al., 2013; Visbeck et al., 2014). The coastal zone, especially the land with high ecosystems service, such as wetland land, not only provides the ecosystem goods, but also provide a range of ecosystem functions (Liquete et al., 2013a; Liquete et al., 2013b; Luisetti et al., 2014; Guerry et al., 2012). The excessive human activities, such as sea reclamation, aquaculture, and industrial pollution discharge into the sea have obviously reduced natural areas and threaten remaining habitat by causing increased runoff of sediment, nutrient and chemical pollutants to these areas (King, 2013; Xue et al., 2004). Habitat Destruction directly induces the loss of ecosystems service value (Coverdale et al., 2013). Diminished and degraded habitats are less available to support healthy populations of wildlife and marine organisms. Additionally, they are less able to perform the economic, environmental and aesthetic functions that coastal populations depend on for their livelihoods and protection (Wolanski, 2006).

It is necessary to strengthen coastal habitat protection for human-natural sustainable development, and achievement of accurate knowledge about the coastal habitat change and assessment of coastal habitat degradation is the essential prerequisite of coastal zone protection. Normally, there are many indicators to evaluate degree of costal habitat degradation (CHD) such as land use/land cover change (LUCC), pollution load towards the sea and biodiversity loss (Meng, 2005). LUCC is the most intuitive index for CHD assessment which directly represents the process of human disturbance and economic activities including urban sprawl, sea reclamation and mariculture, subsequently the following results of human activities such as seawater pollution, loss in ecosystem service function can be revealed through the index of LUCC. Caims et al. classified the degraded ecosystems into two kinds according to the degradation degree: irreversible ecosystem and reversible ecosystems (Cairns et al., 1977). Hobbs et al. put forwards a thresholds theory that it exists four stable states in the ecosystems including undegraded state, partially degraded and highly degraded and thought the accurate assessment of habitat degradation is the precondition of ecosystems restoration (Hobbs and Norton, 1996). John developed an evaluation index system for wetland degradation based on landscape change, named Landscape Development Intensity Index (EPA, 2004).

Obviously, the accurate revelation of LUCC process is the prerequisite for coastal habitat degradation assessment, and the detailed land use classification is the basis for the exact revelation of LUCC process, particularly in the coastal regions, along with the development of economic development and urbanization, the great changes in the spatial pattern of LUCC have taken place, including the construction land reclamation and aquaculture land expansion (Yang et al., 2011; Li and Damen, 2010), these two activities are the main human activities in the coastline, which has produced an enormous economic effect for human, however the rapid modification of the coastal land use pattern also considered to be the most important threats to the sustainability of the coastal ecosystem (Al-Jamali et al., 2011). The classifying and zoning of coastal zone has been attempt in the United States and European (Douvere and Ehler, 2006), nevertheless, the results were mainly provided for coastal management without consideration of the CHD situation in classes and districts. For now, the related research of coastal habitat assessment is still inadequate that the accurate degraded levels of coastal habitat are not clear and the intensity of driving force is lack of quantitative reveal. Due to the lack of detailed land use classification and method of zoning and classification for specific coastal habitat assessment, the specific characteristic of coastal habitat degradation cannot be properly uncovered.

In this study, in order to develop the deficiencies in the research of CHDA (coastal habitat degradation assessment), a comprehensive approach of zoning and habitat degradation assessment is established: (1) a detailed coastal land use classification is constructed in coastal zone which could reveal the special coastal landuse features such as construction land reclamation, aquaculture land expansion and spatial-temporal change of mangrove. (2) an approach of coastal habitats classification and zoning is created which could represent the coastal natural geographical characteristics of each spatial unit, and support for establishing evaluation criterion. (3) The method of CHDA is realized based on the results of the two former approaches, coastal habitat degradation index is set and the evaluation criterion of coastal habitat degradation through internal comparison under the same habitat types is established. Through this integrated approach, habitat degradation assessment could be achieved.

This paper is organized as follows: Section 2 emphasizes the methodology, including landuse classification establishment, coastal habitats classification and zoning approach and coastal habitat degradation index. Section 3 illustrates the study region and data sources. Section 4 offers a discussion of a range of analysis results and applications in the case study. The last section evaluates the value and deficiency of the assessment approach.

2. Methods

2.1. Analytical framework

An analytical framework of coastal habitat degradation assessment is established including three steps: landuse classification, classification and zoning of coastal habitats, coastal habitat degradation assessment (Fig. 1). Achievement of each step includes few processes. The detailed procedure of each step is explained below.

2.2. Landuse classification

2.2.1. Image pretreatment

According to the remote sensing image metadata, through theRPC calibration module based on the Erdas software platform 2013, the GF1, TM and ETM remote sensing images were rough rectified. Then they were RGB false-color composed correspondent in 4, 3, 2 bands. The images were mosaicked together based on the boundary vector of research area. The preprocessing images realized the goal of geometric registration. To strengthen the position accuracy between the three datasets, firstly no less than sixteen pairs of points were adopted as control points, including four verification points that express the effective features on each image and topographic map. Then the topographic map was set as the geo-referenced standard to resample images

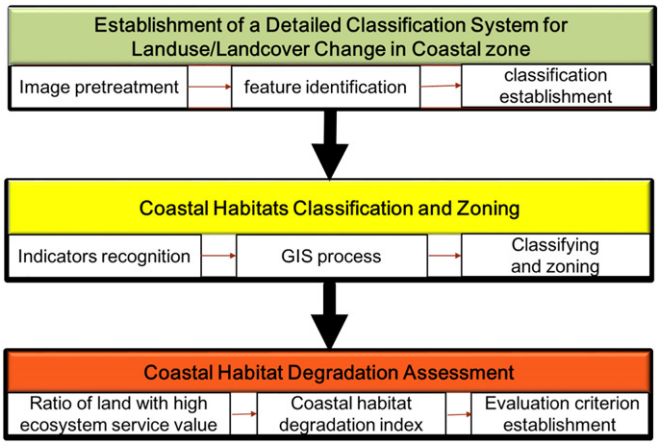

Fig. 1. Analytical framework of coastal habitat degradation assessment.