Sea Restoration and Assessment of Ecosystem in Ningbo City

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Abstract. From the perspective of the demand of marine ecosystem service function, this paper collects, sorts out and analyzes the marine ecological restoration related work by reclamation survey, mainland coastline survey, island coastline survey, blue bay application, coastal zone restoration project, ecological assessment and restoration of reclamation projects in counties (cities and districts). The successful experience of marine ecological restoration is analyzed, summarized and explored to present a relatively complete and typical marine ecological restoration scheme. Through the case study of typical ecological restoration, the optimized marine ecological restoration procedure is established. According to the development status and problems of different sea areas and coastal zones, the most suitable marine ecological restoration scheme is found, so as to solve specific marine environmental problems, and provide case reference and theoretical basis for subsequent marine ecological restoration.

1. Introduction

The international research on the ecological restoration of sea area began in the 1990s. During this period, the marine ecological restoration was mainly in the form of a single project, focusing on typical marine ecosystems such as salt marshes, mangroves, seaweed and coral reefs. In the middle and late 1990s, some developed countries began to formulate ecological restoration plans from the macro level, such as national strategic planning and regional planning [1]. For example, in 2002, the United States formulated the "National Plan for Coastal and Estuarine Habitat Restoration", and systematically collated the information on marine ecological restoration, such as "national coastal habitat restoration review", "systematic approach to coastal ecological restoration", "science based coastal habitat restoration monitoring" in 2003-2004[2].

According to the bulletin of China's marine ecological environment in 2017, the environmental quality of the sea areas adjacent around China's coastal sewage outlets is generally poor, more than 90% of which cannot meet the environmental protection requirements of the marine functional area [3]. All the monitored estuaries and most of the bay ecosystems are in sub-health status; the erosion of sediment coast and silty muddy coast is still serious. Faced with the severe situation of marine ecological environment protection, it is necessary to implement targeted marine ecological protection and restoration measures to improve the ecosystem of estuaries and bay and the environment of ecologically damaged islands.

Ningbo is located in the south wing of the Yangtze River Delta and the north coast of Zhejiang Province. This region has a subtropical marine monsoon climate, with warm and dry climate and less
rainfall in winter, high temperature and rainy in summer, and rainstorm, typhoon and other disastrous weather.

Due to the special geographical location and climate conditions, the marine disaster situation in Ningbo is complex. During 2006-2011, 34 red tides were found in Ningbo sea area, covering an area of more than 1×10⁴ km², and 4 toxic red tides, which had a certain impact on the ecological environment. In 2018, a total of 7 red tides were found in the coastal waters of Ningbo City, with a cumulative impact area of about 502km².

2. Current work of ecological restoration in Ningbo City

2.1. Blue Bay Construction

The comprehensive treatment project of Meishan Bay in Xiangshan Port mainly includes five contents: beach treatment and restoration, ecological corridor construction, wetland protection and restoration, tracking monitoring and impact assessment of project construction, and sustainable development capacity construction of marine economy in the project area.

![Artificial Beach in Meishan Bay](image)

2.2. Ecological assessment of reclamation project

The technical route of the assessment includes four stages: preliminary preparation, field investigation and supplementary data collection, ecological assessment and report preparation.

Preliminary preparation: to collect the basic information of Yinzhou historical reclamation project, the information of the sea area and the preliminary work results, and determine the assessment scope and prepare the assessment work plan.

Field investigation and supplementary data collection: according to the work plan, the project reclamation and surrounding sea areas were investigated by means of UAV aerial photography, satellite remote sensing and field survey, and supplementary data collection was conducted, including sea area ownership and current situation of sea area development and utilization, reclamation process, marine ecological environment, marine biological ecology and biological resources, hydrodynamic force, sensitive area and marine function zoning, social and economic benefits, environmental protection and ecological restoration status.

Ecological assessment: to carry out ecological impact assessment and ecological damage assessment for the assessment area, analyze ecological problems and carry out comprehensive ecological impact assessment. Referring to the estimation methods of marine ecosystem service value, combined with the feasibility and operability of various estimation methods, the loss of ecosystem service function value of reclamation can be divided into four categories and six ecological service functions, namely, the loss of supply function, the loss of regulation function, the loss of support function and the loss of culture and entertainment function. The loss types include food production and supply services (artificial aquaculture production, natural supply of marine aquatic products), air conditioning services, waste treatment services, biological regulation and control services, knowledge expansion services and biodiversity maintenance services.
The total loss of ecosystem service value caused by historical reclamation project in Yinzhou District is 1.519 million yuan/a. Among the loss value components of these marine ecosystem services, the loss of artificial breeding production is the largest, with an annual loss of about 1.083 million yuan, accounting for 71.29%.

3. Typical cases of marine ecological restoration in Ningbo

3.1. Rehabilitation of Shipu Port and Hepu coastal zone
The repaired shoreline is located in the south Bank of Shipu Port, along the coast of Hepu Town, with a total length of 5288m, starting from Panjitang in the East and ending at Hepu shipyard (Boda shipyard) in the West. Artificial seawalls are all along the restored shore, and the main sea use activities on the outside are shipyards.

The Panji seawall was repaired and reinforced. The length of the strengthened and newly built seawall was 1585m, and the dampproof standard was once in 20 years. A total of 3 sluices were built. Compared with the original damaged seawall, the coastline defense ability and the inner land drainage ability was improved, and the life and property safety of Houfanghepu town was effectively protected. The tidal surface layer of the seawall adopts the design of four foot-hollow block combined with riprap to form a pore structure, which provides a shelter and habitat for intertidal organisms, and fully reflects the ecological characteristics of the seawall. In addition, the construction of 8 m wide landscape belt in the inner side of the seawall, using up to 65 vegetation, not only fully reflects the biodiversity, using the combination of arbor, shrub and grass, but also taking into account that the vegetation has flowering varieties in all seasons, greatly improving the coastal landscape. Shipu port coastline of Hepu is the port coastline, most of which are full of wharves. The new coastline provides a new good coastline for port development, which can improve the comprehensive utilization efficiency of the coastline.

3.2. Shoreline renovation in Huangbi’ao Township
Huangbi’ao township is adjacent to Xihu Port in the south, to Xiangshan Port in the north, and to Xianxiang town and Daxu town in the East. With a land area of 43.5km² and a coastal length of 28.6km, the township governs 16 administrative villages with a population of 10738 (2017).

Along the coast of Tatouwang village, sandy soil has been everywhere for a long time, and the beach is exposed (Fig.2). Xiangshan county belongs to the subtropical monsoon climate, with abundant precipitation, especially in summer, rainstorm occurs from time to time, lacking the vegetation to maintain the stability of the soil. The bare coastal surface is washed by rain, and the sediment goes down into the sea, which increases the content of suspended sediment in the sea, makes the sea turbid, and causes pollution to the marine water environment. When the exposed surface is affected by gale weather, fine particulate matter (TSP) is drawn into the atmosphere to form dust, which seriously damages the living environment near the coastal zone.
The renovation works of this bank section include site cleaning and leveling, slope protection and reinforcement, bicycle lane construction, greening works and mangrove planting test area.

3.3. Gan’ao wetland ecological restoration project

The northeast side of Gan'ao wetland is Meishan bridge, the southwest side green belt project, the front Meishan waterway, and the rear is coastal mid-line. Before the restoration project, Spartina is the main vegetation, whose species were very single, and the communication ability of wetland water system is poor. It not only needs to accept the land drainage, including part of domestic sewage, but also is affected by the tide, resulting in poor water quality and ecological environment of wetland waters, which is far from a good ecological wetland.

Through many engineering measures, such as surface cleaning, water system communication, river embankment construction, plank road construction, vegetation restoration and so on, Gan'ao wetland has enhanced the wetland sewage purification function, wetland drainage capacity, inhibited the biological invasion of wetland, restored the wetland ecology, increased the hydrophilic function of wetland, beautified the wetland landscape, and improved the ecology of coastal wetland to create a better wetland ecosystem and maintain wetland ecosystem health.
4. Conclusions
Ningbo Marine Ecological Restoration Project will bring positive and sustainable impact. The first is to effectively control the discharge of marine pollutants, improve the quality of sea water and the ecological environment, and restore the ecosystem of islands and surrounding waters. The second is to improve the coastal environment and facilities, improve the living conditions, and enhance the quality of cities, which plays a positive role in realizing the natural harmony between people and social environment. The third is to effectively improve the ability of marine monitoring and management, and provide important technical support for remediation. It can effectively protect precious coastal resources and marine ecological environment, control the deterioration of marine ecology, and reduce the impact of human factors on natural resources and natural environment.

However, there are still some problems affecting the remediation project. Firstly, affected by the discharge of land-based pollutants, marine engineering and transportation, the environmental quality of Ningbo coastal waters is poor, and the marine ecological environment pollution is becoming more and more serious. Secondly, the contradiction between the supply and demand of marine resources is prominent, the development of marine coastline and the layout of coastal port industry is not reasonable, and the ecological self-healing ability of offshore area is weakened. Thirdly, the local sea related people's awareness of marine environmental protection and legal awareness is still weak, which put pressure on the follow-up maintenance of marine ecological restoration project.

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