The Environment Protection Strategy of Kiaochow Bay Rim in Qingdao, China

Song Jun\textsuperscript{a,b}\textsuperscript{*}, Zhan Erpeng\textsuperscript{b}, Liang Chun\textsuperscript{a}

\textsuperscript{a}College of Environmental Science and Engineering, Ocean University of China, No.238 Songling Road, Qingdao 266100, China
\textsuperscript{b}Qingdao City Planning Bureau, No.55 XiangGang Xi Rood, Qingdao 266071, China

Abstract

Environment protection is the premise and basis for sustainable urban development. The key environment problems of Kiaochow Bay Rim in Qingdao were analyzed in this paper and an environmental protection strategy was proposed, including spatial pattern construction, water environment protection, eco-river construction and pollution control of offshore operation. This strategy can promote the harmony of environment protection and exploitation of Kiaochow Bay Rim, which is favorable to reasonable, scientific and sustainable city development mode.

Keywords: Kiaochow Bay Rim; sustainable urban development; environmental protection; strategy

1. Introduction

The symbol of city development is the chief place where human are living in harmony with nature [1-3]. City development can’t only be limited in the increase of economy and the pronoun of environment pollution, resource exhaustion and ecological deterioration [2,3]. To solve the conflict between city development and environment protection, some new exploration come forth these years, such as ecological city, low carbon economy, ocean economy, etc, which are all aimed to achieve the harmony of environment protection and city economy development [4-6].

Qingdao is the most attractive city of China. We must pay attention to environment problem the same as economy. Relied on the advantage position and resource environment of Kiaochow Bay, Qingdao has

\textsuperscript{*} Corresponding author. Tel.: +86-532-83893283; fax: +86-532-83893299.
E-mail address: qdsongjun@vip.163.com

© 2011 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
Selection and peer-review under responsibility of RIUDS
achieved great success, but meanwhile the eco-environment of Kiaochow Bay suffered from great damage. For example, coastline, small bay and beach besmear were enclosed or filled, when the city central moved east and new town was contrasted disorderly. The water area and tidal prism decreased sharply with the highway construction and marine reclamation land of Kiaochow Bay Rim, which also lead to the disappearance of mudflat, wetland, reef and marine organisms. A large mount of pollutant was discharged into city rivers directly, which made rivers and the whole bay contaminated seriously.

In this paper, to solve the environmental problems of Kiaochow Bay Rim in Qingdao, an environmental protection strategy was proposed and discussed in detail, which is of significance meaning to promote forming harmony relationship between the city and the bay.

2. Present situation of eco-environment

Kiaochow Bay Rim is the mother bay what Qingdao depends upon for surviving. In the development history of Qingdao, the plentiful resource of Kiaochow Bay played a double function of zoology and economy service, which greatly promoted the development of economy, social, culture, etc, of Qingdao. Fig.1 shows the spatial scale of Kiaochow Bay Rim. The survey results of environment situation of Kiaochow Bay are discussed as follows.

2.1. Water quality

The water quality of Kiaochow Bay is stable relatively. However, due to massive discharge of wastewater pollutants, the concentration of pollutants in the rivers and the bay is on the rise. The environmental capacity has reduced gradually as well and the environmental bearing capacity has always been at the state of affluence from 1998 to 2008.

2.2. Shoreline and tidal prism

Due to human activities factors, such as saltern construction, agricultural land expansion, port development, and highway construction, etc, coastlines of the Kiaochow Bay are pushing towards the sea, which has made the area of the bay diminishing year by year. Meanwhile, intertidal zone of the Kiaochow Bay decreased sharply as well. Large-area of natural tidal flat was replaced by saltern aquaculture and artificially reclamation. Tidal prism of Kiaochow Bay is also decreasing constantly, which has weakened its pollutant holding capacity and made adverse impact to the peripheral development as a result. Fig.2 displays the variation of shoreline of Kiaochow Bay from 1935 to 2008.

2.3. Situation of hydrodynamic force

Current velocity of the bay mouth and deepwater channel shows a decreasing tendency invariably, while in the inner bay that is minor relatively. With hydrodynamic field weakening, the winnowing and carrying sand capacity of wave has reduced much. If the sea reclamation projects continue, channel velocity of Kiaochow Bay will decrease a lot. Velocity and degree of the channel situation will be more serious as well, which will make significant impact to safe utilization of harbor resource.

2.4. Ecology wetland

Due to a large scale of coastal engineering, the water area has reduced sharply, which has changed the terrain and flow of Kiaochow Bay and reduced the function of replenishing moisture to wetland.
Meanwhile, the ecology system of wetland suffered from damage and the diversity of organism disappeared gradually. Currently, there’re only 9189.9 hectares forestlands in Kiaochow Bay Rim. The structure is unreasonable and the coverage rate is relative low, which have limited function of regulation to climate and environment.

![Fig.1 (a) The spatial scale of Kiaochow Bay Rim; (b) The variation of shoreline of Kiaochow Bay](image)

3. **Strategy of environmental protection**

The key problem to be resolved is the environmental protection to achieve the sustainable development of Kiaochow Bay Rim. Therefore, we proposed strategies and measures preliminarily as follows.

3.1. **Construction and protection of ecology spatial pattern**

The ecology spatial pattern in bay-surrounding area consists of Kiaochow Bay as basement, ecologic wetland and woodland as spots, and a series of rivers as gallery. The current situation of Kiaochow Bay ecology spatial pattern is integrity relatively, but there are still many problems.

The ecology spatial pattern of Kiaochow Bay should be optimized on the principle of ecosystem integrity maintenance. 1) Delimit reclamation control blue line to protect the bay basement. 2) Establish natural coastline protection belt to maintain ecological spatial continuity. 3) Delimit ecological wetland protection green line to maintain ecological wetland functions. 4) Construct ecological corridor to maintain ecological spatial completeness and improve local climate adaptability. 5) Protect ecological woodlands to increase public vegetation rate, improve local urban climate and maintain biodiversity. 6) Establish coastal building back line to protect the bay. 7) Improve recognition towards the isolated afforestation corridor and invest more funds. 8) Perfect relevant laws to regulate the construction of ecological space.
3.2. Protection of water environment

Protection measures of the Bay and rivers, such as management, planning guide and engineering prevention, should be taken to improve the water environment quality and reduce pollutants discharge into the bay, which can protect the biodiversity effectively, maintain the marine ecology balance and ensure sustainable development and utilization of fishery, aquaculture, tourism and port resources.

- Speed up the construction of the regional environmental infrastructures. Combining urban reconstruction process, improve sewage network collection system greatly and strengthen the pollutant interception projects in urban coast and main rivers. The sewage treatment rate should reach 95% by 2015. Construct, enlarge, and reconstruct about 10 sewage treatment plants by 2010, which can upgrade the sewage treatment capacity to standard level A and reduce 1.4 million tons of COD discharge.

- Promote drainage basin pollution treatment vigorously. Accomplish comprehensive pollutant interception in drainage basin of Haibo River and Licun River in 2010. Construct 280 km drainage pipeline in urban areas to realize most sewage collection.

- Relocate and reconstruct corporations that discharge waste into sea directly. Especially, accelerate relocation of key enterprises like Alkali and sea salt industries. The relocation of old industrial enterprise around the bay will be carried on actively. Meanwhile, upgrade technology, process, and equipment to reduce pollutant discharge.

- Strengthen the implementation of management measures. Improve environment management system combining watershed and regional management. Establish and implement a total amount control system. Supervise the terrestrial outfall forcefully and intensify law enforcement. Optimize the layout of drainage outlets. Strengthen marine environmental protection and surveillance monitoring. Promote programming and environmental assessment process actively. Control sea reclamation.

3.3. River eco-regulation

- For the upstream section of river, protect and conserve the headwaters effectively and establish ecological compensation mechanism of headwaters. Forest for water conservation, protective belt, riparian vegetation, artificial wetland, etc, should be built to increase the stability of headwaters. Meanwhile, in the villages along rivers, centralized sewage treatment and domestic garbage collection work should be well done, which can improve the ecological stability and self-purification capability of river effectively.

- For the section of river flowing through the main urban zone, adhere to the principle of ecological restoration combined with pollution treatment. Take measures of channels cleanout and ecological restoration, as well as intercepting pollution completely, making landscape lighting to riverways, dredging the river, constructing leisure plaza, crating cultural corridor, etc. Moreover, widen river green belts, increase service facilities and improve river basin traffic. These measures can also drive the real estate industry, commerce, tourism and cultural industries development, and pull the rapid development of regional economy effectively.

- For the downstream section of river, river dredging is the main measure, which can improve the capacity of flood discharge. In estuaries regional, a coastal ecological pasture or ecology park can be constructed with ecological protection and recreational function, providing entertainment space for the citizens.

3.4. Pollution control of shipping and relevant maritime activities
• Establish and perfect the shipping pollutant collection and treatment system on the whole ports. Provide sufficient collection capacity to oily ballast and wash water from oil tankers on oil harbour or oil terminals. Equip the main ports with oily wastewater collection facilities.
• Strengthen the control and supervision of ship pollutants. Prohibit ships to discharge ballast water containing toxic substance, washwater or its residues, mixture into the sea directly. Ballast water discharge management plan must be compiled in accordance with policy requirements. Strengthen supervision and inspection of the ballast sewage centralized treatment to prevent excess emissions.
• Reinforce supervision of fishing boats and ports pollutants. The pollution discharging phenomenon at both sea and ports is quite common currently. Pollution prevention, supervision and administration to the fishing boats and ports must be intensified. The laws must be observed and enforced strictly, and the lawbreakers will be prosecuted.

4. Conclusion

The ecology system of Kiaochow Bay Rim has great influence to economy and social development of Qingdao. The protection strategy of Kiaochow Bay Rim mainly consists of construction and protection of ecology spatial pattern, protection of water environment, river eco-regulation, pollution control of shipping and relevant maritime activities, etc. The implementation of environmental protection strategy will exert positive and profound impact on the change of economy development mode relied on sacrifice of eco-environment. This will also promote the formation of the best structure, scale and layout of city development, and achieve the sustaining development of Kiaochow Bay Rim upon the Ecological Carrying Capacity.

Acknowledgments

The authors wish to specially thank the chief engineer of Qingdao City Planning Bureau, Zhan Erpeng, for the useful discussion and suggestion in this strategy research.

References