

# Development in Coastal Areas: The Beibu Gulf

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**Abstract:** Coastal zones have been and will continue being the socioeconomic development centers worldwide. While the economy grows, it generates some footprints on the environment at the same time. The Beibu Gulf Economic Rim defines the economic region surrounding around China's southwestern coastal region and cities around the Beibu Gulf. This article takes the Beibu Gulf as a case to examine the impacts of its coastal development on the coastal marine environment. Data were collected to analyze the relationship between the socioeconomic development and the coastal environmental changes in the Gulf. The impacts and potential environmental risks of human activities on the coastal zone of this Gulf are also assessed. Then some suggestions related to marine environmental protection and ecological compensation are proposed to promote the sustainable development of this region.

Coastal zones have been, and will continue to be, socioeconomic development centers worldwide. While the economy grows, it generates some footprints on the environment at the same time. The Beibu Gulf Economic Rim defines the economic region surrounding around China's southwestern coastal region and cities around the Beibu Gulf (Fig.1). On the one hand, the Gulf is an essential part of China's development plan and also a most promising region economically. On the other hand, with its uniquely natural environment, the Gulf becomes the only stretch of unpolluted sea survived from various development activities, a “Gulf Region” recognized as a biodiversity hotspot, an important Golden Fishery” [1~2], and a crucial target of marine eco-safety management. The Gulf’s global eco-service determines that its environmental quality will impact the eco-environment changes of the countries surrounding the Southern China Sea region to a great extent. This article takes the Beibu Gulf as a case to examine the impacts of coastal development on the coastal marine environment. The impacts and potential environmental risks of human activities on the marine environment are also assessed. Then some suggestions related to marine eco-environmental protection and ecological compensation are proposed to promote the sustainable development of this region.

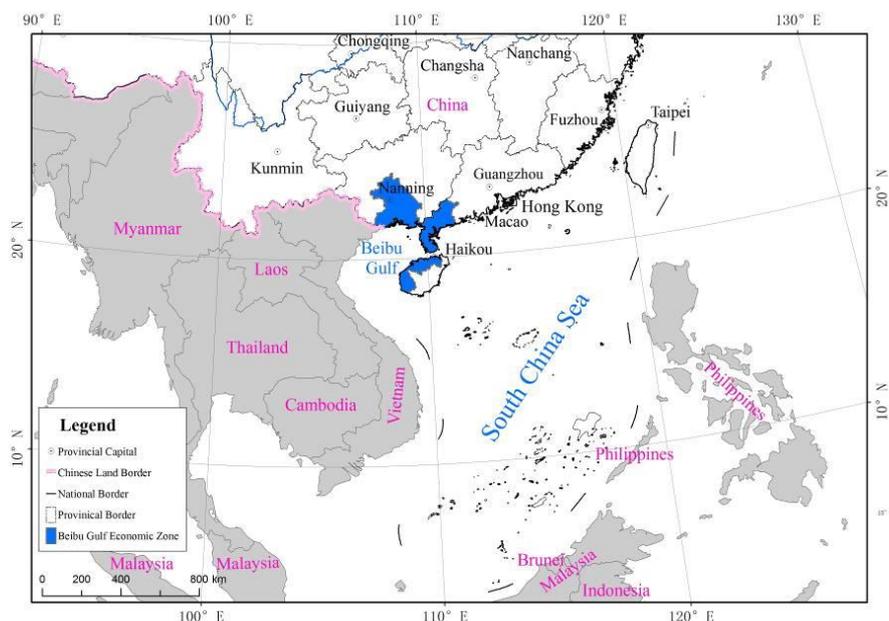


Fig. 1 Map of Beibu Gulf

## 1. Introduction to Economic Development History of Beibu Gulf Economic Rim

Since the late 1980s, the economy of the Beibu Gulf Economic Rim has been experiencing a remarkable growth reflected by its growth of economic aggregate, particularly the since the 1990s. The past decade witnessed a significant growth of economic aggregate of the region from RMB129.22 billion in 1996 to RMB449.138 billion in 2007, an increase of 300%. In addition, the rapid industrial growth in this period was evidenced by the larger market size and 200% growth of Gross Industrial Output Value amounting to RMB 525.32 billion in 2007 from RMB 167.45 billion in 2000 (see Fig. 2 and Fig.3).

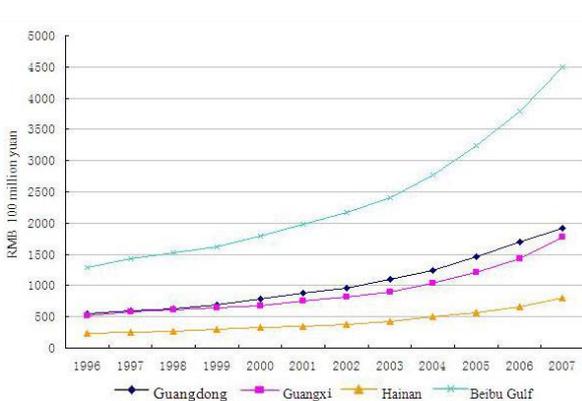


Fig.2 GDP Growth Trend of Beibu Gulf Rim

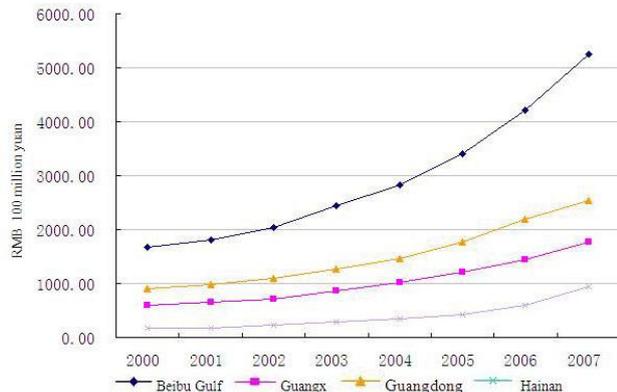


Fig.3 Gross Industrial Output Value Change Trend of Beibu Gulf Rim

## 2. State of the Coastal Environment in the Beibu Gulf

### 2.1 Coastal Water Quality of the Beibu Gulf and Its Causes

As shown in Fig. 4, among the total area of 29,600 km<sup>2</sup> coastal waters in the region<sup>1</sup>, according to water quality investigation and monitoring, clean to fairly clean waters account for 92.6% while those medium to serious polluted only take up 0.7%, indicating that these areas are endowed with the largest part of clean or fairly clean waters. At present, the water quality can meet related standards in general, only that Maowei Sea and Zhanjiang Gulf present an unacceptable concentration of nitrogen and eutrophication is observed in northeastern Zhanjiang Port, Shuidong Port and northwestern Maowei Sea, indicating a descending trend of water quality from the east to the west and from the center to the south.

Water pollution of the coastal waters in this region is mainly caused by rapid economic development, population expansion and discharge of a great deal of industrial waste

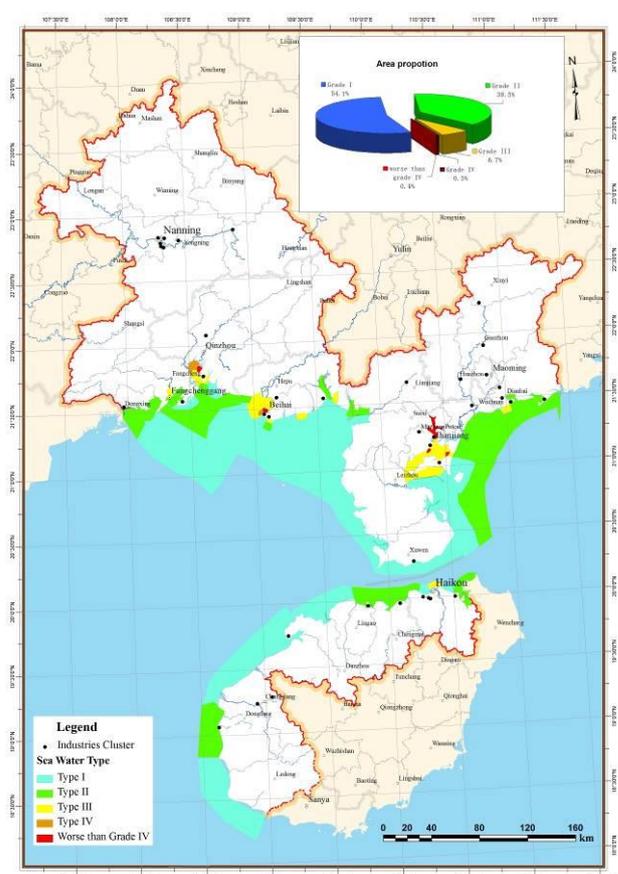


Fig. 4 Map of Water Quality Distribution in Beibu Gulf Rim

<sup>1</sup> The cities and regions researched include Nanning City, Beihai City, Qizhanjiang City and Maoming City in Guangdong Province; Haikou City, Ledong County and Changjiang County in Hainan Province, etc.

water and domestic sewage not going through treatment process. According to statistics, the industrial waste water discharged in this region reached as high as 444 million tons, including water pollutant COD 211.9 thousand tons, petroleum wastewater 340.81 tons, and ammonia nitrogen 4125.9 tons. And the effluent of domestic sewage amounted to 728 million tons.

The emissions of water pollutant COD, ammonia nitrogen and total phosphorous reached 306400, 35900 and 3833 tons respectively. Apart from that, coastal aquaculture also contributes a great deal to organic contaminants in some part of this region. For example, eutrophication observed in the Maowei Sea in the northwestern Beibu Gulf is mainly caused by wastewater discharged from aquaculture. It is found from researches that the thickness of organic sediment reaches as high as 20-90cm. Living benthos were not caught in Maowei Sea coastal region.

## 2.2 Current Situation, Historic Changing Trend and Cause Analysis of Marine Fishery Resources

The Beibu Gulf is one of the seas with largest productivity of fishery resources in the South China Sea and fisheries are also a major industry in the region. The Gulf boasts of more than 520 species of commercial fishes, including more than 60 major species<sup>[3]</sup>, which are 1.5 and 2.5 times of those in the East China Sea and the Yellow Sea and Bohai Sea. Before the 1950s, due to poor productivity and backward technology, fishing depended greatly on traditional sailboats and inshore fisheries dominated in the Gulf region for a long time. However, since the 1970s, because of natural growth of fishery labor force in combination with the shift of non-fishing related labor force to fishing related labor force and fishing technology development, the fishing efforts were reinforced continuously, resulting in fishing boats total power as twice as the recommended fishing operation intensity in the Gulf region<sup>[4]</sup>. It is also the root of distinct declining fishery resources since the 1970s. In recent years, the summer fishing moratorium and other protection measures contribute to the recovery of living resources to some extent, but the living resources still stay in low level (see Fig. 5). In addition, the increasing fishing pressure results in obvious species succession and intensifies interspecific replacement, which in turn reduces the quantity and quality of fishery resources (see Fig. 6). Since 1980s, *Decapterus maruadsi*, *Saurida* and Drumfish accounted for the largest proportion of catches in Beibu Gulf. While since 1990s, most traditional commercial fishes with higher economic value such as *Lutjanus sanguineus*, *Parargyrops edita* and *Nemipterus virgatus* have been declining further, with barely trace of quality fishes.

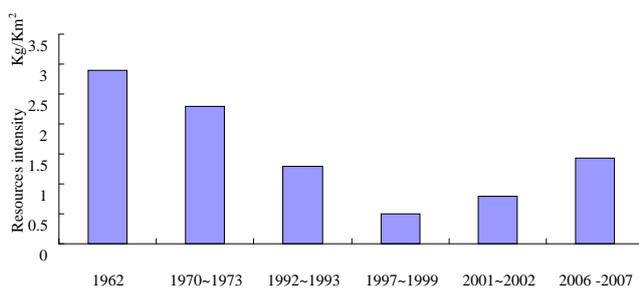


Fig. 5 Change Trend of Fishery Species Intensity in Beibu Gulf

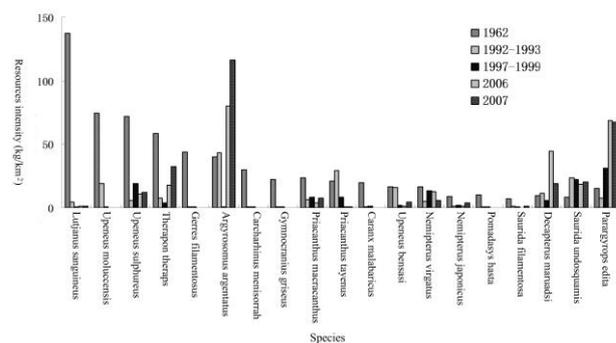
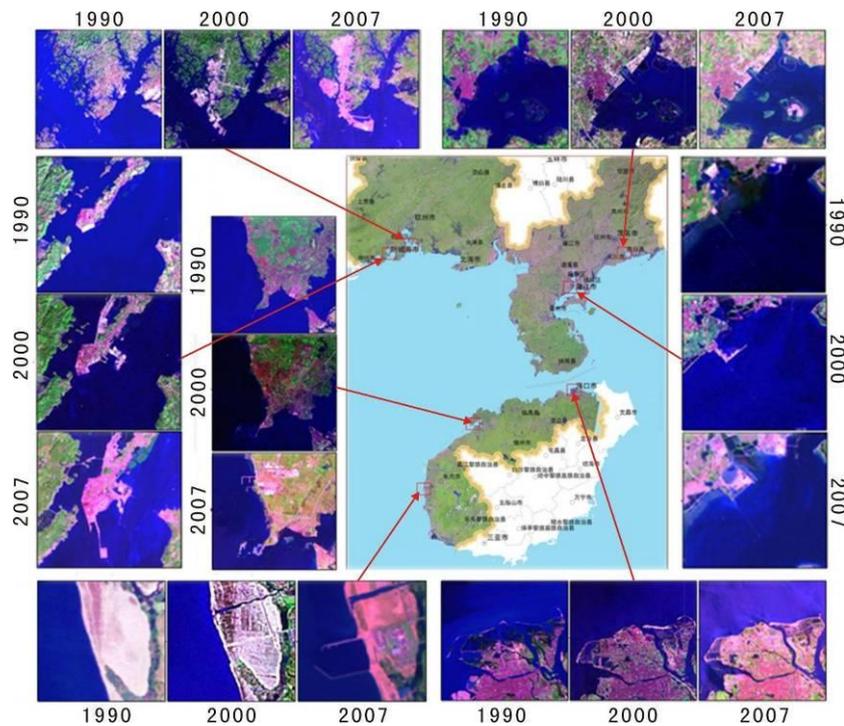


Fig.6 Historical Change Trend of Commercial Fishery Species Intensity in Beibu Gulf

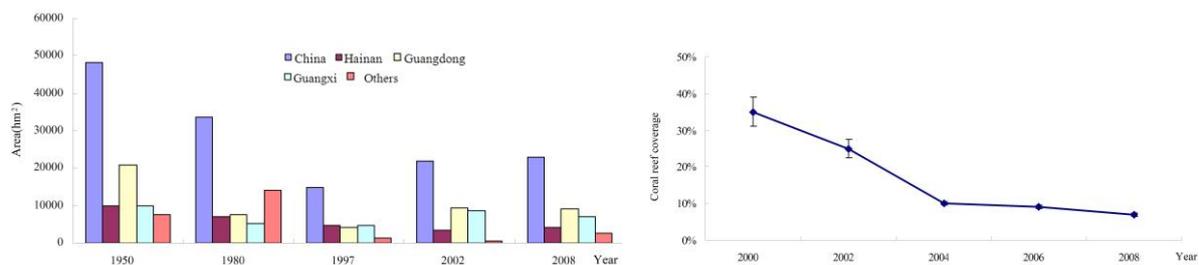
## 2.3 Conditions and Cause Analysis of the Important Marine Ecosystems and Rare Animal Resources

As the interpretation of the remote sensing images in 1990, 2000 and 2007 (see Fig. 7), the gross area for coastal reclamation in the Beibu Gulf Rim exceeded 700,000 hm<sup>2</sup> in the past 50 years. The activities, such as coastal

reclamation, building of harbors and wharfs, aquaculture, shellfish capture and trawl have caused reduction and damage of natural shorelines and directly destroyed the typical coastal ecosystem of the Beibu Gulf. In addition, 69% of the mangrove forests in the Beibu Gulf were damaged in the past century and the mangrove forest areas of Zhanjiang (Guangdong) and Beihai (Guangxi) were reduced by about 50% compared with that of 1950s (see Fig. 8). Furthermore, coral reef ecosystem was in a healthy or sub-healthy state, in particular, in Xuwen of Guangdong, the coverage of coral reef fell sharply (see Fig. 9). Seagrass bed ecosystem is now largely stable; however, in the west of Hainan, seagrass is seriously damaged, thus it is hard to be deposited.



**Fig. 7 Schematic Chart of Coastal Line Occupation Changes in Beibu Gulf (1990-2007)**



**Fig.8 Change Trend of Mangrove Forest Area in China      Fig. 9 Latest Change Trend of Xuwen Coral Reef Coverage**

Reduction of wetland area, fragmentation of important ecological environment and damage of ecological system also cause the decline of rare animal resources. While *Sousa chinensis chinensis* population is steady, the numbers of near-shore *Dugong*, *Pinctada maxima*, *Branchiotoma belcheri* and the like obviously declined. In recent years, there was no scientific evidence for the existence of *Dugong*. The *Pinctada maxima* resource nearby the sea area of Yangpu Bay, Hainan seriously declines and the that species in the west of Leizhou Peninsula, Guangdong are younger and smaller. The monitoring results from 2004 to 2008 shows that the number of *Branchiotoma belcheri* declines sharply and is unsteady. In addition, the great damaged caused by the spawning grounds, feeding grounds, incubation grounds and the like of the main economic fisheries within the area with depth contour of 40m at the coast of Beibu Gulf is also one of important reasons for the decline of fishery resource of Beibu Gulf.

## 2.4 Historical Change Trend and Cause Analysis of Marine Ecological Disasters

From 1980 to 2008, Harmful Algal Bloom (HAB) events occurred for 71 times in the sea area of Beibu Gulf Economic Rim and the sea area still had low HABs events rate since the HABs occurred here only accounted for about 6% of the total HABs accidents occurred in the South China Sea. However, the frequency and the affected area of HABs, especially toxic red tide, increased obviously (see Fig. 10 and Fig. 11). Among the HABs from 1980 to 2000, there were a half of HAB events caused by harmless *Noctiluca miliaris*; among the red tide accidents from 2000 to 2008, 50% red tide accidents are caused by toxic and harmful *Phaeocystis globosa* and only a minority of HABs are caused by harmless *Noctiluca miliaris*. The main sea areas having high HAB rate include Zhanjiang Harbor and Haikou Bay. The waters of Zhanjiang Harbor and Haikou Bay are seriously polluted and port transportation in these two places is well developed, so the HABs occur frequently.

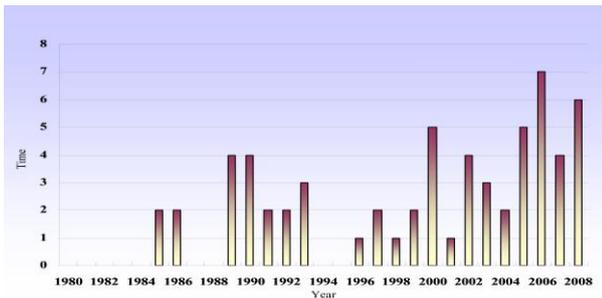


Fig. 10 Time Change Trend of HABs in Beibu Gulf

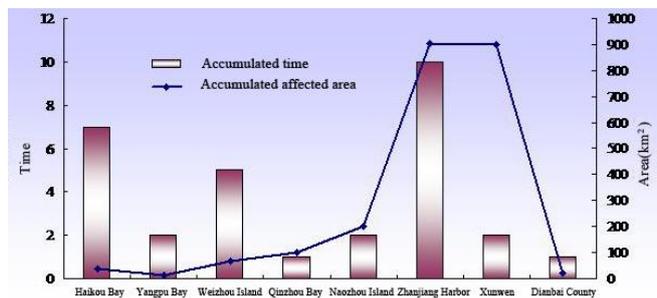


Fig.11 Space Change Trend of HABs in Beibu Gulf from 2001 to 2008

## 3. Analysis of Coastal Development and Ecological Protection Measures of the Beibu Gulf

In order to improve the marine environment of the Beibu Gulf, its development should be further optimized in terms of the industrial structure and development layout. Priority should be given to sustainable development to allow environmentally sound development of the society and minimize the negative impacts of regional development on the marine environment.

### 3.1 Suggestions on Industrial Layout of Coastal Development of the Beibu Gulf

To protect coral reef ecosystems and main economic fish spawning grounds (Core Area of *Paerargyrops edita Tanaka* Protected Areas) around Weizhou Island, and to protect dolphins often gathered in the waters south of Naozhou Island, the industrial development of Weizhou Island and Naozhou Island should not be allowed; To protect *Dugong* and mangrove forest in Tieshan Harbor waters, and to protect *Sousa chinensis chinensis* and reduce HABs in Qinzhou Bay waters, the industrial development intensity in Tieshan Harbor and Qinzhou Bay should be strictly controlled. To alleviate eutrophication and HABs in MaoWeiHai, aquaculture should be strictly controlled and the land-based pollution from Qinjiang should be reduced. Because there are many important marine ecosystems and sensitive creatures along Zhanjiang Xuwen such as coral reefs, mangrove forests and *Pinctada maxima*, the development and utilization of the waters should be strictly controlled. To alleviate eutrophication and HABs in Haikou Port, the industrial development and aquaculture should be strictly controlled while reducing the land-based pollution. Consider *Sousa chinensis chinensis*, seagrass beds distributed, Donghai Island (Zhanjiang) should plan industry on north and central, while sewage discharge should be on east coast. Heavy industrial sewage of Maoming Port should stay away from *Branchiotoma belcheri* distribution waters. For the protection of coastal *Pinctada maxima* and mangrove, the industrial structure of Yangpu Development Zone and coastal area of Lingao should be optimized; Consider pollutant dispersion conditions were better, fewer constraints ocean conditions, the development of chemical industry in

Dongfang, Hainan should be encouraged, and priority should be given to the development of Qisha Industrial Park in Fangchenggang City. Since the distribution of important national mangrove and red tides occur frequently, the enterprise draining the pollutants to the Zhanjiang gulf should be transformed or relocated.

In addition, the pollutant draining principle providing that “no drainage is allowed within the gulf and offshore drainage is allowed” should be implemented.

### **3.2 To Explore and Establish the Regional Entry Mechanism for Key Pollution Industries**

The construction of key industries such as petrochemical, metallurgy and papermaking in Beibu Gulf is in its infancy, in order to avoid environmental problems from the source, the use of domestic leading level of production technology and management is the basic entry requirements, and should try to catch up with international advanced level.

### **3.3 Research on Marine Ecological Protection and Improvement Measures**

3.3.1 To accelerate the construction of urban sewage treatment plants, strictly control the total amount of sewage drained to the sea, decrease pollution and reduce drainage of coastal industries and other onshore pollutants and reduce the damage caused to the near-shore marine ecological environment.

3.3.2 To regulate fishery production order, encourage scientific aquaculture, greatly promote the conservation of aquatic living resources, strictly implement the moratorium system and enlarge the scale of enhancing and releasing and the construction of artificial reef.

3.3.3 To strictly restrict the development and utilization of natural coastline, enhance the protection and restoration of important marine ecological systems such as rare or endangered species and coastal mangroves, sea grass beds, coral reefs and the like and build important marine ecological reserves such as Weizhou Island-Xieyang Island Coral Reef, Sanniang Bay Chinese White Dolphin Reserve, Beibu Gulf Parargyrops Edita Aquatic Germplasm Resource Conservation Zone and Hepu National Dugong Reserve.

3.3.4 To innovate institutional improvement and establish and improve a long-term marine ecological environment protection mechanism. Strengthen the collaboration between marine departments of Beibu Gulf, further improve mechanisms such as coastal marine environment monitoring and warning, fishery resource damage compensation, clean production development of aquaculture, build a regional marine information management system and create a large cooperation platform for environmental protection.

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