

## **CORRELATIONS BETWEEN RESOURCES EXPLOITATION & SUSTAINABLE DEVELOPMENT IN LEQING BAY, ZHEJIANG PROVINCE**

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**Abstract:** According to the dominant resources and its current exploiting situation in Leqing bay, this paper discusses exploiting correlations among various resources. The correlations include four kinds: benefit to each other, contradiction to each other, benefit only to one side and damage only to one side. In order to achieve well harmonization among economy, society, environment and resources, and promote sustainable development of economy around Leqing bay, the integrated coastal zone management (ICZM) must be implemented.

**Key words:** Dominant resources, Correlations, Resources exploitation, Sustainable development, Leqing bay

### **1. INTRODUCTION**

Leqing bay is located at the south part of Zhejiang province, it belongs to four counties of Leqing, Wenling, Yuhuan and Dongtou, yet these four counties are administered by two districts of Wenzhou and Taizhou. Economy developing rapidly provides very favorable condition for the development of marine economy along Leqing bay. It has been one important part of south-zhejiang economic circle where Wenzhou is the leader.

Leqing bay is one of three half-closed bays that have a complete geographic unit and ecological system in Zhejiang province. The total area is 463km<sup>2</sup>, of which tidal flat area is up to 220km<sup>2</sup>. The length of continental coastline is 185km. There are abundant marine resources with multiple exploiting functions in Leqing bay (Fig.1), such as deep water harbors, marine aquatic product, tidal energy, shore tourism and tidal flat, ect. Utilizing these resources promotes economy flourishing around Leqing bay. However, exorbitant and unreasonable exploitations bring a lot of contradictions and antagonisms among various region, department and industry, resulting in damage to the marine resource and decline to ecological environment quality, causing serious influence upon economic sustainable development.

According to the dominant resources and its utilizing current situation in Leqing bay, this paper will discuss various resources exploiting correlations among harbor, channel, anchorage, reclamation, mariculture, shore industry, shore tourism, marsh conservation, tidal power station, coastal engineering. The correlations include four kinds: benefit to each other, contradiction to each other, benefit only to one side or damage only to one side. The purpose of this paper is to seek well harmonization among economy, society, environment and resources, and promote economy developing sustainably around Leqing bay.

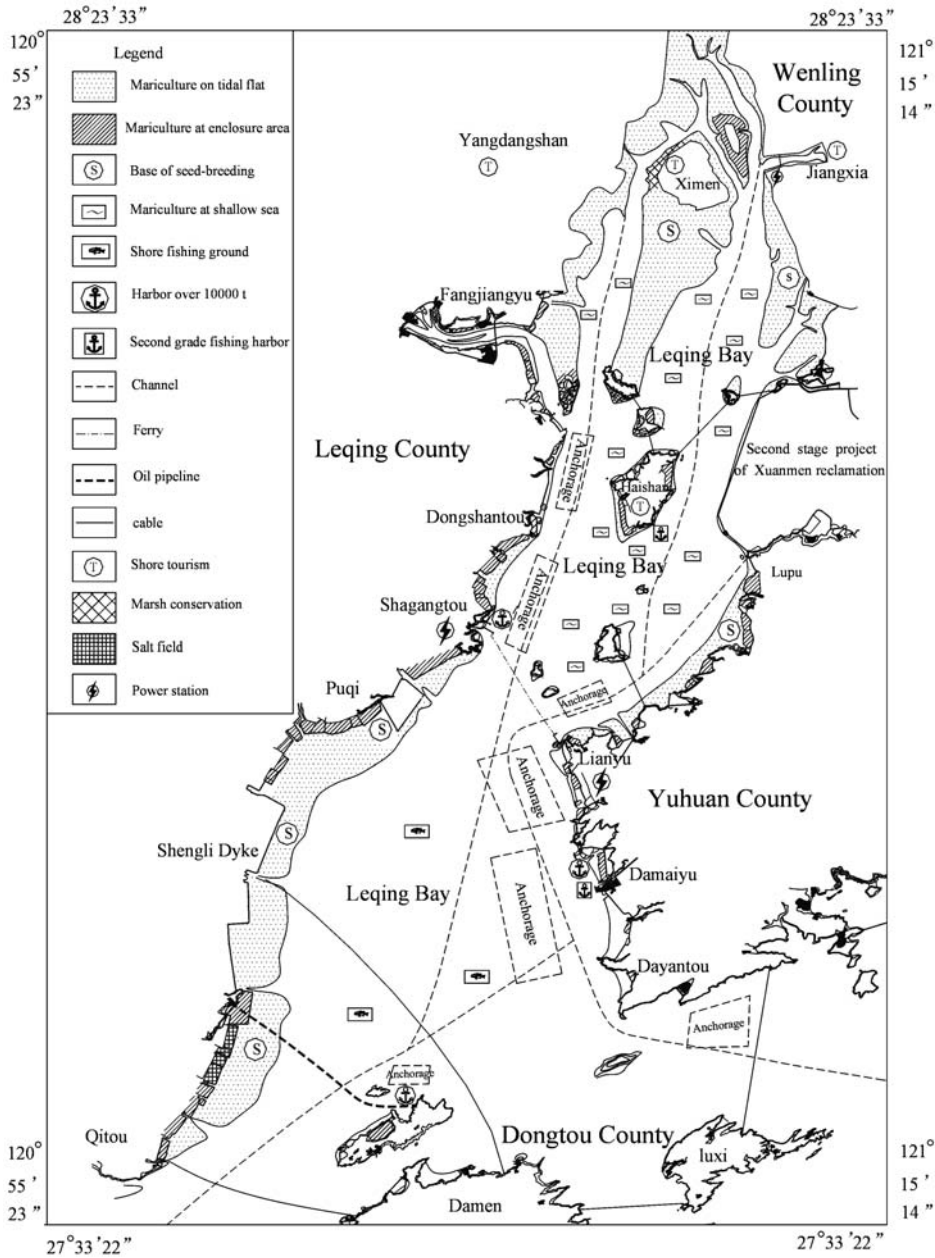


Fig. 1 Resources and its exploitation current situation in Leqing Bay

## 2. MARINE RESOURCES AND ITS UTILIZING CURRENT SITUATION

There are abundant marine resources in Leqing bay, the dominant resources are deep water harbor, marine aquatic product, tidal energy, shore tourism and tidal flat, etc. which are being exploited or will be exploited.

### 2.1 HARBOR, CHANNEL AND ANCHORAGE

Leqing bay is a half-closed bay with the bay mouth opening southward. It is characterized by shoreline winding and environment sheltered, where several segments suitable to build harbor. There are several berth have been built: Damaiyu harbor with four berth of  $1 \times 10^3$ t grade, one ferry berth of  $2 \times 10^3$ t grade and one berth of  $2 \times 10^4$ t grade at the east bank, and Xiaomendao harbor with a berth of  $5 \times 10^4$ t grade at the bay mouth. Furthermore, Several ports are being built: Damaiyu harbor with a berth of  $5 \times 10^4$ t grade, Shagangtou to Dongshantou

harbor with a berth over  $1 \times 10^4$ t grade at the west bank. Additionally, there are some local harbors being exploited.

## **2.2 MARINE AQUATIC PRODUCT**

According to the record, there were 190 species of fish, 58 species of shellfish and 60 species of crustacean occurred in Leqing bay, of which the economic species of fish and shellfish are 106 and 20 respectively. Leqing bay has become one of the three bases of aquatic breeding in Zhejiang province, it is also the important base of seed-breeding, the seed of razor clam and blood clam has ranked the first place in China. The sea aquatic breeding area is nearly  $200\text{km}^2$ , of which the seed-breeding area is  $33\text{ km}^2$ . Nowadays, mariculture at tidal flat is nearly in saturation but mariculture at shallow sea is still full of potential.

Leqing bay is also a shore fishing ground of Zhejiang. Exorbitant exploitation has decreased the fishery resources, yet the fishing structure is being adjusted. Shore aquatic resources are being protected and the fishing is transferred to offshore and ocean.

## **2.3 TIDAL FLAT**

The proportion of tidal flat area to the total area is 48% in Leqing bay, which concentrated at the inner bay and the west bank of the bay. A mangrove marsh conservation zone is planed to build at the inner bay near Ximen island. Lots of reclamations have been fulfilled with total area of  $54.6\text{km}^2$  since 1950s and  $26.7\text{km}^2$  reclamations will be planed to arrange, which is used mainly for mariculture, agriculture and industry.

## **2.4 SHORE TOURISM**

National level scenic beauty spot of north Yangdanshan and provincial level forest park of Jiangxia are located at inner Leqing bay. The sea sightseeing and leisure tour region is planed to build at sea area near islands in the inner bay.

## **2.5 TIDAL POWER STATION**

Jiangxia tidal power station is located at east bank of the inner bay, which was made in 1985 with load of 3200kw and electricity generating capacity of  $530 \times 10^4\text{kw}\cdot\text{h}$ , which has occupied the first place in China and the third place in the world.

## **2.6 MARINE ENGINEER**

In order to satisfy the economy development along Leqing bay, several communication and electricity cables as well as oil pipeline have been laid, and the bridges are planed to build which links the west bank and the east bank of Leqing bay as well as the islands at the bay mouth.

## **3. CORRELATIONS AMONG EXPLOITING RESOURCES**

Rational utilization of the marine resources is one of the important approaches to flourish shore economy. There are abundant marine resources with multiple exploiting functions in Leqing bay. The exploitation of one resource is easy to influence other resources' exploitation, and the exploiting purpose of various region and department is different. Furthermore, the common base of resource exploitation is environment condition, which makes the exploitations correlating with each other through the environment. The correlations includes four kinds: benefit to each other, contradiction to each other, benefit only to one side or damage only to one side, and the correlating degree is different relative to various resources exploitation(Yun Caixing,2002). The correlation among exploitations in Leqing bay is shown in Fig2, the analysis is as follows:

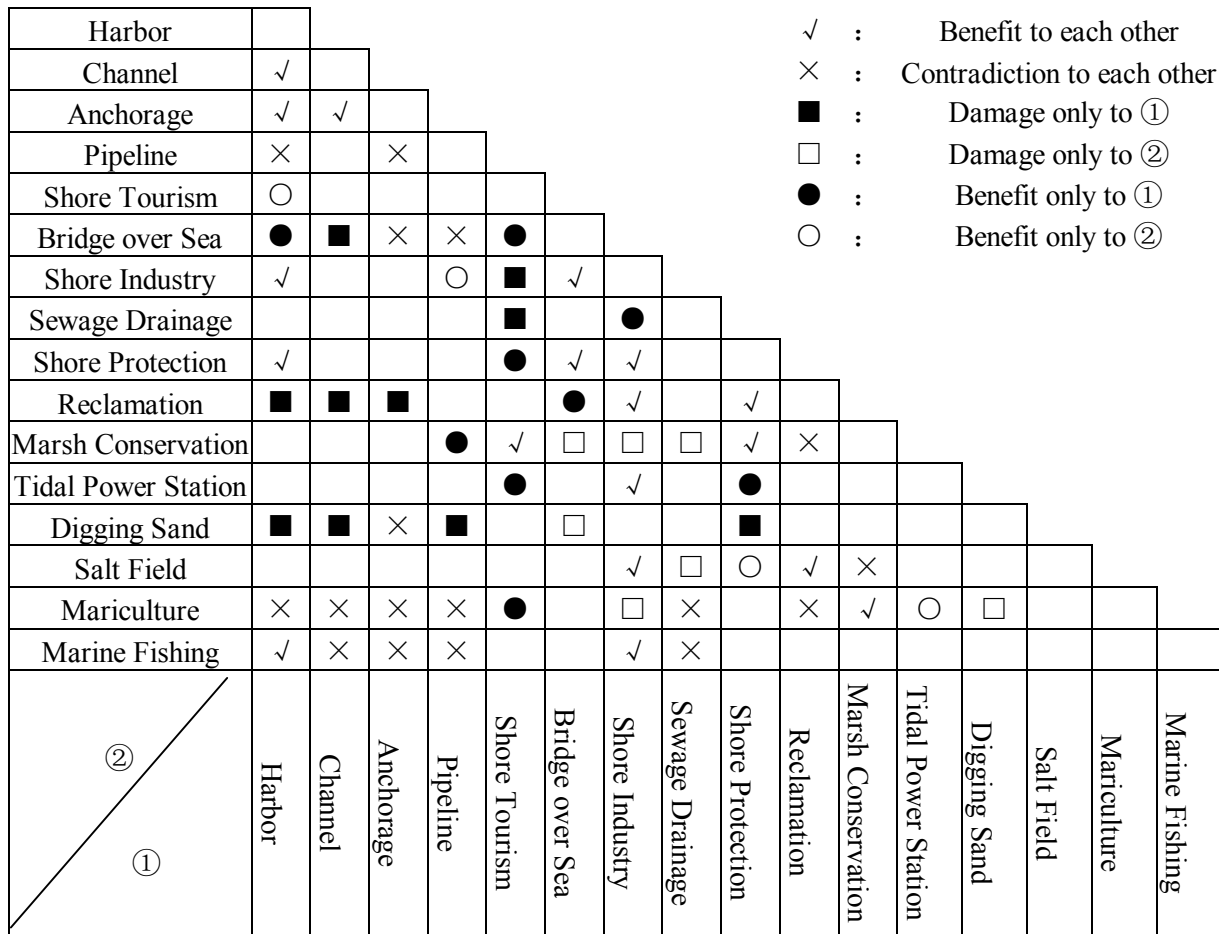


Fig. 2 Correlations among resources exploitation in Leqing bay

### 3.1 BENEFIT TO EACH OTHER

Harbor, channel and anchorage are beneficial to each other. The corresponding channel, anchorage is required when the harbor is exploited. For example, the east bank of Leqing bay is one of the rare excellent segment to build  $3 \times 10^4 - 5 \times 10^4$ t grade berth between Ningbo and Fuzhou, where Damaiyu harbor has been exploited at the deep-water segment between Dayantou and Lianyu. There are four berth of  $1 \times 10^3$ t grade, one berth of  $2 \times 10^4$ t grade and one ferry berth of  $2 \times 10^3$ t grade. Furthermore, one berth of  $5 \times 10^4$ t grade is being built. Correspondingly, the channel for  $5 \times 10^4$ t grade is also being exploited. Its shallowest water depth is 10.1m, and the guarantee rate for ship to sail safely is 100% at the convenience of tide. The anchorage for  $1 \times 10^4 - 5 \times 10^4$ t grade ship to anchor is also occurred near the harbor.

Harbor, shore industry and marine fishing also benefit each other. Harbor is the basic industry, which can stimulate the development of shore industry and marine fishing. At the same time, marine fishing needs service base to trade and process the marine aquatic products. For example, the second-grade fishery harbor was built at the east bank of Leqing bay, where Damaiyu economy development zone has been built near the harbor, which consists of energy, food, aquatic product processing industry and trade. It has become one of the shore industry bases along Leqing bay and done great help to the national economy development of Yuhuan county.

Furthermore, there are many exploiting activities which benefit each other, such as shore tourism versus bridge over sea, shore protection, marsh conservation; shore protection versus harbor, reclamation, shore industry; marsh conservation versus aquatic seed breeding.

### **3.2 BENEFIT ONLY TO ONE SIDE**

The tidal energy utilization is beneficial to enclosure tidal flat for mariculture. The water storage of tidal power station can be exploited as tourism spot, it does great help to the shore tourism. For example, Jiangxia tidal power station is one of the three important sceneries located in provincial level Jiangxia forest park. Simultaneously, marsh conservation can improve the ecological environment quality and increase biologic variety, which benefit the aquatic seed breeding. Furthermore, marsh conservation is favorable to the safety operation of cable and pipeline.

### **3.3 CONTRADICTION TO EACH OTHER**

Almost every resource can be exploited with multiple functions, and the purpose of various departments is different, leading to a lot of contradictions during exploitation. For example, the area with water depth of 10m in inner Leqing bay can be exploited as netting mariculture, or it can be opened up channel and anchorage. But both the channel and anchorage forbid mariculture, otherwise it will influence the ship sailing safely. Therefore, there exist contradiction among the three functions inevitably. At the same time, the tidal flat resource can be exploited as reclamation, marsh conservation, tidal mariculture and aquatic seed breeding. But the reclamation is the activity changing the natural environmental property. It converts the tidal flat into land where mariculture can't be developed and marsh conservation can't be arranged. Therefore, the reclamation conflicts with the latter three activities.

In addition, pipeline engineering conflicts with harbor and anchorage, sewage drainage conflicts with mariculture and salt field, digging sand conflicts with shore protection, anchorage, pipeline engineering.

### **3.4 DAMAGE ONLY TO ONE SIDE**

Blocking up the tidal inlet endangers mariculture. Large-scale blocking engineering will do great harm to the ecologic environment and mariculture. For example, the dam of Fangjiangyu was finished in 1979 with the enclosure area of 9.04km<sup>2</sup>, of which the water area is 2.67 km<sup>2</sup>. Since the dam was built, the mariculture environment of Qingjiang mouth has been changed, salinity was dropped sharply especially in flood, hundreds hectare of aquatic breeding base has been vanished, the famous Yangdan fragrant fish cannot reach the sea to lay eggs and it has been destroyed. Furthermore, the former outstanding Qingjiang mariculture base was degenerated, and the base of experiment mariculture belonged to Wenzhou was compelled to move to other region(Su Jilan, 1999). Simultaneously, the first-stage project of Xuanmen dam with the length of 145m was finished in 1977, which made Yuhuan island connecting to land. After this project, the mouth of Leqing bay passing through the sea was decreased from two to one, which changed the environment of Xuanmen bay, the water exchange period was lengthened, the drainage of flood became not so fluent as it was formerly, suspended sediment from sea was decreased, tidal flat was scoured and the mariculture environment was changed, which ultimately influenced spatfalling, the shellfish mariculture and seed breeding at tidal flat.

Both reclamation and blocking engineering endanger harbor and channel. Reclamation and blocking up the tidal inlet at inner bay will decrease the tidal prism (Speer.P.E.,1985), decrease the water depth of channel and influence harbor function. For example, the inner Leqing bay will be silted with the thickness of 1–2m after the second-stage project of Xuanmen reclamation by numerical model calculating. Because of large-scale reclamation at the west bank of Leqing bay in the recent several years, the harbor of Puqi has been silted and the former dock has to be moved outwards.

Tidal power station influences the seed breeding. Usually, a power station requires building a dam, which influences the migration of fry and spat, changes the former biology group, affects the former seed breeding base function and reconstructing seed breeding base.

Additionally, bridge over sea, shore industry and sewage drainage are harmful to marsh conservation. Digging sand does great harm to harbor, channel, anchorage, and pipeline.

#### **4. SUSTAINABLE UTILIZATION OF THE RESOURCES IN LEQING BAY**

Leqing bay is an important stage to develop economy for its surrounding area. Abundant marine resources provide excellent condition for developing marine economy in Leqing bay. The utilization current situation, allocation efficiency and ecological environment protection bring about a great influence in the marine economy development. In order to realize sustainable development of economy, there is no choice but to exploit marine resources reasonably.

In the recent 20 years, the marine economy develops rapidly and continually, which has become a new growth point to the national economy of Leqing bay surrounding area. The value added in the marine industry at Taizhou and Wenzhou are  $62.81 \times 10^8$  yuan and  $37.88 \times 10^8$  yuan in 2000, the proportion to GDP of Taizhou and Wenzhou are 9.4% and 4.4% respectively, it exceeded the national average proportion of 3.44% in 2001. There is no doubt that the sustainable utilization of resources and the favorable ecological environment will ensure that national economy developing sustainably around Leqing bay.

Sustainable development puts stress on development. Only by developing economy, improving the level of science and technology, can we protect and improve the environment quality. Developing marine economy must pay a price of some resources and environment, but if the cost of resource consumed and environment damaged is too high, the marine economy will not develop sustainably. Therefore, whatever any exploitation will be done, the bearing capacity of resources and environment must be taken into account. That is to say, the unrenewable resource should be used reasonably, and the exploiting rate should not surpass the renewal rate relative to the renewable resources, ecological environment should be circulated well, only then will the resources satisfy not only to us but also to our offspring (Zhang Dexian,2000; Yi Wujun, 2001).

In order to bring the potentiality of resource into full play and keep the marine economy developing sustainably, the integrated coastal zone management (ICZM) must be consolidated. A marine organization should be established making up of the four surrounding counties to administer the common matters: according to the national law of sea area utilization and management, the national law of marine environment protection, etc., establishing the local law such as layout of marine exploitation, the division of marine function, the rule of compensated usage, etc.; harmonizing the contradictions among various resources exploitations, contradiction between resource exploitation and ecological environment protection, as well as the contradictions among various region and department; monitoring and administering the exploiting activities.

#### **REFERENCES**

- Yun Caixing, Jiang Xingwei, 2002. Sustainable development and integrated management of coastal zone, *China Ocean Press*, Beijing.
- Su Jilan, Jiang Tieming, 1999. Strategical study on constructing a great marine economy province of Zhejiang, *China Ocean Press*, Beijing.
- Speer.P.E., Aubrey,D.G.. 1985. A study of non-linear tidal propagation in shallow inlet estuarine systems[J], *Estuarine ,Coastal and Shelf Science* , 21:207~224.
- Zhang Dexian, Chen Zhonghui, Dai Guilin, etc.,2000. Theoretical study on sustainable development of marine economy, *Qingdao Ocean University Press*, Qingdao.
- Yi Wujun, 2001. Resource, environment and its sustainable development, *China Ocean Press*, Beijing.