Government Policies, Economic Development, and Possible Environmental Effects at the Land-Water Interfaces of Guangdong Province, China

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Abstract The coastal zone of South China is characterized by many features that are shared by other developing countries. It is a long-inhabited area with lengthy coastlines, dotted by several modern cities and a large number of fishing ports. Because of heavy population pressure, large demand for food, and the drive to develop modern industries, extensive embankment and reclamation schemes are undertaken, leading to many ecological feedbacks, such as heavy silting of the estuaries, pollution of coastal waters, and depletion of fishery resources nearby. The recent development of offshore oil and gas fields on the continental shelf of the South China Sea has further complicated the issue. On the one hand, one can anticipate rapid economic development along the coast; on the other, there is higher risk of environmental disasters. It is thus necessary to strengthen the present environmental surveillance system and the research effort on the environmental economics of the area.

Introduction

Marine-based resources are of growing importance to most coastal developing countries. These resources could be exploited for export,

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as well as for domestic consumption. To most of these countries, foreign exchange earnings are a "necessary," though not sufficient, condition for economic development. The export of products from their coastal waters could thus increase their foreign currency earnings, thereby speeding up their process of economic development. On the other hand, with the progress of modernization and economic development, it is highly likely that their citizens will demand both more food with high protein content and more energy. To those developing countries with extensive coastal zones and continental shelves, it is logical to look for sources of supply of protein, of energy, and of products that could be exported from these areas and waters. This statement is especially true when the terrestrial portions of these countries become very congested and more and more expensive to develop.

Ideally, economic development and exploitation of marine resources would not be at the expense of the environmental quality of these waters and their surrounding areas. Unfortunately, to achieve the "peaceful coexistence" of economic development and a preserved environment is much easier said than done. In some cases, the physical and socioeconomic constraints do, in fact, pose a major conflict between environmental and economic objectives. In other cases, however, these constraints are less binding. Frequently, problems of environmental degradation are largely the product of poverty, so that economic development can generate the required resources to alleviate the degree of degradation.[1] In both cases, however, one can see that a rational management strategy tailored to meet the needs of the local situation is essential. Ignorance and greed are perhaps the worst enemies to both economic development and environmental conservation. In general, the governments of the developing countries, rather than the market, are more likely to have the necessary information to decide what kind of management strategy is required. In a centrally planned economy, like the People's Republic of China, the role of government is even more critical in taking up this responsibility and is thus of greater importance than its nonsocialist counterparts.

This paper is a survey of the major marine-based resources of Guangdong Province. Guangdong has the longest coastline among all coastal provinces of China. The total length of its coastline is

8,449.6 km, of which 4,314 km is on the Mainland portion and 1,477 km on Hainan Island. The rest is made up by the various offshore islands.[2] Because of these offshore islands in the South China Sea in addition to the long coastline, the marine resources potential of Guangdong is very rich indeed. For the sake of convenience, the marine resources of Guangdong are grouped under four headings: potential land supply and aquaculture, marine fishery, offshore oil fields, and coastal navigation. Before going into the details of the individual marine resources of Guangdong Province, we will first review the essential Chinese policies which have significant bearing on marine resource management.

Decision Making in Marine Resource Management

The marine resource management system in China is very complicated, with many interactions and feedbacks between the individual elements. Marine fisheries are considered one of five agricultural activities in China: farming, forestry, animal husbandry, domestic sideline practices, and fisheries. Chinese government policies with respect to industry, agriculture, conservation, and ports and shipping all have their impact on the economic health of the fisheries.

Unfortunately, owing to the overemphasis on grain production before 1976, the financial resources available to the other four agricultural activities were limited. Hence, the industrial sector was constrained to construct mostly shallow sea vessels. Deep-sea fishing vessels were considered too costly and too demanding in terms of advanced technology such as electronic devices and refrigeration. Industrial sector policy was against heavy investment in such technology.

Another result of the emphasis on grain production is that much of the shallow seabed adjacent to the shore has been reclaimed for farming. This practice has led to the destruction of the spawning grounds of many fish and to silting of many natural harbors and navigable channels. With the benefits of hindsight, many reclamation sites are seen as counterproductive from the viewpoint of marine resource management. Reclamation sites have severely affected many anchoring grounds of fishing vessels and the potential development of many seaports.

Another source of difficulty for the fisheries was the lack of a coherent conservation policy, primarily because of the mistaken perception that marine resources are inexhaustible. Unfortunate results of this perception are the encouragement of overfishing in shallow seas and increased pollution levels of sea waters, especially at the river estuaries.

The change of agricultural development strategy in China since 1976 has reduced the emphasis on grain so that more funds could be channeled to the fisheries. Marine pollution, the undesirable impacts of reclamation, and the diminishing yield from the shallow sea resulting from overfishing in the past three decades have forced the Chinese government to give more attention to environmental conservation and related legislation. Deep-sea fishing, aquaculture, restricted reclamation, and control of toxic substances emitted from agriculture and industries are now considered as possible alternatives and remedies to the previous harmful practices. The new policy slows the reclamation of foreshore seabeds, reduces overfishing in shallow seas, and reduces marine pollution. Hence, less new land for farming and salt pans but an improved marine fishery resource will tilt economic returns more toward the marine-based economy.

The Utilization of Various Marine Resources of Guangdong Province and the South China Sea

Reclamation and Aquaculture

Between 1951 and 1980, Guangdong reclaimed and enclosed 1.40 million mu (938 km^2) of foreshore for agricultural uses. Of this, 0.95 million mu (68% of the total) have been put into agricultural production.[3] In general, the reclamation in Guangzhou, Zhanjiang, and Foshan districts has been quite successful. Shantou District has been less successful. The least successful areas are the Huizhou District and Hainan Island. The successfully reclaimed areas resulted from choosing suitable sites in order to make the best use of the reclaimed land, and from short payback periods (1–2 years). The walls at the reclaimed fields have also protected the fields at the littoral zone from exceptionally high tides during stormy weather. In contrast, the embankments of the reclaimed field in the less successful Shantou District were built on natural submerged sand-

bars. Although reclamation cost only 320 yuan per mu (about half of the Guangzhou case), it left much area unfilled. The grain yield at the reclaimed fields is unstable, and the reclamation totally destroyed the habitat of the jellyfish of the district, seriously affecting the livelihood of many fishermen. Most of the unsuccessful reclamation areas did not have comprehensive planning. Many did not build their embankments up to the required standard. Consequently, they collapsed during stormy weather. The reclaimed fields are poorly drained, so that the crops are inundated after heavy rain.[4] Fresh-water supply is also a problem. Much of the reclaimed 70,000 mu on Hainan Island, for example, is deserted because of salination.[5]

Because of frequent rain, salt production is not important in Guangdong. Apart from the various pockets of salt pans along the coast, the only massive salt pan is at Yinggeju, at the southwest end of Hainan Island. Built in 1957, it has an area of 3,800 hectares and, with a yield of 230 metric tons per hectare, annual productivity amounts to 800,000 tons.[6] However, this figure represents only a small fraction of the Chinese total and is hardly comparable to the productivity of salt pans in North China.

Aquaculture in China includes the growing of seaweeds (of which kelp is the most important) and the rearing of various kinds of fish, shellfish, and other marine aquatic products. Although the area potentially suitable for aquaculture in Guangdong is enormous, up to 1.7 million mu, the existing area is currently seriously affected by reclamation, resulting in a reduction of annual output.[7] For example, as stated above, reclamation at Shantou District has affected the aquaculture of the area. Recently its annual output dropped to 3,300 tons, only about 15% of its peak (at 22,400 tons).[8] Taking Guangdong as a whole, annual output is now only 8,000 tons (8,662 tons in 1980, 1.57% of all marine products),[9] well behind the peak years in the 1950s. Its rank in Chinese aquaculture has receded from second to sixth. Although the currently active aquatic farms employ only 19.5% of the potentially suitable area, the possibility of recovery is still there.[10] However, careful and comprehensive planning is needed.

A second threat to aquaculture in the foreshores and the shallow sea is toxic chemical substances emitted from the cities and industrial areas. The increasing usage of artificial fertilizers in the zone

has the effect of enhancing the level of nutrients in the shallow sea because some of the fertilizer is washed to the sea by rivers and groundwater. The result is uncontrolled growth of seaweeds and algae that compete with other aquatic creatures for oxygen. Increasing application of insecticides and weed killers such as R666 and E605 has left many poisonous residues that are ultimately washed to the streams and rivers. Many artificially reared fish were killed in this manner. A few figures about marine pollution in China suffice to show the potential magnitude of the problem. About 12,728 metric tons of petrochemicals, 1,074 tons of chloride, 10,501 tons of lead, 12,270 tons of zinc, 2,273 tons of copper, 285 tons of chromium, 219 tons of cadmium, 11.4 tons of mercury, 392 tons of R666, and 8.72 tons of E605 are annually emitted into the Pearl River estuary.[11] These amounts are considered well over the internationally acceptable standard and thus harmful to the marine biological environment of both natural and artificial fisheries.

In order to design a better policy of control and conservation of the foreshores and the littoral zone along the Chinese coastline, a survey team of more than 10,000 people was vested in 1980 with the responsibility to study the zone (the exact width of the zone is 10 km from the coastline and up to 10–15 meters deep on the seaward side). So far 9,000 km of coast have been surveyed. If everything goes smoothly, the survey would be finished by the end of 1986. Preliminary results of the survey suggest that China in general has a total of 20 million mu (13,400 km^2) that can be used for artificial breeding of aquatic products. Only 20% of this potentially suitable area has been developed, of which Guangdong has a significant share.[12] Scientific surveys of this kind would thus pave the way for more rational uses of the littoral zones and foreshore seabeds and facilitate the development of a policy of conservation and sound management of the zone.

Guangdong Fisheries in the South China Sea

Of the four seas that make up China's shoreline, the South China Sea, facing Guangdong Province, is the largest in area and second largest as measured by yield of marine catch. As a whole its rate of utilization is also the lowest (Table 1). Hence, between 1960 and

Table 1
Fishery Resource and Degree of Exploitation

	Area km^2	Yield in Tons, 1980	Percent of Sustainable Level	
			Surface	Bottom Stream
Bohai Sea	77,000	294,314 (10.46%)	100	150
Huanghai Sea	380,000	515,069 (18.31%)	93. 3*	171*
East China Sea	770,000	1,415,260 (50.32%)		
South China Sea	3,500,000	552,174 (19.63%)	50	80
East of Taiwan	—	35,872 (1.28%)	—	—
Total	4,880,000	2,812,689 (100%)	62.23	125.6

* Includes East China Sea as well as Huanghai Sea.

Source: Geographic Research Centre, Academia Sinica, *The Pattern of Chinese Agricultural Production* (Beijing: Agriculture Press, 1983), p. 222.

1976, a popular belief among local government officials was that the South China Sea was not yet fully exploited. Consequently, the local government officials of that time did not consider any necessity of protective measures.[13] As they wanted to increase production, the cheapest way was to enlarge the fleet of inexpensive sailing boats. Consequently, 98% of the fishing fleet in the South China Sea is nonmechanical, a fleet that concentrates on the shallow sea not far from shore.

Figure 1 indicates the annual output of marine catch of the South China Sea in selected years. The catches in 1979 and 1980 were well below that of 1974 and about the same as that of 1972 in spite of

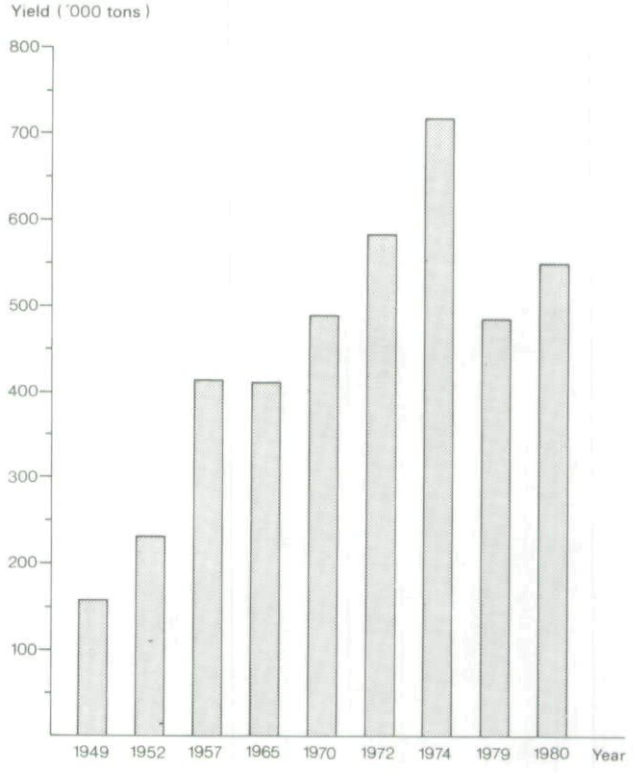

FIGURE 1. Annual production of marine aquatic products in South China Sea. *Source:* Geographic Research Centre, Academia Sinica, *The Pattern of Chinese Agricultural Production* (Beijing Agriculture Press: 1983), p. 228.

the enormous growth in the number of fishing boats. Moreover, out of 486,000 metric tons in 1979, about 8,000 tons were from artificial aquatic rearing. The quality of the catch from seawater has also declined. The 18 types of fish of high economic value declined from 30% of the total catch in 1963 to about 14% in 1976 (i.e., about 76,000 tons).[14] The rest are fish having little value and young fish. It was reported that the last category weighed as much as 90,000 tons (18–20%) and were only marginally marketable.[15] An official motto of this decade was, "If the young fish are inedible, using them as fertilizer is still a contribution."[16] The deficiency of this line of thought became apparent in the late 1970s when the schools of fish of economic value almost disappeared. This dramatic decline can be exemplified by the statistics collected in the Pearl River estuary as shown in Figure 2. The Guangdong government responded to the problem and announced, starting from 1981, a period of prohibited fishing at the Pearl River estuary (from the 20th day of the fourth month in the lunar calendar to the 20th day of the seventh month) in order to save the young fish from trawlers.[17]

It seems quite clear, therefore, that the shallow waters of the South China Sea are not underexploited. In fact, it is estimated that the total reserves of fishery resources within 130 million mu of shallow sea (less than 40 meters deep) is about 1,125,000 to 1,300,000 tons. The sustainable level of catch is about 500,000 tons.[18] With most of the catch in the South China Sea concentrated in the shallow sea, the level of utilization in this zone is clearly 100% or more.

The overall percentage of utilization in the South China Sea in general is determined by the fact that most of the fishing vessels do not have the ability to venture into the deep sea. This is unfortunate because deep-sea fishing has very good prospects in the South China Sea. According to some preliminary studies sponsored by the Guangdong government, deep-sea fishing might produce an average yield of 625 kg per trawling, with various types of deep-sea fish and even deep-sea prawns.[19] The greatest difficulty at present is the absolute lack of deep-sea fishing vessels and refrigeration technology. A second problem is the eating habits of the Chinese, which may take time to change. At present the preference for many deep-sea fish is only marginal and not as strong as for the "fish of economic value" found in shallower water. Third, many parts

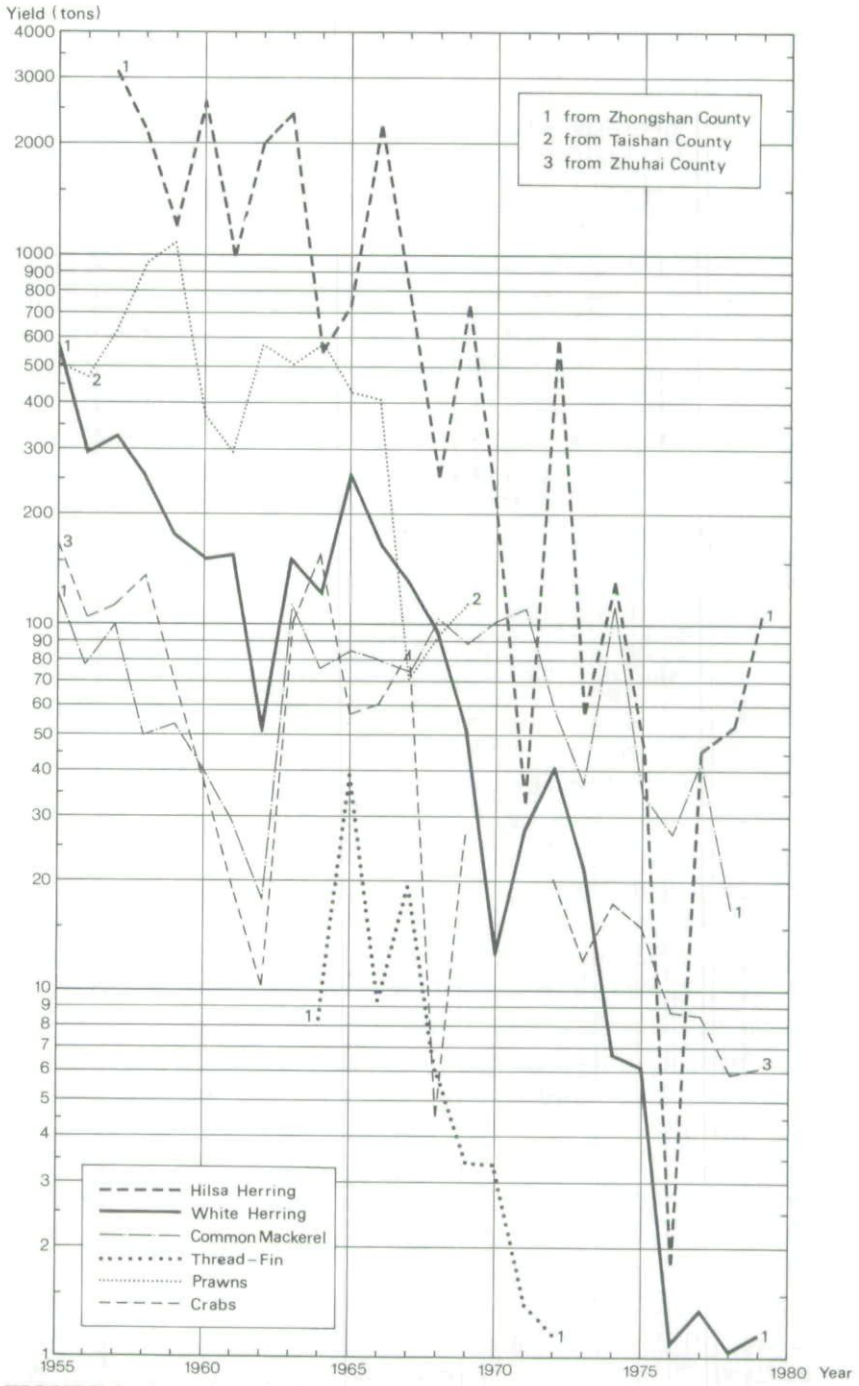

FIGURE 2. Annual catch of marine aquatic products from sampled counties at the Pearl River Estuary. *Source:* Personal communication.

of the South China Sea are areas of international conflict and possible military confrontation. The sovereignty of China over the South China Sea islands has been challenged by Vietnam and the Philippines. Political tension will not help deep-sea fishing in the South China Sea.[20]

The development of deep-sea fishing and the establishment of protective zones will certainly be helpful to ease the degree of overfishing in the shallow sea and to restore some kind of balance between catch and renewal of the fishery resource. Nevertheless, they will not replenish the losses caused by land reclamation and pollution. Better control of these two problems seems necessary if the fishery resource of the South China Sea is to be exploited optimally. Last, it might be worthwhile to emphasize that development of deep-sea fishery resources requires careful planning if the lessons of overexploitation and unwanted conflicts with shallow-sea fisheries are to be avoided.

Offshore Oil Fields in the South China Sea

An even more promising future in store for Guangdong is its offshore oil in the South China Sea. Many foreign oil companies are involved in the development of the South China Sea offshore oil fields. Figure 3 shows the location of some important fields. Of the 43 blocks (about 150,000 km^2) of invited foreign tenders, 31 (72%) are located in the South China Sea (22 in the Pearl River estuary and nine in the Beibu Wan). Total and Arco's blocks are not included. The total estimated reserves of the three oil-rich offshore basins vary, but middle-of-the-road estimates are as follows: Beibu Wan, 1.6 billion barrels; the Yingge Hai Basin, 2.7 billion barrels; and the Pearl River estuary basin, 5.8 billion barrels (Figure 3).[21] In other words, about 10 billion barrels of oil reserves are under the South China Sea.

However, massive investment will be needed before any profitable oil flows can be set up. It has been estimated that China will need between $75 billion and $78 billion to develop its offshore oil resources.[22] The bulk of this sum will be spent in the South China Sea. Most experts anticipate that the $75–78 billion would not be

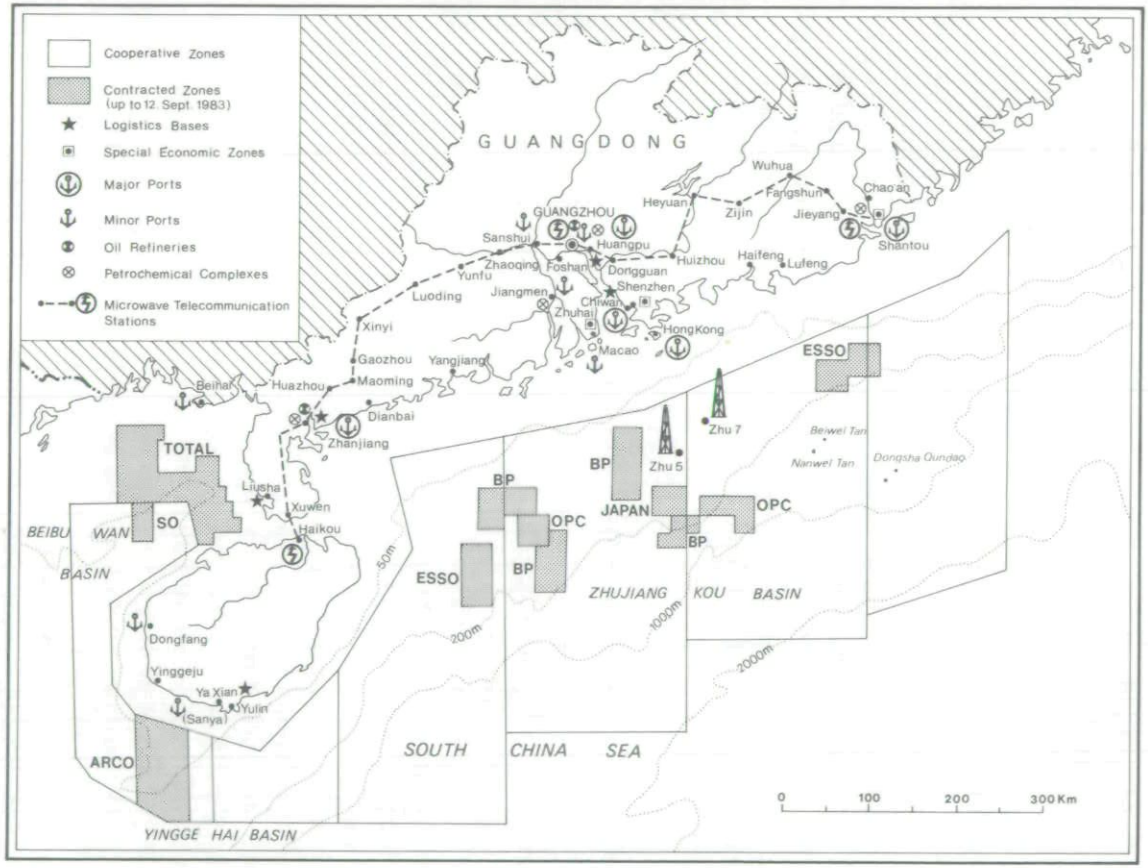

FIGURE 3. The South China Sea oil fields. *Source: China Oil*, vol. 1, no. 1, 1984, pp. 68–69.

spent until 1990 or after. Between now and 1987, the foreign companies will spend only about $1.5 billion on about 100 exploratory wells.[23]

A decade from now, the Chinese offshore fields may produce 750,000–1,000,000 barrels a day, of which the South China Sea offshore oil fields alone would contribute 600,000 barrels. To reach that level, the South China Sea oil fields would need an investment of US$20 billion between now and 1995. More would be needed after 1995 if the output level were to be increased (a rate of 1.6 million barrels a day would probably require a total of $40 billion).[24] Apparently, some of this investment will be spent abroad for purchase of technological equipment. Nevertheless, at least half of it will be spent in the region. As such, the investment on the South China Sea oil field will act as a very strong stimulus to the Guangdong economy. For example, among the 12 categories of supporting services for the oil fields, five specialized services were allocated to the Petroleum Ministry and foreign companies, and seven general services were assigned to the provincial companies and departments.[25] Understandably, the multiplier effect of these investments will not stop at the oil-related industries. The effects will probably go through the whole Guangdong economy.

The development of offshore oil fields has passed the point of no return. The risk of oil spills and sinking of tankers and rigs, as demonstrated by the sinking of the *Glomar Java Sea* during a storm in Beibu Wan, and the likely proliferation of oil refineries along the coast of Guangdong should be given due consideration. Experience shows that development of offshore oil fields may not have immediate direct impacts on the surrounding environment unless there are accidents. However, the indirect impact of stimulating the establishment of onshore oil refineries may be detrimental to the aquatic resources nearby. Zhanjiang, Maoming, Zhuhai, Huangpu, Nantou of Shenzhen, and Shantou are all examples of districts having ambitious plans for oil refineries. If the plans are realized, the aquatic resources, especially the oyster beds nearby, would soon be endangered. An in-depth evaluation of the benefits and costs of these oil refineries seems to be necessary before the green light is given to the plans for these locations. Otherwise, the damage to the adjacent environment may be critical or irreversible.

Sea Transportation and Seaports

In China as a whole, coastal transportation is relatively less important than the railway. However, in Guangdong Province the coastal shipping lanes are of local importance. Given that the railway network within Guangdong Province is not very well developed, freight transportation between the various portions of Guangdong has to rely on either roads or coastal shipping. The role of shipping links has never been more important because Zhanjiang has now been designated as an offshore-oil-field supply center, and Shantou has been designated as a special economic zone. Hainan Island will be another region devoted to foreign joint-venture enterprises. Shipping links between these growth centers and Hong Kong will be of critical importance for their development. With the development of the oil fields and petroleum refinery industries, additional capacity of oil tankers will be deemed necessary. Economic growth in other sectors will also create additional demand for other cargo ships.

Ill-conceived reclamation of the foreshores in the natural harbors and estuaries for more farmland in Guangdong—for example, Shantou and many fishing ports—has resulted in the reduction of water surface, heavy sedimentation, and disturbed tidal currents. Further reclamation may render the Shantou harbor useless for modern navigation. Because natural harbors are scarce marine resources and important to economic development, it may be counterproductive to have more farmland at the expense of a natural harbor.[26]

Conclusion

To sum up, if Guangdong sets its eyes not only on terrestrial resources but also on marine resources, the available marine resources could help speed up the process of economic development. Unfortunately, the government policy of Guangdong for the past decades has been destructive to the available marine resources. Most important are the many imprudent attempts at reclamation, overfishing the shallow and near sea, and emission of pollutants in the rivers and seas. Fortunately, some correctional measures have been taken. It is hoped that the Guangdong government has learned its lesson and will not repeat the errors. However, stimulating economic growth—for example, the exploitation of the South China Sea oil

fields—will generate new sets of problems that may demand new solutions. The current conservational measures may not be comprehensive enough to provide ready answers. An attentive local government is thus needed more than ever in Guangdong to handle and monitor the new challenges. Systematic surveys of the various types of marine resources, clever mixes of modern and traditional technology, and employment of up-to-date pollution-control devices would all help in formulating a policy that is conducive to economic growth without being detrimental to the ecological environment.

Besides a comprehensive policy, what is equally important to the management of Chinese marine resources is to improve its system of collection of related statistics. The current statistics available, including those reported in this paper, are at best crude estimates of the existing reality. It is clear that no meaningful analysis of the economic trade-offs involved between different uses of resources and environmental preservation or control is possible unless accurate data are at hand. In view of these shortcomings, it is perhaps only possible to conclude that there may be tremendous potential economic benefits from oil-field development in the South China Sea and perhaps also from some well-planned projects of coastal reclamation. However, the real costs of these developments are uncertain given that their full environmental impacts on adjacent physical environment, on fishery resources nearby, and on the settlements along the coast are now still unknown.

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