Case Study
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Xiamen's Transition to Orderly Seas

Conflicts among Rapidly Growing Marine Industries and the Environment

Xiamen has sustained one of the fastest economic growths in China. After a decline in commercial activity in the mid-20th century, it was selected in 1980 as one of the country's first four experimental special economic zones and has since risen to one of the world's top 20 ports (PEMSEA, 2006a; Alphaliner 2009). In 1980-1995, the average annual growth rate of Xiamen's gross domestic product (GDP) was well over 20 percent, and its marine economy was growing at an even faster rate. By 1996, there were massive civil infrastructure projects, 101 km^2 of marine aquaculture (Tao, et al., 2005), 15 million tons of cargo, and 5.1 million tourists passing each year through this city of 1,565 km^2 land area and 334 km^2 sea area (ITTXDP, 1996a; Xiamen Statistical Yearbook, 1997).

Due to lack of adequate regulations, coordination, and enforcement, the rapid growth and increased intensity of sea use in Xiamen led to conflicts among the various coastal uses and to unsustainable levels of use (Chua and Gorre, 2000). Large areas of natural habitat were degraded and native species inhabiting these areas declined. These conflicts were wasting valuable resources while poor protection of legitimate businesses hindered investments. In Xiamen, the West Sea was the area where there were the most use conflicts (ITTXDP, 1996a).

Conflicts in the West Sea

Conflicts between fisheries and shipping. Aquaculture structures filled the West Sea and delayed passage and anchorage of ships for several hours at a time. Fisheries authorities issued permits for eel fry gathering without adequate consideration for navigation, thus the situation was further aggravated during the eel spawning season (ITTXDP, 1996a; PDMO, 1996). These delays in shipping due to fisheries obstructions were estimated to have cost the shipping industry from RMB 1.74 to 2.67 million/year from 1991 to 1997 (about US$ 332,365.5 – US$321,299.6[1]) (PEMSEA, 2006b). Shipping-associated pollution in turn damaged aquaculture produce (XDPO, 1998). Vessel collisions resulted in damage on both sides. In 1995, development of a new shipyard in Paitou village, Haicang Town, was delayed when oyster and fish farmers refused to yield rights to the tidal flat (PDMO, 1996).

Conflicts among coastal engineering, conservation, and shipping. Mangrove forests were converted to agricultural fields, aquaculture ponds, and urban construction projects. Thus, there was little to keep upland sediments from flowing into the sea. In addition, construction of causeways blocked tidal water flow and outflow of silt. These and intentional land reclamation significantly reduced the West Sea area from 110 km^2 in 1952 to 52 km^2 in 1997. Sediment had to be continually dredged out at the cost of approximately RMB 24.5 million/year in order to recover the depth of major navigational channels needed by the shipping industry (PEMSEA, 2006b).

Conflicts among waste disposal, fisheries, and tourism. Only about a third of sewage was being treated in 1996 (PEMSEA, 2006b). Aquaculture wastes, untreated domestic sewage, pesticide-laden agricultural runoff, and hazardous industrial and shipping wastes and spills poured into the West Sea. Red tides were common and major fish kills occurred around twice per year. Pollution costs the fisheries industry from RMB 5.9 million to 0.25 million/year in fisheries production (Peng, et al., 2003; PEMSEA 2006b) in addition to other social and economic effects (XDPO, 1998; PEMSEA 2006b). Due to domestic sewage and mariculture, bacterial coliform levels (3,914/liter) were nearly double the levels allowed for recreational seawater (i.e., 2,000/liter) (ITTXDP, 1996a). Sediments near top recreational destinations, Gulangyu and Yuandang Lake, exhibited high concentrations of dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs) (Xue, et al., 2004). In addition, sand from nearby beaches that used to be enjoyed by residents and tourists on the eastern coast of Xiamen Island was being illegally mined to supply the booming construction industry. These drove away Chinese white dolphins, Chinese egrets, as well as tourists.

[1] US$1= RMB 5.2352 (1 January 1991); US$1=RMB 8.31 (31 December 1997)

GEF
Global Environment Facility

UNDP
United Nations Development Programme

UNOPS
United Nations Office for Project Services

PEMSEA
Partnerships in Environmental Management for the Seas of East Asia

Conflicts in Tong'an Bay

Conflicts between waste disposal and fisheries. Sediments and pollution were also taking a toll on fisheries production in Tong'an Bay. In Liuwudian, 22 km^2 of sandy fishing grounds that used to yield from 70 to 150 tons of lancelet (*Branchiostoma belcheri*) per year in the 1950s were smothered by mud from reclamation and causeway construction. Catch declined to 1 ton/year in the 1970s (Chua and Gorre, 2000). Industrial wastewater and oil spills also damaged aquaculture production worth millions of RMB (XDPO, 1998).

Similar conflicts in other parts of China

In addition to similar conflicts between shipping and mariculture, various other sea use conflicts were also happening all over the country: fishing trawlers breaking submarine telecommunication cables and petroleum pipelines off Shanghai, "mass fights and personal injuries" due to disputes over reclamation of or access to tidal areas between adjacent villages in Zhejian and Guangxi, and unregulated reclamation of tidal areas in Guangdong and Guangxi (PEMSEA, 2003).

Uncoordinated Governance of the Sea

The legislation upon which local government bureaus based its operations was largely sector-oriented, and operational mechanisms to harmonize development across sectors were weak. Separate local government bureaus or committees managed each of the various coastal sectors in Xiamen: fisheries, transportation, ports, construction, tourism, defense, and the environment. The bureaus managed interrelated mandates and sometimes conflicting activities with little regard for their effects on other sectors. Information was fragmented and bureaus were not accustomed to consulting each other. Despite an expressed priority for ports and shipping in Xiamen City's vision, there was no mechanism by which the bureaus could jointly decide to favor one sector over another to optimize overall societal benefits. At the same time, since different bureaus were responsible for different sources of marine pollution, there was little sense of responsibility for the overall polluted state. Economic development was generally prioritized over sustainability. Enforcement was poor partly due to lack of resources in the various regulatory agencies.

Various local governments in other parts of China began issuing ordinances for sea use management to reduce cross-sectoral conflicts; for example, Hainan issued "Sea Area Use Management Methods" in 1992. In recognition of these initiatives, the State Oceanic Administration and the Ministry of Finance jointly issued Interim Management Rules for National Sea Area Uses in 1993. The rules gave local government marine agencies the responsibility to determine fees and issue permits for sea area use. These were to be done "in consultation with other concerned agencies" but since they were only issued at the agency level, they were not strong enough to regulate cross-sector conflicts (PEMSEA, 2003).

Integrated Coastal Management

In 1994, the GEF/UNDP/IMO's Prevention and Management of Marine Pollution in the East Asian Sea (MPP-EAS) introduced integrated coastal management (ICM) to Xiamen. Among various dimensions of integration, MPP-EAS advocated integration of various coastal-use sectors and coastal environmental management for holistic and sustainable development. The project supported the development of an interagency coordinating mechanism, a multi-disciplinary experts group, an integrated profile of the various coastal sectors, and an integrated strategic plan (PEMSEA, 2006a).

The Xiamen municipal government organized an interagency coordinating mechanism composed of 22 government agencies led by the executive vice-mayor, supported by a Marine Management Office and advised by a Marine Experts Group. A multidisciplinary group composed of environmental, economic, and legal experts, as well as key government planners and managers developed an integrated coastal profile. The profile identified a number of related issues: (1) natural factors and cross-sectoral conflicts that are hampering further development and which in turn are also

affected by development; (2) inadequate government capability (human, organizational, information, legal, financial, technical, enforcement) to manage cross-sectoral issues and pollution in an integrated and effective manner; (3) low environmental awareness among policymakers and the public; (4) lack of a masterplan for the coastal area; and (5) inadequate pollution management (ITTXDP, 1996a).

The interagency interaction helped Xiamen's various government bureaus better understand the usefulness of interagency cooperation and the need for sectoral bureaus to support the objectives of other sectors for holistic development. In particular, ICM helped emphasize the importance of sustainability to Xiamen's drive for development. The ICM coordinating mechanism realized it needed holistic discussions on the desired direction of Xiamen's development in order to resolve the cross-sectoral conflicts that were hampering Xiamen's development.

Together, the various sectoral bureaus forged a common Strategic Management Plan for Marine Pollution Prevention and Management. The strategy called for the following priority activities: (1) to establish an ICM system and to develop related legislation, regulations, capacity, financing mechanism, plan, information system, monitoring and evaluation for coordinated development and environmental management; (2) to increase public environmental awareness; and (3) to develop a "scientifically sound marine functional zonation scheme" (ITTXDP, 1996b).

The ICM initiative precipitated the development of a marine environmental management regulation and a sea area use regulation and associated integrated law enforcement and sea use permit and fee system. These became the twin legal cornerstones of sea area management and sustainable development in Xiamen.

Zoning of Various Sea Uses

The objective of the marine functional zonation scheme was to reduce use conflicts, optimize use benefits, and improve sustainability of use. Spatial information on the following aspects was organized to provide the basis for zoning (Ruan and Yu, 1999):

- the physical environment (including natural hazards)
- coastal resources;
- remote sensing information;
- current uses;
- use conflicts;
- planned uses identified from the Development Master Plan of Xiamen City, Port Development Master Plan, Ocean Development Plan, Fishery and Mariculture Development Plan, and Tourism Development Plan; and
- nature protected areas previously established to protect the lancelet (1992) and the Chinese egret (1995), and new protected areas needed to protect the Chinese white dolphin.

The major sea area uses identified were navigation, fisheries, and tourism.

Based on available information and similiarities of biophysical and socioeconomic (use) characteristics, Xiamen was divided into four subareas: West Sea, Tong'an Bay, East Sea, and Dadeng Sea. The natural characteristics and different current and potential sectoral uses of each subarea were then considered in order to match each area with the use most likely to yield the greatest overall societal benefit. In formulating the options, the team considered both development needs and environmental conservation needs. Some areas were left open for future needs that may develop due to advances in technology.

For example, the West Sea was being used by the transport (shipping and ports), fisheries (aquaculture), and tourism sectors. It was also the former habitat of white dolphins and egrets. Conflicts pointed to the incompatibility between ship navigational routes and aquaculture structures in the West Sea. The task force thus proposed to locate transportation, fisheries, and tourism in different areas. The West Sea was the only area that was deep enough for shipping and ports. The shipping value of the West Sea is worth billions of RMB while the fisheries or tourism value of the West Sea is worth hundreds of millions of RMB. The West Sea had high bacterial loads while Tong'an Bay had low bacterial loads. Most aquaculture in Xiamen was already located in Tong'an. Thus the task force proposed that the priority ("dominant function") in the West Sea be given to shipping and the priority in Tong'an Bay be given to aquaculture. However, tourism was not considered totally incompatible with shipping, and dolphins and egrets could not simply be redirected to other locations. Thus, areas for tourism, where they did not cross navigational routes, were still allocated within West Sea. Furthermore, despite inconvenience to its top earning shipping and tourism industries, Xiamen issued a Regulation for the Protection of Chinese White Dolphins limiting ship speeds to less than 8 knots, and prohibiting underwater explosions, recreational boating, and surfing in a large proportion of the West Sea, which was also white dolphin habitat (**Figure 1**).

In a similar manner, it was proposed that priority to the sandy east coast of Xiamen Island be allocated for tourism and priority to the cleaner waters of Tong'an Bay and Dadeng Sea be allocated for fisheries (aquaculture). In line with this, since waste disposal was not compatible with growing fisheries products, the zoning team

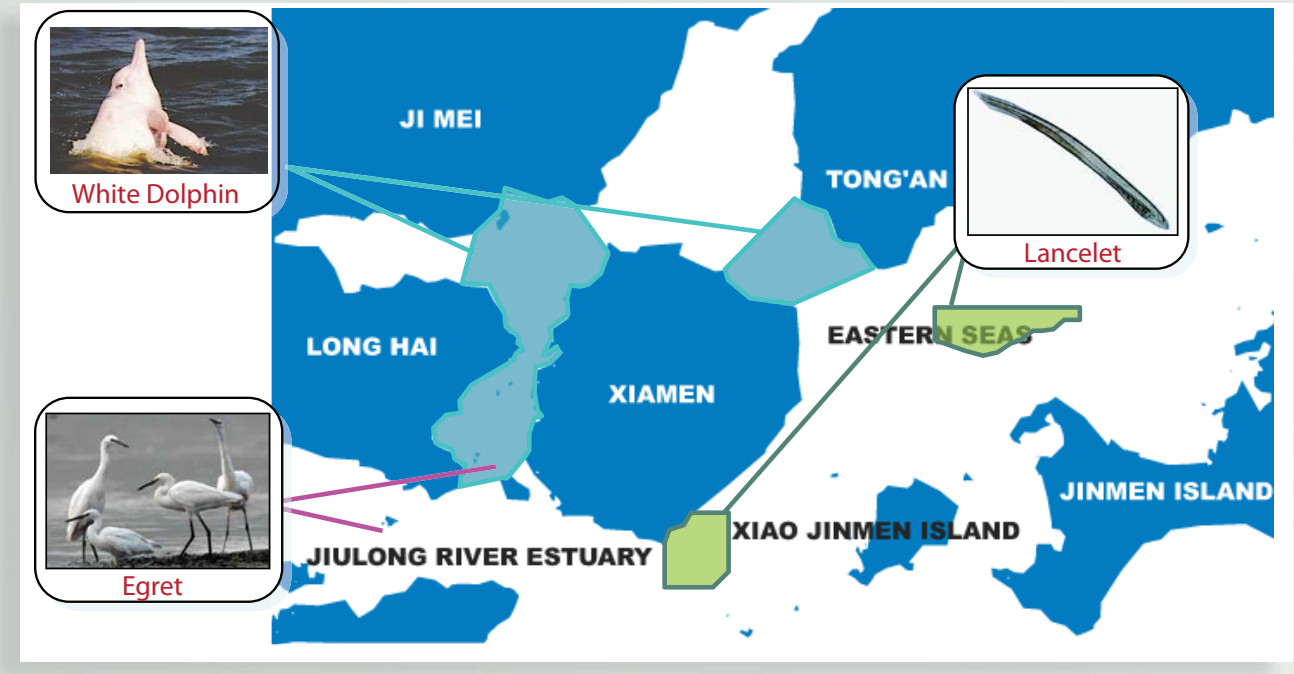


Figure 1. Nature protected areas in Xiamen.

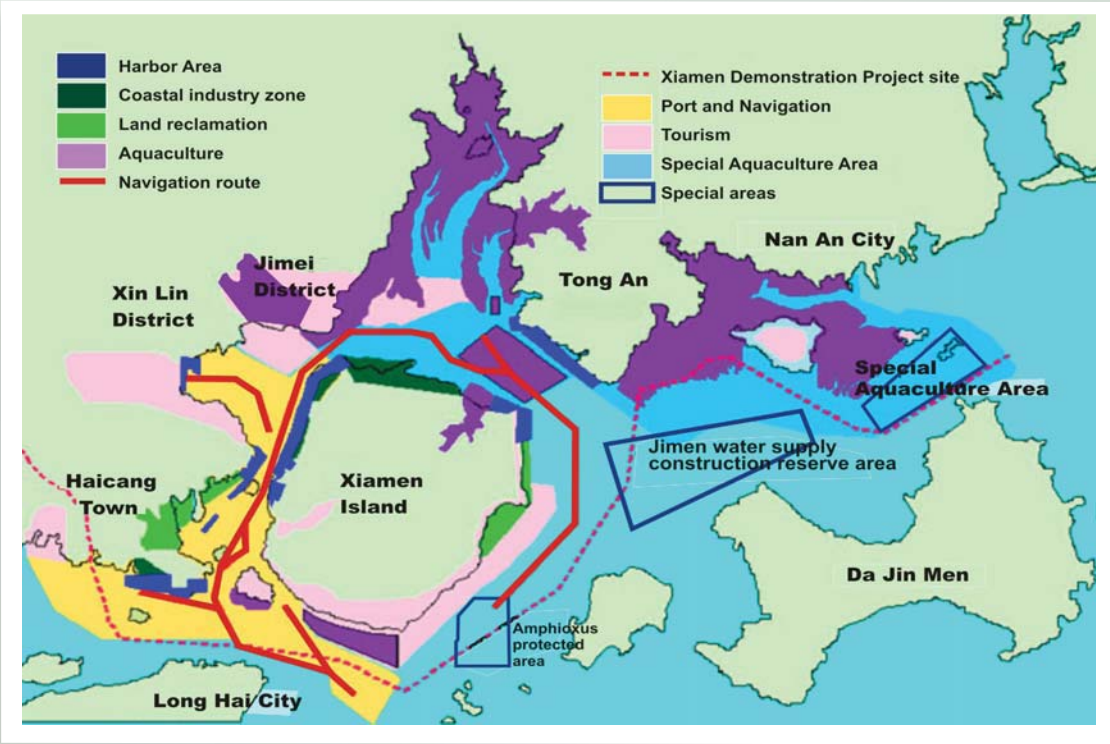


Figure 2. Xiamen sea area use zonation scheme.

recommended that discharge outfalls in Tong'an be relocated elsewhere during evaluation and revision of land-use planning. The municipal government, however, recognized that pollution was generally not compatible with any use and should not simply be relocated. Thus, Xiamen issued, in 1996, the "Regulation on the Protection and Management of the Marine Environment" directing the building of wastewater treatment plants, the treatment of marine pollution, and the rehabilitation of damaged marine ecosystems.

The municipal legislative assembly backed the zoning initiative by issuing in January 1997 the "Regulations for the Management of Sea Area Use in Xiamen", which mandated the development of a marine functional zonation scheme to guide development and supervision of its implementation by the marine management agency.

Throughout 1997, the draft zoning scheme was reviewed and refined through "expert meetings, stakeholder consultations and public hearings". Inevitably, not everyone was happy at the start. For example, seafarmers did not want to be relocated to Tong'an and land developers opposed designation of mangroves in Haicang (West Sea) as nature reserves. Alternatives had to be worked out through negotiation. The seafarmers were given 3 years for the phaseout and were compensated by the shipyard while alternative sites were worked out for the land developers. Some RMB 250 million was paid out as compensation to nearly 13,000 displaced fisher families for property tax relief for relocation and assistance in changing professions (PEMSEA, 2006b).

Eventually, a scheme was finalized that recognized nine types of use zones (**Figure 2**):

- shipping/port;
- tourism;
- fisheries (aquaculture);
- coastal industry (power, shipbuilding, petrochemical, "duty free" zone, airport);
- ocean engineering (reclamation, coastal highway, interisland bridge/tunnel/water conduit);
- mining (sea sand and gravel);
- nature reserve;
- special function (scientific research, outfall discharge, military); and
- rehabilitation (environmental protection, disaster prevention).

Compliance with Zoning and Environmental Management Legislation

After the zoning scheme was finalized, Xiamen directed all relevant government bureaus to follow the scheme in the conduct of their operations and development of projects. Compliance was fostered by orienting government officials of various bureaus in ICM and the zoning scheme. Public compliance was encouraged through continuing the environmental awareness and education program that had been initiated in 1994. This program included newspaper articles, television and radio inputs, incorporation of relevant information into school curricula, public seminars, quiz shows, celebration of ocean and environment days, and an environmental hotline (PEMSEA, 2006b).

Voluntary compliance is ideal but Xiamen also had to improve enforcement of the regulations. In China, each local government sectoral bureau is responsible for enforcing the laws under its legal jurisdiction. Thus there were separate enforcement squads for fisheries, fish ports, maritime safety, harbors, public safety including drug trafficking, customs and smuggling through the sea, and the environment. However, maintaining constant watch by any single agency over a large area of sea is time-consuming and expensive; thus enforcement was far from adequate.



An Integrated Marine Enforcement Squad was organized in 1997 to coordinate and supervise nine different enforcement squads. Unusual activities or violations observed by any member of the various squads would be relayed to the appropriate sectoral enforcement squad. Actual response to complaints or violations was still done by the sectoral agencies, but now many more eyes were on the lookout for each sectoral concern thus boosting overall compliance. In addition, public reporting of unusual activities or complaints was accepted through a hotline telephone number "110". Moreover, since coordination required common standards of conduct across different enforcement squads, the mechanism also helped cross-learning, standardization, and improvement of practices across the various squads.

Each year a thorough checkup of the validity and procedure of all marine projects in the whole Xiamen marine area is conducted by the Marine Enforcement Squad, the Marine Management Branch and the Environmental and Natural Resources Branch of Xiamen Ocean and Fisheries Bureau. The performance of law enforcement is also evaluated annually by the Members of the Municipal People's Congress and the Municipal People's Political Consultative Conference. The people's representatives sometimes even did surprise inspections and participated in patrols (PEMSEA, 2006a).

Xiamen Marine User Fee System

The "Regulations for the Management of Sea Area Use in Xiamen" also mandated a permit and user fee system. The fees help capture some of the benefits of private sea area use for the broader society who are the legal "owners" of the resources. The fees also help internalize or incorporate into the economic and decisionmaking system some of the opportunities lost and the ill effects wrought by individual or corporate sea area use that the public has to bear. Finally, the user fees provide for the administrative costs of managing the system and enforcing use rights.

To these ends, 30 percent of the user fees are submitted to the national treasury while 70 percent are retained in the local treasury. Similar to the specific allocation of waste disposal fees for use in environmental protection (Zijian, 1997), sea use fees are not simply pooled for general use, but rather are allocated for "sea area development, protection and management" (PEMSEA, 2003). Collection of fees in Xiamen rose from RMB 567,500/year in 1999 to RMB 63,920,000/year in 2007 (Zhou, 2007). In comparison, the budget of the Xiamen Ocean and Fisheries Bureau is about RMB 35 million annually including its costs in supervising enforcement of the zoning scheme (PEMSEA, 2006a).

Decreased Use Conflicts

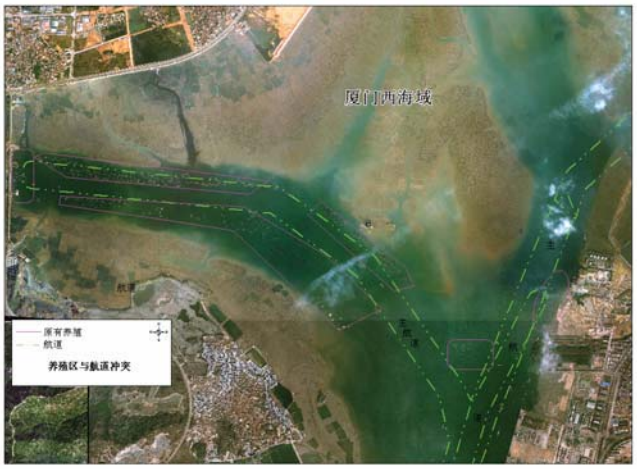
Conflicts between fisheries and shipping. Delays in shipping, reported since 1998, due to fisheries obstructions have been reduced from several hundred vessels being delayed 2-4 hours each to 0 delays. This is equivalent to cost savings of RMB 1.74-2.67 million/year (PEMSEA, 2006b).

Conflicts between coastal engineering and conservation. Reduction in silt accumulation due to reforestation, better environmental management of coastal construction and reclamation projects, and improved water flow from unblocking of causeways has reduced erosion and the need for dredging. Dredging costs have been reduced from RMB 24.5 million/year to RMB 17.2 million/year or cost savings of RMB 7.3 million/year from 1998 (PEMSEA, 2006b). The costs saved from not having to return sand to beaches and from not losing land to erosion are estimated to be worth RMB 0.78 million/year (PEMSEA, 2006b).

Conflicts between waste disposal and tourism. Green area ratio rose from 27 percent in 1995 to 37 percent in 2007. Although ICM contributed to beautifying Xiamen, the increase in tourism cannot easily be said to be due to ICM. There may be many other factors responsible for tourism increase, including overall increase in tourism in China. Nonetheless, from 1992 to 1996, tourism revenue in Xiamen increased at an annual average rate of 8 percent/year compared to an annual average rate of 34 percent in China. After zoning, however, tourism revenue in Xiamen increased at an annual average rate of 17 percent/year from 1997 to 2001 compared to an annual average rate of 10 percent in


West Sea before


West Sea after



Conflict between aquaculture and sea-route.

Conflict between aquaculture and port.

Conflict between aquaculture and island and port.

China (Zhang, et al., 2005; PEMSEA, 2006b; China National Tourist Office, 2009).

Conflicts between waste disposal and fisheries. Treatment of industrial sewage rose from 20 percent in 1994 to nearly 100 percent in the 2000s while treatment of domestic sewage rose from 28 percent in 1995 to 85 percent in 2007. Fisheries losses due to pollution decreased from RMB 5.9 million/year (1990-1994) to RMB 0.1 million/year (1997-2001) (Peng, et al., 2003).

Overall, aquaculture production decreased as a result of zoning; however, the decrease in production was not as lar ge as the decrease in aquaculture area since by the time of the mass removal of aquaculture, production output per area was already low due to crowding and pollution. Moreover, large increases in shipping and tourism have more than made up for losses in fisheries production.

Improved Sustainability

The twin Xiamen regulations on marine environmental management and sea area use not only reduced conflicts, but also improved sustainability. Aquaculture, wastewater, and silt pollution were reduced. Marine protected areas were better enforced. Threatened species were helped to recover. Degraded habitats were rehabilitated. These even helped mitigate climate change even though this issue was not yet as prominent in the mid-1990s as it is today: less oil was used due to reduction in ship waiting time; greening efforts increased carbon uptake and sequestration; and efforts to reduce wastewater discharge also resulted in decreased use of water, recycling of sewage for agriculture, and thus reduced fertilizer consumption.

Lessons Learned

- Strong political will backed by a management and effective enforcement mechanism institutionalized within the government through legislation, broad public support fostered by high public awareness, and sound scientific basis are all necessary if actions for overall societal benefits require that a significant sector must make major adjustments (in Xiamen's case, the relocation of fishfarmers).

- Environmental management can precipitate cost reductions and habitat improvements that in turn redound to socioeconomic benefits. In turn, socioeconomic benefits help secure support for sustainable development program. Marine environmental protection and marine economic development can thus bring out the best in each other.

- Conflicts are costly and wasteful. Poor coordination may be cause for suboptimal or inefficient use of resources. Integrated management can help improve coordination and thereby reduce conflict.

- A resource-rent capture mechanism (e.g., through user fees) helps secure substantial resources required for effective enforcement. In turn, stronger control through inspection and enforcement helps deter evasion of the resource-rent capture mechanism.

Scaling Up

Marine functional zoning reduces use conflicts, improves economic development and sustainability of use, and is thus an operational approach to sustainable development. Xiamen has experienced the benefits of ICM and has adopted it as an approach to sustainable coastal development. Together with the Provincial Government of Fujian and the adjacent cities of Zhangzhou, Longyan, and Quanzhou, Xiamen is now extending the application of ICM to the sustainable development of the Jiulong River Basin area. The local governments in the alliance are coordinating not only the reduction of pollutants, which are the source of 75 percent of Xiamen's pollution from runoff, but

also the planning of transportation, sea use, infrastructure, and tourism development (Zhou, 2007).

In recognition of the importance and broad relevance of zoning based on a review of Xiamen and other local government experiences in sea use zoning, the People's Congress passed in 2001 the Law of the People's Republic of China on the Administration of Sea Areas, which mandates coordinated allocation of sea areas for various sectoral uses. By 2008, all coastal provinces in China had developed and passed provincial sea area use ordinances, which designate areas for fisheries, environmental protection, shipping, tourism, mining, etc. Thousands of field inspections are conducted and over a thousand penalties for nonconformity are issued annually.

Xiamen

Land area (km^2)	1,565
Area covered by ICM (km^2)	Entire municipality (100%)
Coastline length (km)	234
Municipal waters (km^2)	334 sea area
Total number of districts	6
Coastal districts	6
Major seas	West Sea, East Sea, Tong'an Bay, Dadeng Sea
Major river	Jiulong River
Total population (%) (2007)	2.4 million
GDP (2007)	RMB 138.8 billion
Primary (%) (Agriculture)	1.3
Secondary (%)(Industry and Construction)	53.5
Tertiary (%) (Services)	45.2
Value of Ocean Industry (% of GDP) (2003)	23
Employment rate (%) (2007)	96.5

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