

Jiulong River–Xiamen Bay

Ecosystem-Management Strategic Action Plan



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Strategic Action Plan



Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

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June 2012

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Preface

Jiulong River is the second longest river in Fujian Province, a major source of pollutants to Xiamen Bay as well. In recognition of the environmental impact of upstream pollution, the Fujian Provincial Government approved a comprehensive water pollution and ecosystem rehabilitation project in 1999, which involved adoption of a number of policies and regulations on water pollution prevention and treatment and investment. Given the complexity of the river basin itself and the socioeconomic pressures from continued growth, the trans-jurisdictional ecological and environmental problems from the river basin to estuary remain unabated.

From 1994 to 1998, the Xiamen Municipal government resolved sea use conflicts and coastal environmental pollution through an integrated coastal management (ICM) approach, including innovative legislation and institution arrangements, coordination by the municipal government, scientific support, joint law enforcement and public participation, with the assistance of the GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas project. Based on the lessons learned from the water pollution and ecosystem rehabilitation project, and the success of the integrated approach to addressing environmental pollution and sea use conflicts, Xiamen began to scale up its ICM program. The up scaling involved integrating pollution control, ecosystem-based river basin management and Xiamen Bay management into a regional economic development initiative involving downstream and upstream cities.

In 2004, Xiamen, Quanzhou and Zhangzhou established the City Alliance, an initiative among the three major cities in southeast Fujian to promote regional economic development. Longyan, a city at the upstream of Jiulong River, north of Zhangzhou City, became a member as well. While economic development topped the agenda of the Alliance, conservation of the water environment of offshore areas and maintenance of ecosystem services of Jiulong River were important elements proposed by the Municipal Government of Xiamen. During the implementation of the second phase of the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), the Xiamen Municipal Government developed and adopted an ICM Strategic Action Plan in 2005. Integral to the plan were: (a) strengthening the ICM program and the ICM coordinating mechanism; (b) establishing a regional coordinating mechanism and integrated land and coastal area management mechanism; (c) creating an integrated Jiulong River management coordination committee between Xiamen, Zhangzhou and Longyan; (d) establishing an integrated Jiulong River Management Action Plan; and (e) setting up an integrated Jiulong River Management financial mechanism. With the approval of the West Taiwan Strait Economic Zone in 2009, the incorporation of the integrated Jiulong River and Xiamen Bay management plan into the State economic development strategy gained further momentum.

Under this framework, the Xiamen Ocean and Fishery Bureau commissioned a joint study by the Third Institute of Oceanography of the State Oceanic Administration (SOA) of China

and Xiamen University to develop a strategic action plan for an ecosystem-based Jiulong River and Xiamen Bay management. The process involved field surveys, interviews with local communities and staff from the sectors of ocean, environment, agriculture and forestry of the three cities, collection of socioeconomic and ecological environment data, desk review of available management plans and management options, and data analysis. SOA and the National Oceanic and Atmospheric Administration (NOAA) of the United States provided generous support to the project team in scoping, problem analysis, and sharing of lessons from other river basins, in particular the Chesapeake Bay, through their experts.

The objective of the Ecosystem-based Jiulong River and Xiamen Bay Management Strategic Action Plan (JXSAP) is to establish a trans-jurisdictional Jiulong River and Xiamen Bay ecosystem management framework involving the city of Xiamen, Zhangzhou and Longyan. Based on an ecosystem approach, the JXSAP has identified and analyzed key environmental problems, developed a Jiulong River–Xiamen Bay pollution mitigation plan, ecological conservation and management plan and a monitoring program. The ultimate aims of the plans are to enhance the management capacity of Jiulong River and Xiamen Bay, relieve pressure of Jiulong River on Xiamen Bay and ensure river-bay ecological safety. There is no doubt that implementation of the action plan will be advantageous to raising awareness of various stakeholder groups, promoting environment education of the public, establishing sustainable financing mechanisms between the river basin and the bay area, enhancing the coordination capacity between upstream and downstream cities and, ultimately, managing a living river basin and bay that can meet the needs of the present and future generations in the area.

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1

Background

1.1 Background of Strategic Action Plan

Jiulong River, the second largest river of Fujian Province, is the lifeline of the people and ecosystems in the southwestern Fujian province. Xiamen City, located in the Jiulong River estuary, is a famous port and tourist city, and holds an important position in the west-coastal strait economic construction.

The environment quality and health of ecosystems of the Jiulong River and Xiamen Bay plays a great role in the sustainable development of the whole watershed. With rapid economic development, population increase and accelerated urbanization, Jiulong River and Xiamen Bay have been facing serious resource and environmental problems.

For the Jiulong River watershed, the main environmental problems are pollution, soil and water losses and the construction of dam-type hydropower stations.

In 1994, Xiamen launched the integrated coastal management (ICM) programme sponsored by GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas. Xiamen achieved great success in ICM after more than ten years of implementation. However, because the pollutants impacting the environment of Xiamen Bay are mainly from the Jiulong River watershed, which is beyond the jurisdiction of Xiamen municipality, Xiamen has difficulty in fundamentally improving its marine environment quality. In 1999, the Fujian Provincial Government initiated the Jiulong River watershed management programme. Great effort has been put into the integrated environmental treatment and ecological protection of the watershed since then. But the programme did not achieve the expected changes in water quality, and even suffered an algae outbreak in 2009.

The division of administrative areas and departments tasked with environmental management have been main factors for constraining the success of the management projects. It has become an important research issue to solve the increasingly complex and serious environmental problems of Jiulong River

and Xiamen Bay. The success of the undertaking is highly dependent on regional cooperation, involving a combination of watershed management and ICM.

Ecosystem-based Management (EBM) of the river and bay is considered an effective approach to solving transboundary environmental and resource problems. Introducing the idea of EBM for the watershed and coastal zone, the Julong River-Xiamen Bay Ecosystem Management Strategic Action Plan (JXSAP) will focus on land-based pollution abatement and changes in economic growth. It will also integrate the river and sea, by considering both land and sea to achieve improvements in regional environmental quality and ecological security.

The implementation of this Strategic Action Plan aims to transform the theory of Watershed-Bay ecosystem-based management in to practice, enhance the coordination capacity for integrated management, balance the interests and needs of different stakeholders, catalyze a change in the region's production and consumption patterns so as to protect the Watershed-Bay natural ecosystem services, and enhance the sustainable socioeconomic development of the watershed and coastal zones.

The strategic action plan is launched by the Xiamen Ocean and Fisheries Bureau, formulated by the Third Institute of Oceanography (TIO) of the State Oceanic Administration (SOA) and Xiamen University (XU), supported and assisted by the National Oceanic and Atmospheric Administration of the United States of America (NOAA) and regional environmental protection agencies involved in the watershed.

1.2 Research for the Action Plan

1.2.1 Process of Compilation

2007

May 28-29: Xiamen Oceanic and Fisheries Bureau (XOFB) hosted the Julong River-Xiamen Bay Watershed and ICM Workshop, with representatives from the National Oceanic and Atmospheric Administration of the United States of America (NOAA), State Oceanic Administration of the People's Republic of China (SOA), the Third Institute of Oceanography of SOA (TIO), Xiamen University (XU) and Xiamen Environment Protection Bureau in attendance. At the workshop, TIO and XU presented the environmental and biological status of Julong River and Xiamen Bay, and environmental specialists representing NOAA presented a flowchart for integrated management of the river basin and coastal ecosystem.

2008

June 15-19: XOFB and TIO hosted Julong River-Xiamen Bay ecological System Management Project International Forum. The representatives of NOAA, SOA, Zhangzhou Environment

Protection Bureau, Zhangzhou Oceanic and Fisheries Bureau, Longyan Environment Protection Bureau, and Xiamen Environment Protection Bureau were invited.

December: XOFB signed the contract for the Jiulong River-Xiamen Bay Ecosystem Management Strategic Action Plan Project with the TIO. Xiamen University and TIO were tasked to compile the Action Plan, and establish a strategic action plan compilation research group.

2009

October 25: The research group invited four experts and held the expert consultation for the Jiulong River-Xiamen Bay Ecosystem Management Strategic Action Plan Project.

2009

December 29: XOFB hosted an acceptance review. Five experts, namely: Shouming Ou, Institute of Environmental Sciences, Xiamen City; Yunmou Guo, Institute of Marine Research, Fujian Province; Tianyuan Dai, Fisheries Research Institute, Xiamen City; Qi Du, Fisheries Research Institute, Fujian Province; and Liqiong Pan, Xiamen Municipal Bureau of Finance, were invited to form a review group. Review comments were also generated.

2010

March 16: XOFB hosted the Jiulong IRBCAM consultation meeting to collect comments and suggestions from the relevant Xiamen government departments: Xiamen Municipal Office; Xiamen Environmental Protection Bureau; Xiamen Water Resource Bureau; Xiamen Planning Bureau; Xiamen Agriculture Bureau; Xiamen Municipal Administration and Gardens Bureau; Xiamen Tourism Bureau; Xiamen Economic and Development Bureau; Xiamen Port Authority; and the Xiamen Construction Administration Bureau.

Meanwhile, the research group visited and investigated the Jiulong River Watershed several times, interviewing local people, and visiting marine, environmental protection, agriculture and forestry departments, etc. in Xiamen, Longyan and Zhangzhou. The research group sent out about 40 copies of the questionnaires focused on Jiulong River ecological problems and solicited suggestions from the people in the Jiulong River Watershed. Students from Xiamen University interviewed more than 100 local families in Zhangzhou and Longyan City in 15 days.

The research had two major findings. First, there are different ecological issues in different areas of the Jiulong River watershed. In general, the main ecological issues are livestock and poultry farming pollution, agricultural pollution and industrial pollution. The immediate causes are wastewater and waste discharges from livestock and poultry farming, agriculture non-point source pollution and industrial wastewater discharges directly released to the river.

Table 1. Global ICARM Projects.

Asia	America	Europe	Africa	Australia
1. Tigris River, Euphrates River (Iraq, Iran)	1. Chesapeake Bay (USA)	1. Oder River (Germany, Poland)	1. Tana River (Kenya)	1. Moreton Bay (Australia)
2. Chilika Lake (India), Krishna River (India)	2. Colorado River (USA)	2. Danube River (Europe)	2. Rufiji (Tanzania)	
3. Attanagalu Oya (Sri Lanka)	3. Samara Bay (Dominican Republic)	3. Rhine River (Germany, France, Netherland)	3. Yikamati (Mozambique)	
4. Bang Pakong River (Thailand)	4. San Francisco River (Brazil)	4. Danish coastal waters (Denmark)	4. Senegal River (Senegal)	
5. Songkhla lake (Thailand)				
6. Honghe (China, Vietnam)				

Second, the residents of the Jiulong River watershed have realized the necessity and importance of pollution abatement. The deterioration of the ecological environment has affected their lives, particularly in using water for laundry (washing), recreation (swimming) and landscaping, etc.

1.2.2 Review of Literature/Experiences in ICARM

The research group reviewed all available literature on ICARM. **Table 1** shows the approved or already executed representative global cases as of 2007.

1.3 Identification of the Stakeholders

The stakeholders of the Strategic Action Plan mainly involve the following groups:

1. The public and corporations closely relating with the Jiulong River-Xiamen Bay.

These mainly include the residents and the local communities depending on natural resources in production and living in Jiulong River-Xiamen Bay. In addition, tourists, business practitioners and civil society, who are particularly concerned about the ecological protection and economic development of Jiulong River-Xiamen Bay, are also involved.

2. All levels of governments and relevant departments in Fujian Province and the Jiulong River-Xiamen Bay area.
3. Related scientific and technical staff and nongovernmental organizations (NGOs).

1.4 Scope of the Action Area

The Strategic Action Plan covers the whole area of Jiulong River-Xiamen Bay (southwest of Fujian). The total area, the land area is about 14,241 km², and consists of the administrative units in the watershed of Longyan municipality (Xinluo District, Zhangping county), Zhangzhou City (Zhicheng District, Longwen District, Hua'an, Changtai, Pinghe, Nanjing and Longhai), and Xiamen City.

The sea area covers the whole Xiamen Bay, west part of the connection of Estuary-Bay sea area of Zhenhaijiao (located in Zhenhai village, Zhengwei town, Longhai City) and Weitoujiao (located in Weitoujiao village, Jinjing town, Jinjiang). The whole sea area is 2,692 km², and the length of the coastline is 860 km. In order to reflect the ecological connection of Jiulong River– Xiamen Bay, the key sea area for this Strategic Action Plan has been identified as the Jiulong River estuary and West Sea and Southern Sea in Xiamen Bay.

1.5 Action Period

The Strategic Action Plan sets three stages: short, intermediate and long term, setting 2007 as the baseline year.

Short-term:	2011-2015
Intermediate-term:	2016-2020
Long-term:	2021-2025

2.1 Integrated Jiulong River Watershed Management

2

The Status and Challenges in Jiulong River-Xiamen Bay Environmental Management

With socioeconomic development, population growth and urbanization of Jiulong River watershed, the existing development model has led to the continuous deterioration of the watershed quality and degradation of ecosystems, which has not only endangered drinking water supply and health of local people, but also seriously impacted on Xiamen seas downstream.

To prevent and control the water pollution problems effectively, Fujian Provincial Government initiated the integrated watershed management programme in 1999, the Jiulong River Watershed Integrated Management Programme (JLWIM). So far, it has gone through three phases: First phase (1999 to 2001), implementing a “Comprehensive Treatment Plan for Jiulong River Watershed Water Pollution and Ecological Destruction”; Second phase (2001 to 2005), implementing “Jiulong River Watershed Water Environment and Ecological Protection Plan”; and Third phase (2005 to 2010), implementing “Jiulong River Watershed Water Environment and Ecological Protection Plan”.

2.1.1 Management Goals and Scope

The Jiulong River watershed management programme has set corresponding management objectives based on specific situations and understanding of the watershed scientific knowledge in different phases. However, the overall objectives in the different phases are basically the same, which is to take effective control of watershed pollution and the trends of the ecological damage, and manage the watershed ecosystem towards a cycle of sustainable development. The management scope mainly covered the counties and cities within the Jiulong River watershed, while the marine environment downstream of the watershed was not considered in the programme.

2.1.2 Management Strategy

In order to implement the project effectively and achieve objectives, JLWIM developed a series of management strategies, including:

1. Establishment of integrated river watershed management institution;
2. Formalization of the responsibilities of the management institutions and governmental agencies related to the watershed at all levels of government through legislation;
3. Development of a large number of relevant integrated watershed management policies, laws, regulations, standards, planning and plans; and
4. Establishment of coordination mechanisms, restriction mechanisms and incentive mechanisms for watershed management.

2.1.3 Main Measures

According to specific objectives of different stages, JLWIM established a series of different measures. In general, the management measures are:

1. Develop and implement appropriate emission standards and permits to control the industrial pollution;
2. Build more urban wastewater treatment facilities and centralized urban garbage disposal facilities;
3. Establish eco-agriculture demonstration zones to control agricultural non-point source pollution;
4. Implement livestock and poultry farming zoning schemes, promote eco-aquaculture and carry out pollution treatment of livestock and poultry farming operations;
5. Advocate favorable consumption mode; and
6. Secure investment to implement the plan.

2.1.4 Challenges

Upon completion of the first two phases of the JLWIM Programme, results showed that the coordination capacity of different levels of governmental agencies was enhanced. The behavior of government agencies and enterprises have become “friendly” to the environment to a certain degree. The rate of the emission of some pollutants, such as COD, has been effectively controlled.

But some problems still exist, such as the inadequate participation of stakeholders; weakness of the authority of the integrated watershed management agency; low effectiveness of the incentive

mechanism; and no changes in the consumption and lifestyle positive patterns of people.. As a result, nitrogen and phosphorus concentrations in the water body increases every year. Fishery resources have and continue to degrade in the Julong River estuary and Xiamen Bay. **Table 2** shows the detailed assessment of the watershed management programme for 2010.

2.2 Marine Environmental Management

Table 2. Assessment results of JLWIM.

Phase	Indicators	Assessment Results
Planning program	Planning process	Lack of public participation and failing to reach consensus
	Management Scope	Sea area connected to the watershed was not covered in the management scope.
	Management Goals	Goals get more and more specific, but the degree of support was unclear due to the absence of effective public participation. Absence of goals of ecological protection and restoration. Obscure goals of agricultural non-point source (NPS) pollution control. Lack of harmful material control targets in water source protection.
	Main Measures	Most measures are focusing on pollution control, especially the point source pollution, but the measures improving aquatic ecology directly and control NPS are absent.
	Plan Investments	Planned investments were in large quantities, but some planned investment projects are less relevant to targets Investment project planning and management objectives need to be strengthened to a degree directly related to the analysis and selection of priorities.
Government Actions	Institution setup	Integrated watershed coordination and management institution has been set up, but the members of the commission are not representative.
	Empowerment and given resource	Though the level of integrated management of the institution had been raised, the institution is not an authorized agency, and it wasn't given new authority and resources, such as the environment protection department which plays lead roles.
	Policies, regulations and standards	Current rules and regulations are mainly sector-oriented and there are no integrated watershed-bay management regulations. The authority levels of related policies and regulations are low. Lots of policies and regulations have not been actually implemented.
	Coordination mechanism	The authority of non-permanent coordination mechanism is not enough. The coordination needs to be strengthened for the sectoral coordination and the key stakeholders' coordination.
	Constraint mechanism	It is relatively complete, but enforcement is still to be improved.

Table 2. Assessment results of JLWIM (Continued).

Phase	Indicators	Assessment Results
	Incentive mechanism	It is only limited to fiscal stimulus, and the fiscal stimulus is not strong. It does not link the watershed-bay management performance to the officials' performance evaluation.
Preliminary results	Changes of governments behaviors	Levels of harmonious and unified actions have improved. The phenomenon of competing rights and resources among governments is still serious. The local governments still give priority to economic development.
	Changes in corporate behaviors	Most industrial enterprises have reduced emissions. But the sewage pipe network needs to be improved. The operation of wastewater treatment facilities needs enterprises' own guarantee for sustainable financial mechanism. Large farming enterprises have improved the pollution treatment facilities.
	Changes of Individual behaviors	Chemical fertilizer and pesticide use by farmers continues to increase. There is a fluctuation in pig farming, and it has recently increased without control measures.
	Changes in investment behavior	Only about half of the planned investment is realized. The government's planned investment projects can't be completed on time especially in underdeveloped areas.
Secondary effect	Changes of water quality	Water quality is not improved. COD concentration shows decrease trend; The concentration of nutrients is in an increasing trend; Changes of the harmful and toxic substances, such as pesticides and heavy metals are unclear.
	Aquatic ecosystem	Though the changes are not clear, the aquatic ecosystem health has not been improved Fecal coliform bacteria (FCB) remain above standard.
	Pollutant fluxes flowing into sea	COD pollution load into the sea declines. Nutrients into the sea rise; Heavy metals increase in recent years; Total pollutants except COD increase.

2.2.1 Main Management Measures

With rapid economic development, Xiamen is facing tremendous environmental pressures. The Xiamen government not only adopts various measures to protect the marine environment, but also strengthens the integrated coastal zone management to make sustainable development of the marine economy an important objective and task of government work. Thanks to the involvement of international organizations, ICM in Xiamen was developed and implemented since 1994, which resulted in legislation (foremost), centralized coordination, scientific support, integrated law enforcement, financial sustainability, and public participation. Xiamen's ICM model has successfully realized effective protection of the marine ecological environment.

The practices of integrated marine management in Xiamen include:

1. To establish a local marine legal system based on the national legal framework so as to provide a legal basis for ICM;
2. To establish and develop a coordination system for ICM, to strengthen the government's macro-management and guidance of marine activities;
3. To establish a marine scientific support system of integrated management, and strengthen the foundation of integrated marine management;
4. To strengthen the comprehensive law enforcement capacity in Xiamen seas; and
5. To enhance community involvement and to increase public awareness on marine conservation.

2.2.2 Existing Problems

While Xiamen ICM and its coordination mechanisms have been established, there are still a lot of overlaps and conflicts of duties among sea-related departments. With the rapid development of the economy, increase in population and urbanization, Xiamen Bay is facing an increasingly serious problem in resources and the environment. Meanwhile, marine environmental management program in Xiamen Bay is supposed to adapt and adjust according to natural and anthropogenic pressures.

Through the implementation of the second strategic plan for ICM and the analysis of existing marine environmental management in recent years, it was found that the primary problems in the field of marine environmental management are as follows:

1. For the purpose of adaption to changing situations, it is necessary to further improve integrated marine management, constantly adjust and perfect the coordination mechanisms for ICM.
2. The impact on transboundary ecological environmental problems is increasing significantly. Jiulong River brings a large amount of sediment and land-based pollutants to the Xiamen seas, which are mainly responsible for the environmental damage in the Xiamen seas. The average annual sediment from Jiulong River discharged into Xiamen seas is about 6.36 million tons, and the contribution of COD, total nitrogen, total phosphorus from Jiulong River Watershed accounted to 53 percent, 70 percent and 73 percent of that in Xiamen Bay, respectively.
3. Integrated management of land and sea use has not yet been achieved.

Since Xiamen, as a bay-based city, is embedded in the land and the sea, the land area has not been included in ICM completely. At present, sea and land planning in terms of the process and implementation of planning are still inconsistent. Moreover, the integrated management of the Jiulong River watershed, which is located outside the jurisdiction of Xiamen, has not been linked with ICM effectively, which has some negative effects on the performance of ICM in Xiamen.

4. The construction of a sewage collection network is lagging behind schedule, and as a consequence, rural areas are seriously short of environmental infrastructure. That is the main reason that rural areas are large pollution source, posing a great threat to the marine environment.
5. Development activities in coastal habitats lead to decline in water quality. Port construction and urban infrastructure construction occupy the natural shoreline and coastal wetland habitats. Submarines blasting shockwaves, coastal engineering and exploration and construction activities are in conflict with marine environmental protection and cause great damage to natural shorelines, coastal wetlands, as well as the habitats of the Chinese white dolphins and the Xiamen *amphioxus*. Mangrove ecosystems and other areas are suffering from degradation.
6. The marine ecological monitoring network and data-sharing system have not yet been established comprehensively. Marine and environmental protection departments have

carried out a lot of work in terms of marine environmental monitoring, but only focus on coastal water quality and pollutant monitoring. However, the work with regard to the monitoring of pesticides and other toxic or harmful substances, which affect food security and regional ecological safety, has not yet part of the monitoring program. Besides, monitoring programs are lacking in uniformity and the sharing of monitoring data and information is limited, which is why it is urgent to establish an “authority” monitoring network system to facilitate data sharing.

7. The efforts of technological support for ICM require further strengthening.

A science-based approach is needed to backstop integrated river basin and coastal area management. Current needs in scientific advancement in Xiamen include: status and trends of marine biological diversity; the changes of ecosystem services in Xiamen Bay; polluting mechanisms and the self-purification capacity of Xiamen Bay; the allocation of environmental carrying capacity in the bay; management strategies of pollution control and eco-zoning in bay area; evaluation system of marine ecosystems; and marine disaster occurrence mechanism and forecasting. Research mentioned above would be able to serve as additional technology support for ICM to help improve effectiveness of management.

8. Single source of environmental investment.

The funds used for marine environmental protection in Xiamen mainly depend on the government’s financial investment, since environmental investment models, such as international loans, private investments and public-private partnerships (PPP) have not been established.

3

Threats and Priority Issues

Through the analysis of the status quo and trend of ecological environment in Jiulong River Watershed–Xiamen Bay, as well as the existing major environmental issues, the main threats in the region and priority problems were identified and selected as follows:

1. Water pollution control in the watershed and bay is still outstanding. Non-point source pollution or NPS (agricultural NPS pollution/pollution caused by livestock breeding) has become the largest contributor to water pollution of the watershed-bay. Agricultural NPS pollution contributes 44 percent, and 22 percent of total nitrogen and total phosphorus and 21 percent, and 46 percent of total nitrogen and total phosphorus coming from livestock breeding. Pollution input from Jiulong River and surrounding administrative regions is mainly responsible for pollution in Xiamen seas.
2. The hydropower stations in the Jiulong River watershed are so numerous that they interfere with river circulation, reduce freshwater resource, and exacerbate the water pollution and aquatic ecosystems in the watershed.
3. The problems of drinking water safety, red tide and oil spill disasters threaten the ecological safety in the watershed-bay region.
4. The conflicts exist between construction of estuarine and coastal engineering and protection of rare species, natural shoreline and coastal wetlands.
5. The capacity for integrated ecosystem management of the watershed-bay is weak, and online monitoring capability, unified coordination and management mechanism, joint law enforcement and the disposal of environmental emergencies need to be further strengthened.

4

Compilation Principle

- **Systematic (Sea-Land coordinated) principle;**
- **Equity principle;**
- **Operational principle (feasible/doable);**
- **Highlighting priority and considering general;**
- **Sustainability principle;**
- **Stakeholder involvement principle; and**
- **Adaptive management principle.**

5

Strategic Action Targets

5.1 Short-term Objectives (2011 -2015)

Objectives for Pollution Control and Water Quality:

- The trend of water pollution and ecosystem damage as well as primary pollutants will be controlled effectively in the Jiulong River watershed. The amount of COD, total nitrogen and total phosphorus discharged into the water body will be reduced by 20 percent, using the baseline year of 2007.
- The domestic wastewater treatment rate will reach 80 percent and that in Xiamen island will be more than 90 percent; sewage treatment rate at the county level not be less than 60 percent and the urban area be higher than 75 percent. As a whole, the discharge of major pollutants — total nitrogen and total phosphorus — will meet the standard.
- The rate of approved treatment of solid waste will be more than 80 percent; the rate of industrial pollution sources steadily meeting the discharge limit will not be less than 90 percent; the pollution caused by the livestock breeding industry and agricultural NPS will be under effective control.
- Water quality in serious polluted reaches will be improved and more than 90 percent of the reaches will meet water quality standards of their function zone.
- Water quality for the urban centralized drinking water source will meet the standards by means of gradually reducing the influence of pesticides, heavy metals and other toxic or harmful substances to drinking water sources. The quality of rural drinking water and rural living environment will be improved.

- The area of seas with water quality near or worse than Class IV in Xiamen Bay will be abated (compared to that of 2007 water quality); the area estuarine and West sea, water quality of which are better than Class IV will account for more than 60 percent and 50 percent; and the area of the Southern sea, where water quality is better than Class III should account for 75 percent. That is to say the water quality in Xiamen seas should be improved effectively.

Objectives for Ecological Protection:

- Water resources and the flow discharged from the power station will not be further reduced.
- Watershed-bay's natural shoreline will not be further reduced, to be achieved through setting aside an ecological exclusion belt in the central discharge area of farmlands and urban surface runoff.
- An ecological risk prevention system in the watershed-bay region will be established, so as to basically prevent and deal with oil spills, storm surges, algal blooms and other major ecological disasters which cause extensive pollution to the environment; the ability to supervise the environment as well as set precautions and emergent treatments of ecological safety accidents will be enhanced significantly.
- The degradation of the eco-environment in the fishing area will be alleviated, the decline of fishery resources prevented and tendency of endangered aquatic species to decrease in number halted, and the capacity of conservation of aquatic life will be enhanced.
- The proportion of nature reserves in the watershed-bay region will be up to 12 percent, with enhanced management of the nature reserves.

Objectives of Forming Management Abilities:

- To initially establish the management mechanisms with stakeholder participation, and overall planning and management to help implement an effective supervision mechanism in planning. Secondly, to establish a cross-sectoral inter-regional, inter watershed-bay coordination mechanism, with disincentive as well as incentive mechanisms.
- An effective monitoring system covering the typical ecological zones, marine functional zones, marine ecology disaster-prone areas and the aquatic ecosystem will be established

for a combined water quantity and quality monitoring system of the estuarine, which will be conducive to establishing the authority monitoring network system to share monitoring data.

- An effective ecosystem management performance evaluation system will initially be established, which aims to link the state of watershed–bay to performance evaluation of officials.

5.2 Intermediate Objectives (2016–2020)

Pollution Control and Water Environmental Quality Objectives:

- The trend of water pollution and ecosystem damage as well as primary pollutants shall be controlled effectively in the Jiulong River Watershed. The amount of COD, total nitrogen and total phosphorus will be reduced 20 percent, using the baseline year of 2015.
- The urban sewage treatment rate will be not less than 85 percent and that in Xiamen island and counties will be more than 95 percent and 65 percent; the sewage treatment plants in urban areas will process/clean at least 80 percent of their rated maximum capacity for wastewater. As a whole, the discharge of major pollutants (total nitrogen and total phosphorus) will meet the standard.
- The rate of harmless treatment of solid waste will be more than 90 percent; the rate of industrial pollution sources steadily meeting the discharge limit will not be less than 90 percent.
- Water quality in serious polluted reaches will improve and more than 95 percent of the reaches will meet water quality standards for functional zoning.
- Water quality of urban centralized drinking water source will meet the standards by means of gradually reducing the influence of pesticides, heavy metals and other toxic or harmful substances to drinking water sources. The quality of rural drinking water and rural living environment will improve.
- The area of seas with water quality near Class IV in Xiamen Bay will be further reduced; the area of estuarine and the West Sea, water quality of which are better than Class IV, will account for more than 80 percent and 70 percent respectively; and the area of the South Sea, where water quality is better than Class III, will account for 95 percent so as to improve water quality in Xiamen seas effectively.

Objectives for Ecological Protection:

- The water resources and the flow discharged from the power station will not be further reduced and minimum water flow in all reaches to meet basic ecological requirements will be ensured.
- In order to help the ecological exclusion zone play a significant part in NPS pollution treatment in the central discharged area, assigned watershed-bay shoreline functions will be clear and the proportion of the natural shoreline will be stable.
- An ecological risk prevention system in the watershed-bay region will be established, so as to basically prevent and deal with oil spills, storm surges, algal blooms and other major ecological disasters that cause extensive pollution to the environment; the ability to supervise the environment as well as set precautions and emergent treatments of ecological safety accidents will be further enhanced.
- Marine ecological construction will have some achievements in terms of establishing ecological compensation system in the principle of “the one who uses is responsible for protection and the one who benefits is also responsible for compensation.”
- To alleviate the degradation of eco-environment in fishing area, the decline of fishery resources and reverse the tendency of endangered aquatic species to decrease in number and recover aquatic life and the aquatic ecosystem.
- The areas of nature reserves in the watershed-bay region will represent 15 percent of land and sea areas, and management capacity of the nature reserves will be significantly improved.

Objectives of Management Abilities:

- A mechanism of stakeholder participation, an inter-departmental, inter-regional and inter-watershed-bay coordination mechanism, control mechanisms as well as incentive mechanisms will be established, and applied in practice.
- An effective monitoring system will be established to facilitate the monitoring data sharing among different departments.
- An effective ecosystem management performance evaluation system will be established for the purpose of applying the performance of watershed-bay management in the evaluation of the officials’ achievements.

5.3 Long-term Objectives (2021-2025)

Objectives of Pollution Control and Aquatic Environment Quality:

Up to the year 2025, the discharge of major pollutants to Jiulong River watershed will be comprehensively supervised; aquatic environment will be improved significantly; ecological environment will be generally ameliorated. In addition, all the contaminated water sections will be restored to reach the water quality standards of specified function zones; in Xiamen City, seawater with quality under Class IV swill disappear generally, and the area of seawater of quality above Class III (including Class III) will be more than 80 percent. The centralized processing rate of municipal wastewater will reach more than 90 percent; the harmless treatment of municipal garbage will be realized to a large extent; the quality of urban potable water source will reach the standard.

Objectives of Ecological Protection:

The biological resources in watershed-coastal ecosystem will be evidently restored; the quantity of rare and endangered species will be improved gradually, and biological diversity will be enhanced greatly; the area of nature reserves as well as its ecological function will be stabilized, and the related managing capacity is advanced — so as to form an ecological compensation mechanism and system; a monitoring, supervision and execution system of the marine environment; also to achieve a complete integrated disaster emergency precaution system and ecological risk prevention system; and a sustainable marine ecosystem.

Objectives of Management Capacity Construction:

Laws and regulations of watershed-bay protection will be improved; Integrated management system and capacity as well as the coordination mechanism, control mechanisms and incentive mechanisms will be advanced and applied widely.

The Xiamen Integrated Coastal Management Demonstration Project started in 1994 and the Jiulong

6

Strategic Action Plan

The Xiamen Integrated Coastal Management Demonstration Project started in 1994 and the Jiulong River Integrated Watershed Management Program started in 1999. While both projects contributed to some extent to reduction of pressure on the aquatic environment, they failed to address the underlying causes of watershed-bay environment pollution because of the administrative segmentation of watershed and coastal management that limits the effects of ICM and integrated watershed management. This Strategic Action Plan seeks to address various limits in the past by adopting of the concept of integrated upstream and downstream, breaking the original confinement of administrative segmentation, with agreements reached through cooperation and coordination, and guiding coastal and watershed management activities for the goal of ecological restoration of the watershed–bay. Based on intended principles and objectives, the action plan is designed to respond in five aspects, i.e., management capacity strengthening, pollutant reduction, ecological protection and restoration, public awareness raising and backstopping by technological advancement.

6.1 Management Capacity Strengthening

6.1.1 Establish the Coordination and Regulation Mechanism of Integrated Watershed-Coastal Management

1. Establish a high-level watershed-bay management committee, the Chair of which is assumed by the province governor or executive vice governor, taking charge of uniting, organizing, deploying, commanding and coordinating the integrated regulation affairs of the watershed–bay environment.
2. Set up a management consultative committee, taking charge of providing decision-making support to the management committee. The consultative committee comprises of officers, experts, the public and other stakeholders, with the nongovernment officers accounting for more than 51 percent, to better represent public interest.

3. Reinforce the environment target accountability system of leadership and take measures to ensure implementation. The chief leader of each county and town governments should assume overall responsibility for environmental rehabilitation and social stability in the district under his jurisdiction, and institute a checking mechanism of water quality interface between trans-county and trans-township water sections.
4. Establish a management performance assessment system of watershed–bay ecosystem. The level of performance of planning and regulation by related administrative departments at all levels should be put under special supervision. The supervision results and achievements of the implementation of water quality target will be directly linked with the officer’s achievements; at last leading to a “one ballot veto” system of watershed–bay integrated regulation.

6.1.2 Improve Current Regulations

1. The provincial people’s congress takes the lead in formulating an integrated watershed–bay management regulation — Integrated Jiulong River Watershed–Bay Management Act. The law must clearly define involved provincial departments’ functions and clarify the rights and obligations of the local government in watershed–bay integrated management.
2. Involved provincial departments and local governments should review existing regulations and plans, which target pollution prevention and ecological protection of Jiulong River watershed and Xiamen Bay. Conflicts, overlapping provisions and contradictions in those regulations and plans should be identified and amended to enhance conformity and harmonization between laws, regulations and policies.
3. Every county-level city should formulate an industrial layout plan according to its own environmental capacity. Such a layout plan should be integrated into local economic development plans.

6.1.3 Establish a Sustainable Financial Mechanism of Watershed–Bay Ecosystem Protection

1. Establish a scientific and rational watershed–bay eco-compensation mechanism based on the environmental responsibility of each county and city under the principles of efficiency and equity made by downstream counties and cities to upstream counties and cities. Compensation recipients, roles and responsibilities, compensation modalities and standards should be clearly laid down in the regulations.

2. Specify the financial budget percentage for environmental investment. Provisions should be in place to make sure that the general transfer payment system is eligible for the watershed-bay environment and ecological protection.
3. Expand the financing channels for watershed-bay ecosystem management. In the short term, emission trading mechanisms should be established in some districts; pollution charges should be rationally used in line with the policy of “special fund for special use”; reduction in pollution and green industry should be encouraged; Diverse financial and economic approaches should be used to mobilize social capital into the watershed-bay environmental management investment.
4. Increase water resource prices and wastewater treatment charges to raise funds for watershed-bay management and promote the building of a water-saving city.

6.1.4 Set up Jiulong River Watershed-Xiamen Bay Water Quality Monitoring and Information Sharing System

1. Unite every governmental department and research institution to build a regional marine environmental monitoring network and long-term coordinating mechanism; to formulate a standardized marine environmental monitoring protocol, technologies and methodologies; to establish a regular monitoring experience sharing mechanism among the three cities; to develop a watershed aquatic environmental management information system software and set up a watershed monitoring information database to integrate information resources and realize regional information sharing.
2. Based on the current monitoring system, adding as routine monitoring parameters on pesticides, heavy metals, and poisonous and harmful matter, and adding water quality monitoring stations so as to establish a complete cross-regional Jiulong River watershed water quality monitoring network.
3. Enterprises should undertake environmental monitoring. Environmental management in enterprises should be systemized, standardized and staffed. The monitoring department in the enterprise should monitor regularly the drainage and equipment running conditions and report to higher level institutions and the local environmental protection department periodically.
4. Implement thoroughly the interface water quality target accountability system in each watershed zone of each administrative region. Compliance with water quality targets should be reviewed biannually. Review should be more regular in the event of emergencies. Rewarding and penalty should be laid down to implement the accountability system.

5. Formulate a monitoring plan of marine pollutants and rare marine species. Local nongovernmental organizations and interest groups in photography and bird watching should be encouraged to submit observation reports periodically.
6. Establish an accident emergency monitoring plan and marine pollution accident reporting system, including installation of an accident reporting telephone hotline for public supervision.

6.1.5 Strengthen Capacity on Watershed–Bay Management

1. Launch training for managers, so that the members of the “watershed–bay integrated management institution” receive technical training or managerial skills training related with watershed–bay environmental management and ecological protection at least twice a year.
2. Organize opportunities for the watershed–bay managers to observe and study in the successful demonstration zones, so as to bring in successful experiences and environmental management that suits the improvement of the local region.

6.2 Pollution Prevention and Control

6.2.1 Improve Urban and Countryside Environmental Infrastructure

1. Construct wastewater treatment plants. To implement provincial policies on industrialization of wastewater treatment and encourage the adoption of BOT or TOT for pollution treatment financing. To optimize distribution of draining outlets and processing procedures. To construct large wastewater treatment plants with an intensive and centralized treatment at the regional level. Municipal wastewater treatment equipment should be constructed additionally with higher wastewater treating capacity. For counties that are not suitable for centralized treatment, treatment should be done by individual households or groups of households as appropriate.
2. Construct infrastructure related with the reuse of gray water to realize the reclamation of sewage at the regional, community and individual levels.
3. Boost the infrastructure construction of approved urban solid waste treatment and disposal facilities. Augment the management capacity of urban solid waste. The garbage within one mile of river banks should be cleared and managed by townships and villages. Furthermore, carry out the village ecological environmental management examination system, improving

small town environmental protection examination indicators and establishing a long-term management mechanism.

4. Implement urban stormwater runoff control projects. Urban landscape ecology should be properly restored. The imperviousness of neighboring earth (land) along bay should be reduced by using water-permeable brick or water-permeable ecological materials.

6.2.2 Management of Wastes from Livestock and Poultry Farms

1. Reinforce strictly land use policies for covering banned and limited use zones. Breeding industry planning and loading level of the whole watershed should be scientifically assessed and established. Breeding companies with inadequate layout, serious pollution and low efficiency will be shut off, suspended, merged or transformed into other business ventures. Subsidies should be provided to farmers who switch to other production activities. Government agencies in charge of water supply, power supply, land, financing, agriculture and animal husbandry should cooperate in enforcement of pollution control policies and regulations in relation to breeding of livestock.
2. Establish the long-term supervision mechanism for swine breeding farms within the watershed. Supervision of swine breeding farms with over 50 head of animals should be carried out on a quarterly basis at the township level including inventory of breeding establishments, location, stock, compliance with regulations and pollution treatment standards.
3. Replicate ecological breeding models. Household-based swine breeding should apply “one pool three changes” (one methane tank associated with changes in design of toilet and kitchen), that is, connecting toilet and kitchen wastes with a biogas pool. Related policies should be developed to lead the household to use environment-friendly and safe feeds.
4. Prohibit discarding of ill-death livestock and poultry that have died from illness. There should be an approved treatment and disposal system for such situations, with scientific layout in the area, staffed with skilled personnel for improved disposal management.
5. Promote the application of livestock waste pollution control technologies. Actively disseminate ecological nutrient recycling model by combining and application of the Japanese pig-farming zero-emission breeding technology with comprehensive use of pig excrement in the form of pig-menthe-grass (fruits, vegetables and forests) to close the nutrient cycle;

6.2.3 Agricultural Non-point Source Pollution Control

1. Strive to promote a countryside circular economy development model; establish an ecological agriculture household; and develop courtyard economy (circular farm economy).
2. Strive to apply bio-control techniques to actively introduce and foster natural biocides and other control for plant diseases and insect pests; control the amount of pesticide applied; delimit the no-fertilizer and no-pesticide zones; and develop ecological agriculture and organic agriculture.
3. Adjust fertilizer and pesticide policies: Encourage application of organic fertilizer; promote the use of manure on selected soils; and applying subsurface fertilizer application techniques.
4. Apply projects of pond construction in farms, cross-irrigation and grassland filtering to control the N and P input from surface runoff.

6.2.4 Enhance Industrial Pollution Prevention

1. Optimize the industry distribution in the whole watershed and bay. The benefits among upstream, mid-stream and downstreams should be well-coordinated to strengthen the relevance between upstream and downstream production.
2. Environmental protection examination and approval needs to be rigorously undertaken to strictly control industrial pollutant discharges and to prevent aquatic environmental accidents. Lastly, clean production enterprises should be encouraged and supported.
3. Punish illegal dischargers. The concentrated industry center and heavy-polluting companies in the watershed should be inspected. Companies should be stopped and closed in the case of failure to reach the standard after additional measures have been taken. Companies that go against the existing policies of the State, or show no hope for reformation, should be closed down immediately and switch to another production later.

6.2.5 Implement Total Loading Control Strategy

1. Examine the maximum loading capacity of the watershed and bay based on the environmental capacity of Xiamen Bay. Based on survey, assessment and total loading targets of pollution source, pollutant mitigation quota and options should be proposed to control the concentration and total allowable load from each pollution source.

2. Allocate volume and load control planning targets down to each district, township and each enterprise to ensure that the total amount of pollutants discharged by each watershed is within the total discharge control target for the Xiamen Bay.
3. Implement drainage license and sewage license system. When conditions permit, the emission trading system can be applied.

6.2.6 Continue the Implementation of Energy Saving and Pollutant Reduction Policy

1. Reinforce the incorporation of energy and pollutant reduction targets in leaders' performance evaluation.
2. Focus on the key area of energy saving and pollution reduction, construct a demonstration project on energy saving and pollution reduction, and intensify supervision of the project.
3. Develop a circular economy. Speed up the transformation of living and working environments by incorporating ecological concepts, promoting eco-agriculture, constructing ecological chains between industrial sectors, and promoting recycling of wastes between sectors; promote clean production by enterprises, targeting pollution control from production process, encouraging enterprises to reduce energy consumption, industrial solid wastes and packing, and reutilizing these wastes; and increase energy efficiency.
4. Adopt the strategy of achieving energy savings and pollution reduction through scientific and technological projects; boost the degree of technical innovations and guide the all-round development of energy savings and pollution reduction.

6.3 Protection and Restoration of Ecology

6.3.1 Comprehensive Treatment of Soil Erosion of the Watershed

1. Implement the plan for afforestation projects in the watershed. Pay attention to the protection of natural forests and the construction of shelter forests within 100 m of tributaries, complete ecological forest development including afforestation, alteration of inefficient tree species and

forest conservation. Complete the expansion and conservation of a genus of mangroves in the Jiulong River Estuary.

2. Continue converting farmlands to slope forests (fruits, grasses), and the terracing of slopes and re-vegetation of wastelands, to make them suitable for trees and grasses.
3. For mining and sand mining areas and other important resource exploitation areas, the protection should be mandatory. Investigation and regulation of various types of mines and mineral processing companies should be carried out.

6.3.2 Improve the Conditions of the River's Hydrology

1. In order to conserve upstream water, different methods should be used to improve the status of hydrology and sediment deposition.
2. Create an online monitoring system for water reservoirs to determine discharge volume. Strengthen supervision of hydropower operations in the Zhangping segment of North rivulet, Hua duan segment, and hydropower stations in Chuanchang rivulet (the tributary of west rivulet) in the dry season to maintain the amount of river flows for the ecological functions of the river.

6.3.3 Comprehensive Treatment of the Small Watershed

1. Establish a management plan for tributaries of the Jiulong River.
2. Strengthen daily surveillance of surface waters; put up a management system to control health and cleaning of the major river channels and streams. Remove illegal constructions located along the river and within the protected areas of the water channels. Control mining activities on river ways, and remove existing illegal mining operations.
3. Facilities should be set up to intercept the wastewater in all hydropower stations and reservoir areas within the watershed. Floating garbage and dead animals should be disposed of immediately, in order to a clean and healthy water body.
4. Activities such as shocking fish electrically, poisoning fish, bombing fish are all prohibited in river ways and waters; regulation of aquaculture in the reservoir area should be strengthened. Combine the requirement of reservoir water quality and reasonable

environmental capacity planning to control total amount of aquaculture and the amount of feeding.

6.3.4 Protection and Restoration of the Marine Ecosystem

1. Strengthen the supervision of environmental protection of marine engineering, and control reclamation projects strictly. Improve the hydrodynamic conditions of waters.
2. Protect marine rare species in Xiamen bay and their habitats. Put strict restrictions on human activities in the Chinese White Dolphin (*Sousa Chinensis*) habitat. Implement strict management in the core area of protected areas of amphioxus. Establish nature reserves for the Chinese Horseshoe Crab (*Tachypleus tridentatus*).
3. Protect the bay's natural ecological shoreline and the natural ecology of coastal wetlands around the bay. Increase the bay's environmental purification function by the construction of coastal artificial wetlands around the bay.
4. Carry out the ecosystem restoration project of a typical mangrove ecosystem and so on, ecological restoration projects of islands with no residents and the protection project of natural landscapes of the beach. Establish the restoration plan for the bay ecosystem, continue the implementation of ecological restoration projects of various types of fish, shrimp, shellfish, algae and other economic species and rare and endangered species.
5. Balance the flux of three harbors in the estuary, dredge the middle harbor segment of Jiulong River to improve its flood capacity, to reduce the erosion of the south harbor to protect the steady roots of mangroves and the flood-prevention pressure on the embankment. Open middle and northern harbor reasonably and orderly to the mining industry, and resolutely curb illegal sand mining.
6. Carry out pollution control projects on marine aquaculture. Gradually reduce the density of coastal aquaculture, improve the efficiency of nutrient utilization, develop three-dimensional ecological culture and mixed culture, and implement eco-culture to prevent the pollution deterioration of marine aquaculture.
7. Carry out a port and shipping pollution control project. Strengthen every link of ports and ships pollution control using various means, including department cooperation, performing their own duties, building port and shipping pollution control system, improving emergency response capabilities.

6.3.5 Improve Marine Pollution and Marine Disaster Emergency Response Mechanism

1. Establish a red tide monitoring system, red tide prevention and control coordination mechanism, and technological support for red tide control. Define the West Sea, Jiulong River estuary and Tongan Bay as red tide stress monitoring areas, building up scientific data for local toxic algae, and improving the “*Work program for red tide disaster prevention and mitigation of Xiamen City.*”
2. Constitute emergency response guidelines for storm surges, port and marine oil spills and other marine disasters and contingency plans for major marine pollution incidents, as well as port and marine pollution control projects.
3. Enhance the joint enforcement mechanism, establishing the direct exchange of information and communication channels between different law enforcement teams, so as to increase the enforcement response ability.

6.3.6 Protection of Potable Water Source

1. Strengthen the construction of protected areas for potable water sources, manage these first-level protected areas by adopting closing-up measures.
2. Reduce pesticides, heavy metals and other toxic and harmful substances gradually, as well as the impact of algal outbreak on drinking water sources; strengthen routine monitoring of toxic and harmful substances in the drinking water source areas, combine with warning mechanisms as well as prevention and control mechanisms for algal blooms.
3. Establish an emergency response mechanism for drinking water safety. Compile contingency plans for drinking water sources and, in accordance with contingency plans, construct an emergency back-up system for the drinking water source to ensure the effective operation of the system. Furthermore, conduct regular drills and trainings to help improve the emergency response mechanism.
4. The government of cities, counties (districts) should speed up the construction rate of alternative water sources.

6.4 Raise Public Awareness

6.4.1 Improve Network-building of Environmental Education, Building up Public Supervision Mechanisms

1. Use various media to advocate policies and regulations and some events on all aspects and levels to promote environmental awareness. Environmental pollution and ecological violations must be under public exposure and criticism.
2. Publish regularly the quality of the marine environment of the Jiulong River watershed and the Xiamen Bay in various print media, to enable the general public to have access to the progress of environmental protection work.
3. Improve the systems of public reporting, public hearings, and public participation of environmental impact assessment.

6.4.2 Build Public Environmental Education Bases, Popularize Environmental Education

1. Launch activities entitled “creating green schools”. Initiate green community campaigns in schools, communities and families. Organize various types of environmental training and educational activities.
2. Through the activities mentioned above, enhance the people’s environmental awareness, law awareness and moral standards of environmental protection, mobilize the whole society to participate in, support and supervise environmental protection and ecological construction.

6.4.3 Focus on Stakeholder Interests and Maintain Social Stability

1. Strengthen communication and consensus building among all stakeholders in the watershed-bay area for protecting the environment and ecosystems. Integrate stakeholder opinion and interests into policymaking, and implementation and supervision of policy, planning and programs.

2. On the aspect of policymaking, the acceptability and adaptability by stakeholders should be taken into account as fully as possible.
3. Administer legally, enforce politely, and defend the legal right of the masses.

6.5 Strengthen Scientific and Technological Support Capacity

After the Watershed–Bay management advisory committee has been established, scientific research of watershed–bay management should be unified and coordinated. Key studies suggested to be initiated include:

1. Study on baseline inspection studies for the Watershed-Bay ecosystem;
2. Study on ecosystem services changes in the Watershed-Bay ecosystem;
3. Study on pollution control and ecological protection division management;
4. Study on environment capacity of Watershed-Bay and the distribution of pollutant discharges;
5. Impact of water resources utilization on the Watershed-Bay;
6. Study on capacity and optimized layout of livestock and poultry breeding operations;
7. Study on the best measures and cost effectiveness reducing pollutants to the Watershed-Bay and a cost-sharing policy;
8. Study on ecological wetland protection and restoration research in the estuary and bay;
9. Study on integrated management institutions and mechanisms in the Watershed-Bay ecosystem;
10. Study on standards and financial mechanism for ecological compensation in the Watershed-Bay; and
11. Decision-support system and information sharing platform for integrated management of the Watershed-Bay ecosystem.

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Strategic Action Plan Matrix

In accordance with the orientation of measurements proposed by this Strategic Action Plan, the specific items of key actions to be completed are shown in **Table 3 to Table 8**.

Table 3. Priority Actions for Management Capacity Building.

Project Name	Project Content	Estimated Completion Time	Department Responsible
Set up Management Establishments and Evaluation Systems	In order to coordinate actions of each department and each district, establish a management advisory committee for the watershed-bay and establish management performance evaluation system.	2012	Fujian Province Government
Establish Law and Rule of Integrated Management	Establish unified integrated management regulations for the watershed-bay, such as <i>"Integrated Management Act of Jiulong River – Xiamen Bay"</i> etc.	2015	Chinese People's Congress (CPC) of Fujian Province
Increase Water Quality Monitoring Sections	Enable the effective implementation of total control of pollutants in the Jiulong River watershed. The creation of a water quality monitoring section in the Jiulong River section of Jiangbei River and Nanxi Creek is a priority.	2012	Zhangzhou and Longyan Municipal Government
Establish Information Sharing Platforms	Establish a common information platform among watershed-bay environmental monitoring departments, so that the institutionalization of sharing of river watershed and the bay monitoring information can be realized.	2015	Zhangzhou, Longyan and Xiamen Municipal Government
Online Monitoring of Sewage Discharge of Key Enterprises	Set up online monitoring stations in key enterprises having discharges, requiring the enterprises to report on a regular basis.	2015	Zhangzhou, Longyan and Xiamen Municipal Government

Table 4. Priority Action for Pollution Prevention and Control.

Project Name	Project Content	Estimated Finish Time	Department Responsible
Construction of key infrastructure for pollutant treatment	Sewage treatment plant and collection network project in Longyan City	2010	Longyan Municipal Government
	Sewage treatment plant and associated collection project in Zhangping City	2010	Longyan Municipal Government
	Sewage treatment plant and associated collection project in Nanjing County	2015	Zhangzhou Municipal Government
	Sewage treatment plant and associated collection project in Pinghe County	2015	Zhangzhou Municipal Government
	Sewage treatment plant in the first zone of Zhangzhou Development Park	2015	Zhangzhou Municipal Government
	Rural sanitation infrastructure projects in Longwen district of Zhangzhou City	2015	Zhangzhou Municipal Government
	Expansion project of Shizhoutou sewage treatment plant in Xiamen City	2015	Xiamen Municipal Government
	Expansion project of sewage treatment plant in Xiamen City	2015	Xiamen Municipal Government
	Sewage treatment plant in Xiang'an county of Xiamen City	2015	Xiamen Municipal Government
	Expansion Project of Dongfu sanitary landfill plant in Xiamen City	2015	Xiamen Municipal Government
	Integrated processing center for solid waste in the east part of Xiamen City	2015	Xiamen Municipal Government
	Construction project of integrated sanitation treatment plant in Xiamen City	2015	Xiamen Municipal Government
	Relocate outfall of sewage treatment plant in Tongan district to Aotou in Xiang'an district , and shift to deep-sea off-shore discharge pattern	2015	Xiamen Municipal Government
	Layout the facilities of water reuse at based on the community-level	2015	Xiamen Municipal Government
Improvement of decentralized family pig-farming facility	Carry out “a pool with three changes” (methane-generating pits, Toilets changing, kitchen changing) among family pig-raising farmers.	2012	Zhangzhou and Longyan Municipal Government
Transformation on utilization of pig manure	Complete scaling up and transformation of 500 pig farms in the model of pig manure comprehensive utilization named Kejia model or “pig – biogas – grass (fruit and forest)” model (which is the use of pig manure for biogas production, which is in turn used for pig feeds).	2015	Zhangzhou and Longyan Municipal Government

Table 4. Priority Action for Pollution Prevention and Control (continued).

Project Name	Project Content	Estimated Finish Time	Department Responsible
Transformation of Luodong-type fermentation	Realize Japanese Luodong-type fermentation techniques to raise pigs (inclusion of bacteria to convert manure to fertilizer) and scaling up in 300 pig farms.	2015	Longyan Municipal Government
Bioremediation	Set up 30 pilot projects on "Aquamats", <i>Hai rong</i> ", " <i>Pai ni er</i> " and other microorganism-using treatment projects	2015	Longyan Municipal Government
Improvement of farming techniques	Promote fertilizer injection technology 3-10 cm below ground level; implement crop rotation to improve the efficiency of nitrogen use.	2011	Zhangzhou and Longyan Municipal Government
Construction of demonstration town	Focus on the Lianhua, Ting Brook, Ting Brook Xinxu, Neicuo and Dadeng village to improve the level of sewage-ecological treatment in villages. Construct the Ting Brook, Lianhua, Houxi, Xinxu and several other eco-agriculture demonstration towns.	2015	Zhangzhou and Longyan Municipal Government
Check the enterprises failing to reach the standard of ammonia-emitting	Inspect ammonia-emitting enterprises along Nanshengxi Brook, Xiaoxi Brook, Wenfengxi Brook, and Chuanchangxi Brook in Zhangzhou. Review Longhua Company, Gangchang Chemical Corporation, Zhangping Fertilizer Plants and other corporations with high emissions in Longyan. Shut down corporations which have no obvious trend for rectification or have no effective rectification.	2015	Zhangzhou and Longyan Municipal Government
Shut down industries with pollutive emissions	Shut down or transfer "15 types of small enterprises" and "5 new types of small enterprises"; shut down or transfer the enterprises which have no hope to reach the standard after rectification, and restrict grants to new projects or expansion of existing projects with emissions of ammonia nitrogen and total phosphorus.	2015	Zhangzhou and Longyan Municipal Government
Establish Industrial restructuring plan for the river watershed	Complete a new industrial layout plan for the watershed. Commence introducing new environment-friendly industries, and plan the chain of recycling industry, to transform the industry from a resource-based to technology-based pattern.	2015	Development and Planning Commission of Fujian Province

Table 5. Priority Actions for Ecological Protection and Restoration.

Project Name	Project Content	Estimated Finish Time	Department Responsible
Soil and water conservation of slope farmland transformation project	Turn slope lands into terraces for fruit and tea orchards in Longmen, Baisha and Suban in Xinluo Districts	2015	Longyan Municipal Government
Engineering eroded restoration and treatment project	Implement 10 engineering projects to treat the mine areas in Lantian, Wushikeng, Guoshe and other towns in Xinluo District	2015	Longyan Municipal Government
Soil and water erosion treatment in Huan County	Transform slope lands into terraces; implement soil and water conservation forest and enclosures and reforestation.	2015	Zhangzhou Municipal Government
Soil and water conservation comprehensive management in Huashanxi Watershed, Pinghe Country	Transform slope lands into terraces; Strengthen administration of economic forests.	2015	Zhangzhou Municipal Government
Soil and water erosion treatment in Longhai City	Construct soil and water erosion treatment facilities in Chengxi Town, Shuangdi Town and Bangshan Town.	2015	Zhangzhou Municipal Government
Soil and water erosion treatment in Zhangzhou City	Implement soil and water conservation, engineering treatment and afforestation.	2015	Zhangzhou Municipal Government
Environment-friendly villages and town construction in Zhangzhou City	Create of 10 environment-friendly villages and towns of Jiamei, Jingcheng, etc.	2015	Zhangzhou Municipal Government
Soil and water conservation and biological demonstration project in Xiamen City	Complete soil and water erosion treatment in the Xiamen City.	2015	Xiamen Municipal Government
Planning and construction project of watershed-bay ecological isolation zone	Formulate Watershed-bay Ecological Isolation Zone Construction Plan, and gradually establish ecological isolation zone at centralized farmland sewage discharge area and centralized urban surface runoff area.	2015	Zhangzhou and Longyan Municipal Government
Reconstruction project of slope farmland in Xiamen Ecological flow hydropower stations online monitoring and controlling	Implement reconstruction project for slope farmland in Xiamen. Install online monitoring devices, establishing monitor and supervision system for hydropower plants.	2015	Xiamen Municipal Government Zhangzhou and Longyan Municipal Government
Watershed aquaculture governance	Removing pearl farms in the reservoir of Xizai power station and cage aquaculture in Meihua Lake of Wanan, Baisha Reservoir and Cunmei Reservoir. Prohibit fish cage culture in the whole watershed (including reservoir).	2012	Zhangzhou and Longyan Municipal Government
Seawall opening works in Gaoqi	Construct 800m openings in the high-set seawall at tidal channel of the eastern and western sea area at the Gaoqi side of seawall.	2010	Xiamen Municipal Government

Table 5. Priority Actions for Ecological Protection and Restoration (continued).

Project Name	Project Content	Estimated Finish Time	Department Responsible
Ecological restoration project of mangroves	Carry out mangrove landscapes restoration and natural mudflat landscapes protection projects with at Jiulong River estuary, Dongyu Bay of west sea, Wuguan Mudflat, Dongju Port of Tongan, Mudflat on eastern Tongan Bay. Remove <i>Spartina alterniflora</i> around the mangroves.	2015	Xiamen Municipal Government
Artificial releasing economic species	Proceed with the plan of artificial release of economic species (such as fries, shrimp, shellfish, including Xiamen amphioxus) and proliferation of microalgae.	continuous	Xiamen Municipal Government
Middle channel dredging in Jiulong River estuary	Make three channels by dredging middle channel, prohibiting sand mining on south channel, and allowing orderly mining of sand on mid-north channel. Slow down the erosion of the mangrove foundation by promoting siltation and fixing the south bank.	2015	Xiamen and Longhai Municipal Government
Port and shipping polluting control project	Strengthen each link in port and ship pollution control by various means, combining departments and define their responsibilities, making cooperative arrangements to improve emergency response capability.	2015	Xiamen and Longhai Municipal Government
Ecological construction project on bay ecology shorelines and ring-bay coastal wetland	Improve the function of environmental purification; construct a ring-bay (including Wuyuan Bay, Maluan Bay, Dongkeng Bay and Tong'an Bay) coastal wetland.	2015	Xiamen Municipal Government
Urban rainfall surface runoff control project	Properly transform the urban landscape ecology, using permeable ecological materials (such as permeable bricks) to reduce the imperviousness of the surrounding land along the bay.	2015	Xiamen Municipal Government
Coastal wetlands construction	Construct reed or mangrove wetlands in Wuyuan Bay, Maluan Bay, Dongkeng Bay and Tongan Bay.	2015	Xiamen Municipal Government
Strengthen early warning and response capacity of red tide	Determine West Sea, Jiulong River Estuary and Tongan Bay as Red Tide-Monitoring Area. Carry out red tide and sea pollution emergency monitoring, building up local toxic algae files, improve the accuracy and speed of screening toxic algae, improve Sea Red Tide Disaster Preparedness and Mitigation Programs in Xiamen; implement third level of early warning and response program.	2013	Xiamen Municipal Government

Table 5. Priority Actions for Ecological Protection and Restoration (continued).

Project Name	Project Content	Estimated Finish Time	Department Responsible
Establishment and exercise of emergency response plans for marine disaster	Make emergency response plans for storm surge, tsunami and other marine disasters, and response plans to major marine pollution incidents; conduct regular drilling for emergency response; find and continually address the vulnerabilities of the plan.	2015	Xiamen Municipal Government
Establishing effective communication channels for enforcement team	Establish a mechanism to improve information and communication channels between enforcement teams to enhance response speed.	2015	Xiamen Municipal Government
Restriction of coastal engineering blasting and construction period	April to August is the peak period of Chinese White Dolphin reproduction and feeding. Blasting and construction should be banned in core areas and surrounding areas.	continuous	Zhangzhou and Xiamen Municipal Government
Backup water source construction	Complete construction of emergency backup water source of Xigong Creek in Huan County, and 6-km reconstruction project for the Longhai section, the left side of the main canal priming north creek.	2012	Zhangzhou Municipal Government
Water source protection zone isolation project	Construct guardrail, fence and shelter along the boundary of drinking water source protection zone.	2012	Zhangzhou and Longyan Municipal Government

Table 6. Priority Action for Raising Public Awareness.

Project Name	Project Content	Estimated Finish Time	Department Responsible
Strengthen public attention	Conduct public exhibition of marine-related documentaries and promotion films and increase awareness of marine environmental issues via media.	201	Zhangzhou, Longyan and Xiamen Municipal Government
Adding marine and watershed ecological protection into the primary education	Incorporate marine and watershed information into primary school curriculum. Organize primary school students to visit and experience watershed and coastal areas in order to cultivate their ecological protection consciousness.	2102	Zhangzhou, Longyan and Xiamen Municipal Government
Concerning stakeholders	Minimize loss of income by pig-raising households and workers caused by reforms; Provide appropriate time adjustment and compensation.	2015	Zhangzhou, Longyan and Xiamen Municipal Government

Table 7. Strengthen Scientific and Technological Support Capacity.

Project Name	Department Responsible
Study on baseline inspection studies for watershed-bay ecosystem	2011
Study on services changes in the watershed-bay ecosystem	2012
Study on pollution control and ecological protection division management	2012
Study on environment capacity of watershed-bay and distribution of pollutant discharge	2012
Study on impact of water resources utilization in the watershed-bay	2011
Study on capacity and optimized layout of livestock and poultry breeding	2011
Study on the best measures and cost for reducing the pollutants in the watershed-bay and cost-sharing policy	2013
Study on ecological wetland protection and restoration research in estuary and bay	2012
Study on integrated management institution and mechanism for the watershed-bay ecosystem	2012
Study on standards and mechanism of ecological compensation in the watershed-bay	2012
Study on decision support system and information sharing platform for integrated management of watershed-bay ecosystem	2013

