REPORT ON

INTEGRATED ACTION PLAN

FOR

CONSERVATION AND SUSTAINABLE USE OF AQUATIC RESOURCES IN BEIJIANG RIVER, CHINA

Releasing fish fry by Shaoguan citizen in Beijiang River, June, 2010

by
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April, 2012

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Content

Abstract

Beijiang River as one of a typical upper reaches of the Pearl River is chosen as the project site for this project. Most of Beijiang watershed area lies in Shaoguan Municipal Region. The overall aims of the project at China site are to find out the threats faced by aquatic resources and the impact on the life of fishers, to analyze the social and economical factors causing this situation, to look for management and legislation issues related with the aquatic resources and to find out solutions which not only include long term solutions, but also short term actions. We form an integrated team with 18 team members from disciplines including ecology, fish, mollusc, crab and shrimp, plant, agronomy, economic, law and management. We worked in the sites and exchanging materials and idea together within our team and also worked with stakeholders through participatory methods including group discussion, personal interview, data collection, workshop, rapid rural appraisal, and Delphi method. The major challenges and problems are identified. The aquatic resources are declining mainly due to the construction of dams across river and mechanical sand drugging activities on the river bed. Water pollution in river is the second reason. The livelihood of fishers is declining due to the decrease of fishing resources, and the marginalization by policies neglecting the fishing community. There are still some weakness in our legislation and policy related to aquatic resources and sustainable development, especially on the detail regulation on implementation. The communication and coordination mechanism among different stakeholders is very weak.

In order to formulate action plan, we first proposed a preliminary action plan within our research group. Then we discuss our proposed action plan with different stakeholders who were 40 government officers from 26 different city government departments and township governments, and with 6 fishers of the three fishing villages and a newly formed company for tourism. Proposed management measures can be separated into three parts: the existing measures which can be improved, the newly proposed measures which can be implemented in the next few years, and new measures which can be carried out in a much longer period and larger scale.

The good measures which will be continued and further improved include: (1) social economic development plan according to the strategy position of the region as ecological buffering zone, (2) protection and expansion of forest cover, (3) better protection on the aquatic protection zones, (4) further reduction of water pollution from industry, (5) more biogas digesters in rural area, (6) more artificial fish fry released to Beijiang River each year, (7) the prevention of cage fish culture in reservoirs to prevent water pollution, (8) better control of sand drugging activity in the river, (9) government subsidize for poor fishing families and elders, (10) diesel price subsidize for fishers, (11) Nine-years-compulsory-education for children, and (12) more houses and more job training for fishers.

New Actions which will be taken in the next few years include: (1) the increase of financial resources for protection and conservation of aquatic resources, (2) the recovery of aquatic plants and the habitat of the river, (3) the implementation of the no fishing season regulation from 2011, (4) the reduction of water pollution from iron ore mining, (5) the decrease of chemicals in agriculture, (6) the reduction of eucalyptus forest, (7) more public education program, (8) the establishment of hotline between fishers and hydropower stations, (9) recreation fishing activity as one new development trend, (10) participatory monitoring to prevent illegal fishing, and (11)

better organization system for fishing communities.

The measures which need longer period and larger scale for implement include: (1) re-establishment of stabilized habitat for aquatic resources, (2) more green production technique in agriculture, (3) more sanitary facilities for rural house refuse and domestic sewage, (4) policy to treat fishers as a special group to guarantee their pension and medical insurance, (5) more opportunities for children from fishing families for further education, (6) better eco-compensation program, and (7) the amendment of “The Law of the People's Republic of China on Evaluation of Environmental Effects” and “the Law of the People’s Republic of China on the Protection of Wild Life”.

1. Introduction

The project of "Highland Aquatic Resources Conservation and Sustainable Development" (HighARCS) is supported by EU under Theme 6 of the Seventh Framework Program. The goals of this research are as follows:

- to investigate and evaluate biodiversity of aquatic resource and ecological service of ecosystem in Beijiang river;
- to analyze the main factors that contribute to the decreasing of aquatic resources ;
- to identify different groups of fishermen to better target new development efforts;
- to identify stakeholders and understand their roles and linkages in relation to highland aquatic resource in Beijiang river;
- to identify the possible livelihood development strategies of households dependent on aquatic resource;
- to formulate and implement action plans to enhance poor livelihood and aquatic resource conservation.

The first phase of this project was conducted in 2009 and a background report introduced our findings about the general situation of Beijiang River, the upper reach of Pearl River in South China (WP1). The second phase of this project conducted in 2010. It mainly concentrated on the detail investigation about the aquatic resources and ecosystem services (WP3), the livelihood of the poor (WP4) and the management situation (WP5). Then action plan is made for improving the situation for conservation and sustainable development of the aquatic resources by participatory method. So far, we have finished three reports which included the "Report on Highland Aquatic Ecosystem Services and Biodiversity Values in Beijiang River, China" (WP3), "Report on Livelihoods dependent on highland aquatic resources--a case study at Shaoguan, China"(WP4) and "Institutions, Policies and Conflicts Related to Sustainable Use and Protection of Aquatic Resources in Beijiang River Watershed, China" (WP5). This report concentrates on the action plan to improve the livelihood of fishers and to improve the aquatic resources and ecosystem services provided by Beijiang River watershed. The general background of the research site and the management issue facing in the site are introduced first, and then action plan which can be taken in the next two years and measures which can be taken in a longer term are described.

1.1 Background of the Research Site - Beijiang River

The Pearl River Watershed covered from 21°31'to 26°49'north latitude and from 102°14' to 115°53' east longitude. The Pearl River is the third largest river in China. The major river branches of the Pearl River are Xijiang River (West River), Beijiang River (North River), and Dongjiang River (East River). After they merge together and form the main stream of the river, it runs into the Pearl River Delta and then to the South China Sea. The West River flows through Yunnan Province, Guangxi Province, and Guangdong Province. The North River runs through Hunan

Province, Jiangxi Province and Guangdong Province. The East River runs through Jiangxi Province and Guangdong Province. Total length of the river reaches 2214 km, and with a watershed area of 453,690 km^2, of which 442,100 km^2 is in China. There are 330,000 billion m^3 water flows through the Pearl River annually. The watershed area of the Pearl River in Guangdong Province is 11,125 km^2, which includes part of the Xijiang watershed, most of the Beijiang watershed, the Dongjiang watershed.

The Beijiang River (North River) is the second largest water system in the Pearl River System (Fig.1). It's also one of the most important rivers in Guangdong Province. There are two sources of the upper Beijiang River. One is the Zhenjiang River-the east branch which runs from Xinfeng county of Jiangxi Province. Another one is the Wujiang River-the west branch which originates from Linwu county of Hunan Province. The two sources joint together in Shazhouwei of Shaoguan City. Then it is called Beijiang River. On its way to sea, other branches such as the Wenjiang River, the Lianjiang River, and the Suijiang River join into the Beijiang River. The Beijiang River is 573 km in length with a watershed area of 52,068 km^2, most of which is in the Guangdong Province (42,930 km^2). The part of the Beijiang Watershed takes 38.5% of the area of Pearl River Basin in Guangdong Province and with 45,700 billion m^3 annual water flow. Beijiang River flows through Shaoguan City, Qingyuan City and Foshan City from north to south. The whole upper reach and the most part of the middle section of Beijiang River are located in Shaoguan City.

1.2 Natural Environment of Beijiang River

The upper and the middle reach of the Beijiang River lies in the northern Guangdong Province t. It's within $23^o5'$to $25^o31'$ north and $112^o50'$ to $114^o45'$ east. There are 18.6 million m^2 in this area. It covers 10.5% of Guangdong Province. Shaoguan City is in the south of the Nanling Mountain. It lies in the Hunan Guangdong Fold Belt. The total land cover in Shaoguan is 17.1 million m^2 witch is 92.8% of the total area. The remaining area is covered by river, lake or reservoir. The highest mountain, 1,902 m Shikengkong Mountain in Shaoguan is also the highest mountain in Guangdong Province.

Shaoguan is in the subtropical humid monsoon climate zone. It is wet in the spring, dry in the autumn, cool in the winter and both hot and humid in the summer. The average annual temperature is 18.8℃ to 21.6℃. The average temperature of the coldest month(January) is 8℃ to 11℃ and the average temperature of the hottest month(July) is 28℃ to 29℃. The annual rainfall is from 1,300 mm to 2,400 mm. The rainy season is from March to August while the dry season is from September to February. Most of the solar radiation (90%) comes within warm and rainy season with daily average temperature higher than 10℃. It is good for the growth of plants and agricultural crops. There are 310 days frost-free in a year. The annual total sun shine reaches from 1,473h to 1,925h.

The vegetation in Shaoguan City belongs to subtropical evergreen forest. The forest covers 50% of the area in Shaoguan with standing wood storage of 500 million m^3. The available timber storage reaches 250 million m^3. The timber forests are mainly formed by Chinese fir, pine, and hairy bamboo. The forests of cassia (*Cinnamomum*), paulownia (*Pauownia*), nanmu (*Machilus namu*) , common jujube (*Ziziphus jujba* var. spinosa), yew (*Taxus cuspidata*) , Chinese torreya (*Torreya grandis*) , oak (*Quercus*) , and cypress (*Cupressus* L.) are also important.

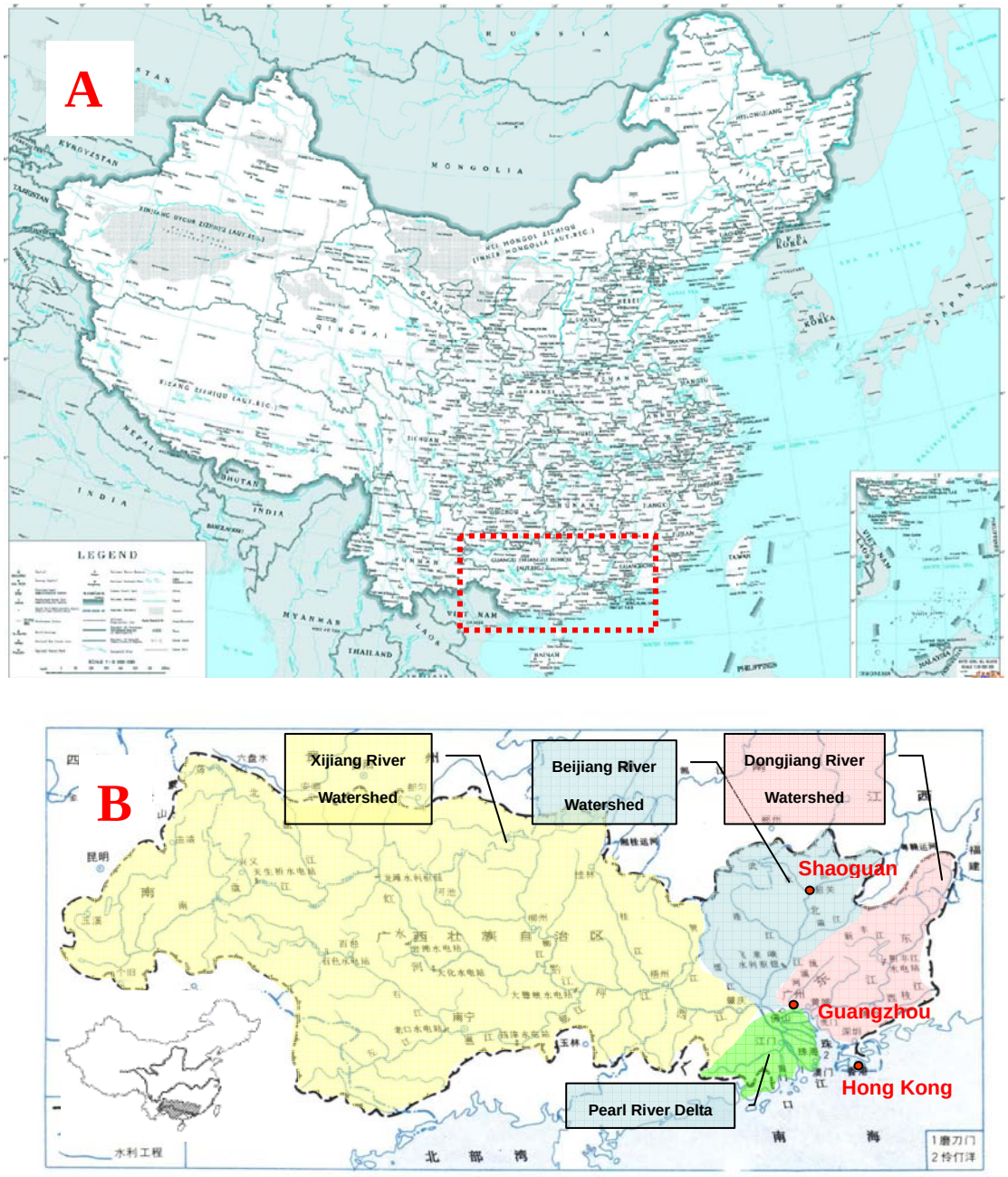


Fig. 1 The Location of Beijiang River Watershed in Pearl River Watershed

Map A shows the location of Pearl River Watershed in China (red box is enlarged in map B)

Map B shows the location of Beijiang River Watershed in the Pearl River Watershed

1.3 Social and economic Situation

1.3.1 Population and nation

By the end of 2008, the population of Shaoguan City is 32,309,000, among which 12,480,000 are nonagricultural residents, and 19,829,000 are agricultural residents. Shaoguan City is a multi-ethnic area with 98.32% Han resident and 1.68% minority people. There are 30 minority nationalities in Shaoguan City, most of them belong to Yao, SHE, and Man, Hui, Jing, Miao, Li, Bai, Dong, and Tujia nationalities. Most Yao people lives in Ruyuan Nationality Autonomous County, Qujiang County and Shixing County and Most of SHE people lives in Nanxiong City and Shixing County.

1.3.2 Economic Development

The local GDP is 57.17 billion Yuan RMB in 2009, increased by 10.1% than that in 2008. The primary industry has an increase of 8.12 billion. The secondary industry has an increase of 23.38 billion. The third industry has an increase of 25.59 billion. According to the resident population, the GDP per capita is 19312 Yuan. Economic structure has changed from agriculture: industry: service =14.2: 48.1: 37.7 in 2008 to 14.4: 40.8: 44.8 in year 2009. The sector in service part increased very quickly in recent years. The seven main products of agricultures in the region are vegetable, rice, livestock, fish, fruit, bamboo, and tobacco.

Table 1 The main annual economic indexes in Shaoguan City

	1、population（million）			2、GDP（10^3yuan）				GDP per capita（yuan）	The structure economic（calculated with price%）		
Year		Nonagricultural population	Agricultural population		primary industry	secondary industry	third industry		primary industry	secondary industry	third industry
2000	3.1093	1.0965	2.0128	19272	4401	7571	7300	7045	22.8	39.3	37.9
2005	3.1866	1.2610	1.9256	335.81	5547	14441	13593	11566	16.5	43.0	40.5
2007	3.2119	1.2587	1.9532	47169	6694	22864	17612	16049	14.2	48.5	37.3
2008	3.2309	1.2480	1.9829	54587	7776	26256	20555	18503	14.2	48.1	37.7

In 2007, the aquiculture output of Shaoguan City was 60,395t, including 59,612t fish, 393t shellfish, 202t shrimps and crabs (Table 2). In 2007, the aquiculture output value was 431.87 million taking 3.93% of the total agriculture output value.

1.3.3 Fishermen in the region

Fishery households are increasing year by year. The number of fishery households is increasing from 19,440 in 1998 to 20,299 in 2007, but the number of fishing workers is decreasing. The number of fishing workers descended from 546 in 1998 to 395 in 2007 (Table 3). It caused by the reduction of fish resources and by the preference of young people who like to work in towns and cities more than fishing today.

Table 2 The aquiculture output of Shaoguan City in 2007

	Yield(t)
Aquiculture output	60395
1.fish	59612
(1) high-quality fish	18420
Ophicephalus argus（乌鳢）	166
Siniperca chuatsi（鳜）	130
Micropterus Salmoides（大口黑鲈）	526
Colossoma Brachypomum （短盖巨脂鲤）	2009
Oreochromis（罗非鱼）	5118
Carassius auratus（鲫鱼）	3809
(2) other fisher	41192
Ctenopharyngodon idllus （草鱼）	14781
Aristichthys nobilis（鳙鱼）	9194
Hypophthalmichthys molitrix 白鲢）	10126
Cyprinus carpio.（鲤鱼）	4853
2.shellfish	393
3. shrimps and crabs	202

Table 3 Current situation of the number of the fishery workers in Shaoguan city

	1998	2000	2001	2002	2003	2004	2005	2006	2007
Fishery families	19440	18046	18123	19047	18179	19983	21174	20163	20299
Fishery population	96389	80709	81078	90549	88784	92838	97051	93846	94717
Professional fishing workers (freshwater fishing)	546	469	482	445	386	432	389	391	395
Part-time fishing workers (freshwater fishing)	715	518	470	352	331	457	1071	437	429

1.4 Research sites along Beijiang River

Pearl River was included as one of the five rivers in Vietnam, India and China in the original research proposal. Because similar natural and social economic situation are existed along the upper reaches of Beijiang River, Dongjiang River and Xijiang River, the findings in the upper reach of Beijiang will be easily extrapolated to other upper branches of the Pearl River. Another reason is operational. The major part of Beijiang Watershed is within the management of Shaoguan municipal government, Guangdong Province. Not only it is easier to get data and information, but also is more convenient to take conservation and development actions.

To understand the livelihood status of the research site, we selected three fishing communities for detail surveys; Lishi, Kengkou, and Zhoutian (see Fig. 2). Lishi is located at the lower end of the Wujiang River which flows into the Beijiang River from the north-west. There are about 70 households in the community and about 30 households depend upon fishing. The major characteristic of this community is that it located just on the river bank. Kengkou is located on the Beijiang River downstream from Shaoguan city. There are around 50 households living in the community, of which about 30 depend upon fishing. The major characteristic of this community is that there are some industrial firms which emit pollutants into the river. Zhoutian is located on the Beijiang River upstream from Shaoguan city. There are around 60 households in the community

and about 30 households depend upon fishing. The major characteristic of this community is that the river is quite shallow because of the hydro power station upstream. Furthermore, unlike the other two communities, there is a community committee responds to the management of the community including fishing.

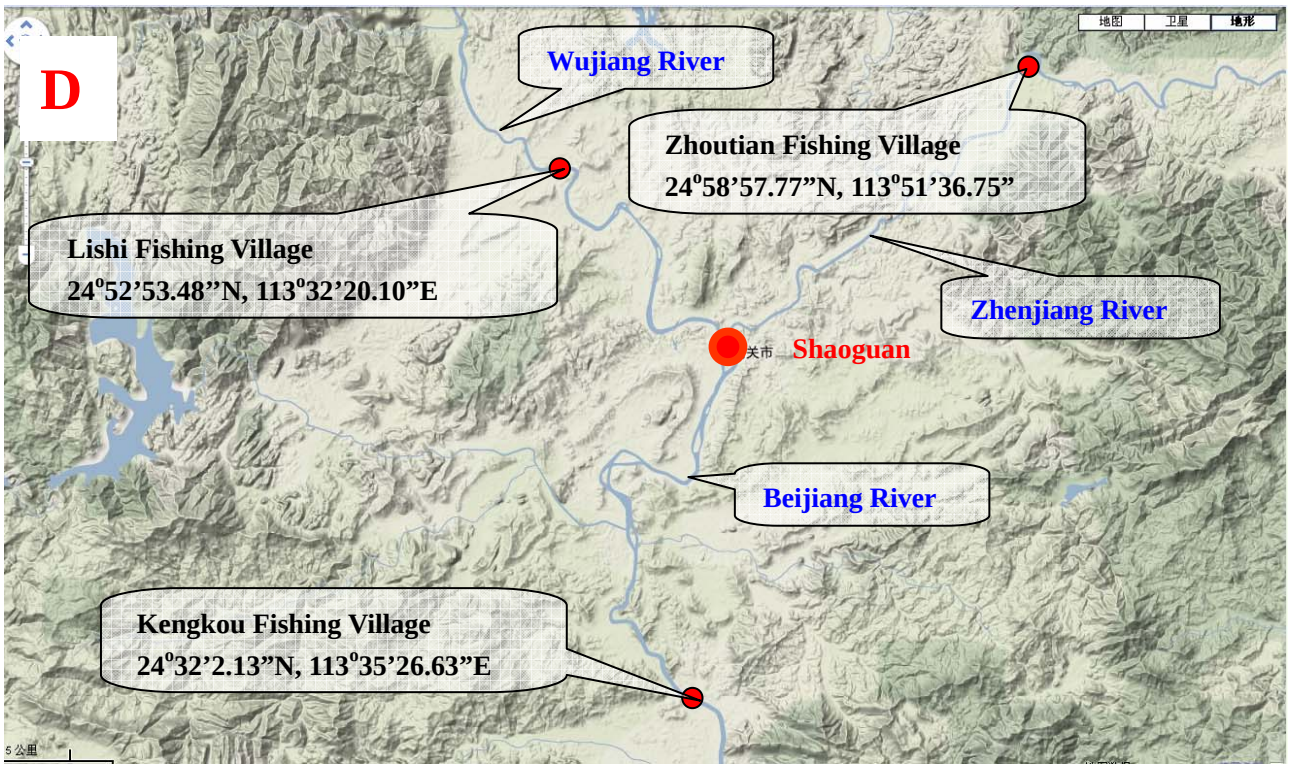


Fig.2 the position of three fishing villages in Beijiang River Watershed

Lishi Fishing Village is 15 km away from Shaoguan along the north-west branch (Wujiang) of Beijiang River

Zhoutian Fishing Village is 35 km away from Shaoguan along the north-east branch (Zhengjiang) of Beijiang River

Kengkou Fishing Village is 31 km south from Shaoguan along Beijiang River

1.5 Major challenge in aquatic resources conservation and sustainable development in Beijiang River Watershed

After our observation and investigation for the research site, it is clear that aquatic resources have been seriously destroyed and the lives of fishers are very difficult. The major reason is the existing conflict between economic development and ecological conservation. The needs for electricity, iron, steel, chemicals and sand were tremendous during industrialization and urbanization process. It stimulated the construction of hydropower stations along the river, the large scale mechanized sand mining under river bed, iron ore mining and transportation along the watershed and more industrial factories set up along the river.

The dams across Beijiang River cut off the natural river flow. Fish species with migration behavior were not be able to go through the river anymore and disappeared. Fish species which like to live in the running water were also suffer from the stagnant situation caused by those dams.

Mining for sand in river bed destroyed the habitat of many aquatic species. Aquatic plant communities in many places were eliminated by sand mining operation and the dramatic daily changes of water level caused by dam operation. Aquatic animal species which rely on stable river bed or aquatic plant community for reproduction are facing serious thread. Pollutions released from expanding cities, towns, factories, mining sites and even fields are increasing. Toxic materials and low oxygen level caused by pollutants decreased the survival rate of many aquatic species especially during their young stages.

The lives of fishers are going down because of the ever decreasing fish resources. Fishers living in fishing community are considered as city residents in our management system. So, they cannot get benefit from government policy for farmers and farming villages. However, they also not are able to get benefit from cities and towns because fishing villages are usually quite far away from town or city. They are a group of people who are living in a marginal situation and are usually ignored by government policy. In order to get their short term benefit, fishers sometimes used destructive methods such as electricity method and poisoning method to get fish.

It is not that easy to reverse the situation or improve the situation.(1) Many government leaders, industrial leaders and even farmers are still considering that economic development is much more important than “those few small fishes”. (2) On the one hand, our law system for environmental protection and resources conservation is still not perfect and many people can find ways to bypass those regulations. On another hand, laws have not been implemented very well. The reasons include the lack of education to let people respect to our law, and the lack of law implementation and monitoring force. (3) No matter the waste treatment, or the recovery action needs a lot of public investment However Shaoguan is located in the mountainous area, it is not a very rich area. It is hard to put large amount from its budget to those conservation and protection projects by Shaoguan Municipal Government. Because of the same reason, it is hard for the government to help fishers to improve their lives such as providing house, subsidy for the reduction of resources, increasing medical care and other welfare. (4) Different parts of ecosystem and the life of people are linked together through material and energy flow. However, government departments and industrial companies usually only work on part of it. Daily communication and coordination mechanisms are either not existing, or very weak. Many industrial leaders don’t know the situation of fishers. Sand mining is not stopped in the aquatic conservation zones by the Bureau of Water Management. Dam gate operations were not informed to the fishers on time and caused big lost of their fishing tools and even thread to their lives.

1.6 Stakeholders identified in Beijiang River watershed area

Theoretically every one living within the watershed is both influencing the watershed, or influenced by the watershed. However, we can identify those have significant impact on aquatic resources. A diagram in Fig. 3 shows the relationship of the major stakeholders in Beijiang River watershed.

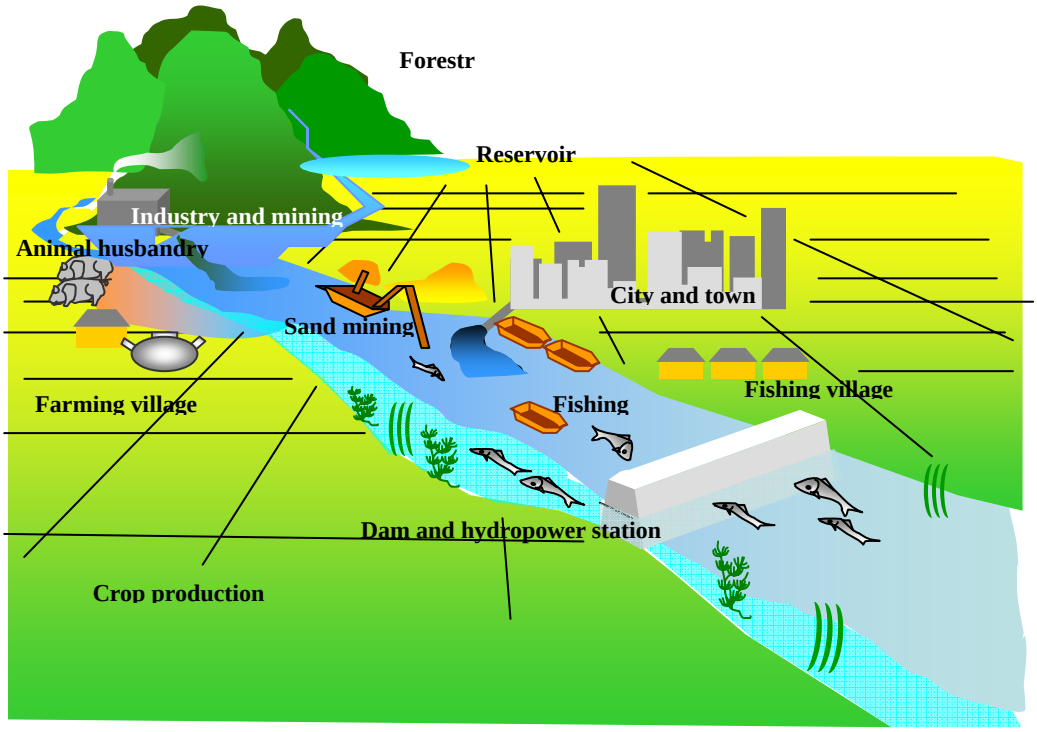


Fig. 3 The major stakeholders in Beijiang River watershed

The most important stakeholder is people :men,women,girls and boys in the fishing villages. The life of **fishers** and their family heavily relies on aquatic species in the river. They usually live nearby the river. Ordinary **resident** as consumer of river fish is also an important stakeholder.

Stakeholders with direct negative impact on the aquatic resources can be identified as follows. **Industry companies** and **mining companies** such as Da-Baoshan Mining Company and Shaoguan Steel Cooperation release a lot of waste water to the river during their production processes. **Farmers and agricultural farms** are also stakeholders, because the drainage water from field or villages usually contaminates with animal waste, human waste, chemical fertilizer and pesticide. Waste water discharge from city would also contaminate the river. However it is hard to charge an ordinary citizen. Shaoguan City government is in charge of the building of sewage treatment plan. During our investigation, we found that most destructive impacts were come from **hydropower stations** with big dams across the river, and the **sand mining companies** with mechanized bumps and shovel to get sand from river bed.

Stakeholders with direct positive impact on aquatic resources are **Shaoguan Institute of Fishery** and **Shaoguan Monitoring Team** for Fishery. They organize artificially fish fry perforation and fish fry releasing activity. Farmers in the hilly and mountainous area are in charge of reforestation and forest conservation. Well vegetation cover helps to provide abundant clean water resources to the river.

Stakeholders with management duties are various government bodies. In Shaoguan municipal government, stakeholders include Shaoguan Bureau of Fishery, Shaoguan Bureau of Agriculture, Shaoguan Bureau of Water Management, Shaoguan Bureau of Environment

Protection, Shaoguan Committee of Reform and Development, Shaoguan Bureau of Forestry, Shaoguan Bureau of Housing and Construction, Shaoguan Bureau of Water Conservancy, Shaoguan Bureau of Labor and Social Security, Shaoguan Bureau of Public Affair, and Shaoguan Legal Office. Government management power can be traced dawn and up. So, township governments leading fishing villages are important stakeholders. Provincial government bureaus and even ministries of the central government are stakeholders if they are important policy makers relating to aquatic resources in Beijiang River.

1.7 Overall aims of the project at the site

China is country developing rapidly. Conflict between economic development and ecological conservation is quite serious. There is the same situation in river watershed ecosystem in China. The Pearl River lies in the subtropical southern China. The river is vital to the life of the people and to the ecological environment. It is also provide important water resources, sand resources, and power resources to support our industrialization and urbanization process. How to balance the social, economical and ecological services provided by the river, and how to balance the short term benefits with long term ecological stability of the river are big challenges. Beijiang River watershed in Shaoguan as our research site is chosen to focus on the specific conflicts and solutions related to aquatic resources.

Different parts of the ecosystem are linked together through material and energy throw. Sustainable development relates not only on natural environment, but also on economic development and social development. However, no matters in terms of research, management, or simply making life, people are used to work or live within only small part of the system. How to get them work together to identify problems and solutions is also a big challenge. This project site is within the area governed by Shaoguan Municipal Government, it is convenient to conduct such a multi- disciplinary research and to find out a comprehensive solution.

The overall aims of the project at China site in Beijiang River within Shaoguan are to find out the threats faced by aquatic resources and the impact on the life of fishers, to analyze the social and economical factors causing this situation, to look for management and legislation issues related with the aquatic resources and to find out solutions which not only include long term solutions, but also short term actions. An integrative action plan will be made by identifying specific goals, results, indicators and agencies in charge of actions. We hope that the implementation of these actions will be helpful to improve the understanding of the stakeholders and to see its preliminary result toward sustainable development.

2. Assessment Methodology

According to the project design, more detail investigation was conducted for biodiversity and ecological services (W3), the livelihood of fishers (WP4), and the management and policy issues

(WP5) in order to deepen our understanding on the issues of aquatic resources conservation and the conflicts for sustainable development (Fig. 4).

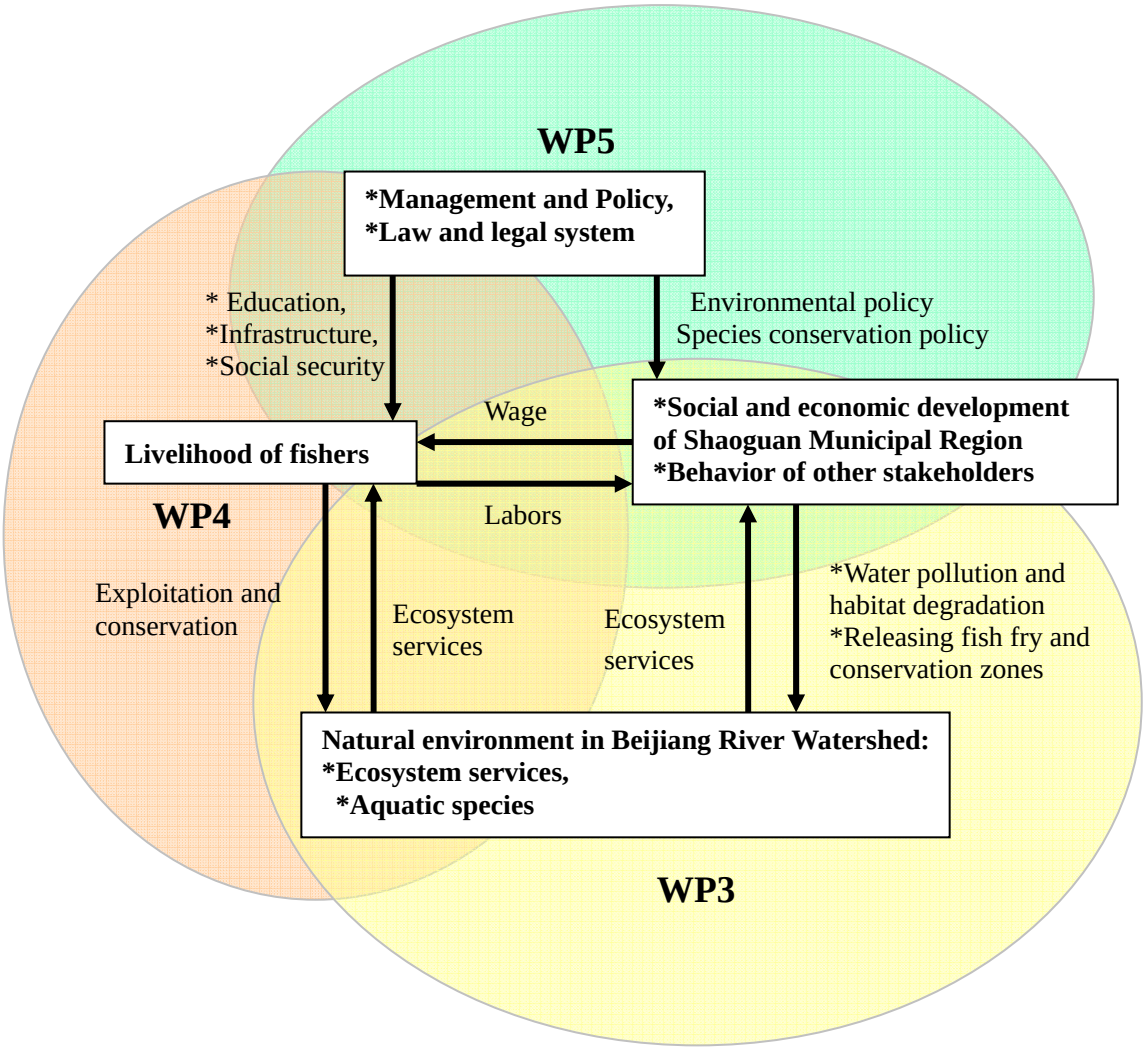


Fig. 4 The relationship of Beijiang River Watershed Ecosystem with the three work packages

The eighteen members in our research team are experts from different fields including ecology, agronomy, botany, fresh water fish, ontonata, mullusc, phytoplankton, GIS, economy, and law (Table 4). They are assigned on one of the work packages (WP3, WP4, WP5) of the project for writing reports. We discussed our working plan, report of our investigation result and our understanding together in campus. Sometime, graduate students of our professors also joined our investigation. In order to work more effectively with various stakeholders and to understand the whole picture of the system by each one of our team, we then divided our team members into three multidisciplinary teams which are shown in the right column of Table 4. Each team was in charge of one of the three sampling villages, several government departments, several industrial companies, agricultural companies, and some farmers during our field work. Team members were usually changed and switched from one to another according to their availability. Graduate students would also join our team some times (Fig. 5).

Table 4. Members in the Research Team in South China Agricultural University

	Name in English	Name in Chinese	Specialty	WP in charge	Field Team
1	Luo Shiming	骆世明	Agro-ecology	WP1,WP2	leader
2	Cai Kunzheng	蔡昆争	Agro-ecology, Crop	WP1, WP3	1
3	Zhang Jia'en	章家恩	Agro-ecology, Geology	WP1, WP3	3
4	Li Huashou	黎华寿	Agro-ecology, Pollution	WP1, WP3	2
5	He Hongzhi	贺鸿志	Phytoplankton	WP1, WP3	2
6	Ye Yanqiong	叶延琼	GIS，Geology	WP1, WP3	3
7	Cui Ke	崔科	FW fish	WP1, WP3-1	2
8	Zhao Huihong	赵会宏	FW fish	WP1, WP3-1	1
9	Fu Jinghua	付京花	mollus	WP1, WP3-1	1
10	Gan Lian	甘炼	FW crab and shrimp	WP1, WP3-1	3
11	Tong Xiaoli	童晓立	Aquatic Insects, Odonata	WP1, WP3-1	3
12	Zhuang Xueying	庄雪影	Plant Taxonomy	WP1, WP3-1	1
13	Wang Quandian	王权典	Environmental law	WP1,WP5	3
14	Jiang Baoguo	江保国	International law	WP1,WP5	1
15	Gao Min	高敏	Environmental law	WP1,WP5	2
16	Liu Yiming	刘一明	Resources Economic	WP1,WP4	2
17	Chen Fengbo	陈风波	Agricultural Economic	WP1,WP4	1
18	Wang Wenzhong	王文中	Agricultural Economic	WP1,WP4	3
19	Shang Chunrong	商春荣	Agricultural Economic	WP1,WP4	2

For background investigation, we had a tour around the watershed for two days together and got some statistic data or writing material from various sources in 2009. Then, we held a workshop of stakeholders in Shaoguan. After, we introduced briefly the goal of our project. Then, we were separated into three groups for detail discussion.

For the second stage of the research for W3, WP4, and WP5, we chose three sampling villages according to their typical locations and activities. We went to the each village with a multidisciplinary field team for about 6-10 times according to the research need. The work in villages including personal interview for families with different wealth ranking, discussion with focus groups of men, women, boys or girls, discussion about the long term family lock book for detail activity record. Subjects of the discussion included their life strategy, their living environment, and the changes in the past 10 years, the actions and management issues etc.

In order to get a feedback on our background investigation from stakeholders and also to have participatory appraisal on the management issues, policy issues, actions and ecosystem services. We conducted two workshops with stakeholders in 2010. After we introduced about situation of Beijiang River ecosystem, the aquatic resources, the life of fishers and policy and management issues, each one in the workshop expressed his or her idea. We carefully listened and made notes. We also asked them to fill two forms by the end of the workshops. One is about the degree of agreement on our understanding of the basic situation. Another one is for Delphi method

to understand the view of stakeholder on the important ranking of different policies and management issues. Each stakeholder filled the form independently. After the first round of Delphi method, we summarized the result and gave feedback to stakeholders. Then, we conducted the second round of Delphi method separately through mail, e-mail or direct contact.

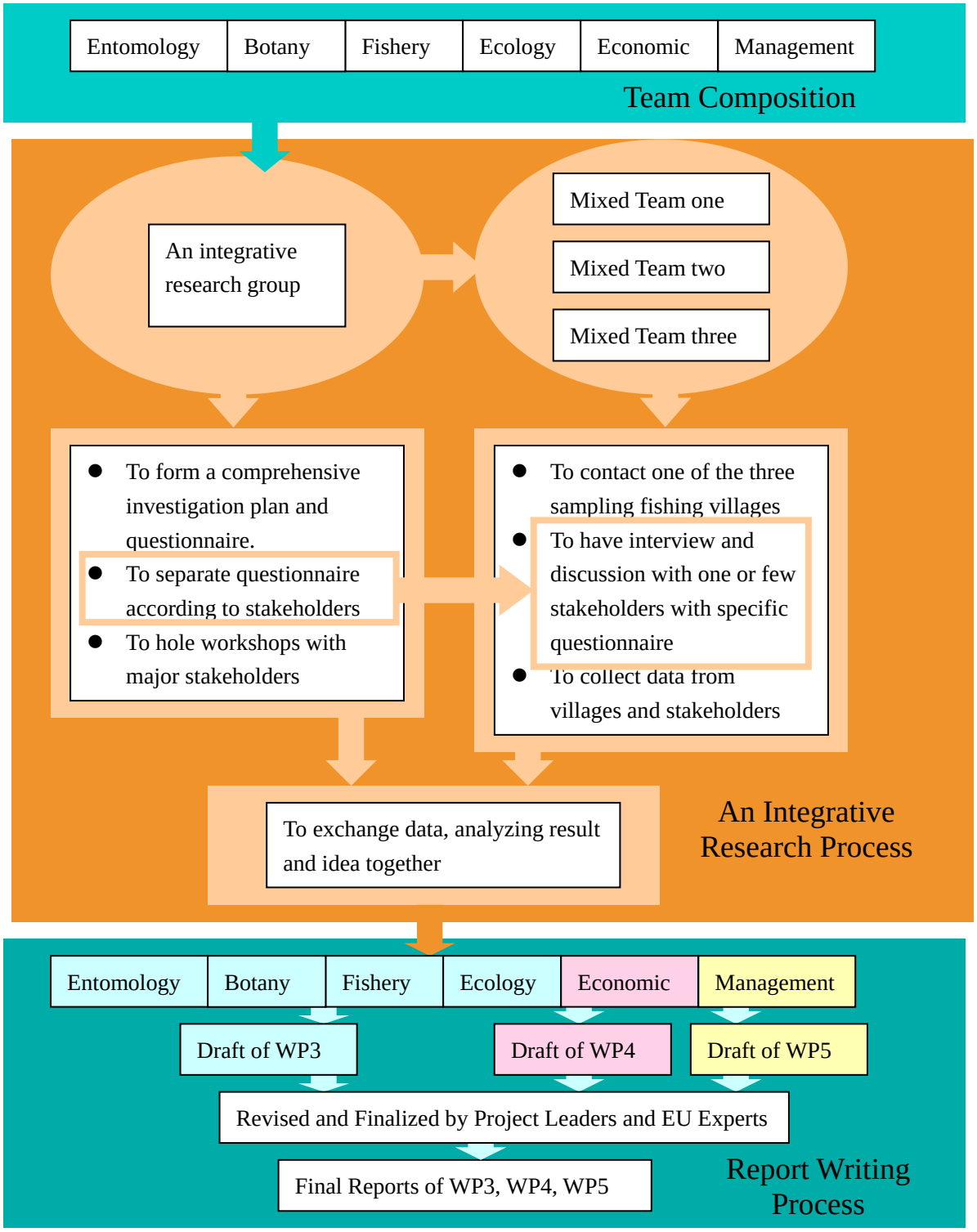


Fig. 5 The Assessment Methods for Beijiang River Watershed

Each time before we went to the side, we designed a sheet of questionnaire together within

our team. If we were going to different stakeholders, we compiled all questions related to the specific stakeholder together and formed a specific questionnaire. After the investigation in the field, we either had a group meeting or wrote a short report to exchange findings and data of each team.

3. Overview of biodiversity and ecosystem service values (WP3)

The biodiversity and ecosystem service values in the Beijiang River watershed have been assessed for the HighARCS project and are summarised below. Please see Shiming Luo et al.(2011) for detailed report on these findings..

3.1 Biodiversity evaluation of aquatic resources

Literature review, field surveys, market surveys and household visits were undertaken to identify the aquatic species in the Beijiang River. The locations chosen to survey were the three project sites Lishi, Zhoutian and Kengkou which represent typical fishing villages along the river.

3.1.1 Fishes

According to Pan JH (1985), there were 143 species in Beijiang River, including 3 introduced species. However, recent investigation conducted by the project, Guangdong Freshwater Fish Resource Investigation during 2005-2009 found that there were 141 native species in the Beijiang River. Among them, 94 species or 66.67% were cypriniformes, 19 species were perciformes (13.48%), 18 species were siluriformes (12.77%), and less than 3% species were other species (Sun-yat sen University, 2010). Almost all fishes in the Beijiang River can be consumed as human food. These fishes are very important to the daily life of local people. The species of cypriniformes and siluriformes are especially important, because they grow fast and can adapt to the changing surrounding quickly. Historically, the fish resource in Beijiang River was very rich. Fish harvested from the river in 1950’s reached 8,000 tons annually. Because of human activity such as sand quarrying, dam construction, and water pollution, the fish resources have been decreasing rapidly, and the annual fishing production has not been more than 2,000 tons since 2000 according to Shaoguan annual statistic reports. Most of the fish species captured were of the low valued species such as *Saurogobio dabryi* and *Hemiculter leucisculus*.

Distribution: The project site Lishi is located in the northwest upper branch of Beijiang River, Wujiang, and joins into the main stream of Beijiang River from the north-west after passing through Lishi for 15 km. The project site Zhoutian is located in the northeast upper branch of Beijiang Rive, Zengjiang and joins into the main stream after passing through Zhoutian for about 35 km. The third project site Kengkou is located in the mainstream of Beijiang River about 31 km down from the joining point of Wujiang and Zengjiang in Shaoguan City (Fig.2). The surroundings of these three sites are quiet different. The quantity of fish caught was more in down stream. More fish species which adapt to the clean and fast running stream could only be found in the upper sites (Shaoguan Fish Monitoring Team 2011). There are usually more fish in terms of quantity behind the dams of hydropower stations with deep water, but less in front of the dams or in certain sections of the river with shallow water.

Fish species composition: According to our investigation, 26 native species of freshwater fishes, belonging to 23 genera, 7 families and 3 orders were found in the 3 fishing villages. Among them, there are 20 species of cypriniformes, making up 76.9% of the total, 4 species of perciformes, or 15.4% of the total, 2 species of siluriformes, or 7.7% of the total. During the survey, the fishers told us that the composition of fishery harvesting was quiet different from the past that both the number of species and the amount of fish declined sharply. The fish species in Beijiang River found that are of conservation concern is listed in table 5 below.

Table 5 Fish species of Beijiang River that are of conservation concern

Binomial	National Red List status	IUCN Red List	Economic or livelihood value	Population trend in catchment	Method of identification
Abbottina rivularis	Not Evaluated	Not Evaluated	Food fish	Unknown.	Literature review.
Acheilognathus tonkinensis	Not Evaluated	DD	Small fish	Unknown.	Literature review.
Carassius auratus auratus	Not Evaluated	Not Evaluated	Commercial fisheries.	Unknown.	Literature review.
Cobitis sinensis	Not Evaluated	Not Evaluated	Small fish	Unknown.	Literature review.
Cyprinus carpio	Not Evaluated	Vulnerable(VU) (A2ce)	Commercial fisheries.	Unknown.	Literature review.
Metzia formosae	VU	VU	Food fish	Unknown.	Literature review.
Microphysogobio fukiensis	Not Evaluated	LC	Small fish	Unknown.	Literature review.
Misgurnus anguillicaudatus	Not Evaluated	Not Evaluated	Fisheries: commercial; aquaculture: commercial; aquarium: commercial; bait: occasionally	Unknown.	Literature review.
Pelteobagrus fulvidraco	Not Evaluated	LC	minor commercial	Unknown.	Literature review.
Pseudogobio vaillanti	Not Evaluated	LC	Small fish	Unknown.	Literature review.
Pterocryptis cochinchinensis	Not Evaluated	Not Evaluated	Commercial fisheries.	Unknown.	Literature review.
Puntius semifasciolatus	Not Evaluated	Not Evaluated	Small fish, Ornamental fish	Unknown.	Literature review.
Rhinogobius giurinus	Not Evaluated	Not Evaluated	subsistence fisheries	Unknown.	Literature review.
Rhodeus lighti	Not Evaluated	LC	Small fish, Ornamental fish	Unknown.	Literature review.
Sarcocheilichthys parvus	Not Evaluated	LC	Small fish	Unknown.	Literature review.
Sarcocheilichthys sinensis	Not Evaluated	LC	Commercial fisheries.	Decline	Literature review.
Saurogobio dabryi	Not Evaluated	Not Evaluated	Fisheries	Unknown.	Literature review.

Schistura fasciolata	Not Evaluated	Not Evaluated	Small fish	Unknown.	Literature review.
Schistura incerta	Not Evaluated	Not Evaluated	Small fish	Unknown.	Literature review.
Schizothorax wangchiachii	Not Evaluated	NT	Food fish.	Unknown	Literature review.
Sinibotia pulchra	Not Evaluated	Not Evaluated	Small fish	Unknown.	Literature review.
Sinibotia robusta	Not Evaluated	LC	Small fish	Unknown.	Literature review.
Toxabramis houdemeri	Not Evaluated	Not Evaluated	Food fish	Unknown.	Literature review.
Traccatichthys pulcher	Not Evaluated	LC	Fisheries: of no interest	Unknown.	Literature review.
Yunnanilus nigromaculatus	Not Evaluated	EN	None	Possibly extinct	Literature review

3.1.2 Molluscs

According to Liu et al. (1979), there are 86 species of mollusks in the Pearl River and only 8 mollusc species are common molluscs caught by fishermen in three river sections close to the three fishing villages which are chosen as our project sites. No detailed data on the other species were found. Table 6 shows the species of conservation concern in the survey. The majority of these species belong to Unionidae and Vivipardae families. Some large molluscs such as *Hyriopsis cumingii* and *Cipangopaludina ampulliformis* have good potential for market development (Liu et al, 1979; Li et al, 2009). Therefore, attention should be paid to the development and sustainable utilization of these large molluscs.

Table 6 Mollusc species of Beijiang River that are of conservation concern

Species binomial	National Red List status	IUCN Red List	Economic importance	Population trends at the site/wider catchment	Source
Hyriopsis cumingii	Not evaluated	LC	Commercial use for producing freshwater pearls, and used for food, animal feed, buttons and art ware	Declining in the catchment	Literature review
Lamprotula leai	Not evaluated	LC	Important use buttons and art ware	Declining in the catchment	Literature review
Lamprotula mansuyi	Not evaluated	NA	Use for food, animal feed, buttons and traditional Chinese medicine	Declining in the catchment	Literature review
Bellamya limnophila	EN	DD	Used for food	Population is small	Literature review

Benthic organisms (such as mollusc) are valuable bio-indicators for water quality, especially for the quality of bottom water and sediment. For example, *Cipangopaludina chinensis* is very

sensitive to neutral polluted water, and *Semisulcospira libertina* is very sensitive to even slightly polluted water (Deng et al, 2007). Since a lot of *Semisulcospira libertina* can be caught from the three sampling sites. It indicates that the water and sediment in the river are not seriously polluted at present.

A lot of apple snail (*Ampullarius gigas*), a native species of Amazon River basin in South America which was introduced into China in 1981, was found in Beijiang River. Due to its rapid growth, amphibious nature, strong reproduction ability and adaptability, it soon formed its natural populations in most parts of southern China. It now threatens the biodiversity and ecosystem functions where it is found (Yang et al, 2010). Therefore, preventive and control measures should be taken.

3.1.3 Shrimp and crab

Fishermen also catch shrimps and crabs with fish, such as *Procambarus clarkii* (Louisiana crayfish), *Macrobranchium nipponense* (Giant Freshwater Prawn) and *Eriocheir sinensis* (Chinese mitten crab). These shrimp and crabs have high nutritional value with rich protein and minerals. However, *Procambarus clarkii* is an invasive alien species native to south-eastern United States, and holds a competitive advantage over native species and may damage the native ecosystem.

3.1.4 Aquatic plants

Based on the literature (Ye et al., 2005), there are 175 aquatic vascular plants belonging to 35 families and 100 genera in Beijiang River watershed area.

A total of 10 submerged plants were collected and identified in the three sites. Of these, *Potamogeton wrightii*, *Vallisneria natans*, *Myriophyllum verticillatum*, and *Hydrilla verticillata* were found in all three sites. *Potamogeton wrightii* is the most abundant species. *Ceratophyllum demersum* and *Potamogeton crispus* were only seen in two of the three sites and their populations were usually small. The remaining species were seen in only one site and had small populations except for *Najas marina* which is the dominant species in Lishi. All these species are listed as Least Concern in the Red List of IUCN.

3.1.5 Odonata

The Odonata surveys were conducted at three sites (Lishi, Zhoutian and Kengkou) in the Beijiang River on 28-29, Oct. 2010. The survey methods include observed, netting and kick sampling (for larvae). Most Odonata species found were very common and widely distributed in all kinds of freshwater habitat. They have not been valued as indicator species. No research so far have been conducted on the relationship between them and the environment in the Beijiang River. All species of Odonata in the Beijiang River were assessed as Least Concern and none of them are used by people in their daily life. The species in the Beijiang River as follows:

Lishi reach of the Wujiang River:

Site 1: 1 species *Anax parthenope julis*

Site 2: 21 species

Anax parthenope julis Brauer, 1865

Epophthalmia elegans (Brauer, 1865)

Ictinogomphus pertinax (Hagen in Selys, 1854)

Brachythemis contaminata (Fabricius, 1793)

Orthetrum pruinosum neglectum (Rambur, 1842)

Orthetrum sabina sabina (Drury, 1770)

Orthetrum glaucum (Brauer, 1865)

Sympetrum darwinianum Selys, 1883

Sympetrum eroticum ardens (McLachlan, 1854)

Sympetrum risi risi Bartenev, 1914

Tholymis tillarga (Fabricius, 1798)

Tramea virginia Rambur, 1842

Trithemis aurora (Burmeister, 1839)

Libellago lineata (Burmeister, 1839)

Copera marginipes (Rambur, 1842)

Ceriagrion auranticum ryukyuanum Asahina, 1967

Ischnura senegalensis (Rambur, 1842)

Pseudagrion pruinosum fraseri Schmidt, 1934

Pseudagrion rubriceps rubriceps Selys, 1876

Pseudagrion spencei Fraser, 1922

Prodasineura autumnalis (Fraser, 1922)

Site 3: 8 species

Brachythemis contaminata (Fabricius, 1793)

Crocothemis servilia servilia (Drury, 1770)

Pantala flavescens (Fabricius, 1798)

Trithemis aurora (Burmeister, 1839)

Libellago lineata (Burmeister, 1839)

Ceriagrion auranticum ryukyuanum Asahina, 1967

Pseudagrion spencei Fraser, 1922 (larva)

Pseudagrion spencei Fraser, 1922

Zhoutian reach of the Zhenjiang River:

Site 1: *Crocothemis servilia servilia* (Drury, 1770)

Site 2: *Anax parthenope julis* Brauer, 1865

Crocothemis servilia servilia (Drury, 1770)

Orthetrum pruinosum neglectum (Rambur, 1842)

Orthetrum glaucum (Brauer, 1865)

Pantala flavescens (Fabricius, 1798)

Sympetrum eroticum ardens (McLachlan, 1854)

Trithemis aurora (Burmeister, 1839)

Matrona basilaris Selys, 1853

Copera marginipes (Rambur, 1842)

Ceriagrion auranticum ryukyuanum Asahina, 1967 (larvae)

Onychothemis testacea *tonkinensis* Martin, 1904

Kengkou reach of the Beijiang River:

Site 1: Not found Odonata.

Site 2: *Orthetrum sabina sabina* (Drury, 1770)

3.2 Values of ecosystem service provided by Beijiang River watershed ecosystem

3.2.1 Ecosystem Services of Beijiang River Watershed

Ecosystem services are the conditions and processes through which natural ecosystems and the species that make them sustain and fulfill human life (Daily 1997). Ecosystem services can be divided into 4 types: product supply, ecological maintenance, culture functions and support functions (Springate-Bafinski et al., 2009). We defined that the ecosystem of Beijiang River Watershed used in this research is the same as the management area of Shaoguan, since Shaoguan cover almost entire Beijiang Watershed area except a very small part lied in the very beginning of the upper streams which can be traced back to Jiangxi Province. It is estimated that the total ecosystem services provided by Beijiang River watershed was 29.8 billion Yuan in 2007 (Table 7). This represents 61.4% of the GDP of Shaoguan City in the same year.

Table 7 The Summarized table of ecosystem service values of 2007 in Shaoguan City (unit: million Yuan)

	Total
Gas regulation	4407.65
Climate regulation	3523.78
Water conservation	4708.86
Soil formation	5109.65
Water treatment	2541.26
Biodiversity conservation	4240.29
Food production	342.46
Raw materials	3214.99
Recreation	1712.51
Total	**29801.45**

(1) Provisioning Services

Wood: In the year 2008, the standing forest stock was 65.235 million m^3, with the biomass of forest being 73.666 million tons, including 46.91 million tons of commercial forest biomass and 26.755 million tons of non-commercial forest biomass in Shaoguan.

Aquatic products: In 2007, the aquaculture output of Shaoguan City was 60,395 t, including 59,612 t fish, 393 t shellfish, and 202 t shrimps and crabs, and total value was 4.3×10^8 Chinese Yuan. Most of the fish was produced by fish culture in fish pond.

Water for productive use: There are 1,567,200 hm2 of agricultural land and 1,433,000 hm2

of forest land in Shaoguan in 2008. Many parts of them get benefits from irrigation. The industrial water consumption was 5.49×106 tons in 2008.

Hydropower Supply: The actual utilizable hydropower reaches 1,474,000 kW in Beijiang River. The annual hydropower generated electricity can reach 55.8 billion kWh.

River Transportation: In 2008, there were 698 km water transportation channels in Shaoguan and the shipping capacity reached 15 million tons.

Food products: In 2009, the grain growing area was 1,567,266 ha with a total production of 9,010,000 t in Shaoguan.

(2) Regulating services

According to the ecological service assessment methods, the value of forest ecosystem service in Shaoguan was 8.4737 billion Yuan in 2008, including 2.3675 billion Yuan of forestry carbon assimilation, 2.5528 billion Yuan of forestry oxygen releasing, 1.998 billion Yuan of forest water saving and flood control, 300 million Yuan for cleaning atmosphere, 0.3855 billion Yuan of forest soil erosion control, and 0.1375 billion Yuan for wildlife protection benefit (Shaoguan Bureau of Forest, 2008).

(3) Supporting Services

The supporting service includes soil development, circulation of materials, etc. Soil is formed through a slow process for thousands of years. The total land cover in Shaoguan is 17,100 km^2 (Statistical Bureau of Shaoguan, 2008). It is estimated that soil carbon storage is 118 times larger than all plant carbon storage, while soil nitrogen storage is 19 times larger than plants nitrogen storage (Schlesinger，1991).

(4) Cultural Services

Cultural services typically include the spiritual enjoyment, inspiration, entertainment, sports, aesthetic, education etc. In Beijiang basin, it’s mainly sightseeing, fishing, boating and swimming. There are 10 forest park, 22 nature reserves, many cultural tourism resources and historical sites in Shaoguan City.

At present, ecosystem services are facing serious threads. Many newly built dams across the river cut off the river and changed the water depth and flow pattern. Pollutants from facotries and mining sites cause water pollution. Sand mining activities along the river are stimulated by market demand and seriously destroy the sandy river bed where is the habitate of many aquatic plant and molluscs species.

3.2.2 The economic cost of maintaining ecosystem services in Beijiang River

We calculated the economic cost of Beijiang River by using the methods of literature review, expert consultation, and social-economic information gathering and participation technique as suggested by the IUCN toolkit (Springate- Baninski *et al.* 2009). The management cost was by far the biggest cost. It was about 1.41 billion Yuan each year and less than 5% of the service value provided by the ecosystem.

(1) Management costs

Costs for water pollution control: Major water pollution sources of the Beijiang River include agricultural sewage discharge, household sewage discharge and industrial sewage discharge. The total direct cost of water pollution control is about 6.7×10^8 Yuan during the period 2006-2010.

Cost for the maintenance of river channels: The costs for maintaining river channel included: 2,000 and 3,680 million Yuan for river dike protection and flood control during the period of 2002-2010; 400 million Yuan RMB for river bed dredging, 200,000 RMB for the cleaning and transporting of river garbage and water hyacinth (*Eichhornia crassipes*), 247.2 million Yuan RMB for waste treatment during the period 2006-2010.

Cost for biodiversity protection: Cost of fish species protection and proliferation is about 3 million Yuan RMB every year.

Cost for fisheries management: It is about 3 million Yuan RMB per year.

Cost for reforestation and water conservation: Cost of reforestation project along hilly area of Shaoguan highway system was about 384 million Yuan. The investment for water conservation was about 2.1×10^8 Yuan during 2006-2010.

(2) Opportunity cost

Development of heavy industry and chemical industry: For maintaining the water quality of Beijiang River, it is not allowed to develop certain industries which may pollute the river. Local government had turned down many proposals about the setting up of chemical industry or heavy industry with pollution. Its economic loses for that region was large and it is hard to be estimated.

Biological conservation, ecological compensation and monitoring: Some projects in Beijiang River watershed have to be changed from their optimum design to a more expensive design for the conservation purpose. Some projects have to pay more ecological compensation fee, and ecological monitoring fee in this sensitive region.

(3) Cost for other reasons

Water borne disease: River water can transmit water borne disease, such as schistosomiasis. Cost for the controls of water bourn disease in Shaoguan City is about 0.2 million Yuan each year.

Costs for flooding: In order to prepare for flooding, the expenditure for material purchase and personal training is 3.65 million Yuan each year in Shaoguan City.

3.2.3 Participatory evaluation of Beijiang River ecosystem services

According to the ecosystem service and ecosystem cost methods (Olive Springate-Baninski, David Allen, William Darwall, 2009), a participatory assessment for ecosystem service provided and ecosystem cost charged by Beijiang River was conducted. The most important ecosystem services considered by stakeholders are aquatic product supply, daily water supply, flood control function, hydro-power supply and dilution of pollutants. Spiritual function, clean environment, reduction of diseases, educational value and sand production are considered as the second important category of ecosystem services. However, different view from stakeholders could be identified. Fishers paid more attention to clean environment, water pollution, and aquatic products

than other stakeholders. Leaders of enterprises paid less attention to the pollution diffusion, aquatic products and drought than other stakeholders.

3.2.3.1 The assessment result of ecosystem services

(1) The most important ecosystem services recognized by stakeholders

The most important ecosystem services ranked by the stakeholders include aquatic products; daily water supply, reducing flooding, hydro-power supply and dilution of pollutants by Beijiang River (see the red part in ecosystem service of Table 8). The average importance achieved from stakeholders is all more than 3.61 in the maximum 5 point evaluation systems. These services can touch everyone living in the Beijiang River area. However, fishermen pay more attention to aquatic products (Table 9, item 4), and pay less attention to the flooding caused by river (Table 9, item 15). Government officers and leaders of enterprises give more attention to daily water supply than farmers and fishermen. It may be the reason that many farmers and fishermen rely on well water rather than tap water (Table 9, item 2).

(2) The second most important ecosystem services considered by the stakeholders

The second most important ecosystem services considered by the stakeholders (an average score of 3.16-3.55 points) include the spiritual function, clean environment provided, reduction of diseases; educational function, and sand production for construction (see the orange part of ecosystem service in Table 8). It is beyond our expectation that spiritual function was so heavily weighted by stakeholders, because they are not so popularly involved in religious, neither in intellectual activities. The function for clean environment was considered less important by farmers than by the other stakeholders, possibly a result of farmers' activity being confined on land (Table 9, item 14).

(3) The third most important category of ecosystem services recognized by stakeholders

The third most important category of ecosystem services (2.56-3.04 points) ranked by the stakeholders include biodiversity, scientific research, stable air temperature and humidity, industrial and agricultural water supply, beautiful environment, residential value, and river transportation (see the yellow part of ecosystem service in Table 8). In general, the values given by fishers were lower than from other stakeholders, except for scientific research (Table 9).

Table 8 Evaluation Result for Ecosystem Services

	Item of Service	Average	SD	Duncan's multi-range test*								
Ecosystem Service provided by Beijiang River	11 swimming	1.71	1.22	a								
	9 boating	2.06	1.36	a								
	8 game fishing	2.07	1.37	a								
	10 tourism	2.08	1.28	a								
	6 transportation	2.56	1.38		b							
	23 research	2.58	1.55		b	c						
	1 irrigation	2.87	1.77		b	c	d					
	12 air humidity	2.94	1.56		b	c	d	e				
	20 beautiful environment	2.98	1.54		b	c	d	e				
	3 industrial water supply	2.99	1.63		b	c	d	e				
	13 stable air temperature	3.00	1.5		b	c	d	e				
	19 residential value	3.03	1.63		b	c	d	e				
	18 biodiversity	3.04	1.48			c	d	e				
	5 sand for construction	3.16	1.57				d	e	f	g		
	22 education	3.32	1.58					e	f	g	h	
	17 reduce diseases	3.34	1.58					e	f	g	h	
	14 clean environment	3.53	1.54						f	g	h	i
	21 spiritual home	3.55	1.34						f	g	h	i
	16 delete pollution	3.61	1.55							g	h	i
	7 hydro-electricity	3.62	1.48							g	h	i
	15 reduce flooding	3.71	1.58								h	i
	2 daily water use	3.77	1.74								h	i
	4 aquatic products	3.98	1.34									i
Ecosystem cost caused by Beijiang River	-2 drought	2.15	1.55	a								
	-3 transmit diseases	2.75	1.61		b	c	d					
	-10 water hyacinth	2.88	1.66		b	c	d	e				
	-8 planting tree	3.09	1.63				d	e	f			
	-11 picking up river garbage	3.21	1.67				d	e	f	g		
	-7 fishing management	3.24	1.56					e	f	g		
	-4 pollutant diffusion	3.52	1.49						f	g	h	i
	-6 river bed clearance	3.6	1.49							g	h	i
	-5 dike building	3.62	1.52							g	h	i
	-9 river pollution control	3.83	1.57									i
	-1flooding	3.86	1.73									i

- Factors with the same character did not significantly different within 5% significant level; they can be assigned to the same group. The numbers in front of the service items are the same as in table 15. Negative number indicates ecosystem cost.

(4) The least important category for ecosystem services for stakeholders

The least important category for ecosystem services (1.71-2.08 points) ranked by the stakeholders includes tourism, fishing as sport, boating as sport and swimming. Although tourism is developing very quickly, the number of people involved in these services is still very limited. However, the value given from government officers and leaders of enterprises is significantly higher than from fishers and farmers, possibly as people from these groups may have more

opportunity to enjoy these services due to their better financial situation.

3.2.3.2 The assessment result of ecosystem costs

（1） The most important ecosystem costs

The most important ecosystem costs ranked by the stakeholders include the damage caused by flooding and pollution, the expenditure used in waste water treatment; dike building and dredging of river bed for transportation (see red part in ecosystem costs of Table 8). They are very relevant to the most important category of ecosystem service (Table 8, red part in ecosystem services). It is reasonable because the costs reflect the money used for strengthening the services, or the damage caused by stopping that service. For example, the stakeholder considers reduce of flooding and dilute pollution are very important ecosystem services. Hence they also considered that the money spends in waste water treatment, dike building and dredging is also very important. The leaders from enterprises group gave significantly lower values than the other stakeholders on pollutant diffusion by the river (Table 9, item －4), possibly as many companies are releasing pollutants to the river and they are not directly affected by the polluted river.

Table 9 the influence of Stakeholder to the evaluation of ecosystem services

	Average score for the evaluation of the importance				Result of Duncan's multi-range test*			
Stakeholders	**Gov.officer**	**Leaders of enterprise**	**Farmer**	**Fisher**	**Gov. officer**	**Leaders of enterprise**	**Farmer**	**Fisher**
Average	**3.54**	**3.42**	**3.28**	**2.87**	**c**	**cb**	**b**	**a**
10 tourism	2.80	2.64	2.29	1.73	b	b	ab	a
6 transportation	2.87	3.50	2.59	2.27	ab	b	a	a
20 beautiful environment	3.80	3.71	3.41	2.50	b	b	ab	a
3 industrial water supply	4.00	4.14	2.35	2.66	b	b	a	a
-11 picking up river garbage	3.47	4.07	3.47	2.89	ab	b	ab	a
1 irrigation	4.40	4.71	3.70	1.85	bc	c	b	a
12 air humidity	3.60	3.42	3.53	2.50	b	ab	b	a
13 stable air temperature	3.53	3.71	3.35	2.61	ab	b	ab	a
18 biodiversity	4.13	3.57	3.17	2.61	c	bc	ab	a
-1 flooding	5.00	5.00	4.47	3.16	b	b	b	a
15 flooding control	4.60	4.21	4.21	3.24	b	ab	b	a
2 daily water supply	4.93	5.00	4.05	3.13	b	b	ab	a
-8 tree planting	4.06	3.78	4.12	2.42	b	b	b	a
14 clean environment	4.40	4.07	2.95	4.41	b	b	a	b
-4 pollutant diffusion	3.80	2.35	3.41	3.74	b	a	b	bc
4 aquatic products	3.80	3.21	3.53	4.32	b	a	ab	b
-2 draught	1.53	1.00	2.65	2.41	ab	a	c	bc

* Factors with the same character did not significantly different within 5% significant level; they can be assigned to the same group. The numbers in front of the service items are the same as in Table 15. Negative number indicates ecosystem cost.

（2） The second most important ecosystem costs

The second most important ecosystem costs ranked by stakeholders include expenditure used

for fishing management, picking up river garbage, and tree planting (Table 8, orange part of ecosystem costs). Fishers gave a significant lower value to tree planting than other group of people (Table 9, item -8).This may be due to the fact that only a very few activities of fishers link directly to the forest up in the hill and mountain, like firewood collecting if flooding did not carry enough wood for them.

（3） The third most important category of ecosystem costs

The third most important category of ecosystem costs ranked by stakeholders include the expenditure induced by diseases spreading along rivers and the picking of the invasive water hyacinth in rivers and lakes (Table 8, yellow part in ecosystem cost).

（4） The least important group of ecosystem costs

The least important group of ecosystem costs includes the lost caused by drought such as field crop failure and lack of drinking water supply. Many people recognize that river itself is not the reason of draught (Table 8, white part of ecosystem costs).

3.2.3.3 The analysis of differences among different stakeholders (Table 9)

（1） men and women

There is no significant difference in the ranking ecosystem services made by men and women. This is likely due to the equal statue of men and women in their daily life in this region. They often work together and share their life together without significant sexual work separation.

（2） government officers, company leaders, farmers and fishers

The higher the average ranking given by a stakeholder group, the more important they considered the ecosystem services provided by freshwater. The average ranking value for ecosystem services is in this order: government officers (3.54) > leaders of enterprises (3.42)> farmers (3.28) > fishers (2.87) (Table 9, line 1). Surprisingly the fishers have the lowest average, even though they are probably the most heavily reliant upon the services provided by the river. This may be due to the concept of ecosystem services being quite abstract and that some groups of fishers and farmers needed more explanation, whereas the government officers and leaders of enterprises are usually more educated. The slide explanation for government officers and leaders of enterprises in a meeting room was more easily understood than oral explanation by different researchers for farmers and fishers in their houses.

（3） The farmers perception about ecosystem services

Although fishers gave lower value to many ecosystem services and costs, they did score the clean environment (Table 9, 14) , water pollution (Table 9, －4) , aquatic production (Table 9, 4) , and drought disaster (Table 9, －2) very highly. Although leaders of enterprises gave high scores for many ecosystem services and costs, they did score pollutant diffusion, aquatic products and drought relatively low. These may be the reason of conflict of interest among different stakeholders. Hence, the difference between fishers and enterprise leaders should be solved by education about ecosystem service, communication among stake holders and policy regulation.

Leaders of enterprises need a greater understanding of the importance of the river to the livelihoods of fishers and the serious impacts of water pollution. Government policy should help fishers to overcome the loss caused by pollution and other economic activities. For example, ecological compensation fund should be set up and collected from industrial companies which damaged ecosystem services. More financial support should be channeled to help the conservation and proliferation of aquatic species, to improve the housing and employment opportunity of fishermen, and to recover ecosystem structure such as reforestation, soil erosion control, pollution treatment etc.

4. Overview of Livelihoods (WP4)

4.1 Livelihood Strategy

In the watershed of Beijiang River, the livelihood strategies of different social groups are varied. The main livelihood strategies of fishers are fishing, trading fish, working outside (labor), planting vegetables, raising livestock, and gathering woods from the river or the forest. The fishing communities are more directly dependent upon fishing, particularly for the old generation (Table 10).

Table 10 Percentage of households' income resources in the three sampling villages

Name of the sampling village	Lishi	Kengkou	Zhoutian
100% of income from fishing	35.48%	34.38%	3.33%
50%-100% of income from fishing	25.81%	28.13%	30%
under 50% of income from fishing	19.35%	15.63%	20%
Total household with income from fishing	**80.64%**	**78.14%**	**53.33%**
100% of income from laboring	9.68%	0.00%	6.67%
50%-100% of income from laboring	25.81%	12.50%	36.67%
under 50% of income from laboring	12.90%	6.25%	23.33%
Total household with income from wage outside	**48.39%**	**18.75%**	**66.67%**

Data sources: from household survey in the selected fishing communities

4.2 Class and livelihood

Although the status of fishers' livelihoods are analyzed based on the wealth group which are defined as rich, medium and poor groups, the majority of fishers would probably more realistically to be fitted into the 'coping' category, especially if they have health problems or no outside wage income source. Otherwise some may be categorized as the "subsistence" category. There are only very few fishing households which can be fitted into the category of "accumulating".

Although the rich households have higher income from fishing, interviews suggest that the poor households are more dependent upon fishing (Fig. 6). Within the fishing communities, there was little evidence of unequal class relations. The economic statuses of most fishers are poor, and there is some commonality across households in access to productive resources. They can therefore be considered as a single economic class with the exception of a few engaged in business activities.

There was no evidence of unequal relations between fishers and farmers, although fishers depend upon the wealthier farmers to buy their fish. However, there are clearly significant disparities in wealth and in access to government resources between fishers and farmers. The gradual undermining of the environmental resources which fishers depend on and their unfavorable access to state resources suggest that fishers are becoming slowly alienated from their traditional livelihoods, and are entering the urban or rural working class. As there are only limited significant differences in terms of economic status within fishing communities, and between fishers and farmers, the most unequal relations that fishers are integrated into are with the powerful social classes in towns and cities.

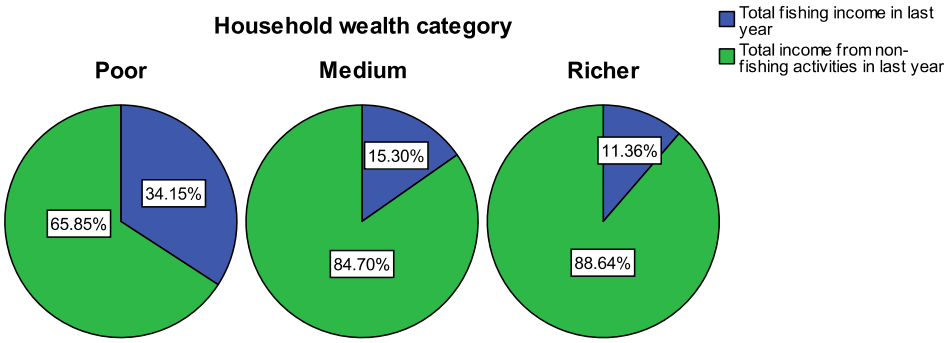


Fig. 6 Percentage of aggregate group income from fishing and non-fishing activities for each wealth category

4.3 Market and Credit relations

Fish stocks have declined in all villages. There are a number of explanations for falling stocks. Hydro dams and sand mining are considered the most important two factors. The income of fishers is therefore low. They sell most of their fish locally, and often eat the lower quality fish by themselves. Opportunities for large investments that would offer accumulation opportunities are limited in this context. Few fisher households take loans. If they do need to make a big investment, most households can not access to institutional credit as they lack sufficient collateral and it is complex to apply for a formal loan. They mostly take loans from family members or other relatives who work outside. There are no private money lenders. Either way, most of the fishers do not think loan can improve their family economic status.

4.4 Access to Political Power

The insecure economic status of fishers is compounded by their weak political position. The fisher households have limited access to political power and there was a strong feeling of powerlessness within their communities. The state pays insufficient attention on their problems. There appeared to be a perception that the farmers have greater access to political power than the fishers and receive a lot more support from the government. Although there are some national and provincial regulations relating to aquatic resources and protection of the resources, there is a lack of local management regimes for fishing communities. There are no formal or informal organizations such as Fishermen’s Association or Fishermen’s Cooperatives for fishermen to

participate in Shaoguan Municipal Area. Such organizations would at least offer the community the opportunity to voice their concerns. Even community organizations at the basic level in the fishing communities themselves are limited.

4.5 Gender and Age Relations

In terms of gender and age relations, the report found that most husbands and wives go fishing together and have quite equal status, but there are still some job divisions between them (Table 11). Generally, women are responsible more for housework and men are responsible more for heavy jobs. Most of the children do not go fishing with their parents. Their parents also don't like their children to go fishing in the future. Most of the children engage in some of the housework while young, and then aspire to move to urban centers to work after they finish 9 year free education.

Table 11 The reply from men and women on the division of jobs between sexual groups

	Answer from men（%）			Answer from women（%）		
	Men's job	**Women's job**	Job for both	Men's job	**Women's job**	Job for both
Selling fish	35	**35**	31	15	**60**	25
Cleaning house	13	**70**	17	0	**95**	5
Collecting firewood	48	**16**	36	14	**61**	23
Cooking	4	**65**	30	9	**86**	5
Washing dishes	12	**64**	24	5	**86**	9
Collecting water	31	**37**	31	12	**88**	0
Looking after parents	8	**22**	70	0	**47**	53
Money saved	59	**6**	35	65	**24**	12

Original resource: deal with the data by focus group on May 2010

4.6 Major Concerns of the Fishers about their livelihood

Based on the analysis of fishers' livelihood, the current key issues faced by fishers are as follows.

1. Declining of fish stock. Fish stock is declining in Beijiang River due to pollution, sand mining, the construction of dams and hydropower station, which have a significant impact on fishers' livelihoods. The income of fishers is lower than the farmers. The fishers have to diversify their livelihood activities to subsidize their daily live. Almost all young people do not depend upon fishing any more. Although some regional programs have already done by the government to improve the environment and the aquatic resources, fish stock declining continues.

2. Fishing license issues. Many fishers do not have a license for fishing; hence can not get the diesel oil subsidy. The fishers must pay 105 Yuan annual fee for the fishing license. The license will be canceled if the fishers do not pay the annual fee by any reasons. The government refused to reissue the license in order to control fishing activity. Because of the increase of diesel price in recent years, it is very hard for those fishers who do not have the license and hence the diesel oil subsidy.

3. Pension issues. Most of the fishers do not have a pension which is concerned seriously by the fishers, particularly the older generation. The fishers may have no income when they stop fishing, because they do not have any land for farming. In rural areas, there is a new pension policy for all the farmers, but fishers can not share this policy. Fishers belong to the group as residence and at present the residence in town or city pay one part for their pension and the working affiliation pay another part. But the fishing communities do not have any collective income source and can not help the fishers to pay the other part of the pension. The fishers have to pay all for themselves if they want to have the pension in the future. But most of the fishers do not rich enough to pay, particularly for those belong to the poorest part.

4. Medical care issues. There is also a new policy for all the farmers to participate into the health insurance but the fishers can not share this policy. Only the better-off households can afford to pay the health insurance designed for city residents. For poor households, they have to pay all medical treatment as soon as they get sick and the economic situation of their livelihoods may become worse.

5. Housing issues. Part of the fishers live in the houses provided by the government, but there are still many fishers without their own houses and have to rent a house or live on boat. Most of the houses in fishing villages are close to river and the houses are easy to be inundated by flooding. The government is preparing to build new houses for the fishers who are living on the boats within Shaoguan urban area, but there are no plans for the fishers who live in rural areas so far.

6. Compensation issues. The behavior of some stakeholders such as pollution emitters, sand mining companies, and hydropower stations have a significant impact on the ecosystem and the livelihoods of fishers, but there are still no definite criterion for compensation related to the ecosystem services and the loss of fishing harvest.

7. Subsidize for no-fishing season. A no-fishing season will be implemented from April 1 to June 1, 2011. During this season, the livelihoods of the fishers, particularly the specialized fishers, will be very difficult. The local government has not decided how to subsidize the fishers or how to provide them with opportunities for living.

8. Education issues. At present, the education of primary and junior secondary school is free and the fishers' children can also enjoy this policy. But most of the fishers still find it difficult to pay for further education including senior secondary school and university education. Some of the households have to borrow money from their relatives to pay for their children's higher education. Hence, many children have to find jobs instead of education from the age of 15-16.

9. Transportation issues. It is not convenient for some fishing communities to reach out for school, health centre and market because of poor infrastructure in transportation.

10. Vulnerability to economic and environmental shocks. Because of low incomes, the abilities of fishers to bear the economic and environmental shocks are very weak. At most of the time, the fishers only get help from their relatives or neighbors when they need money for medicine, building house, or natural disasters. It is difficult for fishers to get loan from the bank

for lack of mortgage.

11. Communication issue related to dam gate operation. Although notice to the public will be delivered through TV or radio by hydropower stations before they raised water gates and lowered the water level of the rivers, most of the fishers can not get the notice in time which may threaten the fishers' assets or even their lives when they were fishing in the rivers.

12. Organization issues. The fishers do not have their own organization, such as Fishermen Association or Fishermen Cooperative. It is difficult to organize the fishers when they meet problems. They have very week bargaining power whenever encounter other stakeholders.

5. Overview of institution, policy and conflicts (WP5)

The major institutions, laws, policies and conflicts related to the study site in China are reviewed here. The review is arranged here according to environmental elements, including biodiversity, fishery resources, water and forestry. The contents of each section include an introduction to the related rules and an analysis on the conflicts we identified. Rules related to sustainable livelihoods will also be reviewed after the environment issues.

5.1 Biodiversity

5.1.1 Related institutions, laws and policies

China's constitution of 1982 protects rare species. Article 9 of the constitution stipulates that the state encourages reasonable utilization of natural resources and protects rare species. Wildlife protection Act of 1988 shares the same view. Ocean Environment Protection Act of 1995 attaches great importance on the protection of ecosystem. Desertification Act of 2001 designate different functional zones for the purpose of development planning.

The establishment and management of natural reserves is one of the major means of maintaining biodiversity. Nine conversation areas with area more than 3,780 ha have been set up in order to protect the biodiversity in Shaoguan municipal area. The protection species include Asian giant soft-shell turtle, marbled eel, wattle-necked soft-shell turtle etc. At the same time, crude fish killing methods such as explosion, poison or electricity were prohibited. Fishermen get their fishing license from Shaoguan Fisheries Administration Team. There are 180 families with fishing license at present. Efforts such as fry releasing, "returning the grain field in slope to forestry", establishing management system for the protection of key national protected wild animals and plants, have been strengthened in the past decade. (Bureau of Environment Protection, 2008)

5.1.2 Primary problems identified

A. The protection list is too short. Constitution and Wildlife Protection Act only protect rare or endangered species on the national or provincial list, while those not on the list, but are important for livelihood are not protected by law.

B. Rules on restoration and sustainable development of biodiversity are still very weak.

Current laws are more concerned about the protection than about the restoration and sustainable development of natural resources.

C. Unreasonable delineation of powers usually results in either inefficiency or conflict. The law classifies various species into two major sorts: aquatic and terrestrial, and delineate jurisdictional powers accordingly. However, some species are not easy to be classified as aquatic or terrestrial, and this dilemma usually leads to conflict or vacuum of different jurisdictions.

5.2 Fishery resources

5.2.1 Related institutions, laws and policies

Since late 1970s to middle 1990s, China’s legal rules on fishery resources in inland waters have taken its initial shape, which mainly includes: Aquatic Resources Propagating Protection Ordinance (1979), Wild Animals Protection Act of the People's Republic Of China (1988), Fishery Act of the People's Republic Of China (1986), Detailed Rules For the Implementation of The Fishery Act of the People's Republic of China (1987), Aquatic Animals And Nature Reserve Management Ordinance (1997), Fishing License Approval Ordinance for the Protection of Fishery Resources (1989), Fishery Resources Proliferation Tax Ordinance (1988). With these legislations, China has established legal institutions on fishing license, fishery resources proliferation tax, no-fishing periods and no-fishing zones, prohibition of destructive fishing methods, limitations on fishable size, protection of larva and aquatic animals of important economic value, and thus formed a comparatively complete legal system on development, utilization, maintenance and management of fishery resources (Tang et al., 2010).

In mid-1990s, due to the fishing capacity surplus and fishery resources recession, China began to implement a series of fishing policies such as training and transferring fishermen to other occupations, no-fishing on Yangtze River in spring, to control the overexploitation of fishing resources, and improve aquatic environment by proliferation discharge and artificial reefs construction, and modify the Fishery Act and Fishing License Approval Ordinance accordingly (Tang et al., 2010). Guangdong Province also make its own rules in accordance with national legislation which include Guangdong Fishery Management Ordinance (2003), Fishing License Management Ordinance of Guangdong Province (1992), Collections Standards for Fishery Proliferation Tax of Guangdong Province (1989), Interim Collection Rules for Fishery Proliferation Tax of Guangdong Province (1989), Fishing License Approval Rules of Guangdong Province (1992), Important Aquatic Animals Fry Management Rules of Guangdong Province (1995), etc.

5.2.2 Primary problems identified

A. Some effective protection and management polices hasn't yet been adopted by legislations, including training and re-allocation of fishermen, and joint effort for law enforcement on sand mining along the river banks.

B. The standards and detailed rules for fishery resources compensation are still not clear. The

Fishery Agency of Shaoguan consulted the hydropower dams on the feasibility of charging them fishery resources compensation tax in 2004 and 2006, but due to the lack of authorization from formal legislations, the agency doesn't have the power to do more on this matter (Shaoguan Fishery Agency, 2008).

C. Current law depends on fishing license and “double control” (i.e., control of both the number of fishing boats and the power of fishing boats) to curb the total effort in fishing, but the specific conditions for get fishing license is not clarified in the laws except the requirements for the capacity of motorboats. And there is almost no exact statistics number that can be used for scientific analysis for the purpose of resources protection. (Liu et al., 2008)

D. Problems in law enforcement process still exist. The size and number of fishing tools remain unchecked. The protection for fish fry is not implemented well. Environmental Impact Assessment (EIA) hasn’t been effectively implemented in resources protection. There is insufficient coordination between different law enforcement agencies.

5.3 Water

5.3.1 Related institutions, laws and policies

General legal principles on water pollution control were promulgated for the first time in the Environment Pollution Act of 1979, in accordance with which a series of water environment standards were later passed by the state. Water Pollution Control Act (1984), Interim Rules for Water Pollution Discharge License Management (1988) and Pollution Control Rules for Reserved Drinking Water Area (1992) were also passed one by one since 1984. Water environment standards cover surface water quality, farmland water quality, fishing water quality and pollution discharge. To enhance the treatment of water pollution and make best use of pollution fund, Water Pollution Control Act was amended in 1996, and new rules on river drainage area management and coordinated treatment of urban sewage was added (Wang et al., 2006). In 2008 Water Pollution Control Act was amended for the second time to adopt rules on government responsibility, total amount control, pollution discharge management, emergency control and civil damages.

Major management measures for water pollution control include pollution discharge fees, water environment standards and monitoring, total quantity control. Plan for water supply and demand shall be made. Activity of mass harvesting ground water or surface water shall be permitted only by getting governmental license. Different functional zones of water resources shall be set up. Resources for drinking water both from underground and surface will be protected. Pollutant discharging by enterprises and individuals alike shall be strictly restricted in terms of quality, concentration and total discharge.

5.3.2 Primary problems identified

A. Conflict in supervision provided by different government agencies. Government agencies like environment, construction, agriculture, fishing, shipping, geology and mining also share

certain authority on water administration, but there are almost no coordination mechanisms between them, which lead to partitioned administration power to the intake, consumption, and discharge of water.

B. Lack of coordination between different administrative areas. Current laws don't provide operational methods on the legal responsibilities of areas in upper and middle river reaches if they pollute the water which finally runs into the lower river reach.

C. Too much deliberation power but little feasibility for the law enforcement agencies. Many rules are quite ambiguous as to the authority of law enforcement agencies and protection of aquatic resources, and the punishment for serious pollution accidents are not harsh enough to make up for the damages (Nie, 2009).

5.4 Forestry

5.4.1 Related institutions, laws and policies

Early forestry laws limit lumbering volume and guarantee the growth of forestry for the purpose of sustainable production, while functions like air purification, health enhancement were listed as secondary. Forest Act of 1984 changed this order to make environmental functions first, and Forest Act of 1998 attached great importance to ecological functions.

Major legal rules set up include the following. Forests are classified for different protection measures. Records of forestry resources must be kept. Forestry development plan and forestry management plan should be made. A forestry development fund is required to set up. Land reclamation, rock quarrying, sand quarrying, soil extracting and other activities with the result of deforestation are forbidden. Forest protection troop and forest police are established to facilitate the forestry protection and the reduction of forestry fire and pests. Introduced saplings must be quarantined for possible pests. Governments encourage tree planting and adopt a quota and license system to control lumbering. Long-term loan shall be granted for tree planting projects. Lumbering, mining and other construction projects shall be taxed to collect fund for the restoration of forests. Returning slope farmland to forests shall be subsidized.

5.4.2 Primary problems identified

A. Forests in China are generally divided into three categories: state-owned, collectively owned and privately owned. However, the boundary of forest ownerships are not that clear.

B. The legal responsibilities of forestry agencies include both protection and production, which often conflict with each other.

C. Though awareness of the necessity of forest protection has improved since the revision of Forest Act, forest protection usually make way for forest economic development due to the lack of specific and applicable ecological protection rules.

D. The ecological compensation fees don't take a conspicuous stand in the forest tax system. (Wang et al. 2006)

5.5 The livelihoods of fishers

5.5.1 Related institutions, laws and policies

The weak groups in our society such as women, children and senior citizens enjoy special care from the laws. The systems for rural basic life security, new rural medical care cooperation and rural medical relief are due to be established. Those rural residents without any family member or relatives are entitled to “five guarantees” (guarantees to food, clothing, residence, medical care and burial). Allowances for the relief from natural calamities have been set up. Fishing folks are registered as urban citizens, but they don’t have any pension or basic life security. Medical insurance is not compulsory for them, which means they have to pay 120 Yuan annually to buy it, and most of them think it is still too expensive. Those fishing families with fishing permits are entitled to get oil subsidy.

In general the legislation related to natural resources and livelihood of the vulnerable groups are getting more attention in China and the legislation system is improving. However, more practical policies and the monitoring process should be strengthened.

5.5.2 Primary problems identified

A. There are no effective fishing organizations. Currently the fishing villages are usually put under the jurisdiction of adjacent sub-district offices which actually have no full administrative power over those villages. As a result, the fishermen cannot defend their interests effectively by means of complaint to higher authorities. One example is the fishing village of Li Shi, whose party secretary is said to be corrupt, but the villagers don’t know how to dismiss him or his son who succeed him on this office.

B. The legal status of fishermen is too uncertain to enjoy enough social security or other preferential policies. Most fishing villages are located in rural area, but they don’t own any land or enjoy preferential policies that are made for the sake of farmers. According to the state registration system, fishermen are city residents, but neither those residents’ committees in cities or in the countryside take the responsibility of their livelihood. In fact, the income of most fishermen is very unstable and it is hard to be counted as low income family, so it is difficult for them to apply for low income subsidy.

C. Health care for fishermen is inefficient. Because fishermen are considered to be city residents but not farmers, the costs of their health care are of the same standards as those city residents. Most of the fishermen whom we interviewed thought that the cost of medical insurance was still too high for them to buy. Though the Implementation Rules for Medical Insurance of City Residents in Shaoguan also states that low-income families are fully subsidized by the government, most fishermen families aren’t qualified for that. (Shaoguan Fishery Agency，2005)

D. Inefficient communication between hydropower stations and fishermen. It often causes damages to the fishing nets when hydropower stations open water gates to release flood, but fishermen cannot get compensation for their loss.

5.6 Stakeholders' Idea for Policy Improvement

Table 12. The importance of each policy and management measures evaluated by different stakeholders

*The red parts indicate the important management measures which are highly evaluated by stakeholders. The green parts are considered unimportant by stakeholders. The importance of the black parts is ranged in between red and green parts. Two measures with different number in "Duncan's Multi-range test result" indicate significant difference on stakeholders' ranking. The bigger the number, the more important the measure related.

Management and Policy Measures	Aver. score	Dacun's Multi range test result										
Part 1 improvement of ecosystem services												
(1) Industrial Pollution Control	4.42									11	12	13
(2) Sand Mining Control	4.32							9	10	11	12	13
(9) Artificial discharge of fish fries	4.14						8	9	10			
(4) Ban of direct dumping of garbage	4.07					7	8	9				
(5) Control of fertilizer and pesticide	4.07					7	8	9				
(3) Dams Control	4.04				6	7	8					
(11) Monitoring and publicizing water quality	4.04				6	7	8					
(6) regulation on sewage from boat restaurants	3.97			5	6	7	8					
(8) Building of dam passages for fish and boats	3.84		4	5	6	7						
(7) Forestation	3.71		4									
(12) Control of water reservation of dams	3.68		4									
(10) Limitation on fishing tools	3.25	3										
(14) Limitation of poultry farming	2.74	2										
(13) Ban of caged culture in reservoirs	2.46	1										
Part 2. improvement of the livelihood of fishers												
(16) Medical care	4.54											13
(23) Maintenance grant to the poorest	4.43										12	13
(15) Oil subsidy	4.42									11	12	13
(19) solve housing issue	4.34								10	11	12	13
(25) Compensation form hydropower stations	4.32							9	10	11	12	13
(22) Building of tap water facilities	4.19						8	9	10	11	12	
(27) Compensation form sand mining companies	4.18						8	9	10	11	12	
(26) Centralized processing of garbage	4.17						8	9	10	11		
(21) Improvement of roads to fishing villages	4.05					7	8					
(20) Professional training	4.01				6	7	8					
(17) Reduction of Tax and fees	3.81		4	5	6							
(28) Fishermen organization	3.79		4	5	6							
(24) Providing job information	3.73		4	5								
(18) Reduction of administrative procedures	3.61		4									

According to the Delphi method investigation, stakeholders ranged the policies from the most important ones (5 marks), to the least important ones (1 marks). The average from all stakeholders showed the following result (Table 12).

(1) For environment improvement and resources protection policies, stakeholders considered that

a. The policy for the control of industrial pollution and sand mining control should be put into the first priority.

b. The second important policies included: releasing fish fry, garbage treatment, reducing chemical fertilizer and pesticide, controlling the number of dams crossing river, monitoring water quality and announcing the results to the public, and stopping waste discharged from boat restaurant.

c. The third important policies included: setting up fish channels in dams, tree planting and reforestation, public information on water level changed by hydropower stations in river, fishing tool regulation, limiting the scale of animal husbandry, reducing net-box method of fish cultivation in reservoir.

(2) For policies related to the improvement of the fishers' livelihood, stakeholders considered that:

a. The most important policies are medical care, poverty relief, diesel subsidy, housing, compensation from hydropower station;

b. The second important policies are better tap water supply system, compensation from sand mining companies, improving road system to fishing villages, and job training;

c. The third important policies are reducing tax, good organization for fishers, information for job opportunity, and simplifying government management procedures.

(3) The difference among stakeholders towards policy change.

Fishers are much more eager to change the present situation than other stakeholder in improving environment, resources and their livelihood. Leaders from enterprises are much less so. The average marks given by different stakeholders were significantly different such that fishers 4.05 (group a) > farmers 3.81(group b) = government officers 3.81 (group b) > leaders from enterprises 3.67 (group c), although fishers didn't understand ecosystem services well enough to catch up with more educated government officers and industrial leaders where the average marks given for ecosystem services were in this order: government officers 3.54 (group a) > leaders of enterprises 3.42 (group a, b)> farmers 3.28 (group b) > fishers2.87 (group c).

6. Summarized Challenges and Issues

Biodiversity and market surveys at the 3 project sites have identified: 26 fish species; 8 mollusc species; 10 aquatic plant species; and 26 Odonata (dragonflies and damselflies) species. Many those fish species are declining. *Psedohemiculter diap*, a globally threatened species, is also declining in the site. *Metzia formosae* as a nationally threatened fish species, and *Misqurnus anguilicaudatus* are also declining at the site. It is estimated that the total ecosystem services provided by Beijiang River watershed reached 29.8 billion Yuan in 2007. It is about 61.4% GDP of this area at the same year. The challenges and issues related to the conservation and sustainable development of aquatic resources in Beijiang River watershed are interrelated (Fig. 7).

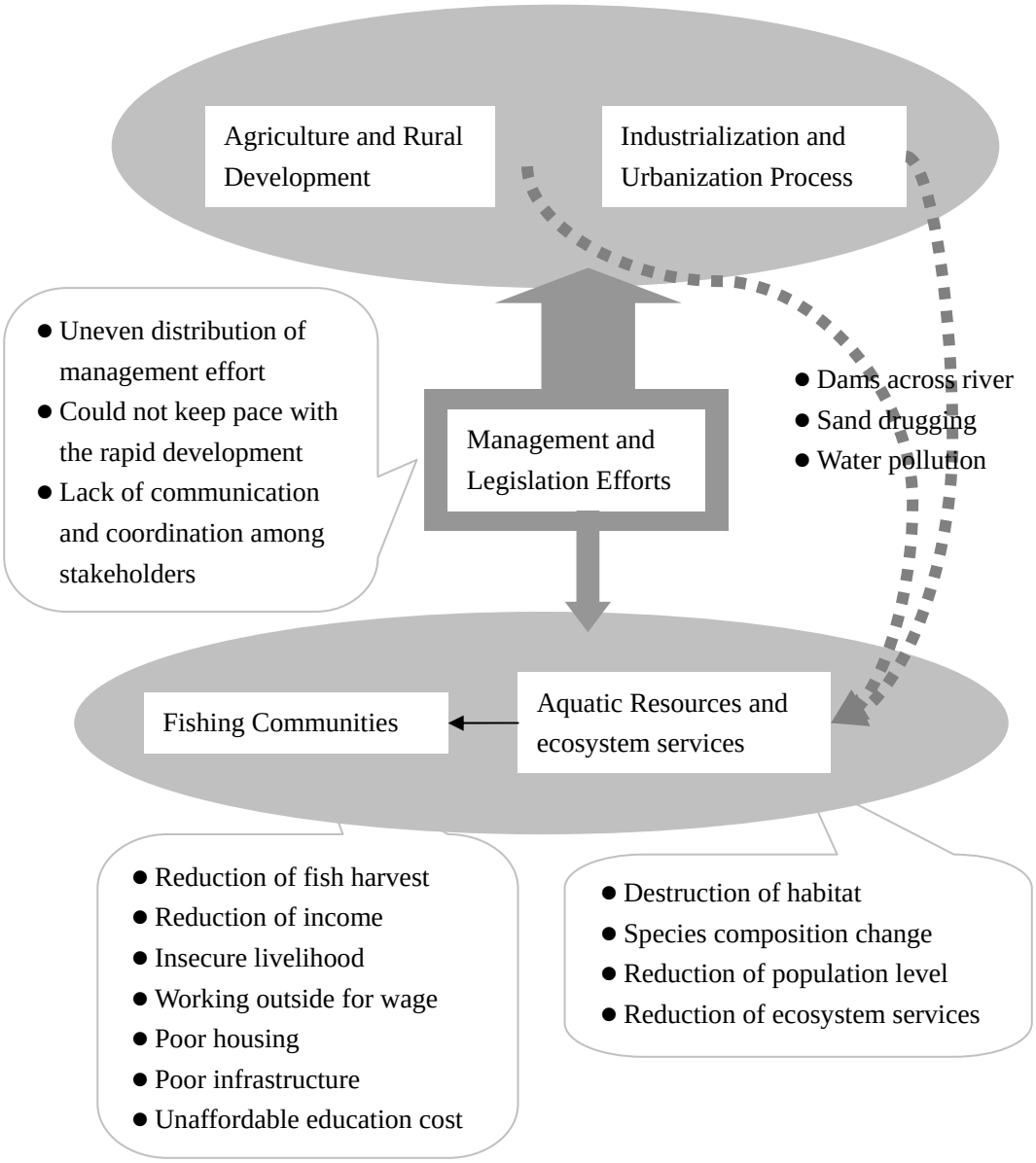


Fig. 7 The major challenges and issues related to aquatic resources and livelihood of fishers in Beijiang River watershed ecosystem

6.1 The destruction of aquatic resources

The aquatic resources and biodiversity are declining mainly due to the construction of dams across river and mechanical sand drugging activities on the river bed. Water pollutions caused by wastes discharged from industry, agriculture and household are the secondary reason for the decline of aquatic resources. The total fish harvested from the river are decreasing. Composition of fish species has altered dramatically because of the water flow decreased and the migration fishes could not go through the river dams. Many local aquatic species have disappeared or are disappearing. Some invasive species like apple snail and water hyacinth have found their way of survive and expansion in the river.

6.2 The poor livelihood of fishing communities

The livelihoods of fishers are also declining due to the decrease of fishing resources, and the marginalization by policies neglecting the fishing community. They are considered city residents; however they live outside towns and cities. Top down organization is very weak. There is no bottom up NGO either. They can not enjoy the welfare and social security policy for farmers and they are not rich enough to pay for medical insurance, pension, and education just like other city residents. The housing situation is very poor. Many of them are even living in small fishing boats. The road and water supply system in some fishing villages are not ideal. Most of the young generation in fishing villages is moving out and only the older generations are left behind.

6.3 The falling behind management and legislation

There are still some weakness in our legislation and policy related to aquatic resources and sustainable development, especially on the detail regulation on implementation. Even worse situation is related to the law and policy implementation aspects. On one hand, the people don't respect enough to the laws. On another hand, there are not enough resources including manpower and money to enforce the implementation of those laws. No compensation fund can be collected for ecological conservation and fish proliferation. No fish channel has been built for seasonal fish migration.

6.4 The lack of necessary communication and coordination

The communication mechanism among different stakeholders is also very weak. Industrial leaders don't understand the livelihood of fishers and the importance of aquatic resources. Fishers don't pay much attention to forestation and tourism. There are still sand dredging activities in conservation zones for aquatic resources. The information of gate operation by hydropower station did not reach fishers on time and usually cause the lost of fishing tools.

In general, these conflicts are typical in developing countries especially in the rapidly growing countries. The environment consciousness has not reach to the level to balance with economic consciousness. The management and policy can not keep pace with the rapid changing social and economic situation.

7. Methods adopted for formulating integrated action plan

Before we worked on action plan, we have spend about two year to conduct site visit, collecting data, set up log book for fishers, identification of stakeholders, workshop to discuss situation and management issue with stakeholders and Delphi method to identify the order of problems and management issues which they concerned. In order to formulate a reasonable action plan, we then took another three steps (Fig.8).

Firstly, we proposed a preliminary action plan within our research group which formed by researchers from various disciplines including fishery, ecology, forestry, entomology, economy, law and management. We proposed action plans according to the understanding of each person.

Then we combined those similar actions and separated those actions which can only be done in a much longer period than two years, or much larger scale than the river and its adjacent area into another parts. Then we concentrated on those more “realistic” actions and identified their goals, main agencies in charge of implementation, and indications for success, and difficulties which may be faced during implementation. We combined these action plans into a table form.

Secondly, we sorted the action plan into different sheets according to the implementation bodies such as the one for Shaoguan Bureau of Fishery and Shaoguan Fishery Monitoring Team shown in Fig. 9 bellow. Then, we went to the site and conduct different discussion with different stakeholders by using the sheet with action plan related to them. We discussed with 40 government officers from 26 different city government departments and township governments, and with 6 fishers of the three fishing villages and a newly formed company for tourism (Table 13, Fig.10, Fig.11). We got a lot of feedback from different stakeholders about the necessity, possibility, difficulties and indicators of these action plans.

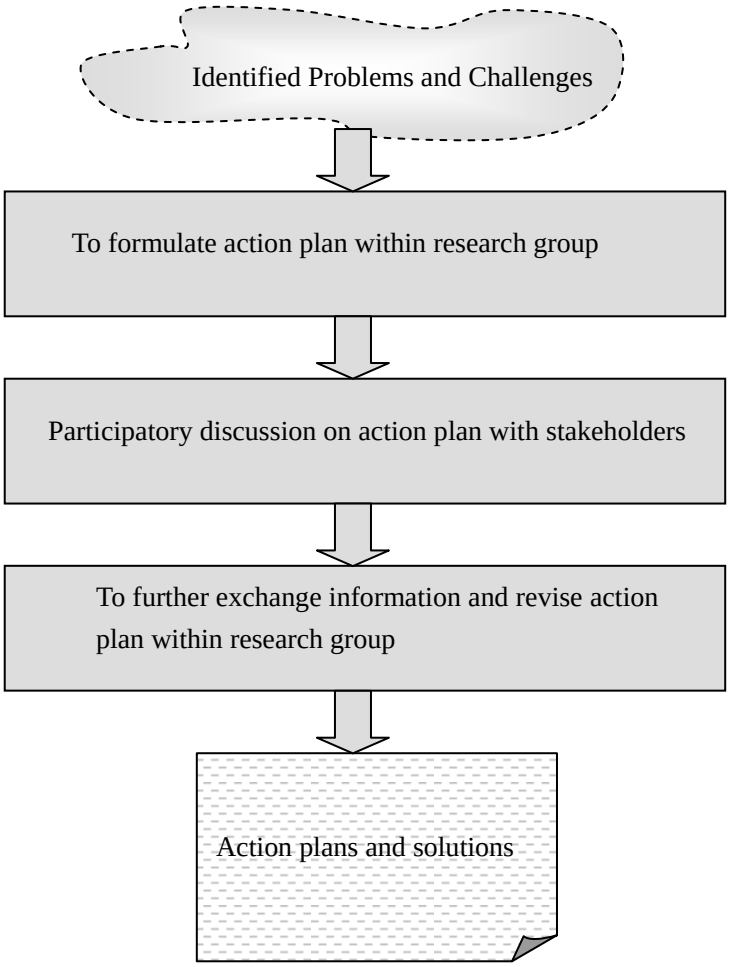


Fig. 8 Final three steps for formulation of action plans (See Fig. 5 for other previous steps)

水产局与渔政支队相关的行动计划

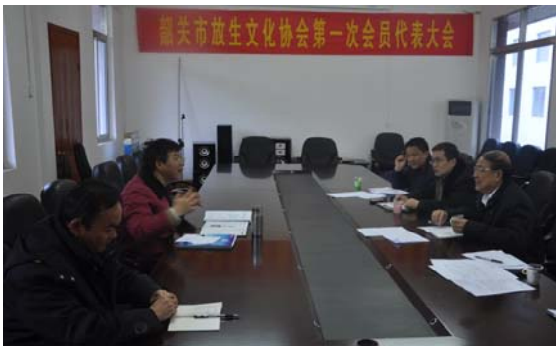
行动内容	执行主体	预期效果	检测指标
1.水产品的人工增殖放流。 具体包括①鱼类。不仅是常见的四大家鱼或低值种类，是否可以考虑放流一些经济价值较高的种类？②放流地点的选择。扩大放流区域。扩展至整个北江流域。尽可能考虑在上游放流。在两个大坝之间也进行鱼类增殖放流活动。③水生植物的增殖放养。给鱼类提供适宜的栖息环境和产卵场所。	韶关市水产研究所 韶关市渔政支队 韶关市水产局 韶关市农业局 韶关市财政局	① 鱼类种类、数量的增加。 ② 水生生物多样性修复 ③ 水域生态改善	① 向渔民了解渔获物种类是否增加。 ② 向渔民了解水体环境的变化。
2.珠江禁渔制度实施	韶关市渔政支队 韶关市水产局	渔获物种类增加，渔获物个体增大。	向渔民了解渔获物的变化情况。
3.加强网具管理 限制网目过细渔具的销售及使用。	韶关市渔政支队 韶关市水产局	保护小型鱼类及稚鱼、幼鱼。	渔获物的个体变化。
4.已设置自然保护区的区域，标示区域范围，禁止挖沙	韶关市渔政支队 韶关市水产局	保护水体环境	水生植物数量恢复
5.禁止电鱼、毒鱼等非法捕鱼活动，加强执法力度，加强鱼类保护的宣传、教育活动。	韶关市渔政支队 韶关市水产局 韶关市公众媒体，韶关市宣传部	保护水生生物资源，在群众中树立正确的鱼类保护概念。	水生生物资源的恢复
6.水利设施增设鱼道。 已有水利设施采用“提鱼机”，新建水利设施要求必须设置鱼道	韶关市渔政支队 韶关市水产局 韶关市水利局	鱼类、特别是洄游种类能越过大坝。效果需要长期观察。	效果需要长期观察。
7. 增殖放流的时间、品种、地点和数量	韶关渔政大队	增加河流中的渔业资源	渔民的捕捞量

Fig. 9 A sample of action plan table which was used for the discussion with officers from Shaoguan Bureau of Fishery and Shaoguan Fishery Monitoring Team

Table 13. Stakeholders who joined the discussion of action plan for Beijiang River in February, 2011

Affiliation	Number of participants
Shaoguan Bureau of Fishery	1
Shaoguan Bureau of Agriculture	1
Shaoguan Monitoring Team for Fishing	2
Shaoguan Institute of Fishery	1
Youqiang Fishing for Leisure Company	2
Water Management Bureau of Qujiang Township	1
Resident Committee of Wushi Street, Wushi Town	1
Wushi Township Government	3
Resident Committee of Kengkou Street, Wushi Town	1
Fisher moved to a newly build house	2
Fisher in Kengkou Fishing Village	3
Shaoguan Bureau of Human Resources and Social Welfare	3
Shaoguan Bureau of Reform and Development	1
Shaoguan Bureau of Health	1
Shaoguan Bureau of Finance	1
Shaoguan Bureau of Legislation	1
Agriculture Office of Lishi Township Government	1
Resident Committee of Lishi Street, Lishi Town	1
Zhengjiang Regional Government	2
Shaoguan Water Bureau	8
Zhoutian Township Water Management Station	1
Zhoutian Township Economic Office	1
Shaoguan Water Management Bureau	1
Water Management Bureau of Renhua County	2
Renhua County Government Office	1
Mayor of Zhoutian Township Government	1
Resident Committee of Zhoutian Street	1
Shaoguan Environmental Protection Bureau	3
Shaoguan Environmental Protection Monitory Bureau	2
Shaoguan Water Management Monitory Team	1
Shaoguan Bureau of Forestry	1

Thirdly, we further discussed those action plans and feedback from the stakeholders within our group and then revised our original plan. In order to form a more realistic action plan, we separated action plan which can be implemented at present and is directly related with Beijiang River, and measures which can be considered in a longer period and in much wider scope related to the whole watershed.



Shaoguan Fishing Monitoring Team

Wushi Township Government

Shaoguan Bureau of Water Affair

Zhoutian Township Government

Shaoguan Bureau of Health and Office of Legislation

Lishi Township Government

Fig. 10 Discussion action plan with various departments of Shaoguan government and township government in January, 2011

New house for fishermen provided by government

Lishi fishing village

Youqiang Fishing for Leisure Company

Zhoutian Longkeng Village

One family in Kengkou fishing village

Zhoutian Longkeng Village

Fig. 11 Discussion Action Plan with Fishing Communities and Farmers in January, 2011

8. Management Proposals

Total 29 actions have been identified for further protection, conservation and wise use of aquatic resources in the Beijiang River Watershed. The summarized table can be found in the Appendix Table. Those actions not only related to the conservation of biodiversity, improvement of ecosystem services, but also related to the livelihood of fishers including men, women, boys and girls. Some of the actions are also extended to the improvement of the management and policy in different management level. According to the time frame, action plans can be divided into three categories. The first category includes those management measures which are already taken by local government and other stakeholders and should be encouraged and continue in the future. The second category includes those management measures which will be taken within 2 years before the end of this HighARCS project. Those can be considered short term actions. The third category includes those necessary management measures which have been identified, but can not be fully

implemented within the project time. WE can call them long term actions.

8.1 Good measures in Shaoguan will be continued and further improved

People and Government in Shaoguan City have taken some actions and measures for environment conservation, aquatic resources conservation, livelihood improvement and management change. These actions and measures will be encouraged and continue in the future stage.

8.1.1 Development Strategy in Shaoguan will follow the ecological planning

Objectives: Shaoguan city has been listed as areas of ecological buffering zone and restrictions for industrial development. According to the regionalization planning of Guangdong Government, Shaoguan (Beijiang River Watershed) is assigned as the "Ecological Development Zone". That means that ecological protection is put into the first priority by provincial government. The development plan in Shaoguan for the 12th Five Year Planning (2011-2015) should follow the principle and guide of "Ecological Development Zone".

Implementer: The Reform and Development Committee of Shaoguan (RDC) is in charge of the development planning in Shaoguan.

Indicator: After we discuss with the officers in RDC, the conservation of aquatic resources and ecological services, the improvement of the livelihood of fishers, and the reduction of discharged pollutant should be included in the 12th Five Year Planning of Shaoguan.

8.1.2 Forest cover in Shaoguan will be protected and expanded

Objectives: There are 22 nature reserves zones in Shaoguan, which include 3 national conservation sites, 13 provincial conservation sites and 6 municipal conservation sites. There are 11 forest parks in Shaoguan, which include 3 national forest parks, 2 provincial forest parks and 6 county forest parks. Forest resources and natural preserves are preserved to protect animals, plants and wetland resources. These zones will be strictly protected. Besides, more forests for ecology and water conservation along Beijiang River should be development in the next few years. It is not that easy, because more people like to plant eucalyptus for money.

Implementer: The Shaoguan Bureau of Forest is in charge of the forest protection and development in the area.

Indicators: The statistic of forest cover by native species will increase in the next few years.

8.1.3 Aquatic Protective zone will be protected better.

Objectives: There are 9 aquatic resource protection zones set up along Beijing River within Shaoguan. However, sand dredging is still quite active within the zones. It is illegal. For a provincial forest conservation zone, an office in charge of the protection and conservation is set up with officers and financial budget. However, there is no such office for provincial conservation zone for aquatic biological resources in Shaoguan. Most of the jobs are taken by the Fishing Monitory Team of Shaoguan. There are not enough officers in this team. So, sand mining activity has not been totally stopped in the conservation zones.

Implementer: Guangdong Provincial Fishing Monitory Team and Shaoguan Fishery Monitory Team are in charge of protection zone and the Bureau of Water Affair is in charge of sand mining management.

Indicator: We will visit Guangdong Provincial Fishing Monitory Team and explore the possibility to set up an office for aquatic conservation zone. Beside, the sign for protection zones should be set up at the starting point and the end point for each protective zone. Regulation should be written on this sign and let the public know about what can do and what can not do in the protected zone. We hope that the illegal activity in the protection zone will be able to stop within two years. Communication with the Bureau of Water Affair should be strengthened. The sand mining activity should be stopped within few years.

8.1.4 Water pollution prevention and control for industry will be implemented better

Objectives: Water pollution prevention and control measures have been taken seriously, which include the implementation of the "principle of three synchronization " which means that pollution control facilitate should be designed, constructed and put into operation simultaneously with production facilitate, the establishment of the water quality monitoring network, the closing down of a number of enterprises with heavy pollution. The closed industries include small-scale iron and steel enterprise, 8.3 million tons of cement production capacity, and 8.8 million tons of pulp production capacity. Enterprises such as bleaching, dyeing, electroplating, food processing have also been carefully screened and selected according to the quality of discharged water. Through improving wastewater treatment techniques and optimizing the water circulation system, industrial wastewater released by Shaoguan Smelter reached the standard and water reuse rate reached 96.3％. The discharge volume of industrial wastewater was reduced from 2,412 m^3/h in year 2000 down to 300 m^3/h in year 2009. However, heavy pollution from iron ore mining and transportation is still existing (Fig. 12). Some complaints from fishing villages near the industrial parks about water pollution also exist. Heavy metal pollution is quite serious in Beijiang River watershed because of the mining industry and metal smelting industry in that area. “Prevention and Treatment Plan for Heavy Metal Pollution in Shaoguan” is being made by Shaoguan Bureau of Environment Protection. Many more restrict regulation will be put into that plan such as daily pollution monitoring system, report requirement for the change in raw material used and output level of production, the public announcement requirement about pollutant discharge, and more detail waste treatment requirement.

Implementer: The Shaoguan Bureau of Environment Protection, Dabao Shan Mining Cooperation and other factories in the industrial parks are in charge of this action.

Indicators: All industrial development should more restrict follow the "principle of the three synchronizations”. The yellow colour of the river caused by iron ore mining should disappear in the next few years. The complaints about water pollution should be reduced. “Prevention and Treatment Plan for Heavy Metal Pollution in Shaoguan” will be made and implemented.

Fig. 12 Half of the Beijiang River contaminated by drainage water from iron ore became yellow (upper picture) and one of the drainage sources of this yellow water near the fishing village of Kengkou (lower picture)

8.1.5 More biogas tank will be set up in rural area.

Objectives: Eco-agriculture and biogas application are emphasized in rural area of Shaoguan. Because more than 100 thousand biogas digesters have established before 2010, 6,566 t COD (Chemical Oxygen Demand) from animal husbandry and households has been cut off annually from being discharged into rivers. Although more than 100 thousand families in rural area have installed biogas tanks within 400 thousand families, about 30% of the biogas tanks are not working very well. It is because some families no longer raised pigs due to the disease problem, and also because the lack of maintaining and repairing support. The financial support for biogas tank building will continue in the next two years. We discussed this with the leaders from Shaoguan Bureau of Agriculture. They agreed that on the one hand maintaining and repairing support should be strengthened, on another hand biogas tank development will focused on the medium and large tanks in livestock farms instead of small 8-10 m^3 family tanks.

Implementer: Shaoguan Bureau of Agriculture is in charge of biogas tank activity.

Indicators: More biogas tanks will be set up in the next two years in medium and large livestock farms and the maintenance system will be improved. The workable biogas digesters will increase from about 65% to about 80%.

8.1.6 More fish fry will be released to Beijiang River

Objectives: Since 2006, the fish releasing activity have being carried out under the principle of "leadership from government, and join effort from the public". An Association of Releasing Life was established in 2010. Recently, Shaoguan Fishing Monitory Team has set up a special website which is opened for the public to join the releasing activities. This is a good beginning to let more people to be involved and join this activity. There are 10 fish fry releasing stations in Shaoguan recently. The amount of fish fry released is about 50 thousand to 100 thousand each year. Most of the fish species are carps and other low value fish fry. This activity should be strengthened in the next few years.

Implementer: Shaoguan Fishery Monitoring Team is in charge of this releasing activity.

Indicators: The money donated by public or spent by government for fish fry releasing will increase. The number of released fish will be increased and even doubled in the next two year. Some of the high value species will also be raised and released.

Fig. 13 One fish fry releasing activity in Beijiang River, 2010

8.1.7 The fish cage culture method in reservoirs will be continuously prohibited.

Objectives: The fish cage culture method in reservoirs can cause heavy water pollution in water resources. This activity has been stopped by the government of Shaoguan in 2009 because of the bloom of blue and green alga in Nanshui reservoir. This type of fish culture should be prohibited in the future.

Implementer: Shaoguan Bureau of Fishery

Indicators: There should be no fish cage culture in reservoirs in Beijiang River watershed in the future.

8.1.8 Sand mining activity in Beijiang River will be better controlled.

Objectives: Measures to control sand mining in Beijiang River such as public tender for license, mining zone restriction, mining monitoring and inspection, resource taxation have been taken by Shaoguan Bureau of Water Affair. Sand mining is one of the major reasons of environment and resources damage in Beijiang River. According to "The Law of the People's

Republic of China on Evaluation of Environmental Effects" (2002) and "Management Catalog of Construction Projects for Environmental Effects Evaluation" (2008), sand mining should have environmental assessment for sand mining activity whenever sand mining reaches 100 thousand m3/ yr, or wherever is within the range of natural egg laying, feeding, migration path and winter shelter for important aquatic species. Sand mining activity should not be put into operation before the approval of environment assessment report by the Bureau of Environment Protection, and then the issuing of mining permission certificate by the Bureau of Water Affair. However, no environment assessment reports have been made for many mining sites. So, these sand mining activities were illegal. Officers of Shaoguan Bureau of Water Affair told us that illegal sand mining companies were not care about paying the very low penalty fee. The standard of penalty fee and the responsibly is going to be raised in the newly revised edition of "Guangdong River Sand Mining Management Regulation". Shaoguan government should revise related local policies and also raise the penalty standard and responsibility accordingly.

Implementer: We will communicate with officers from the Bureau of Environment Protection and the Bureau of Water Affair, and take necessary steps to implement the environment assessment for sand mining activity in Shaoguan and increase the penalty standard in Shaoguan for illegal sand mining.

Indicators: Every sand mining site has environmental assessment before put into production. The penalty level of illegal sand mining will be increased in the next two years.

8.1.9 Government subsidize for the fishers will be continued.

Objectives: Government subsidize for the poorest fishers. The old fishers without any family member or relatives are entitled to the welfare of "five guarantees" (guarantees for their food, clothing, housing, medical care and funeral), hence can get subsidize about 200 RMB per month from local government. The poorest households who are identified by the government can also get subsidize from the local government. However the standard for supporting the poorest are very hard to meet and only a very few households can get this subsidize.

Implementers: Shaoguan Bureau of Human Resources and Social Security is in charge of this.

Indicators: all the poor meet the standard will continue to get living subsidize from government.

8.1.10 Diesel subsidize for the fishers will be continued.

Objectives: Because of the increase of diesel price, the local government began to subsidize the fishers from 2007, but only benefit those fishers who own the fishing license. Most of the fishers do not own the license because they did not renew their licenses. The total number of licenses that can be issued is less than the total number of fishers. A suitable way to issue these licenses has not been worked out.

Implementer: Shaoguan Fishery Monitory Team

Indicators: At least those with fishing license can continue to get diesel subsidize from government. We hope that a solution for those fishers without license will be found.

8.1.11 Nine-years-compulsory-education for children will be continued

Objectives: The education in primary and junior high school is free for all the children in China, including those from fishers' households in Shaoguan. Occasionally, we can see few

children drop off school. We hope this will be totally eliminated and every child will be able to finish 9 year education in the future.

Implementer: Shaoguan Bureau of Education.

Indicators: All children in fishing villages can enjoy 9 year free education in the future.

8.1.12 More low rent houses and more job training provided for the fishers.

Objectives: Nowadays, the local government provides some low-rent-houses to the fishers who are living on boats in the urban area. Training is also provided to these fishers to help them find a job in the urban. At the end of 2010, there are 20 households moved to those low-rent-houses and most of them find a job in the urban (Fig. 14). About 130 households will move to those low-rent-houses within 2011. The housing plan should be implemented as schedule.

Implementers: Shaoguan Bureau of Fishery and Shaoguan Fishery Monitory Team.

Indicators: All boat families in river section of Shaoguan urban area will move to the new houses provided by the government by the end of 2011. Most of the adults can get job training and find their new job position in the city.


Fig. 14 New house provided by local government for fishers who lived in boats (left)

8.2 New Actions will be taken in the next few years

After investigation, we found some other measures which have not been tried before, are worthwhile to put into action soon.

8.2.1 To increase financial resources for protection and conservation of aquatic resources.

Objectives: Shaoguan government has budget every year for this purpose. For example about 100 thousand Yuan for fish fry releasing each year. But it is not enough. According to the law, sand mining companies and hydropower stations have to pay compensation for the lost and damage of aquatic resources. However, there is no standard for the amount they should pay for the conservation and proliferation of aquatic resources. Compensation fund collected by the government is used for other purpose. So, we are going to propose a motion for Guangdong People's Political Consultative Conference about setting a compansation standard for fish resources and using them for aquatic resources conservation and protection.. We would like also to pursuit related Guangdong government departments who have the power to make necessary regulation and policy on this. We hope that some change will happen in related policy or regulation in the next two year.

Implementers: Guangdong People's Congress, Guangdong People's Political Consultative Conference, Guangdong Bureau of Fishery, and Guangdong Bureau of Finance have the

potential power to make regulation and law for compensation.

Indicator: Detail standard for collection of compensation fund will be set up and begin to be implemented for conservation of aquatic resources.

8.2.2 To implement the no fishing season from 2011

Objectives: According to the new regulation "A unified no-fishing season regulation along the Pearl River Watershed" (珠江流域实施统一禁渔期制度方案) from the Ministry of Agriculture and the Department of State last year, the no-fishing season scheme will be implemented from April 1 to June 1 each year from 2011 in the major courses and branches of Pearl River including Beijiang River. The most difficult part for the implementation of this regulation is the life of fishers during this period. A subsidy plan has been proposed by the related provincial department. We hope that will be finally passed by the government and provincial people's congress. Leader from Shaoguan Fishing Monitory Team expressed that there will be difficult to monitor such a large area. So, education and propaganda conducted by the government will become very important. It will let the fishers know that it will be good for them eventually, and also let the public know about this event and form a much larger monitory force from the public. We hope that the no-fishing season regulation will be implemented at least in the major part of Beijiang River, and the fish population will be able to recover after that.

Implementers: Provincial government will be in charge of in subsidy plan for fishers during the no-fishing season. The Shaoguan Fishery Monitory Team will be in charge of the education and monitoring activity. The HighARCS research team will also help to educate the stakeholders.

Indicators: We hope that the no-fishing season regulation will be strictly implemented at least in the major part of Beijiang River, and the fish population will be able to recover after that. The fish harvested by fishers will be increased.

8.2.3 To reduce water pollution from iron ore mining.

Objectives: Iron ore mining activity caused a lot of pollution in the area. Government and the mining industries have taken many steps to check the pollutants running away from the mining sites. However, we found that the pollution also comes from the storage and transportation stage. When there was heavy rainfall, yellow water which came from the storage sites along railroad, run into Beijiang River and half of the river became yellow. Fishers in Kengkou complained about this acid polluted water which not only destroy fish in the river, but also destroy their boats. According to the leaders from Kengkou Township Government and Shaoguan Bureau of Environment Protection, they will be able to stop this pollution activity if it is reported. So, we will report about the pollution situation including the detail chemical test result of the yellow water running into Beijiang River and the possible treatment method to them and ask for action this year. New regulation which will encourage people to report cases of water pollution and the lost of aquatic resources to the Fishing Monitoring Team of Shaoguan government should be made within next two years.

Implementers: Kengkou Township Government, Shaoguan Bureau of Environment Protection will be in charge of enforcement of environmental law. Iron ore companies involved are in charge of pollution control.

Indicators: Water running through Beijiang in rainy days will not be contaminated and in yellow color again. More direct indicator should be waste water control facilities are set up.

8.2.4 To reduce water pollution from rural area.

Objectives: Besides biogas tank construction in rural area, no newly built livestock farm will be allowed by the government within 1 km along Beijiang River, and even within 5 km along the drinking water resources. Waste water treatment facility will be forced to build for those existing livestock farms in this critical zone. In order to reduce nitrogen and phosphorous pollution from agriculture, it is necessary to reduce excessive use of fertilizer in crop production in Shaoguan. The labels of "green food" and "organic food" are issued only the production site and production process strictly follow the guidance and regulations. The amount of fertilizer used is usually much less than farmers' practices today. There are several production companies producing "green food' or "organic food" in Shaoguan now. According to statistics in 2008, there were 89,360 tones, 43 types of agricultural products have been labeled with "green food "which were produced in 5,802.6 ha land and 3,300 ha fishpond. It will be expanded in the next two years. Because the market prices for these healthy foods are usually 30% to 100% higher than common prices, many big companies would like to accept the technique to produce "green food" or "organic food". Rice is one of the important crops in Shaoguan. Rice production area in North of Guangdong Province reached 36.5% (441 thousand hm^2) total rice production area in Guangdong (Zhang Chao, Zhang Luxiang, et. al., 2010). There is a more reasonable rice fertilization scheme. More effective extension and education process like training class, poster, and handbook and TV program will be able to let more farmers to know and accept this. We will cooperate with Shaoguan Agriculture Bureau to implement this action plan.

Implementers: Shaoguan Agriculture Bureau is in charge of this.

Indicators: Less chemical fertilizer amount is used in crop production. More amount of "green food" or "organic food" will be produced in the next two years.

8.2.5 To adjust the policy for eucalyptus forest development.

Objectives: In recent year, eucalyptus developed very quickly in Shaoguan and other regions in Southern China. It is good to get more economic return from this fast growing tree species. However, the large scale displacement of this tree with local vegetation, and unsuitable management method such as very high planting density can cause biodiversity lost and soil erosion (Qian Guoqin, 2007). Some reservoir also suffered from the toxic running off water from nearby eucalyptus forest in Shaoguan. So, it is necessary to protect natural forest and native tree species and control the development of eucalyptus in Shaoguan. More dialogue between HighARCS and Shaoguan Forestry Bureau will be taken place in the next two year and more reasonable development strategy of eucalyptus will be formed in the next two years.

Implementers: Shaoguan Forestry Bureau is in charge of this action.

Indicators: A new policy for the development of eucalyptus forestry will be made and the quick growing rate of eucalyptus forest will be slowed down.

8.2.6 To have more public educational activities

Objectives: Through the research in these two years, we found that more education for the public to understand the importance of aquatic resources and ecosystem services is needed in Shaoguan. For example some government officers didn't know about the actual situation of the fishers and they didn't care about the fish species. The important value of water pollution given by the industries leaders was significantly lower than other stakeholders. The average important value given by farmer and fishers for ecosystem services was lower than the value

given by government officers and industrial leaders. Electricity and toxic methods are still illegally being used by farmers and even fishers today in some places. Various methods can be considered to adopt for public educational activities, such as public media including news paper and local television program, education materials such as CD, poster, booklets, training activities including short introduction course and technical training. The topic for public education may include:

(1) What are ecosystem services? How can we protect and increase ecosystem service?
(2) Why it is so important to preserve fish species and other aquatic species?
(3) How heavily the fishers rely on aquatic species? Is it important to preserve this fishing culture in the future?
(4) How important are the aquatic plants to the life of fish species?
(5) Why dam, sand mining, and water pollution can damage aquatic resources? How do we can reduce its negative impact?
(6) How do we implement the law about the preservation zone for aquatic species?
(7) Why electricity method and toxic method are so harmful to aquatic species and the life of fishers?
(8) What should we do for the no-fishing season from April1 to June 1?
(9) Where does the running water from iron ore go? And how does it affect the aquatic ecosystem?
(10) What is a suitable scheme for eucalyptus development?
(11) What is the right method for rice fertilization and pest control?

Implementers: Research team of HighARCS can help to make some reports to the media, and prepare some education and training materials. The activities can be held by cooperation with Shaoguan Bureau of Agriculture, Shaoguan Bureau of Forestry, Shaoguan Bureau of Fishery, Shaoguan Fishery Monitory Team etc.

Indicators: More than 5 reports will appear in the public media. More than 5 training will be held in Shaoguan for different stakeholders. More than 5 posters or booklets will be designed, printed and delivered to the public and stakeholders.

8.2.7 To notice the fishers about the water gate operation by hydropower stations on time.

Objectives: The sudden drop of water level and strong current caused by gate opening operation for irrigation or flood control could cause severe lost of fishing tools, and sometimes even threatened the lives of fishers working in their small boats. The fishers hope that the hydropower station notices them the time of water gate opening beforehand. It is the duty of hydropower station to let every one affected knows about the gate operation before hand. It seems that there is no difficulty for the hydropower station to send the message to all the fishers via mobile phone. Township leader of Zhoutian said that they could coordinate this between hydropower station and fishing village. Township leader of Wushi also expressed that they can collect cell phone numbers from fishers and give them to the power station. We will further contact township government to improve the communication process between hydropower station and fishers.

Implementers: Township governments in charge of the management of fishing villages will collect cell-phone numbers from fishers and send them to the hydropower stations.

Indicators: The communication system between fishers and hydropower stations are set up. Gate operation can be informed on time.

8.2.8 To strengthen government management organization for fishing communities

Objectives: Although fishers in general belong to non-farmer statute, many women married to fishing communities were from farmer's families and hence still belong to farmer in terms of management status by government legislation system. According to law, non-farmers are managed under city residents' committee, and farmers are managed under rural villagers' committee. It is so confused that fishers said that they could not even find suitable government departments in charge to issue birth certificate or death certificate for them. Considering that most of the fishing villages are very close to town, it is possible to unify the management system for fishing communities by nearby city residents' committees in Shaoguan. The township government should urge the resident's committees to listen to the voice of fishing communities and help them to solve problems.

Implementers: Township governments and city resident's committee with fishing villages are involved in the improvement of the leadership.

Indicators: A better organized fishing communities will appear in the next few years. Most of their affair can be effectively treated by local government.

8.3 Further measures in longer period and for larger scale

Actually more steps can be taken in the watershed level by government and by other stakeholders in a long term base for the improvement of aquatic resources, ecosystem services, livelihood of fishers and social management system.

8.3.1 To re-establish food chain and stabilized habitat for aquatic resources

Objectives: To recover river ecosystem by re-establishing food chain beginning from recovery of aquatic plant community and by releasing endangered or locally disappeared aquatic animal species in Beijiang River. In order to achieve this goal, it is necessary to do some basic research for artificial reproduction and cultivation of those target plant and animal species. It is also necessary to do research on the structure of fish migration channel, because no migration channel which can help fish successively across water dams has been set up so far along Beijiang River. This goal may be achieved by research and demonstration efforts for about 5-10 years.

Implementers: Universities research institutions including, local government including South China Agricultural University, Municipal Government of Shaoguan will be able to fulfill this task.

Indicators: At least 20-30% sections of the river will be stabilized with good aquatic plant communities and rich biodiversity. Migration fishes will find their way going through dams and shallow waters. Some endangered aquatic species appear again in Beijiang River.

8.3.2 To popularize green production technique in agriculture

Objectives: To reduce non-point resource pollution by enforcing green production technique in agriculture. Small farmers are mostly part time farmers today and not care about their land and crop enough to adopt advance technique. To organize farming activity in a much larger scale is essential to reduce chemical fertilizer and pesticide pollution and produce more healthy food.

Implementers: Shaoguan Agriculture Bureau, various farming companies and farmers' associations will play important role in this aspect. Research institutes and universities also can develop more practical green technique for the region.

Indicators: More than half of the crop land will use "green production technique". The chemical fertilizer used per unit crop land area will be decrease about 10-20%.

8.3.3 To set up more sanitary facilities for rural house refuse and domestic sewage.

Objectives: At present, most villages in rural area do not have sanitary facilities such as sewage pine, or artificial wetland, or septic tank to reduce pollution from farming villages. Most of the wastes are discharged directly to the drainage ditches and to the river. It is necessary to extend public sanitary facility from urban area to rural area. The collection, storage, transportation and treatment system for rural house refuse and domestic sewage should be set up with the implementation of the "new rural construction plan".

Impel mentor: Shaoguan Bureau of Environment Protection and Shaoguan Agriculture Bureau are in charge of this.

Indicators: More villages have good sanitary facilities.

8.3.4 To put in place a policy to treat the fishers as a special group to guarantee their pension and medical insurance.

Objectives: There are already such policies to treat the person who are working in the coal mine and forestry firms. Along with the decline of fish stock, the fishers could be treated as a special group to resolve their pension and medical insurance issues.

Implementers: Guangdong Provincial Government has the power to make such decision.

Indicators: fishers will be happy to get pension and medical insurance with lower cost which they can afford.

8.3.5 To improve the current eco-compensation program

Objectives: Shaoguan city is one of the ecological areas of Guangdong Province, which is limited for its economic development. But the current eco-compensation provided by the government of Guangdong Province is not enough for its natural resource conservation. If the provincial eco-compensation program can be improved, Shaoguan local government may get more financial support for supporting environmental conservation and sustainable development.

Implementers: Guangdong Provincial Government and Guangdong People's Congress can make such regulation and law for eco-compensation.

Indicators: More financial support will be channeled to Shaoguan for eco-compensation purpose.

8.3.6 To revise two critical laws related to aquatic resources

Objectives: Article 3 of "The Law of the People's Republic of China on Evaluation of Environmental Effects" (2002) stipulate: "Any projects that have negative impact on environment within the territory under the jurisdiction of PRC shall conduct environmental integrative assessment (EIA)", and according to article 25, "any project that fails environmental impact review shall not be permitted to begin construction". However, article 31 states that any construction builder who start his project without prior EIA qualification license from the related governmental agencies shall be required to halt the project and apply for EIA license immediately. Actually this article 31 is contradictory to article 25 of the same law and open an escape door for construction builders. It makes it possible for construction builders to start their projects first and make it legal later while article 25 absolutely forbids such maneuvers. So, it is important to improve this law. It is also important to revise "the Law of the People's Republic of China on the Protection of Wild Life" to include important

species supporting life and ecological functions in the protection lists no matter weather those species are endanger and rare or not.

Implementers: National People's Congress has the authority to revise these laws.

Indicators: The above mention weak points are amended.

In general, the challenges faced by Beijiang River for conservation of aquatic resources and sustainable development are very similar to the challenges faced by other regions in Pearl River and many other river systems in China. Economic development and ecological conservation are the main conflict in this rapidly development stage. Experience on integrated action plan in Beijiang River will be helpful to solve similar issues in other rivers all over China.

9 Acknowledgements

This report is the result of the cooperation between many stakeholders in Shaoguan Municipal Region and our research team shown in table 4 and table 13 of this report. Many of our graduate students, undergraduate students and even our alumni also joined our research. They are student Cai Jian (蔡建)，Liu Xiaoli (刘晓丽), Chen Peiyong (陈培勇), Lin Feng (林凤), Zhang Liang (张亮), Chen Wenbin (陈文斌), Wei Hua (魏华), and Jiang Chen (姜琛) from College of Economic and Management, student Zhen Hai (郑海), Yi Zicheng (易自成), Qiu Xiaohui （邱晓辉），and Li Yun (李韵) from Agricultural College，student Zhang Hao (张浩) from College of Resources and Environment，student Tengchuan (黄川腾)，Zai Cuihua(翟翠花), and Mo Huizhi (莫惠芝) from College of Forest, student Li Yanming (李炎明), Zhu Guowen (朱国文), Li Haihong (李海红), and Bai Yaowen (白耀文) from College of Animal Sciences, student Lin Jianpei (林建裴),Ye Xiaohang (叶小航), Shen Jianguo(沈建国), and alumni Ou Caifeng (欧彩凤) from College of Humanity. They engaged in various research activities such as site investigation, data collection, statistic analyse, and mapping. We would like to thank them for their efforts and time contributed to this project. The guides from EU experts were essential for us to learn the procedure and method for the research and to form the framework of this report.

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Appendix Table Integrative Action Plan for protection and sustainable use of aquatic resources in Beijiang River Watershed, Shaoguan China

***** In the "objective" column, "1,2,3" means (1) Those actions which have already taken by local government; (2) New Actions will be taken in the next few years, (3) New Actions in a period longer than this project. "EB" refers to ecology and biodiversity. "LH" refers to livelihood of the fishers in the region. "MP" means management and policy improvement. When an action relates to the object, "+" will appear in that column**.**

Objective*				Activities	Indicators	Monitoring and evaluation	Main responsible agencies
123	EB	LH	MP				
1			+	1.1 Development Strategy in Shaoguan will follow the ecological planning	the conservation of aquatic resources and ecological services, the improvement of the livelihood of fishers, and the reduction of discharged pollutant should be included in the 12th Five Year Planning of Shaoguan	the 12th Five Year Planning of Shaoguan	The Reform and Development Committee of Shaoguan
1	+			1.2 to protect and expand forest cover in Shaoguan	forest cover by native species	The statistic of forest cover by native species will increase in the next few years	Shaoguan Bureau of Forest
1	+		+	1.3 improvement of aquatic conservation zones	Clearer sign for the protection zones and more officers are hired and more petrol activities for conservation work	Better management structure and financial support for conservation activities	Guangdong Provincial Fishing Monitory Team, Shaoguan Fishery Monitory Team, Bureau of Water Affair
1	+			1.4 to control water	Better water quality in Beijiang	Water quality data in	The Shaoguan Bureau of

				pollution from industry sector	River	Beijiang River	Environment Protection, and different industrial companies
1	+			1.5 to reduce non-point pollution from rural family	More biogas tank in rural area	The number of biogas tanks using in rural area	Shaoguan Bureau of Agriculture
1	+			1.6 to release fish fry	More fish fry will be released to Beijiang River	The record of the number and species released	Shaoguan Fishery Monitoring Team
1	+			1.7 to stop cage culture for fish in reservoirs	Fish cages will be totally stopped	There should be no fish cage culture in reservoirs in Beijiang River watershed	Shaoguan Bureau of Fishery
1	+		+	1.8 to have better management of sand mining activity	To revise related local policies and also raise the penalty standard and responsibility for illegal sand mining.	The reduction of illegal mining.	Bureau of Environment Protection and the Bureau of Water Affair
1		+		1.9 to continue government subsidy for fishers	all the poor meet the standard will continue to get living subsidize from government	Poor and old in the sampling villages can get subsidy from government.	Shaoguan Bureau of Human Resources and Social Security
1		+		1.10 to continue the subsidy policy for diesel price	Diesel subsidy will be there	The fishers in the sampling villages will continue to have the diesel subsidy.	Shaoguan Fishery Monitory Team
1		+		1.11 to continue 9 year compulsory education program	Boys and girls can go to school without charge	To monitor the situation in the sampling villages.	Shaoguan Bureau of Education
1		+		1.12 to continue provide low rent house and job training for fishers	The number of low rent houses for fishers and the number of fishers who get the job training	All boat families in river section of Shaoguan urban area will move to the new houses provided by the	Shaoguan Bureau of Fishery and Shaoguan Fishery Monitory Team

						government by the end of 2011. Most of the adults can get job training and find their new job position in the city	
2	+			2.1 To increase financial resources for protection and conservation of aquatic resources	Detail standard for collection of compensation fund will be set up and begin to be implemented for conservation of aquatic resources	To compare the budget of different year for protection and conservation of aquatic resources	Guangdong People's Congress, Guangdong People's Political Consultative Conference, Guangdong Bureau of Fishery, and Guangdong Bureau of Finance
2	+		+	2.2 To implement the no fishing season from 2011	No-fishing season regulation will be strictly implemented at least in the major part of Beijiang River, and the fish population will be able to recover after that. The fish harvested by fishers will be increased.	To compare the fishing record of the sampling villages.	Provincial government will be in charge of in subsidy plan for fishers during the no-fishing season. The Shaoguan Fishery Monitory Team will be in charge of the education and monitoring activity.
2	+		+	2.3 To reduce water pollution from iron ore mining	Water running through Beijiang in rainy days will not be contaminated and in yellow color again. More direct indicator should be waste water control facilities are set up	Water quality during rainy season near Kengkou fishing village.	Kengkou Township Government, Shaoguan Bureau of Environment Protection
2	+			2.4 To reduce water pollution from rural area.	Waste from livestock farm will be better controlled, and more "green food" or "organic food" is	The water quality near livestock farm increased and fertilizer and pesticide used	Shaoguan Agriculture Bureau

					produced. More land under production are using reasonable fertilization methods	decreased	
2	+		+	2.5 To adjust the policy for eucalyptus forest development	A new policy for the development of eucalyptus forestry will be made and the quick growing rate of eucalyptus forest will be slowed down	The related policy statements and the statistic for eucalyptus area	Shaoguan Forestry Bureau
2	+	+	+	2.6 To have more public educational activities	More than 5 reports will appear in the public media. More than 5 training will be held in Shaoguan for different stakeholders. More than 5 posters or booklets will be designed, printed and delivered to the public and stakeholders.	The media materials used for the public education.	Research team of HighARCS can help to make some reports to the media, and prepare some education and training materials. The activities can be held by cooperation with Shaoguan Bureau of Agriculture, Shaoguan Bureau of Forestry, Shaoguan Bureau of Fishery, Shaoguan Fishery Monitory Team etc.
2		+	+	2.7 To notice the fishers about the water gate operation by hydropower stations on time	The communication system between fishers and hydropower stations are set up. Gate operation can be informed on time.	To visit fishers and see if they satisfy with the result.	Township governments in charge of the management of fishing villages will collect cell-phone numbers from fishers and send them to the hydropower stations.
2				2.8 To strengthen government management organization for fishing	A better organized fishing communities will appear in the next few years	to unify the management system for fishing communities with nearby	Township governments and city resident’s committee with fishing villages

				communities		city residents' committees	
3	+			3.1 To re-establish food chain and stabilized habitat for aquatic resources	At least 20-30% sections of the river will be stabilized with good aquatic plant communities and rich biodiversity. Migration fishes will find their way going through dams and shallow waters. Some endangered aquatic species appear again in Beijiang River.	To recover river ecosystem by re-establishing food chain beginning from recovery of aquatic plant community and by releasing endangered or locally disappeared aquatic animal species in Beijiang River.	Universities research institutions including, local government including South China Agricultural University, Municipal Government of Shaoguan
3	+			3.2 To popularize green production technique in agriculture	More than half of the crop land will use "green production technique".	The chemical fertilizer used per unit crop land area will be decrease about 10-20%.	Shaoguan Agriculture Bureau, various farming companies and farmers' associations
3	+			3.3 To set up more sanitary facilities for rural house refuse and domestic sewage	More villages have good sanitary facilities	The collection, storage, transportation and treatment system for rural house refuse and domestic sewage should be set up with the implementation of the "new rural construction plan".	Shaoguan Bureau of Environment Protection and Shaoguan Agriculture Bureau
3			+	3.4 To put in place a policy to treat the fishers as a special group to guarantee their pension and medical insurance.	Fishers will be happy to get pension and medical insurance with lower cost which they can afford.	The policy will be publicly issued.	Guangdong Provincial Government

3	+	+	+	3.5 To improve the current eco-compensation program	More financial support will be channeled to Shaoguan for eco-compensation purpose.	To monitor the policy change of provincial government regarding eco-compensation.	Guangdong Provincial Government and Guangdong People's Congress
3			+	3.6 To revise two critical laws related to aquatic resources	"The Law of the People's Republic of China on Evaluation of Environmental Effects" and "the Law of the People's Republic of China on the Protection of Wild Life" gets revised.	To watch the progress of regarding the revision of these two laws.	National People's Congress