

**Chinese Practices of Ecological Compensation and Payments
for Ecological and Environmental Services and its Policies
in River Basins**

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1. Introduction

The study on ecological services has developed from its primary concept and meaning into service types, mechanism and evaluation approaches, etc. Daily (1997), Costanza (1997), Gairns (1997) and MA (2003) have classified the functions of ecosystem services respectively. The watershed service functions mainly include water adjustment, water supply, biodiversity protection, cleaning, food production, culture, entertainment, water and soil conservation, water source conservation, wood production, and carbon deposit from forests in a watershed. Generally, these can be grouped into four functions: products supply (freshwater, water products, wood products, carbon storage, etc.), control (water adjustment, water and soil conservation, water source conservation, cleaning, etc.), biodiversity protection (provides living environment), and information (culture, entertainment, etc). When the traditional patterns of constructing and maintaining the watershed through government investments receive more and more pressure, the role of the market emerges. Financial deficit and government failure make many stakeholders take action, which lead to more and more people willing to pay for the environmental services. At the same time, many private companies, individuals, the NGOs and communities, driven by the benefits of cost reduction, new returns, public relations improvement, decreased risks of natural disaster and the protection of the existing welfare, are all getting involved, and the market is becoming the most effective means of maintaining the watershed eco-services and reducing poverty in the upstream.

In China, the government has been managing of the watersheds for the past 20 years. There is enormous pressure on natural resources and the health of the ecological environment is threatened. This has subsequently created pressure on the Chinese government to meet the public and the environmental needs. Since the government is the only main ‘player’ in this responsibility, the environmental upgrade is quite low. In the late 1990’s, stimulated by a series of factors such as grassland degradation, decrease of forests, natural disasters like floods and droughts, increasing environmental understanding and care, etc., the government began to explore more effective ways of protecting the environment. The concept of Payment for Environmental Services (PES) was rapidly introduced and accepted. PES is gradually taking root in Chinese society and increasingly private funds are being invested in watershed management. The market for PES has been primarily developed, and various PES modes have been put into practice. However, lacking capacity in watershed management, the transaction cost in PES is very high. It is difficult to define the main suppliers, buyers and scope of watershed payment; to evaluate the services of hydrology and water resources, or to determine the criteria of payment. This system has been initiated in some watersheds in China and such pilot projects should be studied to identify the problems the implementers are facing, their successes and opportunities to exploit before embarking on further projects in other watersheds. Hence, we need to study the typical cases of payment for watershed

services (PWS) in China, analyze their successful experiences, existing problems, and payment mechanism and provide solutions, as references to the establishment of PWS in other similar watersheds.

This paper firstly review the situations of PWS in China, analyzes 4 typical cases in China, studies on their feasibility, mechanism and institutional arrangements, the efficiency and effectiveness of the implementation, and puts forward relevant policies and suggestions.

The paper covers the following 9 parts:

1. Introduction
2. Methodologies
3. PES in China
4. PWS in Miyun Reservoir
5. PWS in the Thousand Islands Lake
6. Water quality control and PWS in Jinjiang River
7. Water right trading between Yiwu and Dongyang
8. Findings and policy suggestions
9. Remarks and discussions

2. Methodologies

The methodologies in this research include literature and data collection and analysis, interviews with key stakeholders, and field surveys and questionnaire surveys on households and farmers. The interviews were taken mainly by a half-structural way, and the basic topics were divided into many secondary topics, which interviews were carried out based on the secondary topics step by step. Interviews and investigations were carried out in the 4 cases.

● Second-hand data collection

March 2006 is the phase of second-hand data collection. During this time, we collected the information on payment modes, fund sources and distribution, institutional arrangements, implementation polices, at all levels throughout the country.

● Field surveys

We investigated the Jinhua River for Yiwu-Dongyang Water Rights Trade, PWS in Miyun reservoir, Thousand Island Lake and Jinjiang River respectively in March, June, July and August, 2006.

● Questionnaire surveys on households and interviews with key persons

The interviewees are mainly the leading officials from the forest, water resource, environmental and financial sectors in Pan'an County, Dongyang city, Yiwu city, Miyun County, Fengning County, Chun'an County and Quanzhou city, as well as the related persons from the administrative departments of Miyun and Xin'an River reservoirs. Farmers were interviewed in random in terms of questionnaire surveys.

3 The review on the processes and practices of ecological compensation and PES in China

3.1 The background, concept and scope of PES

3.1.1 Theoretical basis and background of PES in China

The theoretical basis of PES includes the Value of Environmental Services, Environmental Externalities, Ecosystems, Ecological Assets, Public Goods, etc. As public goods, environmental services have the features of externality. The international community defines it as the Payment for Environmental Services (PES), a payment from enterprises, households or government for environmental services, which is based on the clear property right and low transaction cost.

PES was introduced into China due to the deterioration of our ecosystems, so the legal and political structures support the ideas in China. Due to the deterioration of environment and increasing incidents of watershed conflicts and appeals, the questions on the equity, environment and development in the watershed is increasingly emerging, which have drawn broad attention from the society, and there are many proposals on establishing PES mechanism in every conference of the National People's Congress (NPC) and the Chinese People's Political Consultative Conference (CPPCC). Therefore, the establishment of the PES scheme has a broad social basis. PES has drawn great attention from the Central Committee of the Communist Party of China (CCCPC) and the State Council. In a series of CCCPC documents, such as "The Outline of the Eleventh Five-Year Program for the Economic and Social Development", "Decision on Implementing the Scientific Concept of Development and Strengthening Environmental Protection by the State Council" and "Key Points of the Work of State Council in 2006", all these policies call for action to be taken to reform the payment system for environmental utilization. It was suggested that the payment (compensation) mechanism for environmental services must be established at an earlier stage, and relevant reform measures must be put forward in fields of finance, pricing, taxation, credit, trade, etc. On April 17, 2006, at the 6th Conference on Environmental Protection, Premier Wen Jiabao clearly stated that the policy and mechanism of PES must be established and improved based on the following principles: "Users should protect, destroyers should restore, beneficiaries should pay, and polluters should be charged fees".

Meanwhile, in order to coordinate the development and environment in the entire region and reduce poverty in the upstream, the central and local governments increase payment transfers to the key ecological function zones and the upstream poverty-stricken areas; encouraged the development of ecological industries in the upstream; adopted various means such as "development in another site"; for migration to downhill or downstream for poverty alleviation; supports and cooperation between downstream and upstream; etc., so as to protect environment and compensate the loss of development rights limitation in the upstream, reaching double goals of poverty reduction and headwaters protection, which is also an important drive for PWS. Because the upstream areas are generally poor, and at the same time these areas are

also planned to be limited development areas or prohibited development areas, there was an increase in the discrepancy and inequity of regional development, and that may further affect the sustainable development for the entire region. In order to compensate these areas, payment transfer is increased. For example, payment transfer from province to county takes place in Zhejiang province, and the poor counties receive higher payment than the richer counties. In the provisions of *Decision on Implementing the Scientific Concept of Development and Strengthening Environmental Protection by the State Council*, two goals will be achieved in the 11th Five Year plan through PES, i.e. environmental improvement and rural development. In addition, environment control funds and projects will be increased in the poor counties and cities. Due to the remote location and little industries, the upstream can provide ecological services at lower costs. The implementation of the compensation for environmental protection of the upstream can arrive at the goals of improving the farmer livelihood in the upper reach, reducing poverty, protecting headwaters with the win-win of environment and economy, which becomes the main drive of PWS.

The economic development and increase in central and local financial revenues also provides the economic basis for PES. Meanwhile, people have a much higher demand for environmental quality. In the developed provinces like Zhejiang, Fujian and Guangdong, there are voluntary practices of PES such as the Water Right Trade.

Although the legislation on PWS has not yet been established, there are certain Resources Acts and Environment Protection Acts that have terms or clauses on PES such as the Forest Law, Grassland Law, Environment Protection Law, Sand Control Law, etc., Special Rules by State Council including Ordinance of Basic Farmland Protection, Ordinance of Grain-for-Green, Ordinance of Nature Reserve, etc., that further promote the PES policy.

On basis of economy, society, politics and law, the situations of the confusion of environmental property right and duty, shortage of resources, environmental degradation and the imbalance of regional development have caused serious social and economic problems, which have negative impacts on scientific development and sustainable development. Therefore, PES has become one of the important strategies of China's environmental and economic policy, and it is an inevitable choice when society, the economy and environment enter into a certain phase as in China.

3.1.2 The concept and scope of PES in China

In China, the concept of PES has experienced a process from natural to human, from ecological construction and management to environmental economy policies. At the same time, PES mode is developed from initial subsidies of environmental protection to the current compensation for the limitation of development rights and payments for ecological services. Different scholars hold different understandings to the concept of PES (Wang D. H, 2006; Wang J. N, 2005; Feng D.F, 2006; Zhang H. Y, 2006), among which the key difference is whether pollution control and pollution

charges should be included in PES. The definition of PES that Wang Jinnan give were widely accepted, Wang thinks the PES includes 5 aspects: 1) Payment for Ecological Services, i.e. payment for those who provide ecological services; 2) Resource based Ecological Compensation (EC), i.e. “Equivalent occupancy and compensation” mode in the natural resource use; 3) Damage-Based EC, i.e. an economic punishment for destroying environment by individuals or enterprises; 4) Development Based EC, i.e. a compensation for those who protect the environment or give up development opportunities for protecting environment, a compensation for development right limitation; and, 5) Conservation Based EC, i.e. an protective investment in the regions or objects with important ecological value.

The scope of PES includes: the compensation for residents migration near the water sources or reservoir, subsidies for the construction of sewage treatment plants, investment in sanitation facilities, compensation for forestry sectors in the upstream including subsidy for non-commercial forests, sealing hillsides for afforestation, the subsidy of Sloping Land Conversion Program (SLCP), compensation for regional development limitation, payment of farmers suffering from production loss for controlling non-point pollution and the use of fertilizers and pesticides, etc. At present, the priority fields of PES in China are key ecological function zones, river basins, payments in exploitation of natural resources, issues left over from history at the period of economic transition.

PWS is one of the priority areas, and its process and mechanism include the definition of payment scope, payers and payees, payment criteria, payment modes, and payment type etc.

3.1.3 The feasibility of PES and its development phase in China

Internationally, the market for ecological services originated from watershed management. Take the watershed management planning of Tennessee for example, the 1986 conservation area plan in the US provided payment for the land owners of the cropland around watershed and marginal grassland in order to reduce soil erosion. From the aspects of theoretic study and practical exploration, Costa Rica started carrying on the payment schemes of environmental services early in 1995, and became the global pioneer of PES schemes. In 1995-1999, Costa Rica developed 11 schemes to increase carbon storage, with 158 million dollars invested in 5 forest management schemes, 135 million dollars in 5 energy schemes and 1 million dollars in 1 agricultural scheme. The US adopts pollution credit transactions in order to reduce eutrophication in rivers and improve water quality. Australia adopts evaporation credits to reduce soil salinization due to deforestation. At present, the framework of watershed services has been established in many nations, such as the US, Costa Rica, Ecuador, Columbia, Mexico, Brazil, etc. Internationally, the main types of PES are water conservation and water and soil adjustment. A typical PES mode is the subsidy from the Costa Rica water-power company for upstream afforestation, or payment from the Columbia Irrigation Association of Kakao River for river flow regulation, which is both a payment for water and soil adjustment

through the use of afforestation and vegetation to regulate water flow. The bottled water companies in France pay for environmental services through compensating upstream households for the reduction of agricultural production and for afforestation.

Is the current policy in China on PWS rational and feasible? How can PES be setup and implemented in China? Because property rights of natural resources and lands are owned by the state, the distinction of property rights and the relevant environmental property rights become key barriers to the PWS implementation. Meanwhile, the PWS faces a great deal of problems due to the lack of relevant legislations and appropriate institutional arrangements, and it is still in a phase of theoretical research and exploration. However, there is an increasing demand for environmental services thanks to the rapid development of China's economy, which makes PES, as an idea of protecting environment and coordinating the development between the up and down streams, widely accepted by government sectors, enterprises and individuals.

In China, as people gradually understand the value and importance of watershed services, more and more individuals, water companies, local governments and organizations are willing to be involved in and pay for this activity, in order to reduce the loss from the degradation of watershed ecological services. At the same time, people (the owners of forests in the upstream watershed) who maintain the services are also looking for buyers and users to cover conservation costs. Therefore, the PES in China is driven by the supply and demand at different levels. However, throughout the country, PES still heavily relies on government's involvement. So, the international PES mode is not feasible in China at present, since the PES in China is in a primary stage, and we need some time to reform relevant policies and institutions. Now, the government is still the main purchaser and facilitator, and the market plays a supplementary role mainly in the medium and small watersheds where the relationship of stakeholders' rights, duties, losses and benefits is simple and clear. At present, PES pilots are in some relatively rich provinces like Zhejiang, Fujian, Guangdong, etc, and the key fields focus on ecological function zones, river basins, payment in exploitation of natural resources, issues left over from history at the period of economic transition.

3.2 Payment for Watershed Services (PWS) in China

The practices of PWS in China, before the theoretical research, are carried out in different levels from province to province, from city to city, from town to town, from village to village, and from watershed to watershed. Since the water resource rights are owned by the state, the protection of watersheds, water resource is mainly supported from the government's budget. From the 1990's, the central government has invested a large amount of money into the large PWS projects to pay for watershed services in order to restore the environment in the main river basins in response to the worsening conditions of the watersheds all over the country. The large national PES projects include Natural Forest Protection Project (NFPP), Sloping Land Conversion Program (SLCP), Forest Ecological Compensation Project (FECF), etc.

Meanwhile, the local government also realizes the importance of watersheds; therefore, in some developed provinces such as Zhejiang, Fujian, Guangdong, etc, the PWS between the upper and lower reaches was done through provincial financial transfers or negotiation between cities. There are several PWS modes such as water rights trade, develop off site, charges for water resources, etc.

There are 5 types of PWS in China: national ecological compensation programs, local government-dominated ecological compensation programs, voluntary trade market in the small watershed, water right trade, and ecological compensation from water charges (See Table 1).

However, the current PES in China mainly relies on governmental payments or administrative arrangements, and it is intersected with different sector regulations and activities, which often cause problems like non-effective payments, high transaction costs, unlinking between beneficiaries and suppliers of environmental services, who really should get the payments, disconnection between watershed services and watershed protection, etc. The establishment and improvement of PWS schemes require more stakeholder involvement, comprehensive decision-making, public participation and reform on relevant policies and institutions.

Table 1 Classification of PWS cases in China

	National ecological compensation programs	Local government-dominated ecological compensation programs	Voluntary trade market in the small watershed	Water right trade	Ecological compensation from water charges
Cases	<ol style="list-style-type: none"> 1. FECP 2. SLCP 3. NFPP 4. Sealing hills for afforestation 5. Water Transfer from South to North Project (WTSNP) 6. Shelterbelt of Three North and Upstream of Yangtze River Project 7. Wetland Protection Project 	<ol style="list-style-type: none"> 1. Ecological compensation in the Beijing Miyun Reservoir 2. Ecological compensation in the Tangpu Reservoir 3. Ecological compensation in the Dongjiang River source area 4. Ecological compensation in the Thousand islands lake 5. Ecological compensation in the Zhujiang river 6. The upstream pays the downstream in Fujian province 7. Compensation in Jinpan Development Zone for poverty alleviation: develop off site 	<ol style="list-style-type: none"> 1. Payment between Yuandong town and Fucun town in Jinhua city, Zhejiang Province 2. Xiaozhaizi river payment: water purchase agreement between Jinji village and Luozaizai village 3. Baoshan Supo river PES: payment from water & electricity company 4. Long term PES mechanism in Deqing County, Zhejiang province 	<ol style="list-style-type: none"> 1. Water right certificate in Heihe River 2. Water right transfer in Ningxia and inner Mongolia 3. Water right trade between Dongyang and Yiwu 4. Water transfer cross province in Zhanghe river 	<ol style="list-style-type: none"> 1. Water charges in Yao County 2. Payment from water & electricity companies to farmers in Qujiang County
Features	Payment comes from the central government, partly from provincial government; the central government provides special funds; the developed provinces provide part of the subsidies.	Payment funds are from provincial, municipal financial transfer, mostly used for the upstream water source or reservoir areas.	This mode reflects the WTP, WTA and protective perception of the government, households and enterprises, mostly occurs at the village and town level voluntarily. However, it barely lasts long due to the lack of payment basis and low payment ability.	Orientated by market, the trade takes place under certain rules enacted through the negotiation between the local government and watershed management media agency, transferring from under developed region to developed region, or from low value added sector to high value added sector, with a mature market.	Charges directly based on water volume, mostly in the areas where water & electricity company is closely impacts on water soil erosion with clear beneficial areas and protective areas.
The roles of government and market	Directly paid by the government	Paid by local governments (provincial, municipal or County)	Directly paid by water users according to the agreement, and the market play a certain role.	The local government facilitates in the negotiation and coordination with payment according to the water price.	Local government supplies payment criteria based on water fee and ability to pay.

3.2.1 National ecological compensation programs

National purchase of watershed services is one of the main modes of PWS in China, and it is mainly carried out through large national ecological compensation and construction projects, including 6 large key forest projects, i.e. Sloping Land Conversion Project (SLCP), Natural Forest Protection Project (NFPP), Sand Control in Beijing and Tianjin Project (SCBTP), Key Shelter Forest in Three-North and Upstream of Yangtze River Project (KSFP), Wildlife Protection and Natural Reserve Construction Project (WPNRCP) and Construction of Fast Growth and Fruitful Forest Base in Key Areas Project (FGFFBP). In the 1998 Amendment of Forest Act, the regulations clearly read: the state will set up a fund for Forest Ecological Compensation Project (FECF), and FECF is national payment for ecological non-commercial forests.

SLCP pays farmers for grain seeds, seedlings and management who convert cropland to forest land in the sloping land. It is the broadest ecological project with the highest rate of public participation all over the country, initiated in 1999 and started in 2002. Until the time of this report, it has extended to 25 provinces (regions or municipalities) and 1897 counties. The total central financial fund invested in SLCP is up to 14.15 billion dollars from 2001 to 2005 (Tao W.D., Ai C.Y, Zhang S. Q., et al, 2006). The amount of the subsidy is 6.67-10 kg corn per ha and 38.2 dollar per ha in cash. For the past 5 years, the total area of SLCP land is 1.5 billion ha (0.72 billion ha for afforestation in sloping cropping lands and 0.83 billion ha for afforestation in barren hills). According to the Program for SLCP issued by the State Forestry Administration (SFA), the total area of SLCP will be 14.67 million ha, and the total budget will reach 42.1 billion dollars by 2010 (Xu J.T., Tao R, Xu Z.G., 2004). Thus, it is unprecedented ecological project worldwide with such a large scale and huge budget, and it is the first time that China will spend such large amounts for environmental services and protection. At present, it is the hot issue to study the cost-efficiency, economic and ecological sustainability, impacts on farmer's income and the environmental goals of SLCP (Xu J.T., Tao R, Xu Z.G., Tao W.D., Ai C. Y., Zhang S.Q., et al, 2006).

NFPP extends to 17 provinces (regions or municipalities) within the upstream of Yangtze River, the mid-upper reaches of Yellow River and North-east Inner Mongolia, and includes 734 counties and 167 national forestry bureaus in the key national forest areas¹. The deforestation of natural forests along the above mentioned rivers is prohibited with a large decrease of timber production by 199.1 million m³ in North-east and Inner Mongolia. The local government is supposed to protect the other 94.2 million m³ of natural forest. The fostering of forest must be quickened, 8.66 million m³ of forest and 6 million m³ of grassland will be planted along the two rivers, and the forest coverage in these areas will reach 3.72%. The amount of the subsidy is 9 dollar per ha per year, 90% of which will be paid by the central government.

¹ The 6 key forestry projects, <http://www.forestry.gov.cn/SHTGC/02.htm>

FECP aims at protecting forests through an economic incentive of paying for ecological non-commercial forests. This is the first time that China transfers national finance to protecting forests. As a new institutional innovation, FECP has passed its experiment in 11 provinces and met the goal of protecting forests through economic means. The payments are mainly used for collectives and individuals, who manage the shelter forests and special forests, and the amount of payments is about 9 dollar per ha per year, among which 30% is used for regional management, and the local and provincial governments are encouraged to provide supportive funds. In 2001, the Ministry of Finance (MOF) transferred 120 million dollars to 11 provinces for trial, covering 685 counties (enterprises) and 24 national reserve forests, up to 13.33 million ha. Guangdong, Fujian, Zhejiang and other provincial governments have transferred their parts of funds to their locals for pilots. In December, 2004, the Central Funding System for Ecological Compensation was initiated and in full operation throughout the country, the payment scope under the Fund includes the key state-owned non-commercial forest, scattered woodland and shrubbery land in areas of the dissertation and soil erosion. The central government paid 250 million dollars in advance on the 27 million ha of non-commercial forests for ecological benefits. There are some existing problems in the FECP, such as low payments, incomplete payments, unclear accepters & suppliers of the payments, high transaction costs, imperfect market and competitive mechanism, etc.

Water Transfer from South to North Project (WTSNP) is also a national mode of payment for cross-regional watershed resources. WTSNP comprises three sub-projects, i.e. the East Line, West Line and Middle Line, among which the Middle Line is the fast project. That is because water resources restrict the development of the Beijing municipality, so the state invested 11.5 billion dollars in the Middle Line to ease the water crisis in Beijing and Tianjin areas. Since 1991, the Beijing municipality has increased the water rate several times, and the water rate, besides including the supply cost of the water project, tap water supply cost and sewage treatment cost, it also includes the water fee added in 2002, i.e. charged water users including organizations and individuals, and the added fee is used for fund collection for the WTSNP.

Due to the national limited ability to pay, there are more and more stakeholders like the local governments, water companies, water users, etc, together contributing to the fund sources, which makes up of the important factors of PWS in China. Based on the payment bodies and means, the PWS cases can be sorted into the 4 types, i.e. local governmental payment, voluntary transaction, water fee and water right trade.

3.2.2 Local government-dominated ecological compensation programs

Due to the limitation of the central governmental fund which mainly targets the key water source areas, key ecological function zones, natural reserves zone and ecological fragile areas, local governments organize the up and down reaches to discuss, negotiate and sign agreements to pay for watershed services, in order to improve watershed environment, and provide clean and sufficient water. This means

of payment led by local government becomes the main PWS in China and include the following for example the compensation from Beijing municipality to the water source areas in Miyun reservoir and Guanting reservoir, compensation from upstream of Xiaoshun River to Tangpu reservoir in Zhejiang province, payment transfer to Dongjiang headwaters and water & electricity charges for compensation in the river, PES in Thousand islands Lake, the mode of development off site between Jinhua and Pan'an in Zhejiang province, and subsidies from downstream to upstream in Fujian province, etc. (See Table 1).

Miyun reservoir is the main source of drinking water for Beijing, providing 80% of the domestic water, among which 56% is from Chao River and Bai River, which originate from Chengteh and Zhangjiakou of Hebei province. In order to reduce the sedimentation and pollution that the reservoir is facing, the Beijing and Tianjin municipalities directly negotiated with Fengning County of Chengteh city, the water conservation forest area, and reached an agreement, i.e. a Fund for ecological non-commercial forest will be set up, to which Beijing and Tianjin will transfer an annual payment of 125,000 and 50,000 dollars respectively. Meanwhile, the Beijing municipality also invested 1.875 billion dollars including subsidy of 875 million dollars from the central government to the *Capital Program for Sustainable Water Utilization in Early 21st Century (2001-2005)*, in the projects of environment construction and pollution control in the upstream and in Miyun and Guanting reservoirs, so as to increase forest coverage rate, and reduce point and non-point pollution.

In order to solve the domestic and industrial water use problems, Shaoxing city of Zhejiang province invested 262.5 million dollars in the construction of Xiaoshun River in 1996. Tangpu reservoir, as the only fresh water source, located at the boundary of the mountainous areas between Shaoxing County and Shangxu city. The compensation is paid by water fee and cross-regional water trade, and other measures are taken such as garbage collection, sewage treatment. Firstly, 0.12 cent per ton is collected from a water charge into the special fund of reservoir environment protection. Secondly, Shaoxing city and Cixi city signed an agreement on water supply, Cixi will pay 87.5 million dollars from 2005 to 2022, and Shaoxing supplies 150 million m³ of water to Cixi, and the citizens of Cixi and Shaoxi share the same water resource with the same price (See Box1).

A mixed mode of transfer payment and water & electricity charges in Dongjiang River is a successful case of cross-region payment in China. The water source areas, originating from Xunwu County of Ganzhou city, Jiangxi province, includes Xunxu, Anyuan and Dingnan counties, and are very important to supply clean water for the Zhujiang Delta including Guangzhou, Shenzhen, Dongguan and Hong Kong. Guangdong province adopts a payment transfer and PES fund collected from a water power station to ensure water quality in Dongjiang River by compensating the water source areas (See Box2).

The Thousand islands Lake is also called Xin'an River, originating from Huangshan Mountains in Anhui province, belonging to the Qiantang River system, a sub-branch of the Yangtze River. 97% of the water area of the lake is in Chun'an County, 0.3% in Jiande County, and 2.7% in the upstream, Anhui. It is the important tap water source for Huangzhou city and the downstream. The water quality from Huangshan mountain is class III, and it is class I from Thousand islands Lake to the downstream. The main PES in Thousand islands Lake is the investment in ecological protection and construction in Chun'an County, and the PES fund comes from tourism revenue from Thousand Islands Lake as well as state, provincial and urban project funds for sewage treatment, garbage refloat, noncommercial forest, sealing hillside for afforestation, forestation, etc.

The PES mode that Jinhua city adopts to compensate the Jinhua river headwaters is a "hematogenous type" of payment, so called "Development off site". In 1996, in order to alleviate the poverty in Pan'an and protect the headwaters environment, Jinhua city built an industrial park called Jin-Pan Economic and Technological Development Zone within the city. The revenue gained from the Development Zone returns to Pan'an, as compensation for its efforts in waterhead protection and the limitation of development right. Consequently, Pan'an does no longer approve polluting enterprises, and ensures the outflow water quality better than class III.

Fujian province is also exploring the mechanism of PES, and set up a good fund mechanism to protect the key watersheds. From 2003 to 2007, Xiamen city, Longyan city and provincial Environmental Protection Bureau respectively provide annual payments of 1,250,000, 625,000 dollars and 550,000 dollars, especially used for Jiujiang river protection; 2005-2010, each, provincial Development and Reform Committee and Environmental Protection Bureau from Fuzhou city, Sanming and Naping cities respectively provide 1,250,000, 625,000 and 1,875,000 1,875,000 dollars, especially used for Minjiang river protection. From June 1st, 2006, Quanzhou city started *Temporary Provision for Special Payment for the Protection of upstream of Jinjiang River and Luoyangjiang River*. The downstream cities (counties) provide an annual 2.5 million dollars (12.5 billion dollars in total for 5 years) to compensate the upstream for water pollution control. The special fund is collected from the city financial investment at a fixed rate and the downstream beneficial counties (regions) according to the ratio of water use quantity. This mechanism is effective in fathering watershed, and 89.4% of monitoring data of the intersectant boundary show that the water quality in 12 of the water systems has reached and even outreached class III, obviously higher than the national average level and that rivers in nearby provinces.

PES also took place in Zhujiang River. In March 2006, Political Consultative Conference chairmen from Yun'nan, Guizhou, Guangxi and Guangzhou provinces together proposed the *Proposal on Establishing PES Mechanism in Zhujiang River: paid by Guangdong to Yun'nan and Guangxi* to the Committee of CPPCC. Aiming at

solving the grim salt tide in down reaches of the Zhujiang River Delta, the proposal suggests setting up a special fund by Guangdong finance. The fund is mainly used for protecting and constructing water reservation forests in the mid-up reaches of Zhujiang River and building water conservancy facilities. The fund is collected from the local tax at a rate of 3/10,000 in the developed Zhujiang Delta. A system on regular PES meeting will be set up soon through coordinating with the local governments in Sichuan, and the measures and criteria of payment will be implemented so as to define the duties of each party. The main measures taken are to improve water quality, increase water quantity and reduce the salt tide on the Zhujiang River.

Box 1: PES mode in upstream of Xiaoshun River

In order to solve domestic and industrial water use problems in Shaoshun Plain, Shaoxing city invested 262.5 million dollars into the construction of Xiaoshun River project in 1996. The project consists of 3 parts: the water source project, water transportation project and water purifying plant. Tangpu dam, the riverhead, locates at the mountainous areas between Shaoxing county and Shangxu city, with a total storage capacity of 235 million m³ and the maximum water supply capacity of 1 million tons/day (400,000 tons/day at 1st period). It is the only tap water source to Shaoshun Plain. In November 1998, Xiaoshun River closure was completed. In October 1999, people were emigrated from the dam area. In April 2000, Tangpu dam closed sluice to store water, and the water quality reaches the national surface water standard of class II, successfully solving domestic and industrial water use problems for 1.3 million people in Shaoshun Plain.

The 3 main streams of Nanxi, Beixi and Wanghuaxi and over 20 sub-streams are the main water sources of Tangpu dam. The 3 streams originate from Chitougang of Zhuxi county of Chengzhou city, Wangtan and Jidong towns of Shaoxing county, and runs into Cao'e River. The watershed area of Tangpu dam is 4.6 million km², including 2 regions: the 1st grade core reservation region around the dam with a total area of 520,00 km² and the 2nd reservation region where the 20 sub streams pass at the upstream of Xiaoshun River protected area.

● A mixed PES mode of water fee and water resource trade

1. In January 2004, Shaoxing city initiated the *Interim provision on the special fund of waterhead protection*, which read that from July 1st, 0.002 dollar/ ton will be collected from the water fee, and the total collected money will be transferred to the special fund account by every end of the year. The fund will be specifically used for domestic garbage and sewage treatment, rural non-point pollution control, natural ecological rehabilitation, environmental protection, etc. According to the present scale of water use, 250,000 dollars can be collected a year, which will greatly support the construction of infrastructures and environmental protection in all villages and towns along Xiaoshun River, which also is consistent with the principle of “the beneficiary shall protect”. This trial mode can be viewed as a “blood transfusion” type of PES.
2. A water supply agreement was signed between Tangpu Dam Co. Ltd. of Shaoxing city and Tap Water Company of Cixi city. According to the agreement, Cixi will provide 87.5 million dollars, Shaoxing will supply 1.2 billion m³ of water to Cixi from 2005 to 2022, and citizens of the two cities will share the same water with the same rate. The total budget of the project is 64.25 million dollars, and the water pipe network will be funded, constructed and managed by Cixi Tap Water Company. Moreover, Cixi city has to pay Shaoxing city 20 million dollars of dam construction fee at one time.

● Protective measures, costs and losses

1. The Shaoxing city government has made relevant policies to compensate the crowd around the dam, including *Several opinions on the treatment of mountain forest above the submerge line of Tangpu dam*, *Minutes of the coordinative meeting on issues of polluting enterprises in the protected waterhead Tangpu dam area*, *Methods on protection of waterhead environment in Tangpu dam*, etc.
2. To ensure the dam construction and water quality, people living around the dam paid a great deal of the construction costs. Especially, a total number of 15,623 farmers from 5,406 households of 19 villages in Shaoxing county and Shangxu city were moved out. An area of 2,427 ha of cash crops such as bamboo, tea and orchards was flooded, and 7 polluting enterprises were shut down and moved out.
3. Industrial, domestic, agricultural and livestock pollutions are the 4 main factors determining the water quality in the upstream of Xiaoshun River. Although Shaoxing has had the most polluting plants moved outside after the dam was done, however, there are still 31 industries and a daily 22 tons of domestic garbage generated by 112,000 people in the upstream.
4. With the help of special PES fund, Wangtan town has set up facilities of garbage compression, clean and transportation; while Jidong town was equipped with incinerator treating 5 tons of garbage one day; Wanghua block of Pinghshui town centralized collect and bury garbage from 5 villages; and Gulai town has installed domestic sewage treatment equipment with a capacity of 5 tons/day.
5. In 2005, Shaoxing city made another plan for environmental pollution control in the upstream of Xiaoshun River to expand the scale of domestic garbage treatment, and 3 small animal breeding farms were shut down. Meanwhile, the of water & soil conservation trial in the Tangpu dam project was activated.
6. 23 maintenance sites were set up 38 km² deep in forests around the dam, and local farmers were employed to work at the sites, in charge of the cleaning of water surface refloatation, and curbing activities such as logging and hunting in the dam area.
7. To avoid the impact on water quality caused by soil erosion, the Dam Administration also newly grew 187 ha ecological forest around the dam, resulting in a nearly 100% of forest coverage ratio and a plentitude of water reservation in the dam area.
8. Base on the idea of “fish breeding in water, and tree planting ashore”, more than 2 million filter-feeding fish were set free in 14 km² of dam water by Tangpu Dam Administration, so as to avoid eutrophication.

Box 2: PES mode in Dongjiang headwaters

Dongjiang River is the important water source to Guangzhou, Shenzhen, Dongguan and Hong Kong, and the Pearl River Delta regions. It originates from Xunwu county of Guangzhou city in Jiangxi province, and the riverhead areas include Xuwu, An'yuan and Dingnan counties. The upstream is also called Xunwu River, and becomes Dongjiang when it meets with Hehe dam and Anyuan River in Guangdong province. It runs through Heyuan, Huizhou and Dongguan into Pearl River in Dongguan. The length of the Gongjiang main rivers is 562 km, with a total watershed area of 35,340 km². The length across Jiangxi province is 127 km, with a watershed area of 3,502 km². The average surface run-off of Dongjiang River (for many years) is 29.7 billion m³, among which about 3.2 billion m³ of run-off is from Jiangxi and 2.9 billion m³ runs into Guangdong province.

This region belongs to the sub-tropic monsoon humid climate, with an annual average precipitation of 1,650 mm, and the rivers are densely distributed, with an average density of 0.72 km/km². 90% of the areas are mountains with a forest coverage ratio of 75.3% in 2003. There are 300 national forest parks and many provincial nature reserves, with rich bio diversity including 661 plant varieties and over 400 species of wild animals. The general environment quality in the riverhead is good, water qualities of most rivers reach or even outreach the national surface water standard of class II, and water qualities of outflow province are kept above class II.

The total population of the 3 counties in the Dongjiang Riverhead areas is 810,000, including 700,000 agricultural populations. The farmer's income per capita is 190 dollars, accounting for 71.36% of the average level, 40.41% of that in Guangdong (the lower reach of Dongjiang River), and 6.3% of the level in Pearl River Delta (3000 dollars in 1999). In 2000, the poor people accounted for 42% of the total provincial population.

● The PES mode adopted by Dongjiang riverhead areas

A PES mechanism through payment transfer to local finances in the mid-upper reaches of Dongjiang River and power fee collected from the water power companies has been basically established in Guangdong province. Its specific measurements are as follows:

1. Since 1999, an annual 1.25 million dollars of special fund has been allocated from the provincial finance into the stand improvement of water reservation forests in Dongjiang River.
2. From 1999 to 2007, a total of 78.27 million dollars of payment will be input into the compensation of non-commercial forests. So far, 54.98 million dollars has been invested, equivalent to 15 dollars/ha.
3. Since 1992, an annual 5 million dollars of special fund has been arranged by the provincial finance for the protection of water quality in Dongjiang River systems.
4. Since 1995, 2.5 million dollars has been annually transferred to the economic development special fund in Heyuan city, as an adequate compensation from Guangdong province to Heyuan city for its contribution to water quality protection, and the payment has been increased to 3.75 million dollars from 2002.
5. From 1999 to 2004, over 500 million dollars payment was transferred from the provincial finance to Heyuan city and it reached 125 million dollars in 2004.
6. From 1994, 0.06 cent/Kws (250,000 dollars per year) has been collected by Maple-dam Water Power Company, used for poverty reduction in remote regions and water & soil conservation around the dam. In 2003, the fee was increased to 0.12 cent/kws.

● Ecological protection measures taken by Dongjiang Riverhead areas

1. The *Resolution on strengthening the protection and construction of eco-environment in Dongjiang Riverhead areas* was passed and acquired full legal force. The Jiangxi province and Ganzhou city released the *Implementing plan for strengthening the protection and construction of eco-environment in Dongjiang Riverhead areas*, focusing on the following 8 projects:

- (1) Ecological forest construction, giving priority to sealing hillsides for forestation, Grain for Green and Shelter forest construction in Pearl River;
- (2) Water protection project: integrated control of small watersheds;
- (3) Ecological rehabilitation in mines: fathering of mining ruins and tailings;
- (4) Ecological rural project: biogas project;
- (5) Flood control and drinking water: obstacle clearing in river channel and tap water sanitation;
- (6) Integrated agricultural and rural non-point pollution control;
- (7) Ecological tourism;
- (8) Ecological transmigrant.

2. Bio measures (Natural forest protection, shelter forest in Pearl River, Grain for Green, SHR) and engineering works (hill pond building, level trench and interception ditch digging, bench terrace construction, etc.), ecological agriculture development and soil erosion control. From 2001, 5,000 ha of shelter forest have been built in the Pearl River, and 10,000 ha of croplands have been cancelled for forest growing. The national key ecological non commercial forest management project was also started, covering an area of 83,000 ha. 8 nature reserves were established, covering an area of 37,147 ha. At present, the forest coverage ratio in Dongjiang Riverhead areas reached 72.2%, making the Dongjiang River a base of water reservation.

3. Wood related industries are banned in the riverhead areas, and more than 20 paper-making and 300 rare-earth enterprises have been shut down.

In the above PWS modes, the local government plays a key role in negotiation and making payment planning, and the fund is mainly from provincial financial transfer

payment, resource tax & charges and other subsidies. In most cases, the more developed downstream compensates the upstream headwaters or reservoir areas for the costs of environmental protection, the loss of farmers' income and the loss of development right limitation. Because the property rights of natural resources such as water, forestry and land is state-owned in China, the payment mode takes the major position in the PWS cases. However, due to the absence of the involvement of private sectors and NGOs, it is very high in transaction costs, and low in efficiency. The protection of watershed and the payment received does not match, and the payments can not cover the costs and losses.

3.2.3 Voluntary trade market in the small watershed

There occur various modes of voluntary compensative transactions in the medium and small watersheds, due to the limitation of funds, and management and regional problems in the PES mode dominated by the government. The successful cases include the long term effective PES mechanism in Deqing County of Zhejiang province, the payment transaction between Yuandong town and Fucun village of Jindong district, Jinhua city aiming at solving non-point pollution in the small watershed, water purchase agreement in Xiaozhizihe and water charges from Subo River Water Power Company in Yun'nan province, etc.

The long-term effective PES mechanism was established in Deqing County, Zhejiang province, according to "the beneficiaries should pay". Deqing County's successful experiences are: first, to make relevant policies, identify responsibility and rights; and second, to fix the fund source and usage, collect funds from multi-channels and to set up a payment financial system as compensation for financial loss in the western area through payment transfer (See Box 3).

The PES cases of payment transaction between Yuandong town and Fucun village of Jindong district, Jinhua city aims at solving non-point pollution in the small watershed. This payment transaction both in Jinhua city and Xiaozhizihe's water purchase agreement in Yun'nan province is the result of voluntary consultation in the village and township level (World Agroforestry Center, 2006). The payment agreement in Jindong district is mainly to control non-point pollution by restricting the development of livestock breeding industry in the upstream villages, while Xiaozhizihe's water purchase agreement is mainly to increase water supply to the downstream areas based on water quality and quantity. Their same characteristic is that the transaction is taken place through agreement, and the amount of payment is much less, reflecting imperfect market and low ability to pay. However, it can work well in the less developed and serious water shortage villages and towns.

The payment for water ecological services in Subo River is through negotiation between the government and the Hydrodynamic Company, Yunnan province. The company will pay the fund gap between the subsidy of Grain-for-Green and the payment of the central government for the upstream which supplies water and power

for the company, through which to father soil erosion reduction in the watershed because it is also possible to reduce the costs of the company (Lv Xing, Fu Baohong, Li Hetong, 2006). This mode shows that various environmental projects and multi-channel fund sources can effectively protect and father small watersheds.

The above PES cases are driven by the demand and supply in the market, and also by the willingness to pay (WTP), willingness to accept (WTA) and protective perception of the government, households and enterprises. It becomes one of the market-oriented PES modes in the small watersheds, and is a beneficial exploration and an important complementarity to PES in China. However, the mode often can not be durable, largely because there is an absence of PES mechanisms and relevant regulations of payment criteria and implementation methods, which are suitable for different watershed types at the national level, plus the difficulty in PES evaluation and the low ability to pay. It is very difficult to form the compensation mechanisms to satisfy all stakeholders. It is necessary for the government to set up the relative policy to guide the PES implementation, and it is likely to succeed if it links the financial and industrial policies within a watershed.

Box 3 A long-term effective PES mechanism in Deqing county of Zhejiang province

Deqing county of Huzhou city in Zhejiang province was named the *2004 national ecological demonstration area* by the State Environmental Protection Administration (SEPA). The western area of the county is for water conservation and ecological forests, and the Duihekou dam located in Fatou town is the tap water source of the whole county. For many years, towns such as Moganshan and Fatou have taken the responsibility of protecting environment. Based on investigations and surveys, Deqing County put forward the establishment of a long-term effective PES mechanism according to the principles of “the beneficiaries shall pay”, multi-channel fund collection and oriented payment.

In February 2005, the county government imitated the *Opinions on the establishment of PES mechanism in western towns*, where it makes clear the PES principles, scope, fund collection and utilization, etc. Also, the Leading Group Office of Ecological Construction in Deqing County released the *Notice of methods on the collection and management of PES fund in western towns of Deqing County*.

The PES fund is mainly collected from the following 3 aspects: 1) the establishment of Ecological Non-commercial Forest Compensation Fund. For the state and provincial non-commercial forests, an annual payment of 15 dollars/ha will be offered, and 7.5 dollars/ha to other non-commercial forests; 2) the establishment of township financial institutions, providing financial guarantee to Mogan and Fatou towns; 3) the establishment of PES for the entire county. The channels are: 125,000 dollars from the county financial budget, 10% from the water resource fee all over the county, 1.25 cent/ton increased in the water fee from Duihekou dam, yearly 1% from the land rental in the county, 10% from pollutant discharge fee and 5% from the Agricultural Development Fund.

The above PES fund will be brought under the county special account, specifically used for the protection and construction of eco-environment in western areas. The main purposes of the PES fund are: compensation and maintenance of ecological non commercial forests, investment in daily domestic garbage treatment, construction of environmental protection infrastructures in the western areas, protection of Duihekou dam riverheads, payment to enterprises shut down or moved outside for the sake of environment, and payment for the environmental protection activities approved by the county government.

3.2.4 Water right trade

The definition of water right is the precondition to water resource management (Sun

Xuntao, 2005). According to *Ordinance on Water Use Permission and Water Resource fee* (Ordinance in abbr.) newly initiated in April 2006, water use from watershed will be supervised. At present, The Ministry of Water Resource is now making Temporal Regulations of Water Distribution (Regulation in abbr.); a unified criterion will be made on water distribution within a watershed. The Regulation is also for better implementation of the Ordinance to control total water use. According to the Ordinance, the Permission Credit of water use will be examined grade by grade from high water management sector to local one. The Regulation focuses on the control of total water use within a watershed for each province by the watershed management institutions, while the Ordinance pays more attention to the Permission Credit of water use and water charges from water users, administrated by the local water sector who sets quota based on the control of total water resource, and the total goal is to make true a water resource management system linking a watershed to the region of the whole river basin. With the improvement of the system and policy of water right, there will be more and more cases of water right trade and the efficiency of water utilization will be largely advanced through the market mechanism.

Water right trade is one of the most important PES modes. The first one occurred between Dongyang and Yiwu cities successfully. The Ministry of Water Resource guides and recognizes water right trade in the newly initiated regulations of *Decisions on Water Right Transfer by the Ministry of Water Resource*. Consequently, various cases of Water right trade develop in China. ShaoXing and Cixi signed an agreement on water supply, Cixi will pay 87.5 million dollars from 2005 to 2022, and Shaoxing supplies 150 million cubic meter of water to Cixi, and the citizens of Cixi and Shaoxi share the same water with the same price.

In order to save the vanishing E'ji'na oasis and increase water flux, Gansu province carries out water right certificate system in Heihe River, aiming at building a water-saving society based on government control, market orientation and public participation in management system and operative mechanism. Water right is distributed according to the number of livestock and farmland area per household, the water user can purchase irrigation water from water organization that controls the total water volume and ensures a sound water fee. Water users are encouraged to save and sell water at a market regulated price and under government guidance. The surplus water in the transaction will be repurchased by the water management organization (the suppliers) at 120 percent of the base price, so as to encourage water-saving. Through water right trade, the households have the concept of commercial water, and their perception of water-saving, so a restructure of the rural economy is greatly stimulated as well.

The mode of “Investment for water-saving, water right transfer” in Ningxia and Inner Mongolia is a successful case of cross-industry water right trade. The contradictory situation of water scarcity and water-wasting existed in the two districts of Ningxia and Inner Mongolia at one time. In addition, the distribution of water resource among

different industries is also very unbalanced, the agricultural use water account for from percent 90 to percent 96 of the total, the coefficient of water utilization of the aqueducts system is only 0.4, and more than half of the water is wasted in the course of transportation. Under the coordination of Yellow River Conservancy Commission water-saving reconstruction was done in the Hexi, Hedong irrigation districts, Qingtongxia City, Ningxia and Dengkouyang irrigation district, Inner Mongolia (the name changed into Hangjin irrigation district later), and the saved water was transferred to the newly built power plant for getting a payment. The trade mode ensures enough water resource for the plant with opportunities of development, on the other hand, expands channels of financing for the improvement of the irrigation regions, avoids waste of water, and optimizes the water use and water allocation. This means also protects the farmers' legal right to use water, promotes regional economic development, and improves water utilization efficiency through water saving investment and construction. It is first time that water right market optimized the distribution of water resource through cross-industry water right transfer in such a scale so as to improve water utilization efficiency (Yuan Jinlin, 2005).

Cross-province water transfer took place in Zhanghe River through water price agreement. In the spring of 2001, Northern China suffered from continuous severe drought and little rainfall, and there was a demand from Yuejinqi irrigation region of Henan province for water to the Zhangze reservoir of Shanxi province. The Upstream of Zhanghe River Administration Bureau actively coordinated the two stakeholders, and it was agreed that water would be supplied from Zhanghe reservoir to the downstream, and the Yuejinqi irrigation region would pay. According to the agreement, the price was 0.3 cent per cubic meter, and 30 million cubic meter of water from 5 reservoirs in Shanxi was transferred to Yuejinqi irrigation region, and from there it went to Anyang city, solving the water crisis for 13,333 ha of crop land in Hongqiqu irrigation region, 66,667 ha in Yuejinqi irrigation region, 300,000 people and 40,000 livestock.

Water right trade is the most direct means of water resource transaction based on water quality and quantity, both sides reach an agreement through negotiation, and obligations and duties of each side are quite clear, making it easy to fulfill. Whereas, the clear water right is preconditioned. Due to the ambiguous primary water rights, the transaction cost is much higher. This mode is suitable for the regions with scarce water, clear distinctions in or settled primary water rights, or developed regions with high ability to pay and high water value. The transfer of water right is mainly taken from a less developed to a more developed region or from low value-added sectors or industries to high value-added sectors or industries.

3.2.5 Ecological compensation from water charges

This payment is through charging a water fee to collect the compensation and payment fund, often with other payment modes mixed together, making up of the whole of the payment system. For instances, the water sector and water and soil

conservation sector in Yao County collect an annual 10% of the water resource tax to pay the forestry sector for the protection and management of ecological forests in the headwaters. In Qujiang County, Guangdong province, the government charges a fee from the water and power companies to pay the farmers who protect the watershed source, 0.125 cent per ton from the drinking water company and 0.0625 cent per KWH from the water power station.

The payment mode is directly based on water quantity, and is easy to be adopted because the water power company is closely connected with soil erosion in the watershed and it is easy to define the beneficial region and the compensation region. However, there is still an equity issue when implementing it, largely because it is difficult to distinguish the water users and water suppliers when the water resource is charged.

3.3 Summary of the cases

As seen from the above cases, PWS in China is a system of public payment mainly of transferring payment from the central or local governmental (See Figure 1). In the above 17 cases (excluding the national ecological compensation programs), the local government-dominated ecological compensation programs accounts for 43%, water right trade accounts for 25%, voluntary trade market in the small watersheds accounts for 19%, while the mode of Ecological compensation from water is the least percentage.

The four PWS cases vary at the different scale: province, city, town or village. They are mutually complementary, and together with national ecological compensation programs, are the structural elements of the PWS scheme in China.

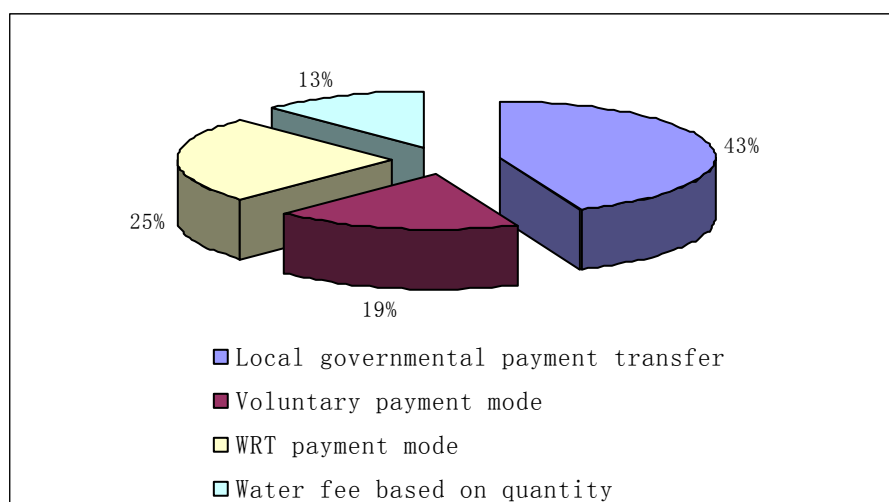


Figure1 PWS cases in China

The first level is national payment, the largest PES programs where the fund is from the central government, and used for environmental protection and ecological

compensation in the key watersheds like Yangtze River and Yellow River, important ecological functioning zones and the headwaters from the national perspective.

The second level is provincial payment, and the fund is mainly from provincial financial revenue, used for the protection of important tap water sources and rivers within or cross province.

The third level is the PES mode in the medium size watersheds, and the fund is from county local revenue and water fee collected from water power companies and water users, usually gets facilitated by the local governments.

The fourth level is the payment from village and township in medium and small watersheds, often driven by water demands. Due to the low ability to pay at this level, PES usually occurs in a situation where there is an urgent demand for water. The funding is from village and township collective income, water fee and power charges from downstream farmers and water power companies.

Seen from the above 4 levels, PES in China is still in a primary stage due to funding limitations. At present, PES should be developed in the key areas on principles of “from easiness to hardness, and from the key areas to the common areas”. The key areas of PES in China are key ecological functioning zones, 3 big headwaters (of the Yangtze River, Yellow River and Lantsang), mid-small watersheds, 661 city water sources, payment in development of natural resources, issues left over from history at the period of economic transition, etc. (China Council for International Cooperation on Environment and Development (CCICED), PES Group, 2006)

As we can see, PWS in China is mainly based on the central or local governmental payment, and various markets for PWS develop in medium and small watersheds. Governmental and economic sectors such as the water power companies attach great importance to PWS because they see it as an effective tool of integrative watershed management. The market for PWS has developed rapidly in various modes as it has bee. However, there are some problems with many aspects of PWS such as imperfect market rules, lack of payment criteria and regulations, low-efficiency implementation, etc. Therefore, the market for PWS is still in primary stage. The government still plays a key role in watershed management by providing a good environment for the mechanism, system, culture and law for the further development of markets for PWS.

4. Case study on PES in Miyun Reservoir

4.1 Characteristics of the Study Region

Miyun Reservoir is located in the mountainous areas, bestriding the main paths of Chao River and Bai River with a total storage of 4.375 billion m³. The watershed area of Chao River and Bai River is 6,960.59 km² and 8,827.41 km² respectively, out of which 88%, i.e. 15,788 km², is controlled by Miyun reservoir. The Chao river system originates from Halawan, Liangui town, Fengning County, Hebei province, and runs

through Fengning, Luanping, Chengteh and Gubeikou of Miyun County into Miyun reservoir, Beijing. The main system of Bai River originates from the mountainous range of Guyuan County and Chongli County of Zhangjiakou city, Hebei province. It runs through Guyuan, Chongli and Chicheng counties in Zhangjiakou city, Xuanhua district, Yanqing County, Huairou district and Shihetang town in Beijing into Miyun reservoir.

Two-thirds of the watershed areas controlled by the reservoir are within the regions of Chengteh and Zhangjiakou cities of Hebei province, and 1/3 is under the administrative region of Beijing municipality. In the total 11406.33 km² watershed area in Hebei (Dong W.F., 2006), the upstream Chicheng County occupies 46.4%, while Fengning occupies 36.7% (See Figure 2). At present, the daily water intake from Miyun reservoir is 1.17×10^6 m³, nearly half the amount of the water supply to Beijing, making the reservoir the important water source to Beijing. Since 1999, the water in Miyun reservoir has been decreasing due to the continuation of 6 years of droughts. The water volume dropped by 40% until now.

In order to guarantee the water quality and quantity in Miyun reservoir, the Beijing municipality discussed conserving watershed and saving water for agricultural use upstream with the Hebei government. Three specific measures were taken: 1) to reduce rice growing area, and replant maize, in order to reduce water for agriculture; 2) to reduce irrigation area, and the use of irrigation farming has almost been put out of practice; 3) to substitute typical crop farming but rather plant trees on sloping lands (Grain-for-Green). At the same time, farmers who incur economic loss by taking those measures will get payments from the upstream government.

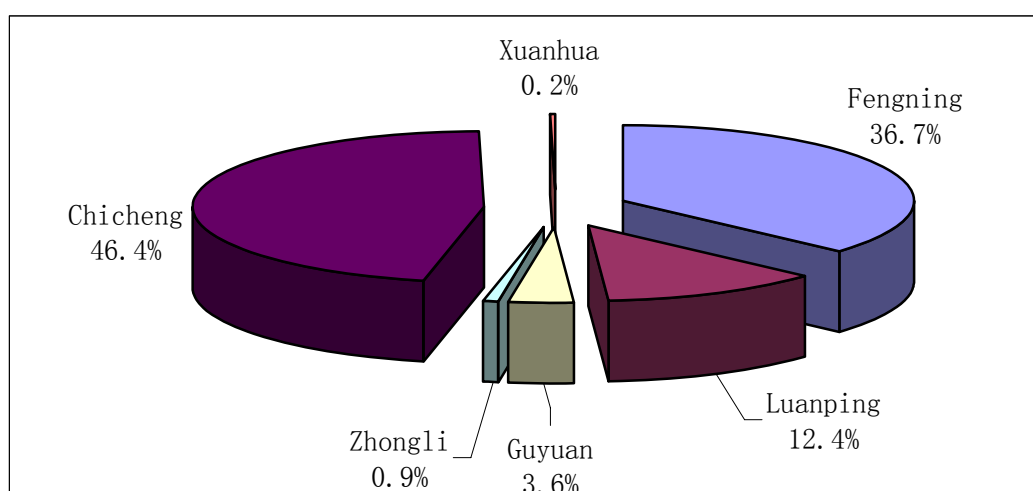


Figure 2 Watershed area percentages in upstream counties of Miyun Reservoir

4.2 Principles of PWS

The principles of the PWS in Miyun reservoir are as follows:

(1) Beneficiaries shall pay, protectors shall benefit, and loser should get payment

At present, the main function of Miyun Reservoir is that it supplies fresh water for Beijing City, and about 80% of all fresh water delivered to Beijing citizens comes from Miyun Reservoir. Bai and Chao rivers are the main water sources of Miyun Reservoir. As we see from Figure 2, 46.4% and 36.7% of the 2 watersheds are located in Chicheng County of Zhangjiakou and Fengning County of Chengde in Hebei respectively. To ensure water quality in Bai River, Chicheng County has shut down more than 20 small enterprises in mining and paper-making, and strictly set limits on the development of mining in Bai River. It is estimated that, this action caused revenue losses of 250 million dollars and a loss of nearly 50,000 jobs. At the same time, the Chicheng County invested 10 million dollars and controlled soil erosion on 3.19 million kilometers' of watershed, which greatly reduces sediment flow into Bai River. The latest testing results show that 6 main indexes in Bai river running out of Chicheng all reach the national water standard of class II.

At the same time, to ensure water quality in Chao river, Chengde city shut down 70 more small polluting enterprises in 1996, and another 138 mining enterprises along the riversides from 1999-2004. Therefore, the development of metallurgy and mining industries as the key industries in Chengde is restricted due to the pollution and high water use. In order to conserve water and soil, Chengde city released a document prohibiting grazing along Chao riversides in 2002. Only captive breeding of cattle and sheep were allowed, which caused the number of sheep to decrease by 50%. There are less than 1 million left.

In addition, in order to ensure water quantity for Beijing city, the relative government developed saving-water projects, and combined Yunzhou reservoir and Hulihe reservoir of Hebei province, Baishuibao reservoir and Guanting reservoir of Beijing to transfer water to Miyun Reservoir under the condition of water deficiency for them.

We can see from the above description, economic development in Zhangjiakou city and Chengde city in Hebei is restricted with a resulting large loss due to protecting the Miyun Reservoir watershed. On the view of water value, the two Cities should get compensation and payment, while Beijing City, as a main beneficiary, should pay for the protection costs and compensation for the relevant losses.

(2) It facilitates sustainable water utilization, in favor of the integrated improvement of watershed environment

Hebei province also paid the costs for the protection of Chao and Bai rivers based on political factors, if they did not get payment and compensation from the upstream. However, for economic benefits and livelihood improvement, there are still some pollution matters, to a certain degree, such as the excessive use of fertilizers and pesticides as well the discharge of industrial waste. The implementation of ecological compensation mechanism can drive the enthusiasm of farmers' participation and extend fund sources for environmental protection and ecological

construction of the downstream. At the same time, the obligation and duty of the two sides will be fixed by the regulations or agreements on the basis of ecological compensation goals. It will facilitate the sustainable utilization of water resource in Chao and Bai rivers, in favor of the maintenance of good environment in the watersheds.

(3) To improve the coordination between the upstream and downstream, and ensures the sustainable development in the social and economic aspects in Beijing and its adjoining regions

Along with the rapid development in the downstream regions, there will be more demands for clean water resources, so the downstream urgently needs the upstream to increase carrying capacity of water resource and water environment, so as to continuously supply a good quality water resource. While the upstream areas need rapid development to reduce the economic gaps, and as result, water use and sewage discharges will increase.

In this condition, the environment and development between the upstream and downstream is facing conflict. If environmental efforts didn't get compensation, the development in the upstream would be restricted and drop behind, which will impact on the coordination and development in the whole watershed. Therefore, the establishment of PWS mechanism between the up and down reaches can get over the limitation of administrative boundaries with an integrated watershed planning in the whole watershed. So, the implementation of PWS policy can ensure the capital water use. At the same time, the financial transfer payment, technological support and the construction of ecological projects in the compensation activities will improve environmental protection and farmers' livelihood, and push the upper reaches development, which can facilitate the coordinative development of the up and down reaches, and ensure the sustainable social and economic development in the Capital and the nearby regions.

4.3 Feasibility analysis

The feasibility includes 2 aspects:

The Beijing municipality makes payment to the upstream Chengde and Zhangjiakou cities, Hebei province, to protect watershed environment, to increase water quantity and improve water quality in Miyun reservoir. The feasibility includes 2 aspects:

(1) It is easier to define the beneficial areas and protective areas and determine the payment based on water quantity and quality. On the basis of the watershed catchments district and area ratio, we can divide the beneficial areas and protective areas in the watersheds, and the payments can be made by comprehensively taking the watershed area, water quantity and water quality into account. The protective areas include the whole areas of Chicheng, Fengning and part of Luanping counties of Hebei and the whole Miyun County, part of Yanqing County and Huairou district in

Beijing, while the beneficial area is the Beijing City.

(2) Being more developed than the upstream, the downstream areas have the ability to pay, and a proportion of the payment can be taken to invest in the construction of headwaters forests and environmental infrastructures

In 2003, the farmer's income per capita of the upstream Chicheng, Fengning and Luanping counties of Hebei is 144.8, 121.5 and 182.5 dollars respectively, while the farmer's income per capita of Huairou district, Miyun County and Yuanqing County of Beijing is 726.8, 735.6 and 707.3 dollars respectively (Hebei Statistical Yearbook, 2004). Being the direct beneficiaries, the citizens in Beijing have a disposable income per capita of 1735.3 dollars in 2003, more than 2 times of that in the upstream. The average water fee in Beijing is 0.46 dollar/m³, while the high water-consuming enterprises like bathing, car-washing and bottled water companies are charged high fees of 7.7 dollars/m³ and 5.2 dollars/m³, from which a portion can be drawn into the construction of headwaters. Meanwhile, the water users who are using too much water shall pay by raising their water fee, as a special fund for PWS (Liu *et al.* 2004, Beijing water affair bureau, 2004).

4.4 Analysis on the benefits and losses in the two sides of supply and demand in the payment

In the payment that occurs in Miyun reservoir, the stakeholders involved include 6 towns of Zhangjiakou and Chengde of Hebei, among which Chicheng, Fengning and Luanping counties of Hebei, Huairou district, Miyun and Yuanqing counties of Beijing are the largely affected catchments where economic development is limited to some extent, due to their efforts in changing industrial and agricultural behaviors for the protection of Miyun reservoir.

In Beijing, Miyun County is the mostly affected region where the Miyun reservoir is located, and where the policies of transmigrant, substituting paddy planting for dry farming and afforestation. At the same time, SLCP are carried out. The development of polluting and high water-consuming industries is restricted in this area. The same measures were also taken in headwaters in Hebei where grazing is also forbidden to control soil erosion. Take Chicheng County for example, the local government has attached great importance to the ecological construction in Bai River ever since 1983, until now 827 km² of soil erosion has been fathered, accounting for 24.53% of the total controlled area. In order to protect the water sources, more than 70 economic cooperation projects which may cause water pollution have been cancelled, and 21 enterprises were either shut down or reduced their production. Moreover, grazing was thoroughly prohibited from December 1, 2002, leading to the reduction of the number of sheep from 560,000 to 110,000. In 2006, Chicheng County started to convert rice growing for dry farming or afforestation in Bai River (Wang X, Ma Z. S, 2006). All the above measures are taken to restrict water use and protect water resources directly or indirectly, which undoubtedly affect the local economic development and the welfare of the local people resulting in the larger economic gap between Hebei and Beijing.

In order to diminish the tension of supplying water to Beijing, Hebei distributes 1 billion m³ of water to Beijing every year for free. Hebei also belongs to the same ecological fragile area as Beijing does, having the same problem of water scarcity. To solve the problem, we need to cooperate, enhance the integrated planning and management of water resource, strengthen the efforts on water-saving in the whole watershed, and speed up the construction of the Middle line of Transferring Water from South to North project.

Both Zhangjiakou and Chengde cities wish to establish a “mechanism of payment for water utilization based on water value” by means of “linking water to benefits”. This is to achieve a win-win situation of safely supplying water to Beijing and Tianjin and promoting ecological and economic development in Zhangjiakou and Chengde cities.

“Linking water to benefits” or “exchange resources with support”, means that Beijing and Tianjin could offer a certain payment to support the development in the two regions, in terms of funds, materials, projects, and other various means.

To ensure water utilization before the implementation of Transfer Water from South to North, authorized by the State Council, Beijing initiated the *Capital program for Sustainable Water Utilization in Early 21st Century (2001-2005)*, and the projects of water conservation, water saving, pollution control, agricultural ecological economic zone and in the upstream water source areas like Hebei, Shanxi and Beijing within the 5 years from 2001-2005. At present, the implementation of the projects is weak, and no long-term effective payment mechanism was established since the supports vanished with the end of the projects.

Who will pay for watershed services in the Miyun reservoir? How much is the willingness-to-accept (WTA) for the upstream to protect the watershed environment and supply the clean water to Beijing? The findings of the survey in the Miyun reservoir and Hebei province are detailed below:

(1) Who should pay for a better environment? The survey indicates that 53% of the respondents said government should pay; 44% said Beijing citizen should pay. Only 13 % of the respondents thought industrial enterprises should pay. Therefore, most of people thought government and beneficiary should pay for watershed services, but it looks like that polluters, industrial enterprises need not be responsible for cleaning their pollution. It shows that the perception of public is limited.

(2) The high WTA that is required by the farmers for improving their livelihood due to lower income and huge efforts on the headwaters protection. The average WTA equals 1003.1Yuan (128.6\$). At the same time, there is still a high WTA to give up using the fertilizer, which is 635.6Yuan (81.5\$) per mu, so, it is difficult to control the non-point pollution by reducing the fertilizer use if there is not enough compensation.

(3) 60 percent of interviewees would not like to give up or change their crop structure for protecting the Miyun reservoir if they cannot get the payments.

Seen from the above analysis, farmers in the headwaters will act based on the payments. Therefore, multi-source funds are necessary to conserve the watersheds.

4.5 Payment mechanism and institutional arrangements

The payments in water resource protection of Miyun Reservoir include two types: direct fund payment and project payment.

(1) Direct fund payment for ecological services

From 1995, Beijing started paying Zhangjiakou and Chengteh an annual fee of 250,000 dollars for protecting water reservation forests, and currently the payment is 2.5 million dollars, of which 1 million dollars goes to Zhangjiakou (Shi H.M, 2006). The Ecological payment fund is only used for specified purposed, concluding the construction of the protection of water resource and subsidies for farmers who converted paddy fields to dry farmland, forest land, or grass land in Luanping and Fengning counties, among which a large portion of the special funds is used for changing local rice growing habits, i.e. reducing or even ceasing rice growing, to reduce water use, so the saved water can be supplied for Beijing.

(2) Compensation for the costs and losses in the protection in the headwaters by ecological program

The main measure is the *Capital Program for Sustainable Water Utilization in Early 21st Century (2001-2005)*. The central government subsidized 875 million dollars, while the Beijing municipality invested 1.875 billion dollars in the projects of environmental construction and pollution control in the upstream of Miyun and Guanting reservoirs. For Miyun and Guanting reservoirs in the Planning, Hebei province invested 498 million dollars through 164 sub-projects including agricultural and industrial water saving, water and soil conservation, Capital ecological agricultural demonstration, point pollution control, capacity building, etc.

Institutional arrangements taken to ensure water quality and water quantity in Miyun reservoir are as follows:

- 1) To substitute rice growing for maize, forest and grass lands, so as to reduce water utilization for irrigation. Meanwhile, trees and grass are planted in these former rice areas because they are good for controlling soil erosion and water conservation;
- 2) To reduce industrial pollution by shutting down small mines and smelteries that are severely polluting and damaging to vegetable growing. To carry out industrial pollution control and comprehensive utilization projects in Fengning, Luanping and Chicheng counties, upstream of Miyun Reservoir. For example, the Jiulong Group intergrated an environmental-friendly utilization of resources and comprehensively recycled utilization of waste water that contained cyanogen from Hougou Gold Mine in Chincheng. Fengning and Luanping also shut down 10 smelteries, and increased the

- treatment ratio of industrial and domestic sewage;
- 3) To enhance the real-time monitoring of water quantity and water quality in the cross-province boundaries and strengthen capability building of Planning implementation, and set up a system for water quantity and quality monitoring. *The Capital Planning for Sustainable Water Utilization in Early 21st Century (2001-2005)* has authorized the Huaihe River Management Committee to build this system;
 - 4) To establish capital ecological agricultural economic zone in Fengning and Luanping counties, to solve the problems existing in the rural industrial restructure, shift from traditional agriculture to ecological agriculture, farmers' off-farm employment, etc. To improve regional development through "blood making" ecological projects;
 - 5) To combine several reservoirs for transferring water to Miyun and Guanting reservoirs to ease tap water tensions in Beijing. In October, 2004, 22 million m³ of water, for the first time, was transferred from Huliuhe and Yunzhou reservoirs, among which 10 million m³ is from Yunzhou Reservoir in Chicheng to Baihebao Reservoir and 12 million m³ from Huliuhe to Guanting Reservoir (Li W, 2004).
 - 6) To reduce irrigation area, and irrigation farming almost doesn't exist in practice;
 - 7) To Convert Cultivated Land back to Forest land or Grassland, so as to improve the forest coverage ratio and water conservation function.
 - 8) Farmers who incur economic losses will get payments from the Beijing government due to the conversion of farmland and planting type.

4.6 The analysis on the effectiveness of PWS: Drivers and obstacles

The analysis on the effectiveness of PWS firstly analyzes the causes of environmental degradation and the effectiveness of the implementation of PWS. The survey shows that factors of environmental degradation are from increased economic growth, policy failure and a moral decline in environmental protection. The economic activities are the first factor which results in the failure of implementation of PWS in the Miyun reservoir. The others are policy failure and decline in moral values (See figure 3).

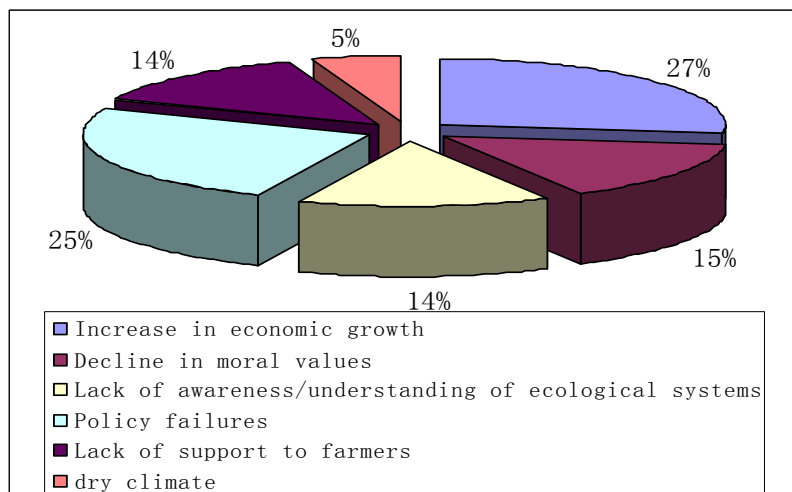


Figure 3 The causes of environmental degradation in Miyun reservoir

The drivers of implementation of PWS in Miyun reservoir were investigated; the rate of protecting watershed environment is highest with 61.9%, the second factor is higher income, with 35%, and subsidy from state or project with 10.6%.

At the same time, the response to the economic incentive is surveyed. When the price of fertilizers increases by 100%, about 58.4% of farmers will still plant using the old methods, the rate of reducing inputs of fertilizers with just 24.2%, substituted by other inputs as such organic fertilizers with 9.3% and cultivate other crops/change land use and stop farming/look for off-farm work respective with 3.7%.

According to the survey, the most effective strategy to reduce environmental degradation from the survey is village policy (laws & rules), accounting for 44.4%, and the next key factor is collective effort and community participation with 26.3%, then taxes and fees with 16.3%, engaging in off-farm employment with 12.5%, while technical training is not important with 10.6%. Therefore, the legislation and regulations for PWS and the involvement by the grassroots are very important to implement the policy. Sixty percent of respondents interviewed think the implementation of PWS policy is effective. 19 % think it is successful, while 12% do not agree and think it is very bad. As for the impact on family income, 15 % respondents believe it is increasing, while 24% believe the opposite is true. The people interviewed believe that charging tax on the people is not a good way to pay for watershed services (See table 2).

Table 2 The effectiveness of PWS in Miyun reservoir

	3	2	1	0	-1	-2	-3	-4
Effect of PWS policy(N)	30	32	34	23	3	11	19	7
Percent (%)	19	20	21	14	2	7	12	4
Impact on family income(N)	24	21	14	30	9	10	38	11
Percent (%)	15	13	9	19	6	6	24	7
Equality on taxes for PWS(N)	14	24	29	40	5	9	27	11
Percent (%)	9	15	18	25	3	6	17	7

* +3=very agreement,0=neutral,-3= very disagreement, -4=don't know

Therefore, drivers and obstacles are as follows:

- 1. As for the downstream, improving water quality and increasing water quantity are the main drivers.** Due to severe water scarcity in the downstream, the Beijing municipality would like to pay the upstream to improve watershed environment. In addition, water plants, Beijing citizens, and polluting or high water-consuming enterprises are more likely to participate in the action since they benefit from it;
- 2. The drivers from win-win policies of economic and ecological benefits in the upstream.** For some less developed regions, the payment for converting inferior land for SLCP or substituting rice growing for maize, forest and grass

lands is equal to or even higher than their income from this field without costs and labor. Therefore, the payments can drive people to become involved in this project with high enthusiasm. At the same time, in some reservoirs areas where the barren hills are contracted to grow chestnut and apricot and the beaches for fast growing poplar trees, the benefits are gained and the reservoir areas are protected as well, but they are largely affected by the stability of land rights and the consistency of such policies;

3. **The use efficiency of funds and the effectiveness of projects are low, due to the absence of regulations of PWS and blurred obligations and duties.** Although Beijing has paid to father the upstream environment, because payment mechanism and the relevant environmental goals are imperfect, leading to low efficiency of funds and the effectiveness of the implementation of projects. It must be put clearly that the protection of watershed is the duty of both the upstream and the downstream, and if the upstream pollutes the watershed, it shall take on its share of payment as well. The PES policy in Miyun Reservoir is co-sponsored by the state, Beijing and Hebei. However, the utilization efficiency of fund and the effectiveness of PES are low, because the funds are managed by several government sectors without the organization of integrated watershed management, the difficulty of monitoring and evaluating the value of environmental services, and the high costs of implementation, due to unclear duties and obligation between upstream and downstream;
4. **Lack of clarity of water rights makes it difficult to transfer water rights, and the effective distribution of water resources relies on markets;**

4.7 Evaluation and lessons

Lessons learned from the implementation evaluation of PWS in Miyun Reservoir are as follows:

- 1) **The water scarcity in Beijing is still severe.** Although the Capital Planning for Sustainable Water Utilization has been carried out, there is still a severe water scarcity situation in the Capital city, due to the 6 years of continuous droughts since 1999, resulting in little rainfall in the upstream, insufficient inflow in rivers and large decrease of poundage in Miyun and Guanting reservoirs, which further accelerates the conflicts between water demand and supply in Beijing.
- 2) **The implementation of the planning needs to be further strengthened.** As seen from the central governmental investment, which was 25 million dollars in 2001, 105 million in 2002 and 118 million in 2003, the 3 years investment only accounts for 25% of the total. Although, implementation of the projects is in progress, the industrial pollution control and water saving projects are still unimplemented. Beijing's input of 610 million dollars has been invested for the past 3 years, accounting for 33% of the total project budget, and it seems difficult to fulfill all the investments and realize the water quantity and quality goals within the time framework. All the above

problems require us to make a breakthrough on the strengthening of the planning implementation.

- 3) **Problems existed in the effect of planning implementation and its relevant measures.** There is an imbalance in the achievement of planning goals in different regions. The index of water quantity is incomplete. With the implementation and completion of the project, the quality and benefit issues appear systematically. “More attention was put in the construction and investment, and less to effect and management” in the infrastructure construction. Adjustment of water price, collection of the water fees and effluent charges are not done on time. The capacity of monitoring water quantity and quality is low. We must pay more attention to these problems.

Experiences and lessons from PWS in Miyun Reservoir are:

- 1) **It explores a mode of sharing the costs and benefits of watershed construction between the up and down streams.** To realize prosperity and sustainable development in the whole watershed, we need to: further strengthen the collaboration between Beijing, Zhangjiakou and Chengde cities, to unify planning, transfer and exploit water resources, and to set up the compensation scheme on regional water utilization and ecological construction.
- 2) **To make clear the property right firstly, based on which the payment criteria and calculating basis can be established. Before the regulations are established, the payment can be contracted by agreement to realize water right trade and compensation.**
- 3) **To strengthen planning supervision and performance assessment, improve the responsibility mechanism and fund use system, enhance the implementation and effect of the project, and keep the project consistent.**
- 4) **To increase direct payment to farmers, encourage local farmers and officials to participate and generate enthusiasm.**
- 5) **To strengthen outreach and technical training, set up responsibility system for experts and leaders, as part of the performance assessment.**
- 6) **To strengthen capacity building in the watershed.** The upstream areas are mostly less developed, so the state and Beijing need to offer certain policy, projects, fund and techniques that provide support for them. The improvements to the local economy can guarantee better construction and protection of watershed environment.
- 7) **To save water through economic tools.** More efforts are to be focused on the adjustment of water fee by a grade price and accumulative mark to extra water use, and cut down unreasonable water use. A water-saving scheme is to be set up by economic means to control total water use and set a quota, based on the theory of water rights and water market and under the watershed and regional water planning.
- 8) **To speed up the construction of the monitoring network of water**

quantity and quality in the provincial boundaries, based on which to publish environmental data, initiate dialogue between the up and down streams, and set up a long-term PES mechanism based on water quantity and quality.

- 9) To begin reform on new public governance, and accordingly reform public institutions and the watershed management mechanism.** It is the new trend of public governance in China to shift from the traditional governmental management to the new type of public governance where the government plays a major role and various private sectors also get involved, which is also the inevitable instructional choice for fathering care of watershed environment and implementing PES in the watershed. The key contents are: decentralized management, self-determination and performance, market competitiveness, partnership between public and private sectors, and contracts or agreements. The shifts from “paddling to steering”, from centralization to decentralization, from government to market, and from service to authorization are the effective measures to establish a kind of public watershed management, improve the effect of watershed public governance, and ensure PWS policies.

5. PWS in Thousand Islands Lake

Xian’ an River (Thousand Islands Lake) originates from south of the Huangshan Mountains, belongs to the Qiantang River system, and is the third largest water system next to Yangtze River and Huaihe River in Anhui province. The total length of the main stream in Anhui is 242.3 km, covering an area of 6,440 km², among which 5,820 km² is in Huangshan city and 620 km² is in Xuancheng city. The watershed is located at the mid-low hills, span 3 districts and 4 counties of Huangshan city, i.e. Tunxi, Huizhou and Huangshan districts and He, Xiuning, Luo and Jixi counties, running through Chun’an County into the Thousand Islands Lake (Xian’ an River Reservoir). The water area of Thousand Islands Lake is 573 km², of which, 97% is in Chun’an County, 0.3% is in Jiande County and 2.7% is in the upstream, Anhui province. The total storage is 17.8 billion m³, making the Lake the largest national forest park and the important water source to Hangzhou city and the lower reaches. Chun’an County has made great sacrifice and contribution to the construction of the reservoir that was completed in 1958, and to its maintenance and protection.

5.1 Feasibility analysis

It is feasible to set up the PWS scheme in the watershed, due to:

(1) It is easier to define the protective areas and the beneficial area. Huangshan city and Chun’an County, as the main water source areas, made great sacrifice and contribution to obtain the high quality of water in the Thousand Islands Lake, while Hangzhou city and the lower reaches are the main beneficial areas.

The catchments area of Xian’an River in Huangshan city, Chun’an County and Jiande County is 6,002 km², 4,427 km² and 13 km² respectively, accounting for 57.5%,

42.4% and 0.1%. The average flow from Huangshan city to Thousand Islands Lake in Zhejiang province is 6.53 billion m³ every year, accounting for 60% of the total inflow in Thousand Islands Lake. The water quality reaches at or above class III. Therefore, Huangshan city requires the establishment of PWS mechanism.

Chun'an County, still the poverty-stricken area, is largely affected by the protection of the reservoir. In the process of constructing the Thousand Islands Lake, the county was greatly affected due to submergence of the areas of valley glacis and sloping land under 108 meters and fall of the arable land per capita from 0.1 ha to 0.018 ha. The regional economy grew negatively. Farmer's net income dropped from 28.1% higher than Jiande County and 57.19% higher than Kaihua County before 1958 to 45.8% and 36.0% lower in 1958 when the reservoir was constructed; whereas, the economic level of Chun'an County before 1958, was no less than that of Xiaoshan in Hangzhou city and higher than that of the nearby counties or cities. The construction of Xin'an River reservoir makes the economic level in Chun'an fall behind by 20 years, and it is until 1978 that the income per capita returned to the level of 1958. Until now Chun'an County is still one of the 25 poorest counties in Zhejiang province and it is the only under-developed County in Hangzhou city. In 2002, the GDP was 510 million dollars, accounting for 2.33% of Hangzhou; the GDP per capita is 1,122 dollars, accounting for 30% of Hangzhou. The water area of the lake is 573 km², 99% of which locates at Chun'an County, and the water quality keeps at class □. Therefore, Chun'an County is the protector as well as the biggest loser, and it deserves to get the payments.

(2) Ecological compensation will be made based on water quality and quantity or catchments area in the upstream according to monitoring the quality of outflow in the inter-section. At present, the relevant regions in Anhui and Zhejiang have set up a dynamic system for monitoring water quality of the outflow, providing a base for the establishment of PWS.

(3) It is the corporate responsibility of the whole watershed to protect Thousand Islands Lake, and the establishment of PWS can realize the value of water and other ecological resources.

(4) It is requisite for the environment and development of Thousand Islands Lake to set up a PWS mechanism, to increase the investment into environmental protection, and to keep the water clean forever.

5.2 Analysis on the benefits and losses from two sides of supply and demand in the payment

In the process of establishing a PWS mechanism in the Thousand Islands Lake, both Huangshan city and Hangzhou city attached great importance to the PWS issues. However, there are conflicts in the issues of how to pay, who should pay, etc. The conflicts and cooperation are mainly focused on the 3 following aspects:

- 1) Huangshan city proposed "to share costs and benefits of the construction of Xin'an River", hoping to get payments and investment from Zhejiang province, and develop less and even non-polluting industries. The

government of Zhejiang including that of Hangzhou city thinks that the water quality from the upstream is not always good, especially the N and P indexes is worse than that of class V, and that is leading to negative impacts on the downstream water quality. Meanwhile, water from Huangshan city is basically class III, but reaches class I after being treated in Chun'an County. So, the payment should be given to Chun'an County instead of to Huangshan city;

- 2) Huangshan city plans to build a reservoir of 800 million m³ storage in the upstream, seasonally regulating the water resource, so as to keep the ecological services and irrigation function well. However, Zhejiang province argues against this plan, because it may bring negative impacts on water quantity and water quality of the downstream, and on the ecosystem function of the whole watershed so well;
- 3) It is also argued by Zhejiang province that since the state is the main beneficiary from water power generated from Xin'an River reservoir, the state should pay for it. In addition, 12.5 billion dollars out of the 25 billion dollars' revenue have been turned into the treasury. Therefore, the central government should pay for the costs of ecological protection in the watershed. .

5.3 Payment mechanism and institutional arrangements

Currently, PWS in the Thousand Islands Lake was only offered to Chun'an County, near the reservoir areas, not to Huangshan city. The fund sources include:

- 1) **Financial transfer from Zhejiang province.** Zhejiang provides a certain amount of funding to the less developed headwaters areas through transfer payments.
- 2) **The special fund for the protection of Thousand Islands Lake was set up by collecting a certain percentage of the ticket and other earnings from Thousand Islands Lake tourism.** Earlier in 1999, Chun'an County set up the first environment protection fund, i.e. the Special Fund for the Thousand Islands Lake Protection, collected from the Thousand Islands Lake tourism earnings and mainly used for ecological protection. In 2004, Chun'an County raised the ticket price, so there is more money going into the special fund.
- 3) **The payments from the central government: the central government invests in the Xin'an River as a key ecological function zone through projects of environment protection, such as, the project for integrated soil erosion control in Xin'an River, sealing hillsides for afforestation project, forestation project, etc.** As one of the 10 national experimental water & soil conservation projects, the project in Xin'an River has been carried out by the water resources sectors. 125 million dollars has been invested into the construction of infrastructures in the severe soil erosion areas, such as the projects of dams against sand and the hundreds of miles of walls protecting river banks.

The specific policies and measures that Chun'an County took to protect the

Thousand Islands Lake are:

- 1) To make normative documents such as *Measures on Water environmental management of the Thousand Islands Lake*, *Measures on managing and protecting fishery resources in Chun'an County*, etc. In 2005, the People's Congress of Chun'an County passed the *decision on further strengthening the protection of Thousand Islands Lake*, and the government of Chun'an County initiated the *temporary measures for water environmental management of Thousand Islands Lake*, supplying the policy support for the protection of Thousand Islands Lake;
- 2) Since 2002, with the support of the state, provincial and municipal environmental sectors, Chun'an County set up a national station for automatic water quality monitoring in the boundaries between Zhejiang and Anhui and a station for automatic air quality monitoring in the Thousand Islands Lake, and built boats with advanced equipments for collecting the trash in the water and a plant for treating waste into harmless things at Thousand Islands Lake ;
- 3) Good work has been done by Chun'an County to control the polluted things flowing into Thousand Islands Lake. a) Industrial pollution has been effectively controlled. Since 1995, Chun'an County has shut down more than 30 industrial and mining enterprises that may gain annual revenue of millions dollars, and the industrial pollution has been taken under control effectively, making Chun'an County the first County reaching the goal of "*two standards by one control measure*". b) Great importance has been attached to the control of pollution source from the rural areas. From 1998, the focus of environmental protection shifted to village and towns, the system for township environmental performance assessment has constructed, bringing the control of the township's environment into the system confining the township leaders' management responsibility, and township and village levels for environmental protection started an administrative organization network in the County. At one hand, the garbage sources were controlled by setting up more than 1,300 rural garbage stations, incinerators and burying sites in all towns; at the other hand, a Center for Organic Food Development under the State Environmental Protection Administration for Chun'an County has been established, to develop organic food. For the past years, the organic food industries have seen a rapid development such as organic tea, fish, oranges, etc. Thus, the use of pesticides and fertilizers that may lead to the agricultural non-point pollution has been reduced greatly. c) Domestic pollution control has been pushed forward. Since 1999, lavation things that contained P have been banned, so were one-time plastic foam dishware. Burning of straws and grasses has been forbidden, and hotels and restaurants in the region of the lake were compelled to use fuel boilers and be equipped with oil purifiers. The treatment of Township domestic sewage has been strengthened too. Starting from 1998, the facilities for domestic sewage treatment are required for the newly constructed residential and office buildings. While for the old

buildings, domestic sewages are treated in a centralized site in each community. At present, 80% of the domestic sewage in towns around the Thousand Islands Lake has been treated. A large plant for sewage treatment is now under construction, and domestic sewage will be treated when it is put into use. d) Tourism pollution has been under control. Environmental protection has been strengthened within the scenery based on the ISO14000 certificate system on environmental control. At present, 90% of the sceneries have gained the ISO14000 certificates, and the current ratio of domestic sewage treatment in Thousand Islands Lakes 100%. A recycling system for shipping waste oil and garbage has been made. Besides, Chun'an County is carrying out a project of reconstructing toilets on ships into ecological toilet, by extending the utilization of water-free sanitary toilets.

- 4) From 1998, fishing is prohibited regionally and seasonally and at the fishing-off season in Thousand Islands Lake, leading to a rapid increasing algae eating fish of and native ones, which greatly improves the water quality in Thousand Islands Lake;
- 5) Forestation and Sealing hillsides for afforestation were carried out to increase forest coverage ratio. The forest coverage ratio in Thousand Islands Lake increases from 23.5% at the time when the Lake was built to the current 95%, and the ratio throughout the County now reached 73.9%. The functions of water & soil conservation have been greatly enhanced, and the impacts on water environment caused by soil erosion were lowered.

5.4 The analysis on the effectiveness of PWS: Drivers and obstacles

The main drivers for the establishment of PWS in Thousand Islands Lake are as follows:

Firstly, there are urgent demands for quality water from Thousand Islands Lake from the downstream Hangzhou city who's drinking water comes mainly from Thousand Islands Lake.

Secondly, it is necessary to construct sustainable and healthy watershed by PWS in Thousand Islands Lake. As the upper reach of Qiantan River, it is very important for good quality water in Fuchun River and the decrease of alkali in Qiangtang River. As ecological demonstration province on the national level, Zhejiang has the responsibility of environmental protection and ecological construction.

Thirdly, both the concerns of drinking water safety and abilities to pay will be increasing with the economic development of Hangzhou city.

However, there are still some obstacles and problems in establishing PWS in Thousand Islands Lake that mainly show as the following 3 aspects:

Firstly, the responsibilities and rights of the up and down streams are unclear, and it is difficult to define the user and supplier, payment criteria, means and types. The water

quality from Huangshan city to Zhejiang province is class III, and is it the responsibility or the requirement of the upstream to pay? Over 60% of the upstream water flows into Thousand Islands Lake, and to whom does the water right belong—the state, upstream or the entire watershed? It will be very difficult to reach an agreement before these issues are made clear.

One of the most important issues is to reach an agreement between the up and down reaches on whether to pay and how to pay. The establishment of PWS in Thousand Islands Lake involves many aspects such as society, economy, resource, environment, etc. It also concerns the distribution of benefits among different administrative regions. Hangzhou city thinks that the state should invest in watershed protection since it gets annual revenue of 12.5 million dollars.

In addition, no agreement has been reached on how to allocate the payment among the upstream Huangshan city, Chun'an County and Jiande County.

5.5 Implementation evaluation and lessons

Experiences and lessons learned from the exploration of PWS mechanism in Thousand Islands Lake are:

- 1) To calculate the amount of payments for watershed services in Thousand Islands Lake, based on the costs of environmental protection in the upstream, while taking the revenue loss and farmer's direct economic loss caused by the limitation of development rights into account;
- 2) The payments for Huangshan city is based on water quality and water quantity, and there will be no payment if the quality fails to reach the contracted standard;
- 3) The sources of funding are: (1) charge from water power company in Xin'an River at a certain ratio, as the special fund for environmental protection and ecological construction of the reservoir; (2) Water resource fee, collected for the ecological compensation fund; (3) Ticket earnings from the scenery tourism at a certain rate; (4) Fiscal transfer payment and ecological projects from the central government, Zhejiang province and Hangzhou city. The traditional way of fiscal transfer should be changed by focusing on the important ecological zones;
- 4) To highlight the policy supports to ecological agriculture and environmental protection industries in Chun'an County;
- 5) To speed up the construction of Eastward water transfer project from Thousand Islands Lake, and collect water resource fee and cooperation engineering tax to collect fund for ecological compensation, so as to promote the establishment and implementation of PWS scheme in Thousand Island Lake.

6. Water quality control and PWS mechanism in Jinjiang River and Luoyang River

Jinjiang River, the third largest river in Fujian province, originates from Southeast slope of Tizai Hills in Xincun village, Taozhou town, Anxi County, and runs through Yongchun, Anxi and Nan'an counties, Licheng and Fengze districts of south Quanzhou into Quanzhou gulf from west to east. The total length is about 180 km, with a catchments area of 5629 km² and annual flux of 4.8 billion m³, most of which is in Quanzhou city. It is the main industrial and tap water source, and also the best choice of supplying water to Jinmen. The river is divided into east and west branches from Shuangxikou of Nan'an to the upstream. The west stream, the main one, originates from Tizi Hills in Dadeban, northwest Taozhou town, Anxi County, with a length of 153 km and an area of 3,101 km². The east stream originates from Snow Mountain in north Yongchun County, with a length of 120 km and an area of 1,917 km². Luoyang River, sharing a boundary with Hui'an, originates from south Pudding Mountain in north Bengluojiang district, and runs through Majia and Heshi towns into Quanzhou gulf, with a length of 40 km and an area of 230 km².

6.1 Feasibility analysis

The feasibility of PWS in Jinjiang River and Luoyang River shows as follows:

(1) With the small size, the two rivers originate and run into sea in the same region, so it is easier to coordinate and manage the two watersheds.

(2) It is easy to define the beneficial areas and protective areas. The protective areas are the upstream Luojiang district, Nan'an city, Anxi County, Yongchun County and Dehua County, while the main beneficial areas are Hui'an County, Quanzhou, Jinjiang, Shishi and Nan'an cities.

(3) PWS ideas are needed to collect funds for water crisis. The main problems in the water crisis of Jinjiang River lies in the harm to water and soil conservation due to the excessive reclamation of forests in upstream, non-point pollution caused by pesticides and fertilizers in the upstream tea and fruit yards, ecological damages caused by water power stations in the middle and up streams, and industrial and domestic water pollution in the watersheds especially in the mid-down streams. According to the Water Resource Bureau of Quanzhou city, the situation of water resource protection in Jinjiang River is very bad. There is no pollution control and garbage treatment plants (sites) in the upstream, and most of the industrial and domestic sewages are directly discharged into Jinjiang River, causing the water quality at part of the river exceed class □, and Shanmei reservoir has become eutrophicated. Because the cities and counties in the upstream can not burden the costs of environment control projects independently, it is only through PWS mechanism to share the costs for environmental protection and the payments for farmers in the headwaters.

(4) The downstream regions develop rapidly, and have the abilities and willingness to pay the upstream for the protection and construction of the two watersheds.

6.2 Analysis on the benefits and losses in the two sides of supply and demand in the payment

Water resource in the above two Rivers are very scarce, and there are larger demands

for water services in terms of quality and quantity. Therefore, PWS mechanism is driven by the demand. Quanzhou city is one of the fastest developing regions in Fujian province, as well as the water scarcity area, 27% contribution to the provincial GDP, feeding 20% of the provincial population with only 8% of the total water resource. The water resource per capita is 1559 m³ and is lower than the national and provincial level, While the water resource per capita in coastal areas is only 650 m³, severe scarcity of water resource, most of it from the Jinjiang River. Therefore, the environment and water supply in Jinjiang River and Luoyang River have very important impacts on the safety of industrial and domestic water in the lower reaches. The upstream also expects an increase of investment in environmental infrastructural construction through a PWS mechanism—one of most important fund sources for mid-small environmental engineering.

6.3 Payment mechanism and institutional arrangements

Good payment mechanism and fund use system have already been established in the above two Rivers.

(1) **The system for payment mechanism and fund collection is perfect.** It is planned to collect 12.5 million dollars from 2005-2009, 2.5 million dollar each year, for the special fund of water resource protection in the upstream of the “Two Rivers”. The special fund is collected from Quanzhou city which invests a fixed 625,000 dollars, and downstream beneficial counties share 1.875 million dollars according to water use ratio, 625,000 dollars from downstream urban revenue, 141,250 dollars from Licheng and Fengze districts each, 32,500 dollars from Luojiang district, 122,500 dollars from Quanguang district, 811,250 dollars from Jinjiang city, 225,000 dollars from Shishi city, 160,000 dollars from Nan’an city and 241,250 dollars from Hui’an city.

(2) **The utilization of payment fund is rational and high-efficient.** The principles of fund use are *overall arrangements special use, focusing on the key issues and ensuring the high efficiency*. The fund is mainly used for water resource protection projects which are organized and carried out by the upstream local governmental and examined and approved by relevant local governmental sectors. The key projects include: environmental protection infrastructure programs, such as domestic sewage and garbage harmless treatment facilities, rural non-point pollution control, ecological protection, key tap water source protection, etc. The projects have to be good for the reduction of pollutants discharged in the upstream of the two Rivers, for the improvement of upstream water environment, and for better social and ecological benefits.

The specific payment criteria are: (1) 62,500 dollars/ton for the construction of township sewage treatment plants in the upstream; (2) 125,000 dollars for County level and 62,500 dollars for township construction of garbage harmless treatment projects only if the filtered liquid reaches the standard; (3) 20-40% to other projects, with a ceiling subsidy of 250,000 dollars.

The institutional arrangements for the PES in the two Rivers are:

(1) In 1996, Quanzhou city initiated the regulations of *Planning for water distribution in the downstream of Jinjiang River*, and allocated water to the downstream in the low-water year, based on which the total water supply to the coastal regions is controlled. On June 1st, 2005, the Quanzhou government made the *Interim provisions on the special fund for water resource protection in the upstream of the Jinjiang River and Luoyang River* (hereafter, Interim Provisions). This is the first PWS mechanism in the municipal level, Fujian province;

(2) *A Pilot working plan for water allocation, saving and protection in Jinjiang River* was made according to the principle of centralized management of surface and ground water. Research has been finished on optimizing water allocation and water-saving in Jinjiang River. A series of programs for water allocation such as *Program for Water Allocation of Quanzhou city* have been made. Gross water control and norm management keeps going in Quanzhou city. Based on the initial water right distribution in Jinjiang River, gross water will be controlled among all businesses, water use quota will be made for every line of business, and water use will be metered. Policy regulations such as *Measures of managing the initial distribution of water right in Jinjiang River* and *Interim provisions on water saving management* have to be carried out soon;

(3) Ecological special fund is mainly used for water resource protection projects examined by the municipal environmental bureau and carried out by local governments in the upstream. Meanwhile, detailed rules for implementation have been made on the payment scope, conditions and criteria, establishment of projects pool, the application and approval for fund, financial management and supervision;

(4) Total Control of Pollutant Discharge, standard system of pollutant emission and responsibility system in the inter-sections has been made;

(5) Performance in the payment has been assessed. The upstream counties (cities or districts) are required to make the water quality in the inter-section meet the demand of water functioning zone. Once it reaches the standard, the payment will be made, so as to encourage the upstream to protect water resource. As for those counties (cities or districts) which fail to reach the standard or finish the reconstruction of projects on schedule, the special fund will be delayed or cancelled.

6.4 Drives and obstacles

The drives for the establishment of PWS in the two Rivers are from the efforts and guidance of provincial and urban governments which play an important role. Being short of water, the governments have to guide the utilization of water resource and protection of watersheds from the overall perspective, set down relevant managerial regulations and institutions, give instructions on the allocation of water and construct together and compensate between the up and down streams.

Meanwhile, the payments based on the standard of water quality and quantity from the monitoring sections has greatly inspired people with enthusiasm for water resource protection, and accelerated the construction of sewage treatment plants in the upstream. At the same time, it is worth well to pay, and the effect is direct and obvious.

The obstacle in the establishment of PWS is that environmental agreement is not signed, so that there are the different ideas on the payment. Under the facilitating of the government of Quanzhou city, the first 5-year period pilot project is carried out. Because the fact that the effect of environmental conservation can not emerge soon, there are some different ideas between the up and down reaches on the payment criteria, the effect of environmental control, etc. The upstream thinks the payment is too low, and more funds are required; while the downstream thinks the upstream should return its payment if the water quality still fails to meet the contracted standard after the payment.

6.5 Implementation evaluation and lessons

PWS in the two Rivers in terms of special fund has brought positive impacts on the improvement of watershed environment, mainly showing as follows:

(1) The establishment of PWS based on water quality and water quantity has greatly inspired people with enthusiasm for environmental protection in the upstream. Through the implementation of PWS, the pressure on the upstream environment control has been relieved to some degree from the payment, and the relationship between the upper and lower reaches has been meliorated.

(2) The investment in environmental protection of the upstream has increased, including:

- 1) In 2005, an initial 1.4 million dollars special fund of water resource protection was allocated to construct 32 big environmental projects including the sewage treatment plant in Yongchun County. At present, the total fund comes to 2.4 million dollars, and the payment policy has generated benefits.
- 2) The *center for water allocation in Jinjiang River* (1st period) was completed, and water quality monitoring stations in Beiqu and Jinji have been established. *Water allocation decisions and precautions on drought condition in Jinjiang River* has been made, the *Outline of water-saving program in Jinjiang River* is to be planned and implemented, and industrial water saving is under experiment.
- 3) The automatic water monitoring system in Beiqu has been completed and passed the test. The system is an important project of water allocation optimization, water-saving, and water protection in Jinjiang River. The monitoring section is located at upper reaches, 1 km from the water intake of the 3rd Water Plant, and water temperature, DO, PH value, turbidity, conductivity, Ammonic Nitrogen, TP, COD, water level, flow and flow rate can be monitored in real-time. The construction of the system started in

mid December 2003, and it operated for trial on June 6th 2004, with a total investment of 200,000 dollars. The system provides technical supports for the establishment of PES mechanism between the up and down reaches, and plays an important role in ensuring tap water safety to Quanzhou city and promoting the unified management of water resources.

(3) The environment in the watersheds has been improved, meeting the standard of water quality made by the provincial government. Assessment goals are specified in the utilization of PWS funds, making it a constraint mechanism for watershed protection. Under the restraint of the mechanism, the upstream strengthened the environmental pollution control and project management, and the water quality has been improved.

(4) The collaborative and interactive relationship between the up and down reaches has been intensified. Although the up and down reaches have difficulties in reaching a consensus on the duties and obligations, criteria and modes, the PWS has made the first step towards a good collaboration between them, and facilitated sharing the costs and benefits of watershed construction and conservation.

Lessons and existing problems:

1) The payment criteria are too low to meet the demand of the environmental protection in the upstream. In 2005, the payment that Sanming city received was only 1/32 of the environmental control costs that the municipality invested in the same year, while the payment to the Jinjiang River was only 1/29 of the investment in the environmental protection of the upstream. Xinluo district of Longyan city and Zangping city also collected millions of dollars by themselves to control pollution from aquaculture, and to construct urban sewage and garbage treatment facilities.

2) The scope of payment is limited. At present, the payment is confined only to the fields of environmental control. However, there is no payment for ecological and headwaters protection and the economic loss caused by the limitation of development right in the upstream. Moreover, it is hard for ecological projects such as headwaters protection, water conservation forest growing, soil erosion control, etc, to be included into the scope of payment use.

3) The payment means is single. The current payment in the Two Rivers is mainly from a special fund, focusing on the environmental pollution control. The PWS is still isolated from industrial restructuring, industrial transition, ecological migration, payment for ecological functions, etc.

4) The payment scheme is temporary within certain phases and can not be the established long-term mechanism. At present, the payment scheme in the Three Rivers was formed under the negotiation of leaders in Fujian province and Quanzhou

City, and the payment criterion is fixed, with a term of 5 years. The effective management mechanism in the whole watershed does not come into being, and long-term legislations and agreements are not signed.

5) Special funds from different sectors are not included in the PWS scheme. Although the costs of ecological protection and environment restoration have been levied by various resource sectors, the funds are used separately, and the utilization efficiency is low, making it difficult to play key role in ecological protection (Zhang H. Y., 2006).

7. Water right trade between Dongyang and Yiwu in the Jinhua River

The Jinhua River watershed covers 4 towns, Pan'an County, Dongyang city, Yiwu city, Jinhua city and part of Jinhua County, with more than 200 kilometers. It is located in the middle portion of Zhejiang Province. It is a middle watershed with a population of 3.2 million.

The headwaters in Pan'an County have two main branches: Xixi and Wenxi. Wenxi comes from Yangcaojian into Nanjiang reservoir and the Wenxi watershed covers 149.1 km². Xixi, from the mountain range of Shanghulin, covering 147 km², runs into Hengjin reservoir through Molin, Yaoquan and Shimu, and its origin is a lot of hills from 500 meters to 1200 meters (See Figure 1). More than 99% of the Rivers that run outside have a water quality of class I perennially. The forest coverage ratio reaches 74.6% in the headwaters.

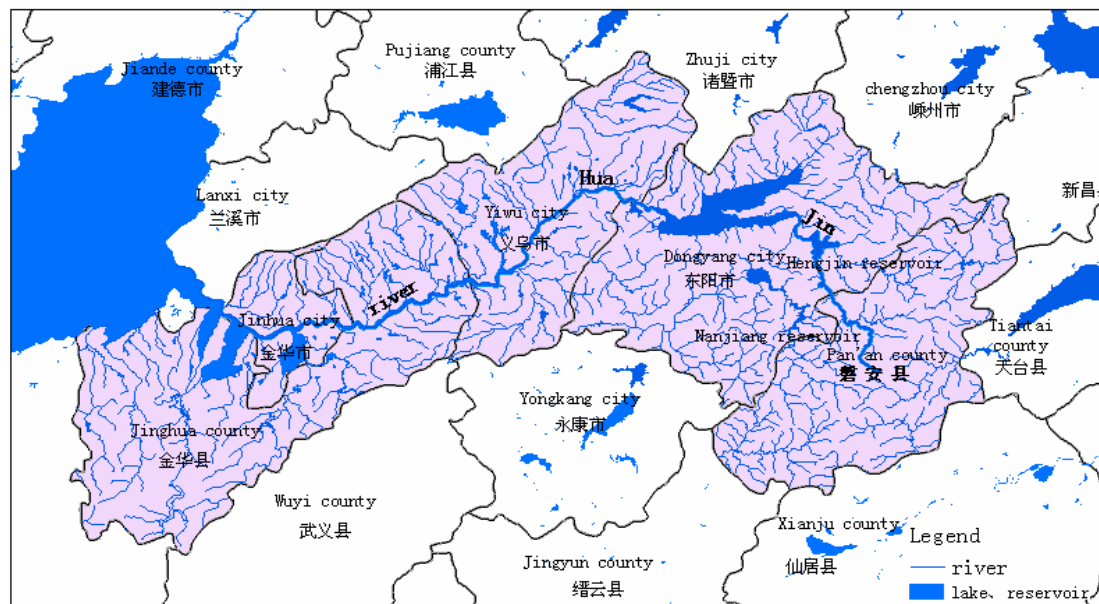


Figure1 The spatial distribution of water systems in Jinhua River

7.1 Feasibility analysis

- 1) The water right trade between Dongyang and Yiwu, driven by a demand-supply market, is an inevitable result of the following aspects: **The relation of supply and demand of water resources between the Dongyang**

and Yiwu is clear, and a win-win situation can be gained. Within the Jinhua River watershed areas, Dongyang city has abundant water resources with population of 785,800 and 2126 m³ of water per capita. Except for normal use of water, there is 30 million tons of water flowing into Jinhua River that is not used beneficially. On the contrary, Yiwu city is short of water with 80% of Dongyang's population but only half of the water per capita.

- 2) **It is feasible to transfer water from Dongyang to Yiwu according to the investigation and demonstration of water resource experts.** 3 scenarios were proposed to solve the water shortage in Yiwu city: a) To enlarge the old reservoir; b) To build a new reservoir to transfer water to Yiwu city through pipes; c) To transfer water from other areas. The facts show that, there is no a place for a new reservoir in Yiwu, and the conditions do not permit lifting irrigation because less water passes by and there is water pollution. Thus, the method of transferring water outside via a channel becomes the only feasible way. Besides, the costs of water purification, newly building or enlarging the reservoir are much higher than water right trade, which makes it the most important driving force for water trade.
- 3) **Market is the effective tool for the allocation of water resources.** Both Dongyang and Yiwu get their benefits through water right trade in the market. Dongyang saves more water through water-saving and new water source projects. The cost of drinking water is less than 12.5 cent/m³, and it becomes 50 cent/m³ when being sold to Yiwu. While for Yiwu, the cost will be 75 cent/m³ if a new reservoir were built. Therefore, the water trade between Dongyang and Yiwu helps both sides save water use, and the market plays its role in optimizing the distribution of water resource.

7.2 Analysis on the benefits and losses in the two sides of supply and demand in the payment

The PWS transaction between Dongyang and Yiwu was done on conditions of mutual benefits of two sides and also win-win of environment and development. The successful experiences lie in:

- (1) Along with industrial development, the size of Yiwu city is expanding, the domestic and industrial use water is increasing, and the water deficiency becomes the restricting factor of regional development.
- (2) Dongyang city has abundant water resource. If there is no water right trade, excepting for normal use of water resource, there is over 30 million tons water flowing into Jinhua River without being used beneficially. Through water-saving reconstruction in the traditional irrigation areas and the development of Zixi River, 50 million tons of water resource can transfer into Hengjin reservoir. At present, except to the agricultural irrigation and urban water supply, there is 165 million tons of water available for good use in Hengjin reservoir. How to get more benefits from the abundant water? Can income be gained directly from the water right trade market? Both of these questions are thought by the Dongyang government, which drive the action of water transaction.

- (3) At the same time, the economic development level of Yiwu is much higher than Dongyang in terms of GDP per capita, with the ability to pay. Meanwhile, the water resources purchased from Dongyang would provide a strong foothold for further development of Yiwu City.

7.3 PES mechanism and institutional arrangement

The water right trade between Dongyang and Yiwu is the first case in China. The agreement of trade includes:

- (1) Dongyang transferred the permanent right of an annual 49,999,000 m³ of water use in Hengjin reservoir to Yiwu city at the price of 25 million dollars, and will ensure to arrive at the good water quality at the national standard of class I.
- (2) Additionally, Yiwu pays the supplier 1.25 cent/m³ (of the actual water supply the same year) as an integrated management fees including the costs of water resource, engineering operation and maintenance, depreciation, heavy repair, environment protection, tax, profits etc. Water right trade, in fact, is the redistribution of water rights, mainly derived by market demands. The water source of Hengjin reservoir is Xixi River, and the 25 million dollars of payment from Yiwu can be thought as the economic compensation to Dongyang for protection of the water source. However, the current existing problem is that most of the water in Hengjin reservoir is from the upstream Pan'an County who has not received any compensation.

7.4 Drives and obstacles

The driving forces of water right trade between Dongyang and Yiwu are:

- (1) **Economic win-win for both sides.** Dongyang saves more water through the water-saving project. The cost of water is less than 12.5 cent/m³, and it becomes 50 cent/m³ when being transferred to Yiwu. While for Yiwu, the cost of 50 cent/m³ is acceptable comparing to the cost of 75 cent/m³ if a new reservoir were built.
- (2) **Win-win of economy and environment.** According to the agreement, the quality of water supplied by Dongyang must reach at the national standard of class I. This is an incentive for Dongyang to protect and restore environment around the reservoir, and strengthen afforestation and migration.
- (3) **Watershed protection is mainly driven by demands, especially by the demands for water quality and water quantity.**

The existing obstacles are:

- (1) The primary water right is unclear. Pan'an County, as the water source area, didn't receive any payment, and the water quality and quantity of Hengjin reservoir are directly affected by those from the upstream.
- (2) There are no policy supports for water right transfer and payment criteria for PWS as references at present.
- (3) There may be some negative impacts on water quality from the upstream due to no payment being delivered to Pan'an.

7.5 Evaluation and experiences

The first case of water right trade initiated the reform of water right institutional, provided successful experiences for more PWS and water right trade in other watersheds. At present, the agreement is carried out well, and Yiwu has received the water resource from Hengjin reservoir. The process and experiences of water trade are:

- 1) The water right trade between Dongyang and Yiwu is mainly driven by market demands, consistent with the market role of minimum cost in resource utilization. Yiwu city is short of water with limited water volume passes through, so the cost of obtaining the same water resource is much higher than purchasing from Dongyang.
- 2) The water trade is also an incentive for Dongyang city to save water and protect the environment and water quality in Hengjin reservoir.
- 3) Water supply began in 2005, and 20 million m³ of water has been supplied, 2 million m³ monthly with a maximum of 50 million m³. The integrated management fee has also increased from 1.25 cent/m³ to 2 cent/m³ along with the increase of the water resource fee throughout the province, among which, 1 cent/m³ is returned to central government and 1 cent/ m³ is kept as the reservoir management fee².

The earnings from the water right trade are mainly used for the construction and protection of Hengjin reservoir, migration, and soil erosion control. The main items include: a) Natural reserve demonstration sites determined by the Ministry of Water Resource (MOWR); b) Purchase of 15 million m³ water from Zixi river; c) Reconstruction of the irrigation system, with 1.87 million dollars from MOWR and Dongyang city each; d) 2,500 people from 1,000 households were transmigrated with a payment of 3750 dollars per capita, and the vegetation will be naturally recovered after the transmigration.

8. Key findings and Policy Recommendations

Based on the review of PWS in China and the analysis of the above 4 typical cases, we present the following findings and conclusions:

(1) The scheme of the PWS is formed at 4 levels with 5 modes in China. Having political, social, economic and legal bases, PWS in China is formed on the current social, economic, environmental and development conditions. At present, PWS in China develops at 4 levels, i.e. the state, province, county and village & towns, and there are 5 payment modes, i.e. national ecological compensation programs, local government-dominated ecological compensation programs, voluntary trade market in the small watershed, water right trade and ecological compensation from water charges. They together consist of the PWS system in China.

² The data is from interviews with the Director General of Yiwu Water Resource Administration

(2) Due to the absence of legislations on PES, it is not easy to clarify water rights, define users and suppliers, delineate the rights and obligations of all the stakeholders, and determinine payment criteria. At the same time, transaction costs are too high, and it can be only piloted in the places where the beneficial areas and protective areas are clear and the downstream has ability and willingness to pay for good quality water. In the mode of water right trading, although Pan'an County is in the riverhead area, it is excluded from the trade. The reason is that there is not a clear water right property in Jinhua River. Pan'an County's low enthusiasm in watershed protection is a potential danger to Jinhua River's environmental protection.

(3) Demand is the key driving force resulting in the emergence and establishment of PWS. At present, water scarcity is severe, so the downstream is willing to pay the upstream in order to get enough good quality water quantity, and that provides a possibility for the establishment of PWS.

(4) In the watershed which originates and enters into a reservoir within the same province or region, the PWS fund mainly comes from local governmental fiscal transferring payment, water charges, etc. While for the important ecological zones, headwaters and cross-boundary basin and large rivers such as the Yangtze River and the Yellow River, the payment is directly transferred by the Ministry of Finance of China. Affected by issues like payment means, benefit distribution between the upper and lower reaches, and due to the inexplicitness of PES legislation, criteria and modes, it is easier to establish PWS within one province or region, but important environmental services, can only be purchased by the central government.

(5) The mode of multi-source payments is an inevitable choice for PWS, and it is easier to establish PWS in the watershed where the downstream is much richer with ability to pay. Restricted by economic level, many regions have no ability to pay although they have the demands for better ecological services from the upstream. Only in the watershed where the down reaches are richer can PWS be developed and improved, such as the payment from Guangdong to Jiangxi in Dongjiang River, the Yiwu-Dongyang Water Rights Trade, and payments in Miyun reservoir and in Jinjiang River. Meanwhile, due to the limited local finance, it is very important to establish PWS in China to collectin multi-channel funds or other forms of compensation such as project, technical support, policy, joint work, etc.

(6) The current barriers of PWS in China are how to determine payment criteria and how to evaluate the payment effect and efficiency. Although, it is hard to reach consensus on certain payment criteria, the payment based on water quality and water quantity is widely accepted.

(7) The government still plays an important role in PWS, and the market plays a complementary and accessorial role in the medium and small watersheds. Absent

a perfect market for PWS, the government plays a role of PWS manager or agency. In the water right trade or other payment modes, the government is still the main decision-maker, and besides one healthy watershed requires the government's surveillance and management. Meanwhile, the market reflects a relation between the watershed protection and payment. Also, the utilization efficiency of PWS funds can be greatly improved, the effects of PES can be maximized in the market, and so it plays a more and more important role in the mid-small watersheds.

(8) The establishment of the relationship between watershed protection and PWS among the up and down reaches is very important to the improvement of PWS in China. If there is not a connection between the environment quality and PWS, the effects of payment are no good. Moreover, people from the water source area will have no motivity to restore watershed environment. It is easier to establish this kind of relation in the mid-small watersheds and the market for water right trade is good for further promotion of PWS.

(9) The market for water right trade within the watershed is still imperfect, and the payment that the upstream receives is much lower than the opportunity costs for watershed protection. Among all the investments for watershed protection, for example, the costs of direct environmental protection, the payment for water resource value, the loss of the limitation of development right (LDR), LDR is highest, and the ability to pay is also much lower than LDR (Haixia Zheng, 2006). Therefore, the local capacity building and land use planning are very important to a healthy watershed.

Based on the above conclusions, we propose the following policy suggestions on watershed management and PES:

(1) The PWS scheme in China should be piloted and implemented from region to region, systematically, from easiest to hardest, and from pilot to implementation. PWS should start first in the rich regions in the important watersheds, ecological functioning zones and headwaters areas. In the mid-small watersheds where the situation of water demand and supply is severe, social funds and a market for ecological services shall be guided.

(2) PWS shall be established in the watershed with clear beneficial and protective areas first, and where preparatory conditions for PWS are good. Social, economic and natural conditions vary with different watersheds, so PWS shall be different in different watersheds, where the demands for water resource is larger, areas that benefit or get protection are easily divided, and which can begin PWS immediately.

(3) To facilitate integrated watershed management in the whole watershed, set up incentive mechanisms and feedback channels between up and down reaches, encourage all stakeholders and volunteers to become involved in the action, establish the sharing mechanism of the benefits and costs of PWS, and improve and guide the establishment of PWS by driving a market and setting new governmental policy. In the current situation, it is of significance that both the government and market is playing its role. The government, as the administrative and

legislative agency, shall play the role as a facilitator and propagator in PWS. While the improvement of markets for water services and water right is also very important in the PWS. At present, the markets for water services vary from regions, and there are higher demands for water resource with a high possibility of involving private funding. However, the market for PWS is constrained due to the lack of clarity of water rights and the water right market imperfection. The market only can be established with relevant policies and an interactive benefit relationship between PWS and environmental protection. At the same time, the payment fund has to be collected and distributed based on the evaluation and analysis of the costs and benefits of PWS, and the benefits and costs of watershed construction and protection should be shared through the internalization of environmental externalities and equitable redistribution of welfare in the watershed.

(4) To build and regulate the market for PWS through the enhancement of national policy support. Since China's economy has developed upwardly, the demands for environmental services are increasing, and it is pressing to set up and standardize the market for PWS. The improvement, standardization and liberalization of the market can also gain the win-win of ecological and economic benefits, where the reform of national policy and institutions are the keys and preconditions as follows:

- a) **To reform on financial system, and increase payment transfer to PWS, based on which to set up a PES special fund.** 1) To reform on the structure of financial output, and to add the social security such as the environmental protection and other public systems into the duties of the central policy; 2) To reform on the financial allocation, and to increase the central governmental financing capacity to realize the strategies that are sustainable and propitious to poor areas; 3) To reform on the system of fiscal transfer payment, to shift from special subsidy to universal transfer payment and income allocation. The state, province and local governments shall increase their transfer payment to the key headwaters areas, set up a PWS special fund, and realize harmonious and sustainable development in the watersheds.
- b) **To reform the current tax system, and collect funds for PWS by combining tax with fee.** At present, it is not time to levy an ecological compensation tax in China. However, it is necessary to levy a greening tax for pollution control to some extent, by charging for pollution discharge, a resource fee, etc., to collect funds for ecological protection. Meanwhile, the government shall carry out the pollution discharge right trading and licensing system to urge industrial companies to reduce pollution.
- c) **To define clear water rights, connect the primary water right with the obligation and liability in the watershed, increase water price, initiate water use licensing, and build the market for PWS.** The main the market for PWS is lack of clearly defined water rights, the same problem in the 4 cases. In the cases of Miyun reservoir and Thousand Islands Lake, the water source areas have not received direct payment from the downstream; neither did Pan'an County in Dongyang-Yiwu water right trade which benefitted the

downstream. The main reason is that the people of Dongyang city think water rights belong to the state or themselves. The absence of initial water rights assignment and cloudy water rights, duties and obligations result in the chaos of natural resource utilization in the watersheds. So, we have to make clear the water rights, increase water price, and carry out a water licensing system. Water resource utilization shall be approved by the Ministry of Water Resource so as to avoid free-riders. Meanwhile, the upstream also has the responsibility to protect watershed, and compensate the lower streams if it pollutes the watershed.

- d) **To encourage and guide the industrial restructure and transition in the water source area to ecological industries, and set up preferential policies for green industries.** Protection and development complement each other; it is not only through the limitation of development but also the preferential policies that help the undeveloped riverhead areas enhance regional development.
- e) **To minimize transaction costs.** High transaction costs are also one of the main constraints of PWS. The transaction costs can be minimized through the improvement of watershed management, information symmetry and establishment of a special fund for watershed management.
- f) **The state should set up the principle and policy of PWS, launch research on legislation of PWS, and set down the PWS criteria and regulations as a reference.** The PWS legislation based on the scientific research and pilot is crucial to push PWS and foster its market. The determination of payment criteria should take water quality and quantity into account, and have the water price play a leverage role. The assessment of official performance should include the environment index instead of the sole economic index, to inspire the enthusiasm of the local government in environmental protection.

(5) To enhance the negotiation for signing PWS agreements before the national payment policy is set up, and boost the development of the market for PWS. Since watersheds vary from region to region in China, and the costs of water rights allocation are too high, it is difficult to push PWS throughout the nation. Before the national PWS criteria are made, agreements can be reached through negotiation based on the supply and demand for watershed services. Relevant binding regulations can also guarantee the protection of watershed and implementation of payment. All 4 cases show that at present it is highly possible for this mode to be carried out in China.

(6) To adopt the mode of multi-source compensation to improve local capacity building. The compensation between up and down reaches is not necessarily through a payment fund, but also through various means such as green industry development, cooperation, etc., to promote the upstream economic development. Due to the limited financial resource, the government can collect funds for PWS from many channels:

- a) Compensation in cash or materials can be made through various means such as state direct payment, financial assistance, tax deductions and exemptions,

- tax return, transfer payment, etc.;
- b) Supports and assistance from projects, technical exchanges, manpower training, etc.;
- c) Reasonable water pricing, downstream cities' payment based on channeled water volume and quality, etc.;
- d) Introduction of private funds that can also realize a win-win of benefits and protection, barren hills and wild lands contracts, development of organic farming, etc. An agreement is to signed ensure the control of soil erosion and increase of ground coverage when the contractor exploits the land;
- e) Funds collection from international organizations.

(7) To set up a database for the monitoring of outflow quality and speed, and build information systems on watershed management, and providing technical supports for payment criteria. At the same time, to make the information of water quality available to public and also instigate the supervision and dialogue between upstream and downstream. At present, the key to payment issue lies on payment criteria, the key to which is how to evaluate the water resources supplied by the upstream. So, the evaluation of water quality and quantity is of importance.

(8) To reform public institutions and adopt good governance, which are the future trend of watershed environment control in China. The core contents are a multiple involvement of the watershed management agencies and other participants, and the establishment of partnerships between public and private sectors in watershed management through contracts or agreements. 1) To give full play to the public administration's advantage in decentralized management, independence and performance, and make the performance assessment system transparent; 2) To introduce the market factors, and reinforce the market competition; 3) To improve efficiency and reduce transaction costs in watershed management, through "weakening the role of government but intensifying the institutions".

9. Remarks and Discussion

In sum, the payment for watershed services is in its primary phase with the main modes of government payments or involvements. The market for watershed services is taking off in the medium and small watershed. The key issues and next steps should be considered as follows:

Relevant legislations and regulations: The laws and regulations on PWS should be established to support the implementation of PWS as soon as possible.

The scopes of PWS, duties and rights of all stakeholders should be clear. First, the scope, key fields, and sequence of the implementation should be decided. Second, the duties and rights of the state, upstream and downstream in a watershed should be set up with the distinct definition of the role of central and local government.

Payment criteria and payment modes: These issues on how to pay, when to pay, how to implement and supervise are all very important and impact the effect of the implementation of PWS. Any payment mode should aim for the goals of building healthy watersheds, green production and industry systems. Therefore, the payment should be many kinds of payment including funds, technology, information, and projects.

Transaction costs: The key barriers of the implementation of PWS are that the transaction costs are too high coupled with the low efficiency of fund use. It is necessary to reform watershed management system and institutions, and relevant public organizations, and ensure the information on water resources and the environment in a watershed is available for the public. It is crucial to set up an independent organization to facilitate PWS in the river basin level all over the country on the basis of law.

The use efficiency of fund and performance evaluation: it is important to strengthen the performance evaluation of PWS, especially the achievements of fund use and environmental improvement, collecting all charges and funds for PWS, setting up special funds, and planning to use and manage as a whole. . As four cross-region PWS, the partnership should be established to facilitate the fund use and activities for watershed environment. The evaluation should be done on time and the next funds should be paid based on it.

The role of government and market: The government plays a key importance at present, but under the conditions of the whole information, the market for PWS will promote efficiency and effectiveness and payment use. Therefore, when the government facilitates and purchases PWS, the relevant institutional arrangements and reform should be done in a timely manner.

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