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WATERSHED ECO-COMPENSATION IN CHINA: Practice and Review

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Words from CAEP President



President HONG Yaxiong

The past thirteen years witness the fastest development of China's environmental protection, and it also has been an important development period for CAEP who is the witness, participant, beneficiary and contributor of this historical development period. In this process, CAEP has gradually grown up into one of the most important domestic and international scientific research teams in the field of environmental policy and planning. In 2013, CAEP was ranked 31 in environment field in *Global Go To Think Tanks Report and*

Policy Advice published by University of Pennsylvania.

Now the curtain is rising for a new round of opening-up and reform in China with even tougher environmental issues than those in the last decades to be addressed in the coming years. To fulfill this formidable task will entail, among other things, innovative environmental policies and extensive international cooperation. The environmental policy, especially the environmental economic policy is one of CAEP's core study areas, so CAEP will, of course, be deeply involved in the process of environmental policy formulation. In this regard, the new-born *Chinese Environmental Policy Research Working Paper (CEPRWP)* may play an important role by facilitating the exchange of information on research results on environmental policies and lessons learnt in the implementation of such policies. It is my sincere hope that CEPRWP could play its part in the overall undertakings of building a beautiful China thus contributing to protecting our beautiful planet. I also hope that the CEPRWP will help build up a bridge of great communication between CAEP and international research institutions.

Forword »

✦ Editor in Chief: Prof. WANG Jinnan



Since its opening-up and reform, China has been in the process of rapid economic development with its people enjoying an increasingly improved standard of life. Meanwhile accompanying this dramatic economic growth is the degradation of environment which has, to some extent, damaged the gains of the opening-up and reform and prevented the economy from a healthy and sustainable development. The Chinese government is increasingly aware of that without addressing the environmental issues it is facing now will jeopardize its long term goal of the great rejuvenation of the Chinese nation. Given the magnitude and complexity of the environmental issues in China, there is no easy way in addressing them and the solution to them entails an equal priority being given to environmental protection, ecological conservation and economic development or even higher than the latter by mainstreaming the former into the overall socio-economic decision-making process. As a matter of fact, China has been in the struggle against environmental

pollution since the very beginning of its economic take-off and trying to explore a pathway that could help address China's environmental issues in the way most suitable to China's specific circumstances.

In recent years, especially since the 12th Five-Year Plan period, the enhanced measures including legislation, policy, regulatory and economic means have been taken by the Chinese government in dealing with environmental problems, of which environmental policies have played an important role in this regard. Corresponding to this situation and in meeting the demand of governments at different levels for environmental policy tools, the environmental policy research projects on topics of a wide range have been conducted by some Chinese environmental research institutions including the Chinese Academy for Environmental Planning (CAEP).

CAEP founded in 2001 is a research advisory body supporting governments in the

development of key environmental planning, national environmental policies, and major environmental engineering projects. In the past more than 10 years, CAEP accomplished the development of the overall planning of national environmental protection for the 10th, 11th and 12th Five-Year Plan periods; water pollution prevention and control planning for key river basins; air pollution prevention and control planning for key regions; soil pollution prevention and control planning; and some regional environmental protection plans. In the same period of time, CAEP also actively engaged in research on such topics as green GDP, environmental taxation, emission trading, ecological compensation, green financing, etc. By so doing, CAEP has become an indispensable advisory body in the environmental decision-making in mainland China. According to *2013 Global Go To Think Tanks Report and Policy Advice* published by University of Pennsylvania, CAEP was ranked 31 in the field of environment in the world. Many

of CAEP's research results and project outcomes regarding environmental policies have drawn great attention of decision makers and international institutions, and have been utilized to contribute to the formulation of national environmental policies concerned. *The Chinese Environmental Policy Research Working Paper (CEPRWP)* is a new internal publication produced by CAEP for the purpose of facilitating the academic exchange with foreign colleagues in this field, in which the selected research papers on environmental policies from CAEP are set out on the irregular basis. It is expected that this publication will not only make CAEP's research results on environmental policies be known by foreign colleagues but also serve as a catalyst for creating opportunity of international cooperation in the field of environmental policies, and environmental economics in particular, with a view of both the academic research and practical policy needs.



CAEP Institutes

- ◆ Administrative Office
- ◆ Personnel Department
- ◆ Planning and Finance Department
- ◆ Scientific and Technological Development and Cooperation Department
- ◆ Institute of Environmental Strategic Planning (IESP)
- ◆ Institute of Environmental Policy (IEP)
- ◆ Institute of Water Environment Planning (IWEP)
- ◆ Institute of Atmospheric Environment Planning (IAEP)
- ◆ Institute of Ecological and Rural Environment Planning (IEREP)
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- ◆ Environmental Engineering Institute (EEI)
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- ◆ Center for Climate and Environmental Policy Research (CCEP)
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- ◆ Center for Heavy Metal Pollution Prevention and Control (CHMPC)
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DENG Zhigeng, WU Shunze, HONG Yaxiong, WANG Jinnan, LU Jun

> Administrative Office



The Administrative Office is responsible for formulating the work rules and management system of CAEP and organizing and supervising the implementation of those rules and system. It assists CAEP leaders in handling daily affairs, coordinating the administrative affairs, drafting and reviewing relevant documents, and organizing the preparation of annual working plan and annual reports. It is also responsible for the management and utilization of archives.

> Personnel Department



The Personnel Department is responsible for the formulation of the human resource management system and its implementation; responsible for such routine works as wages, welfare, statistics, social insurance, transfer of personnel, investigation and human resource allocation; responsible for the work of recruitment, appointment and training of the new employees; responsible for the management of the retired employees; responsible for such matters as organizing employees' annual evaluation, summary, rewards and punishments; and responsible for CAEP's internal auditing and supervision.

> Planning and Finance Department

The planning and finance department is responsible for yearly budget making, cash plan, year-end accounts, daily financial reimbursement, payment of salary, welfare and all kinds of funds; responsible for the management of funds for free medical treatment and housing reform; responsible for handling accounting and payment of various taxes; responsible for the application, use, final settlement, supervision and management of capital construction funds; and responsible for the management of state-owned assets.



> Scientific and Technological Development and Cooperation Department



The Scientific and Technological Development and Cooperation Department is responsible for the organization and management of research projects with regard to such works as application of scientific research projects, contract signing, implementation assessment, project conclusion inspection and acceptance, project outcomes registration, material filing and others; assists the leaders to track, coordinate and manage the implementation of key scientific research projects; responsible for the management of institution's foreign affairs and the organization of domestic and international academic exchange activities; provides secretariat service to the Academic Committee and Advisory

Council of CAEP ; responsible for the establishment, operation and management of post-doctoral programme; responsible for quality control and management of editing and issuing of academic publications; responsible for the maintenance of CAEP Chinese and English websites; responsible for science and technology statistics; assists in making CAEP annual working plan and annual report.

> Institute of Environmental Strategic Planning (IESP)



The Institute of Environmental Strategic Planning organizes studies of national medium and long term environmental protection strategies, regional environmental protection strategies, and environmental protection strategies for different sectors and industries; organizes the study on national medium-term (5 years) integrated environmental protection planning including research of theoretical method and technique for the integrated environmental protection planning and developing annual integrated environmental protection plan; organizes the interim and final assessment of the implementation of the integrated environmental protection plan. IESP also organizes such activities as economic

situation analysis, study of environmental protection planning for typical regions or cities (city groups), formulation of total amount control targets and technical support for their implementation, and technical review of relevant plans and technical guidance for planning implementation.

> Institute of Environmental Policy (IEP)



The study areas of IEP include: the theoretical and empirical research on the role of such environmental economic instruments as taxes, fees, price, credit, securities, etc. in environmental management; assisting relevant departments to develop and implement various environmental economic policies; conducting international cooperation on environmental economic policy; organizing the establishment and update of the list of "high pollution and high environmental risk" products and processes and the list of products, processes and equipment encouraged by the state for environmental protection; theoretical and empirical research of green trade, green credit, green insurance and other environmental economic policies

based on the list; study on development strategy and policy of green economy; research on the theory, product design, and practical application of environmental finance; studies on environmental performance evaluation to be conducted at multi levels of provinces, key cities, sectors, industries and enterprises; study and implementation of strategic environmental impact assessment; effectiveness analysis of environmental policies and measures; and studies on policy, system and mechanism of environmental management.

> Institute of Water Environment Planning (IWEP)

IWEP engages in such works as water environment planning; organizing the assessment of nation-wide and river basin water environment state and carrying capacity; organizing the development, implementation and evaluation of national and river basin (groundwater and marine) water pollution prevention and control plans; organizing the development of national and river basin total amount control plans of major water pollutants, break-down of control target, and control technology and supporting policy research; organizing the assessment of water pollution prevention and control technologies for typical water polluting industries; conducting research on system, policy and plan for river basin water environmental protection and study on drinking water environmental protection; and providing technical services for local water pollution prevention and control planning.



> Institute of Atmospheric Environment Planning (IAEP)

The tasks undertaken by IAEP include: national and cross-province or regional atmospheric pollution prevention and control planning; studies on the basic theory and methodology of atmosphere environment planning; establishing the technical methodology system for national acid rain control and regional atmospheric pollution prevention and control planning; study on the breaking-down and distribution of the total emission reduction target of major atmospheric pollutants for the whole country and regions, control technology, policy and measures of total pollutant emissions control; researches on climate change, sustainable energy and environmental protection policy; environmental protection planning for the energy industry, and environmental impact assessment of the development of energy industry.



> Institute of Ecological and Rural Environment Planning (IEREP)



The main working areas of IEREP include: research and development of national and regional ecological environment protection and restoration planning and its technical specifications; study of policies and regulations related to ecological environment protection; research and development of ecological environment assessment, planning and implementation schemes for important ecological function zones; research and development of planning, policy and technical schemes related to agricultural and rural ecological environment protection, non-point source pollution prevention and control, integrated treatment of village environment, and soil pollution prevention and remediation; study on regional ecological environment quality assessment, rural environmental quality assessment, and biodiversity survey and assessment; organizing the research of national environmental function zoning, ecological function zoning and formulation of implementation plans; and providing technical consultation for relevant departments and local urban and rural ecological environment protection planning and management.

> Institute of Environmental Public Finance and Investment (IEPFI)

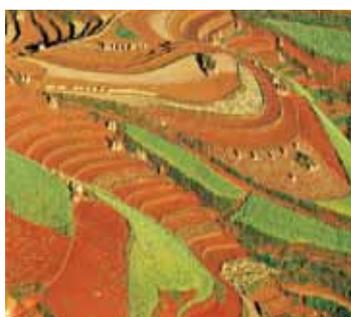


The main business activities of IEPFI include: research on policies related to the administrative responsibility and financial power of environmental protection and environmental public finance; study on the establishment of the statistical system of environmental protection investment and public finance budgeting system of environmental protection; designing fund use mechanism for the special environmental protection funds from the central government, conducting project evaluation, implementation tracking, and performance assessment of projects that use the central special environmental protection funds; technical review of projects of hazardous waste, heavy metal pollution prevention and control, and comprehensive environmental treatment; studies on development policy and planning of the environmental protection industry and environmental services, and on the innovation of environmental service models; studies on the planning for the basic capacity building of the national environmental protection and the tracking assessment of the capacity; preliminary study of key environmental protection projects; and providing evaluation and consultation services related to environmental engineering projects for society.

> Comprehensive Research Department (CRD)

CRD is responsible for the management and coordination of technical business with comprehensive nature; study on system, planning formulation, implementation and assessment of pollution prevention and control for eco-industrial parks and integrated improvement of environment; assisting the departments concerned in formulating the environmental health planning and other environmental health management system.

> Center for Environmental Risk and Damage Assessment (CERDA)



The Center provides technical, institutional and policy support for the Ministry of Environmental Protection (MEP) to carry out environmental risk assessment and management, pollution damage evaluation and compensation, and remediation of contaminated sites. CERDA also participates in developing relevant national and regional policies and regulations, and exercises administration on the qualification of environmental risk and damage assessment institutions.

> Center for Total Emission Control and Management (CTECM)



CTECM engages in such works as organizing the research on the technical specifications, theories and methods in respect of the total amount control; assisting the state in technical verification of the total amount; study on the scheme formulation, quota distribution, control technology and supporting policies in respect of the total amount control of main water pollutants and atmospheric pollutants; organizing the research on analysis methods and application in respect of the environmental statistical data; the research on the theories, methods and application in respect of the environmental economic accounting and organizing the research on the environmental accounting and environmental auditing. The center, based on major demand of national climate change and environmental policy areas, carries out study on the co-emission reduction of atmospheric pollutants and carbon dioxide, organizes the research on the compilation of the detailed list of greenhouse gas and organizes study on the medium and long-term climate change, sustainable energy and environmental strategy and policy issues; and organizes design, implementation and assessment in respect of emission trading and carbon trading mechanism, system and policy.

> Environmental Engineering Institute (EEI)

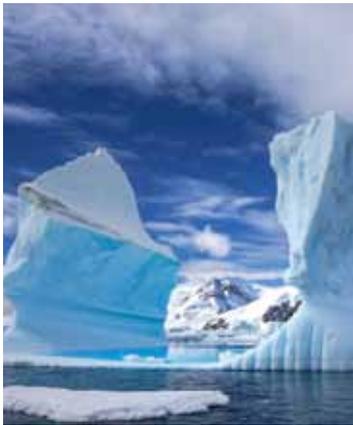
The EEI, an institute operating as enterprises, mainly undertakes such businesses as the technical design, assessment, consultation and training in respect of environmental engineering projects; and the industrialization of the technological achievements in environmental protection.

> State Key Laboratory of Environmental Planning and Policy Simulation (LEPPS)



The research areas of the key lab include: the integrated environmental and economic decision-making support; environmental planning data collection and analysis; scenario simulation analysis and policy simulation analysis of environmental planning; constructing "data-model-system-results" integrated support platform for environmental planning research, thus providing technical support for environmental planning and environmental policy research.

> Center for Climate and Environmental Policy Research (CCEP)



The Center, based on major demand of national climate change and environmental policy areas, carries out studies on medium and long-term climate change, sustainable energy and environmental strategy and policy issues to promote social, economic and environmental sustainability and improve the coordination in the field of environmental protection and climate change policy, and provides scientific basis and policy suggestions for the government to formulate strategy and policy to slow down and cope with climate change, energy policy, economic policy, environmental policy and industrial policy.

> Center for Environmental Data Analysis and Application (CEDAA)

The research areas of CEDAA include: theories and methods of establishing the environmental economic account in China and theories and methods related to the environmental data and their application. Based on the researches mentioned above, CEDAA conducts management oriented research on performance evaluation and the formulation and application of green development indicators, thus providing technical support for environmental statistics and total emission reduction.

> Center for Environmental Zoning (CEZ)

The Center, based on major demand of the national environmental function zoning, carries out the research on basic theory and technical methods of environmental function zoning; conducts research on the establishment of the national environmental function zoning system and zoning-based environmental management system; formulates the management policies and technical regulations on environmental function zoning; undertakes research on the red-line control system and other technical methods of environmental management based on zoning control; provides technical consulting service for the state and local design, implementation process and effect evaluation of environmental function zoning management system; organizes technical exchanges and international cooperation related to environmental function zoning, thus providing all-round technical support for national environmental function zoning.



> Center for Heavy Metal Pollution Prevention and Control (CHMPC)

The major research areas of the center in respect of heavy metal pollution control include: planning research, evaluation, assessment and verification; analysis on the industrial management policies, industrial economic development and environmental protection situation; research on such theories, methods and technology as related to pollution control technology and evaluation, investment and financing policies, risk and damage assessment and emergency system construction; providing all-round technical support for the integrated decision-making on the heavy metal environmental management, and also carrying out the society-oriented comprehensive application research in the fields concerned.



> Center for Investment Performance Management (CIPM)



The main working areas of the center include: research on the theory, technology, methods, policies, system and standards in respect of the performance management in the whole process of the environmental protection investment and projects, formulating such a performance project management method system as covering the whole process from performance objectives to performance evaluation, process tracking, engineering standards, and performance feedback, providing technical support for the Ministry of Environmental Protection and other relevant ministries and commissions in respect of the performance management of the state environmental protection investment projects, and providing commission services in the related fields for the society.

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STUDY ON ECO-COMPENSATION REGULATIONS TA7699 - PRC

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NOTE

In March 2011, Asian Development Bank (ADB) launched a Technical Assistance Project for China, which is the Study on Ecological Compensation Legislation in China (TA7699-PRC). This TA project was implemented by the Department of Western Region Development, the National Development and Reform Commission (NDRC). Prof. WANG Jinnan, the first author of this paper was a core expert of the project team and was responsible for studying on watershed eco-compensation. This paper is a final draft report of Legislation and Practice on Watershed Eco-compensation, which is part of ADB TA 7699-PRC. Therefore We thank very much for the support of ADB and NDRC. The content and views expressed in this paper are those of the authors and do not necessarily reflect the views or policies of the National Development and Reform Commission(NDRC), the Asian Development Bank(ADB), and the Chinese Academy for Environmental Planning(CAEP).



1. Introduction

During 2001-2005, China witnessed rapid urbanization and industrialization and meanwhile, suffered shortage of water resources and deterioration of water environment. As indicated by related surveys, currently, about 2/3 of cities in China have been troubled with shortage of water (110 cities severely troubled), and the yearly deficiency of water for irrigation is about 30 billion m³. Especially in East China and North China, water shortage is intensified due to severe contamination and continuous destruction of the surface water environment from discharge of industrial and domestic sewage and the agriculture non-point source waste water into rivers and lakes. Besides, excessive water resource development has resulted in such environmental problems as surface subsidence and land. Continuous deterioration of water quality and shortage of water resources have threatened food health and public security in China. Under this background, during 2006-2010, China issued a succession of environmental policies and implemented administrative measures, in hope of improving the surface water environmental quality. Among such policies, one was a policy on watershed eco-compensation.

A watershed is an area where environmental elements relate to and influence each other. In a watershed, water environments in the upstream, the midstream and the downstream and in the mainstream and branch influence each other significantly. On one hand, in the upstream area, the ecological environment is vulnerable, so it requires substantive input of labor, material and finance. As a result, the protection of the watershed water environment will result in the lagging

economic development compared with the downstream area. Plus, the protection of watershed water environment cannot get corresponding compensation and earning, which has discouraged the upstream areas to protect the watershed water environment, but to develop economy. On the other, during economic development of upstream areas, pollutants discharged into the watershed in a period will directly influence the water environment in the downstream areas.

Watershed eco-compensation is an environmental and economic policy designed for converting the external cost of ecological damage and water pollution in the watershed into internal cost. It conforms to the principle of "destroyer pays" and "polluter pays". Under this policy, pollution producers will balance the pollution-treatment cost and economic compensation, so that water pollution treatment measures can be carried out. Establishment of a watershed eco-compensation system can require the benefited parties of protection of the watershed environment to bear some cost caused to the protector of the water environment, which can protect enthusiasm of treating water environment in the upstream areas and thereby ensure the right of the benefited parties to share the watershed water resources.

After the pollution accident in Songhua River on November 13, 2005, the State Council on December 3, 2005, issued the Decision of the State Council on Implementing the Scientific Development View and Strengthening the Environmental Protection, which stated to "build an ecological compensation mechanism." The Decision on Some Major Issues Concerning Building a Socialist Harmonious Society



by the 16th CPC Central Committee at the Six Plenary Session further clarified to build an ecological environment appraisal system and compensation mechanism and promote harmonious development between human and nature. The report of the 17th CPC Central Committee stated to build a perfect ecological compensation mechanism. During 2006-2010, the Report on the Work of the Government of each year had also discussed about constructing the ecological compensation systems. Many important documents issued by the State Council like the notice of main work priorities, the notice of deepening the reform of the economic system, the Decision on Implementing the Scientific Development View and Strengthening the Environmental Protection and the Notice of the State Council on Printing and Issuing the Comprehensive Working Scheme on the Energy Conservation and Reduction of Pollutant Emissions all put forward to promote the implementation of the ecological compensation mechanism.

On August 24, 2007, the former State Environmental Protection Administration issued Guiding Opinion of Experimental Work about Implementing Ecological Compensation, to embark on make experiments of ecological compensation in the nature reserves, important ecological function areas, mineral resource development, and watershed water environment protection. After summarizing experience, on May 7, 2008, the Environmental Protection Department issued Notice of First Batch of Pilot Areas for Ecological Compensation, which selected seven representative provinces and cities to as pilot areas for ecological compensation. To be detailed, Shanxi Province was a pilot area for ecological compensation for coal resource development,

Liaoning Province a pilot area for ecological compensation for the headwater conservation area, Zhejiang Province a pilot area for provincial ecological compensation, Minjiang River and Jiulong River of Fujian Province pilot areas for watershed eco-compensation, Dongjiang River of Jiangxi Province a pilot area for ecological compensation for important ecological function areas, Yellow River at South Gansu a pilot area for ecological compensation for watershed supply ecological function areas. In 2009, Hebei Province was named to be a pilot area for full watershed eco-compensation by the Environmental Protection Department. In December, 2011, the 12th Five-year Plan on Environmental Protection (2010-2015) by the State Council specified to "build ecological compensation mechanisms for watershed and major ecological function areas."

Notwithstanding China highlighted ecological compensation systems and policies, it hasn't issued a specialized and guiding ecological compensation law since commencement of pilot work of watershed eco-compensation policies in 2007. Legislation for ecological compensation can only be found in the fundamental law on environmental protection, some laws on preventing and controlling pollution of natural resources and environmental elements as well as some laws enacted by some departments. Among many laws and rules, ecological compensation is not the subject. They have set many principles, but are not operable; they have specified authorities and benefits of different roles of management, but fail to define rights, obligations and responsibilities of the benefit-related parties in the ecological compensation, or the content, procedures, standard, monitoring, evaluation of compensation and the property right system of the



environmental resources. Most compensation is voluntary, which has produced little effect. In practice, administrative departments concerned aren't willing to coordinate, or even some departments have conflict of interest, which has influenced the effect of laws and rules. For lack of lower-level laws, such policies cannot be carried out. Also, the messy and disorderly legislative situation makes it hard to find high-level laws, which hampers legislation and practice in local areas. In some administrative regulations and rules, there are provisions on ecological compensation, but they are of lower-level and generalized, principle-oriented and simple, so they have little meaning for guiding the practice and experimental study and are adverse for building a long-term and steady watershed eco-compensation mechanism.

According to surveys, in the practice of watershed eco-compensation in Beijing, Zhejiang, Henan, Shanxi and Guangdong, it is agreed that for lack of support from higher-level laws, local legislation cannot be brought forward; it has restrained the practice and experimental work of watershed eco-compensation. In particular, for the moment, there is no specification or guidance at national level regarding the cross-border ecological compensation, so it will be impossible for local areas to make breakthroughs in ecological compensation practice. Accordingly, to facilitate the building and perfection of watershed eco-compensation mechanism, it is imperative to establish a specific law to define watershed eco-compensation.

Under this background, to boost the establishment of an ecological compensation legal system, laws on ecological compensation for different areas shall be stipulated. In March, 2011, ADB initiated

its technical assistance project (Project No.: ADB TA-7699 (PRC)) and set up a special team for this project. The team composes of experts in wetland, watershed, area, ocean, forestry, mineral products, fiscal levy, economic analysis and laws and also invites international experts from the ecological compensation field to provide assistance. This is a feature report on legislation for watershed eco-compensation and designed for analyzing problems existing in the practice of watershed eco-compensation, aiming to provide suggestions for the legislation for watershed eco-compensation under Regulations on Ecological Compensation.

This feature report falls into four parts: firstly, introduction, it introduces research background and objectives. Secondly, it has analyzed the practice patterns of watershed eco-compensation both at home and abroad, pointed out existing problems and analyzed the difference in watershed eco-compensation between China and foreign countries. Thirdly, case study of practice of watershed eco-compensation in China; it has analyzed the mode and effect, use of fund during the practice of eco-compensation in Xin'anjiang River and Huaihe River and expounded existing problems. Fourthly, it has put forward suggestions for legislation for watershed eco-compensation after streamlining problems in practice of watershed eco-compensation and the legislative demand.



2. Practice of Watershed Eco-compensation both at Home and Abroad

2.1 Practice and Experience of Watershed Eco-compensation in Foreign Countries

In foreign countries, one may purchase the watershed ecosystem services by means of market trade, one-to-one compensation, ecological label and public payment. Among them, the former three fall into the category of market compensation and the last one the category of policy compensation.

2.1.1 Market Trade

Market trade, also called open trade, takes place when the ecosystem services are measurable and divisible. It is commonly found when the buyer and the seller have trade in a large quantity or full of uncertainties in the ecosystem service market.

(1) Costa Rica: market compensation for watershed ecological protection

Background: Energía Global (EG), located in Sarapiquí watershed, is a private hydropower company serving 40,000 people. It occupies a water source area composed of two branch watersheds of 5,800hm². EG cannot carry out regular production owing to insufficient water resource. Accordingly, to maintain and repair forest cover in the upstream and ensure stable water source of its hydropower station, it has initiated the market compensation for the watershed ecological protection.

Form: EG submits USD 18/ha to the National

Forestry Fund, which will allocate another USD 30/ha. Then, the fund will be paid in cash to the private land owners in the upstream, with the precondition that the private land owners must use their land for forestation, carry out continuous forestry production or protect wooded areas. Those who have just cut the trees or plan to substitute the wild wood with the man-made forests will be disqualified for the compensation. Besides, Compañía de Fuerza Luz and CNFL, both public hydropower companies, and Hidroeléctrica Platannar, a private company, also provide compensation for land through the National Forestry Fund.

(2) Australia Murray-Darling: loan for watershed water evapotranspiration (ET)

Background: in Murray-Darling watershed, Australia, the large-scale land clearing and cutting of local trees and vegetative cover have increased replenishment of ground water and raised the water table to the surface, which has led to severe soil salinization and downstream water deterioration. To deal with this situation, Australia started to provide loan for water ET.

Form: farmers in the downstream buy a loan at AUD 17/1 million liter transpiration water, or make compensation of AUD 85/ha. per year and for 10 years successively. The State Forest Service in possession of land ownership in the upstream can get loan for ET or desalinization through planting trees or other plants, to ultimately improve soil quality.



2.1.2 One-to-one Compensation

One-to-one compensation, also called private trade, is self-organized market compensation. Under this pattern, the benefited party of ecological services will transact directly with the payer. In such transactions, the quantity is small and stable and both parties can reach agreement on transaction conditions and price through negotiation or via the intermediate.

(1) Clean water supply transaction between New York City, the US and the Catskills watershed in the upstream

Background: in New York City, about 90% water consumed comes from Catskills and Delaware River in the upstream. In 1989, the US Environmental Protection Agency requested that all municipal water supplies from the surface water shall, unless the water quality was qualified, be treated with filtering and clearing facilities. The total cost for such action, as estimated, would reach at least USD 6.3 billion (USD 6 billion for new filtering and clearing facilities and USD 0.3-0.5 billion for the yearly operation). If, however, it could input USD 1-1.5 billion into Catskills watershed to improve land utilization and production mode in the watershed for a decade, the water quality would be qualified.

Form: the New York City provides ecological compensation to Catskills watershed. The compensation standard is determined by the Water Service. Compensation means include levying surcharge to users, issuing government bond and trust fund of New York City.

(2) Payment mechanism of Perrier Mineral Water, France

Background: in 1980s, water quality of Rhin-Meuse watershed in Northeast France was threatened by agricultural activities locally. Under such circumstances, natural mineral water companies, who were dependent on the clean water source, had to make a choice, setting up filtering plants, or moving to new water sources, or protecting water source locally.

Form: Perrier Mineral Water Company, the largest natural mineral water manufacturer locally, deemed that protecting water source was the most cost-effective means. Then, it invested about USD 9 million to purchase 1500hm² agricultural land in the upstream and return the land use right to farmers who were willing to improve their land management mode for free. Besides, it entered into contracts of 18-30 years with farmers who agree to use their hand for dairy husbandry. As stated in the contract, Perrier would pay USD 320/ha. per year, for seven years successively.

2.1.3 Public Payment

Public payment is a compensation payment provided by the government in the form of project fund or direct investment. Ecosystem services are public goods, which makes public payment the most common compensation means.

(1) Colombia: collecting ecological service tax

Background: in late 1980s, in face of increasingly severe water resource shortage and tightness of public financial fund, planters of rice and sugarcane in Cauca watershed, Colombia, sponsored 12 water



user associations to put money into protecting upstream areas of the watershed. Later, they successively set up 11 water resource utilization associations, 3 water resource management funds and 3 river companies. Their initiative involved in 1 million hectare of land and 97,000 families.

Form: a charge for use of water resources is levied. Members of the associations voluntarily pay an extra USD 1.5-2 to the Cauca River watershed management company to set up an independent fund for improving watershed water quality and ecological environment. In 1998, the charge for use collected by all water resource associations reached as high as USD 600,000/year.

(2) The ecological compensation fund collected by Parana State Congress, Brazil

Background: in Brazil, 75% of the State-level tax ICMS is allocated according to the financial added value of economic activities. Under this allocation mode, areas having faster economic development and more population will gain more fund than the large-area protected areas. As a result, it has exerted negative impact on the protection of forests.

Form: the Parana Stage Congress passed a law, prescribing that 5% of ICMS would work as "Ecological ICMS", which shall be re-allocated according to the environmental standard. To be detailed, 2.5% will be assigned to areas having protected units or protected zones and the rest 2.5% to regions having watershed, in hope of encouraging protection of forests.

2.1.4 Ecological Label

Ecological label is an indirect payment pattern for ecological environment services. When consumers are willing to pay more for ratified and environmentally-friendly products, such consumers have indirectly purchased the ecological environment services.

In 2000, the volume of trade of organic agricultural products ratified reached USD 21 billion. As estimated, the US consumers are willing to pay an extra USD 0.5-1/pound to buy the ratified and environmentally-friendly coffee. In Sweden, electricity having the green label is 5% higher than that without the label. Consumers buy the ecological environment services through a trustworthy certification system.

2.2 Practice of Watershed Eco-compensation in China

2.2.1 Withholding Policy on Watershed Eco-compensation in Ziya River, Hebei Province

(1) Background

Ziya River water system is one of the five largest water systems in Haihe River

For the moment, watershed eco-compensation in China is enforced primarily through the pattern of examining water quality objectives of the cross-border sections, the drinking water source ecological compensation pattern, and the ecological compensation for the headstream headwater conservation areas. Under the first pattern, monitoring is carried out on the administrative cross-



border section of the watershed. If the water quality from the upstream is qualified, then the downstream area must provide ecological compensation for the upstream; otherwise, the upstream area must provide pollution compensation for the downstream. Currently, practice of this pattern mainly focuses on compensation inside a province. The cross-province compensation only happens in the pilot area Xin'anjiang River watershed, which is on the border between Anhui Province and Zhejiang Province.

watershed. It runs 730km and covers 78,700km². The Ziya River runs through the most cities in Hebei Province, and covers 27,000km², including Shijiazhuang, Handan, Xingtai, Hengshui, Cangzhou, more than 50 counties, and more than 30 million people. Ziya River watershed is the most developed and its per capita GDP takes up 60% of Hebei Province. It also has full-featured industries and the most enterprises, making Ziya River branches the sewage gutter of towns and industries. According to monitoring data in 2007, among the 32 sections under monitoring, 22 are below grade-V; Ziya River water system has the most severe pollution in Hebei Province. Accordingly, Ziya River watershed is typical among water systems in Hebei Province and its successful experience may be used for reference by other water systems.

(2) Solution

Ziya River water system in Hebei Province has adopted the pattern of withholding fund for limit-exceeding sections. Compensation factors include COD and ammonia nitrogen. If limits are exceeded, the ecological compensation fund will be withheld. The standard for withholding the ecological

compensation includes:

Firstly, when the inbound water quality has met the standard (or no inbound current), but during the examination over the cross-city outbound section, if the concentration of COD in water exceeds the limit by less than 0.5 time, then RMB 100,000 will be withheld; by 0.5-1.0 time, RMB 500,000; by 1.0-2.0 times, RMB 1 million; by above 2.0 times, RMB 1.5 million. In the same city, withholding will be accumulative for all sections exceeding the limit.

Secondly, when the inbound water quality has exceeded the limit and during the examination over the outbound section, the concentration of COD continues to rise, then if the concentration exceeds the limit by below 0.5 time, RMB 200,000 will be withheld; by 0.5-1.0 time, RMB 1 million; by 1.0-2.0 times, RMB 2 million; by above 2.0 times, RMB 3 million.

In the same city, withholding will be accumulative for all sections exceeding the limit. Every month, the environmental protection department will directly withhold the compensation fund from the expenditure of the fiscal year according to the limit-exceeding time (s) of the water quality of sections. The ecological compensation fund can only be used for the deep-well drinking water security projects of the Ziya River water system and the water pollution treatment project of the Ziya River watershed.

2.2.2 Cross-border Section Examination Method of Liaohe River Watershed, Liaoning Province

(1) Background



Currently, the water quality of four mainstreams of Liaohe River watershed in Liaoning Province is below grade-V. Liaohe River has the most severe pollution, followed by Great Liaohe River, Hunhe River and Taizi River. The water quality of the upstream of branches of Liaohe River watershed in Liaoning Province is favorable. The water quality of the upstream of Hunhe River and Taizi River, and some branches of Liaohe River is grade II/III. Water quality from the upstream to the downstream declined due to the domestic sewage and industrial wastewater discharged by urban districts on the way.

In October, 2008, Tentative Measures for Examining Water Quality of Outbound Sections of Cross-administrative-area Rivers in Liaoning Province was distributed, specifying examination bases and methods of the 27 cross-district river outbound sections; Notice of Distributing Examination Target Values for Outbound River Sections in 2008 and the Notice of Distributing Examination Target Values for Outbound River Sections in 2009 were issued by the Environmental Protection Department, defining the examination target values for 9 mainstreams of the Liaohe River in Liaoning Province and outbound sections of 18 rivers. The watershed eco-compensation and pollution compensation mechanism was tried out. Sections abovementioned include 2 outbound sections of Shenyang, 2 outbound sections of Anshan, 1 outbound section of Fushun, 2 outbound sections of Benxi, 2 outbound sections of Yingkou, 1 outbound section respectively of Liaoyang, Tieling, Panjin, Dalian, Dandong, Jinzhou, Fuxin, Chaoyang, and Huludao. Among them, 10 run to the sea.

(2) Solution

According to requirements on prevention and treatment of water pollution and the treatment cost, if the mainstreams (including Liaohe River, Hunhe River, Taizi River, Great Liaohe River) of Liaohe River exceed the limit by below 0.5 time, RMB 500,000 will be withheld; for per increase by less than 0.5 time (included), an extra RMB 500,000 will be collected. For other rivers, if they exceed the limit by below 0.5 times (included), RMB 250,000 will be withheld; for per increase by less than 0.5 times (included), an extra RMB 250,000 will be collected.

2.2.3 Ecological Compensation Mechanism for Major Watersheds in Shandong Province

(1) Background

In the South-North Water Transfer Project, the southern section of Yellow River, the Huaihe River watershed, and the Xiaoqinghe River watershed involve in 12 cities and 69 counties in Shandong Province. In this sense, Shandong Province is a major area in the Project and the Two Lakes and One River (Nansi Lake, Dongping Lake, and Xiaoqinghe River) watersheds. In 2006, the discharge amount of key pollutants in Shandong Province fell by some degree, but still failed to meet the goal of reducing COD by 3.5% set at the year beginning. Worse, Shandong Province is in great shortage of water resources, has vulnerable ecosystem, and is still suffering water pollution. Currently, 28.6% of sections of Huaihe River watershed in Shandong are unable to meet the goal set in the national plan; 95.8% of the sections along the South-North Water Transfer line fail to meet requirements of water transfer; only 4% of the Xiaoqinghe River watershed



can meet the standard. Obviously, Shandong still has a long way to go in water pollution prevention and treatment.

(2) Solution

Firstly, compensation will be provided according to the actual loss to farmers (fishermen) that have returned the arable land (fishing land) to wetland before the wetland produces economic benefit. In enforcement, in the first year, the compensation shall be equal to 100% of the net income of the land of the previous year; in the second year, 60%; in the third year, no compensation.

Secondly, for enterprises that have met the national emission standard have to be shut down or move out of the province due to the industrial structural adjustment, some part of the compensation fund, plus other fund, will be provided to them as subsidy.

Thirdly, for municipal sewage pipe networks that have carried out the further treatment projects, the compensation shall be equivalent to the sewage treatment fee collected every year. For network that has carried out "the re-improvement project", the compensation shall be equal to 50% of the pollutant treatment cost cut.

Fourthly, for those that have built new sewage garbage treatment facilities according to the pollution treatment plan, compensation will be provided by means of discounted interest of loan, or providing award for the finished work, so as to strengthen construction of environmental infrastructure in the watershed.

Fifthly, support will be given to enterprises that have adopted advanced and applicable new technologies and new processes to

prevent pollution, to further reduce the total emission of pollutants.

2.2.4 Watershed Eco-compensation Pattern based on water source area protection

(1) Ecological compensation for water source areas in Fujian Province

To improve water quality of the water source area and stop water loss and soil erosion, in 2003, Fujian Province carried out ecological construction in 10 pilot water source areas, including PutianDongzhen Reservoir, according to the concept of "who that benefits shall pay". To be detailed, QuanzhouShanmei, Longmentan, and NanpingDongfeng reservoirs take a portion from the hydropower income as the ecological construction expenditure. PutianDongzhen and QuanzhouShibi reservoirs take a portion from the raised water rate as the ecological compensation. Sanming takes RMB 0.02 from per unit of water rate as the ecological construction expenditure of Dongyaxi reservoir. On this basis, in April, 2007, Fujian again issued Compensation Solutions by Downstream Areas for Forest Ecological Benefit of the Upstream Areas, aiming to build a compensation mechanism for forest ecological benefit in the upstream areas by the downstream areas and promote coordinate development of mountainous areas and coastal areas. The compensation standard is based on the industrial and domestic water consumption in 2005 and gives comprehensive consideration to the ecological zone and its contribution to watershed as well as the local economic development level. After calculation, the yearly compensation for some cities is as



follows: RMB 27 million for Fuzhou, RMB 21 million for Xiamen, RMB 20 million for Quanzhou, RMB 2.2 million for Nanping, RMB 4.2 million for Sanming, RMB 1.6 million for Longyan, RMB 3 million for Zhangzhou, RMB 4.6 million for Putian, and RMB 2.3 million for Ningde. The compensation fund shall be raised by the government inside its administrative region, but cannot be imputed to other departments, units or individuals by means of fee charging or withdrawing compensation fund. It shall be turned over to the provincial financial account at the annual closing. The provincial finance shall, according to the major ecological forest area and the unified compensation standard, calculate the compensation fund of related cities and counties. The compensation fund shall be delivered to cities concerned by means of "special fund for special allocation." Cities concerned, after receiving the special fund document from the province, shall deliver such fund to counties concerned through the farming-support account or by means of "special fund for special allocation", to ensure the timeliness and sufficiency of such fund. Compensation shall be made to farmers who have contributed to protecting ecological functions and water and soil resources of the upstream areas according to a unified standard. Through implementation of this system, a compensation fund of RMB 85.90 million for the ecological forests can be increased, with the annual compensation fund reaching more than RMB 300 million and the compensation standard for ecological forests raised to RMB 7/mu (1mu=667m²). Regarding the time limit of the policy, the limit of bearing compensation fund of each city shall be determined once every three years. The policy shall be carried out since 2007. Furthermore, 35% of the water resource fee will be used for compensation of

ecological forests.

Seeing from the effect of the policy, the ecological compensation mechanism has improved the ecological environment of the watershed in Fujian Province. In the ecological forest areas, 800,000mu open woodland and shrub forests have been converted to wooded areas. The average degree of closeness of standing forests is raised to 0.51 from 0.42, and the unit area standing crop to 5.24m³ from 4.42m³. Study of the ecological compensation mechanisms of these pilot areas has expanded the fund channels for local water source ecological construction, increased input and driven construction of the water source areas.

(2) Ecological compensation for water source area protection in Deqing County, Zhejiang Province

Zhejiang Province has dug into the ecological compensation for drinking water source areas. Deqing County, Huzhou, Zhejiang Province, is a representative, since its western part is the headwater conservation area of the county. In order to return investors for protecting ecology in the west and further encourage people to protect ecology, Deqing County has set up an ecological compensation mechanism. In February, 2005, Deqing County People's Government issued Opinions on Building Ecological Compensation Mechanism in Western Villages and Towns by Deqing County People's Government, defining the scope (west of No.104 national highway in Deqing County) and measures for raising ecological compensation fund. Such measures include: firstly, carrying out the compensation fund of the ecological forests; secondly, building a mechanism that the village and town finance works as guarantee,



and for Moganshan Town and Huatouxiang Town, the basic guarantee by finance shall be exercised so that the disposable financial income of staff supported by the finance can reach the mean level in villages and towns of the county; thirdly, setting up ecological compensation fund of the county and allocating RMB 1 million within the fiscal budget of the county, and taking 10% of the water resource fee, raising RMB 0.1/ton for the raw water resource fee of the reservoirs, taking 1% of land remise fund, 10% of water pollution charge and 5% of agricultural development fund. Opinions have specified that the ecological compensation fund will be brought under the financial account of the county and used specially for protecting ecological environment in the west and building ecological projects. The ecological compensation fund shall be used for specific purpose.

The implementation of the ecological compensation of Deqing County has greatly improved the ecological protection work in the west and has generated ecological protection "benefits": firstly, pollution sources have been treated, with 85 small bamboo shoot plants shutdown, 3 fluorite ores shut down, and 10 chemical bamboo shoot plants rectified; secondly, infrastructures for environmental protection are constructed gradually; thirdly, natural ecological environment has been protected and ameliorated effectively. For the moment, the water quality of the reservoirs maintain grade II-III.

2.2.5 Major problems in Practice

Seeing from practice of ecological compensation of major watersheds, some

problems have been observed.

(1) Lack of legal support

For the moment, legislation on ecological compensation of the country-level is in great shortage and incapable of providing legal basis for the practice of ecological compensation. Despite the Law of the People's Republic of China on Prevention and Control of Water Pollution (revised in 2008) has specified, "the state will, by means of financial transfer payment, build and perfect the compensation mechanism for protecting the water environment of the drinking water conservation areas, and the upstream areas of rivers, lakes and water reservoirs", it fails to state the cross-administrative-area watershed eco-compensation issue, define the labor division of central and local governments in the compensation, the compensation body, or the compensation object. For the moment, there is no policy on implementation measures and technical guide of ecological compensation. Thus the local practice of watershed eco-compensation is full of administrative features, mainly shown in the governmental documents. Also, in the process, problems of insufficient compensation or failed connection between the benefited party and the compensation-needing party pop up.

(2) Insufficient study of theories and technical methods

In practice of watershed eco-compensation, insufficient theoretical basis is an outstanding problem, especially the problem of how to rationally set the compensation standard. For the moment, the standard is set under the lead of the government. It is decided through discussions by departments or even directly



by the leader. It has adopted no scientific method, nor formed through bargaining between the upstream and the downstream governments. As a result, the compensation standard is inconvincible. In some places, the watershed compensation means is irrational, because the examination is taken from the perspective of the watershed administrative section, instead of considering influences from the high-water season and the low-water season. Besides, the compensation means are mainly punitive, rather than encouraging. Seeing from examination criteria, in some watersheds, COD is a main concern, but ammonia nitrogen, total phosphorus, and some other typical pollutants haven't been considered, which disagrees with the situation of the watershed pollution. From the examination scope, for the moment, the examination of water quality of watershed sections targets at mainstreams and primary branches, but not the small branches, this may cause some error to the examination results. In addition, compensation for the watershed water source area hasn't been highlighted. Also, responsibilities and duties haven't been defined for the country, watershed water source areas and the downstream governments. Moreover, policies are unavailable.

(3) Great gap with the stable and long-term ecological compensation mechanism

For the moment, the ecological compensation for watershed water quality adopted in local governments is, strictly speaking, not ecological compensation, but a pollution compensation system of "penalty for limit-exceeding parties" based on the water quality agreement. Main players for such compensation are the government platform. Even if the damaged party and the benefited

party are easy to determine the ecological compensation of the water source area, there is basically no market mechanism. Besides, compensation means are single, mainly in cash, and whether the ecological compensation fund is paid by the finance is legal is pending. Insufficient consideration has been given to policy compensation, material compensation, technical compensation or intelligent compensation. The responsibilities of interested parties haven't been defined. Responsibilities of treating pollution and protecting water quality haven't been determined between the upstream and the downstream. The watershed water quality and water flow agreement based on the "environment responsibility agreement" between the upstream and the downstream hasn't been formed. Accordingly, the practice of ecological compensation foregoing still has a large gap with the ecological compensation mechanism of the ecological meaning.





2.3 Contrasts between Ecological Compensation Means both at Home and Abroad

To sum up from the foregoing practice, there are two compensation patterns in the world, namely the market compensation and the government compensation. Foreign countries mainly adopt the market compensation and China, the government compensation, due to its immature market economy. The two

compensation patterns have their respective merits. Government compensation has powerful guarantee for the allocation of the fund, but is restricted by the administrative area. The market compensation is easy to be realized, but limited by the water right and can only be implemented with the defined water right and low transaction cost. Main differences in the practice of ecological compensation both at home and abroad are shown in Table 1

Table 1 Difference in Practice of Watershed Eco-compensation both at Home and Abroad

country	Connotation	Scope	Standard	Means	Effect
Foreign	Voluntary transaction	Fewer interested parties, smaller scope	The compensation standard is settled through negotiation between both parties, so the compensation effect is good. It can stimulate enthusiasm of protecting environment.	Mainly market compensation	Better
China	Non-voluntary transaction, wider scope	Wide compensation scope, many compensation objects	The compensation standard is set by the government, so the compensation is usually low. The economic development difference between the upstream and downstream of the watershed is still a major problem.	Mainly government compensation	Sometimes, difficult to reach the intended effect



3. Case Study of Watershed Eco-compensation in China

For the moment, the ecological compensation pattern based on examination of water quality of cross-border sections is usually carried out in one province, but Xin'anjiang River is an exception. The watershed eco-compensation for Xin'anjiang River has crossed Anhui Province and Zhejiang Province.

3.1 Case Study of Xin'anjiang River Watershed Eco-compensation

3.1.1 Basic Information of Xin'anjiang River Watershed, Huangshan, Anhui Province

The section in Huangshan of Xin'anjiang River covers 5,545km² and its mainstream runs 242km, taking up 47.5% and 62.9% of their respective total. It has only one cross-province section, at Jiekou. For many years, its outbound flow yearly on average is 6.32 billion m³, taking up more than 68% of the annual water flow into reservoirs of Qiandao Lake. It involves in 1.22 million people in 7 counties of Huangshan.

This section has rich water resources. Its maximum outbound water flow was found to be 11.889 billion m³ in 1999 and minimum 3.228 billion in 1978. On average, its outbound water flow is 6.32 billion m³. Its water quality is stable since 1993. For the moment, 8 sections of Xin'anjiang River watershed are under monitoring, covering mainstreams and major branches. Among these sections, Jiekou is a cross-province

section managed according to the grade-III surface water standard. The surface water is monitored once per month to check 25 indices. In 2010, the 8 sections of Xin'anjiang River in Huangshan reached or exceeded the grade-III standard and 7 of them reached the excellent level. The water quality of outbound sections reached grade-III, to be detailed, the annual mean value of permanganate was 2.08mg/L (for grade-II, ≤ 4 mg/L), COD 7.0mg/L (for grade-II, ≤ 20 mg/L), ammonia nitrogen 0.25mg/L (for grade-II, ≤ 0.5 mg/L).

In 2010, in Huangshan, the discharge amount of COD was 18,294t, of which, 1,904t was from industries (taking up 10.4%), 11,717t from daily life (taking up 64%) and 5,673t from agriculture (taking up 31%). Its total discharge of ammonia nitrogen was 2,472t, of which, 329t from industries (taking up 13.3%), 1,332t from the daily life (taking up 53.9%), and 830t from agriculture (taking up 33.6%).

3.1.2 Environmental Protection Conditions in Qiandao Lake, Zhejiang Province

Qiandao Lake is the largest artificial fresh water lake in China due to the building of Xin'anjiang River Hydropower Station. The power station was commenced in April, 1957 and put into service on September 21, 1959. On April 22, 1960, its first water turbine unit started to generate electricity. Its initial installed gross capacity was 662,500KW and expanded to 845,000KW during 2000-2005. The designed total reservoir capacity is 21.63



billion m³. The watershed area of Qiandao Lake is about 580km², 98% of which is in Chun'an County, Zhejiang Province. Its rain-collecting area above the dam is 10,442km², among which, 6,201km², taking up 59% of the total, is in Anhui Province. The average reservoir inflow per annum is 10.2 billion m³, among which, the inbound flow in Anhui Province is 6.32 billion m³. Besides the mainstreams in the upstream of Xin'anjiang River, the reservoir inflow rivers include Suian River, Lianjiang River and Dongxi River.

(1) Pollutant discharge from industries

Industries in Chun'an County are mainly the textile, foodstuff and building material industries. According to surveys on 59 major and non-major enterprises in the county in 2010, the discharge amount of industrial wastewater was 6.9329 million tons, COD 561.4t (20% of the total discharge), and ammonia nitrogen, 44.6t (13% of the total discharge). Industrial pollution sources are distributed unevenly. Qiandaohu Town, as a major industrial development zone, has diversified industries and a great number of enterprises, making it a major discharger of industrial pollutants. It contributed to 60% of the discharged industrial waste water and 47% of COD in the county.

(2) Pollutant discharge from life source

The life source pollutants mainly come from urban residents, hotels, restaurants, car washing, bathing centers, hospitals and schools. In 2010, the discharge amount of wastewater from living in Chun'an County was 5.9268 million tons, taking up 54% of the total; COD 1,441.95t, taking up 50% of the total; ammonia nitrogen 116.64t, taking

up 33% of the total.

(3) Pollutant discharge from agricultural source

Non-point pollution of agriculture mainly comes from agricultural activities like cultivating of livestock and poultry, aquaculture and farming. According to survey, in Chun'an County, there are 13 large-scale (breeding stock ≥ 500) and 100 more small farms. For the moment, only several of them have carried out the zero-discharge project. Some cultivation farms, however, have a large scale, but insufficient treatment facilities. Even worse, most small farms discharge or stockpile excrements after simple treatment. This has great influence on the water environment. As indicated by data of 2010, the discharge amount of COD of the agricultural source was 834.2t, taking up 30% of the total in the county; ammonia nitrogen, 189.4t, taking up 54%. Moreover, pesticides, fertilizers, agricultural films left in the farmland and unscientific aquaculture can all cause water pollution.

(4) Pollutant discharge from pleasure boats

In recent years, tourism in Chun'an County has been developing fast and has made the mainstay industry of the county. The booming tourism requires more boats and such boats have become a major pollution source of Qiandao Lake. Today, there are 100 more pleasure boats on the Lake; also, there are powerboats, freighters, dredges and self-owned boats. Such boats can produce waste oil, waste water from dining and meal as well as excrements of passengers, which have caused pollution to water.

(5) Garbage flowing into the Lake



Currently, the county has carried out projects of "clean village" and garbage collection and treatment, but still substantive garbage swarms into Qiandao Lake during the flood season, only to pollute the water. According to statistics, the yearly garbage retrieval amount is about 250,000m³. Yet, garbage from Jiekou to Qiandao Lake is more than 100,000t. In the near three years, the expense on retrieving garbage is more than RMB 5 million every year.

Seeing from the five points above, it can be seen that the discharge of COD and ammonia nitrogen from the life source and the agricultural source takes a major proportion. The 12th Five-year Plan for National Economy and Social Development of Chun'an County (2011-2015) still makes the protection of Qiandao Lake a top priority. It requires strictly controlling industrial pollution sources and mainly developing foodstuff & beverages, textile garments and mechanical manufacturing as well as high-tech industries. In addition, with the enforcement of discharge under certain standard and control over the discharge amount, discharge of industrial pollutants will be stabilized, while discharge of life and agricultural pollutants will rise. Rise in population and development of tourism will increase discharge amount of pollutants. In this sense, the agricultural non-point pollution and life pollution will be subject of future pollution control in Chun'an County.

3.1.3 Progress and Effect of Watershed Eco-compensation Mechanism in Xin'anjiang River

In recent years, eutrophication of water in Qiandao Lake is severer and severer. As

monitored by departments concerned in Zhejiang Province, among the 24 indices of quality standard of surface water environment, except the total nitrogen (grade-III; grade-IV in 2008) and total phosphorus (grade-II), the rest 22 meet the grade-I standard. Monitored values of many indices are below the detection limit. This indicates that water quality in Qiandao Lake is good on the whole, but the water environment security situation is pessimistic. Evaluated by the 24 indices, from 2001 to 2011, water quality of Qiandao Lake was grade III-IV (only in 2008, grade-IV). Every year, the index exceeding the limit was the total nitrogen. The eutrophication index range was 28-34. During 2001~2005, the Lake was in an oligotrophic state and during 2006~2011 mesotrophic. The nutritional index is rising year by year. According to monitoring data, quality of water inflow from the inbound section (Jiekou) of Huangshan, Anhui Province, was deteriorated and during 2001~2010, mainly grade-IV. In 2010, the water quality was grade-IV, with the total nitrogen 1.11mg/L, total phosphorus 0.025mg/L and permanganate 1.89mg/L.

Seeing from the monitoring data above, it can be observed that water environmental security of Qiandao Lake was pessimistic. It is imperative to treat water from the upstream of Xin'anjiang River so that it cannot influence the water quality of Qiandao Lake. To meet that end, from 2009, the Environmental Protection Department and the Ministry of Finance worked together to make experiments on the watershed eco-compensation mechanism in Xin'anjiang River in Anhui Province and Zhejiang Province. In 2011, the Environmental Protection Department and the Ministry of Finance issued Implementation Plan on



Making Experiments on Watershed Water Environment Compensation in Xin'anjiang River and initiated the first cross-province watershed eco-compensation project.

The roles of compensation subject and object are shifted between Anhui Province in the upstream and Zhejiang Province in the downstream. Currently, this eco-compensation mechanism only considers water quality (4 indices), rather than water flow. Regarding the monitoring scheme, the eco-compensation section is set on the border between Anhui Province and Zhejiang Province. Monitoring data from the automatic water quality monitoring station are taken as reference. Water is monitored manually once per month and six times per day automatically. The average of monitoring data obtained manually from two provinces is taken as evaluation basis. Regarding compensation fund, the central finance will allocate RMB 300 million, and Anhui Province and Zhejiang Province provide RMB 100 million respectively to work as the compensation fund. If the composite index of water quality is greater than 1, RMB 100 million from Anhui Province will be transferred to Zhejiang Province and vice versa. Regardless of the composite index, RMB 300 million from the central finance will be transferred to Anhui Province as the special fund for protecting water environment in the upstream. The detailed compensation method is as follows:

In the Environmental Quality Standards for Surface Water (GB3838-2002), it has specified four indices, namely, permanganate index, ammonia nitrogen, total nitrogen and total phosphorus. The four indices are used to calculate the comprehensive water quality index according to formula (1). During

calculation, the average of these indices for years shall be taken as the basic limit.

$$P = k_0 \cdot \sum_{i=1}^4 k_i \frac{C_i}{C_{i0}} \quad (1)$$

In formula (1), P is the comprehensive index, and k_0 water quality stable coefficient, which is 0.85 considering changes in natural conditions like rainfall runoff; k_i index weight coefficient, which is calculated according the average of the 4 indices; C_i the average concentration of an index; C_{i0} the basic concentration limit of an index.

(1) Progress of implementing watershed eco-compensation pilot project in Xin'anjiang River, Huangshan

In 2011, the first cross-province eco-compensation pilot work was initiated in Xin'anjiang watershed under the support of the Ministry of Finance and the Ministry of Environmental Protection. This project involved in a cross-border section (Jiekou section) between Anhui Province in the upstream and Zhejiang Province in the downstream. In the following we will analyze the use of expenditure for this first pilot work and the implementation effect in Huangshan. In 2010, the Ministry of Finance and the Ministry of Environmental Protection allocated RMB 46.20 million for ecological compensation to Huangshan, which has started 5 projects using such fund. Huangshan has: (1) built cleaning squads in 418 villages along the Xin'anjiang River watershed, purchased cleaning vehicles, and trained people concerned; (2) organized garbage retrieving teams responsible for collecting garbage on the river surface from TunxiLaoda Bridge to Jiekou section (outbound section); (3) built garbage treatment facilities in villages and towns, selected 10 villages and



towns to build garbage transfer station, and provided cleaning and transporting vehicles; also, it is building a garbage treatment system, under which, garbage is collected by the teams and villages, and then transferred or treated by villages and towns; (4) finished the primary-stage work of water and soil conservation in Hengjiang River section, and the river water source protection in Fengle section; (5) built automatic water quality monitoring station at Jiekou; (5) prepared the outline for plans.

In 2011, according to fund allocation plan of the Ministry of Finance and the Ministry of Environmental Protection, the fund for the pilot project was RMB 300 million, among which, RMB 200 million from the central government and RMB 100 million from Zhejiang Province. RMB 200 million from the central government will be used in the first batch of projects and RMB 100 million from Zhejiang Province for the second batch. For the moment, there are 46 projects (covering 8 sections) are listed in the first batch of 2011. They consume RMB 1.44 billion totally and applied for RMB 186 million. These projects involve in prevention and treatment of non-point pollution in the countryside (including treatment of pollution from raising livestock and poultry, pollution-interception project, construction of garbage treatment facilities, prevention and treatment of industrial pollution, construction of industrial parks, and treatment of environmental pollution and repair of ecology.

(2) Implementation effect of the pilot project in Xin'anjiang River, Huangshan

The pilot project has:

(1) Improved the wastewater collection and

treatment efficiency of Huangshan. Seeing from construction of projects, Huangshan has input a lot into building sewage treatment facilities and mating pipe networks in economic parks, towns, major villages and towns. It plans to build 6 new sewage treatment facilities, which will increase the daily sewage treatment capacity by 30,000t. It will build and expand sewage mating pipe networks by 402km.

(2) Reduced discharge of pollutants in Huangshan and decreased key pollutant discharge indices like COD. It is predicted that the pilot project can cut COD by 11,800t.

(3) Strengthened garbage treatment capacity of Huangshan. Huangshan has built 22 garbage treatment facilities, capable of disposing 146,000t garbage in 22 villages and towns, which has taken the first step in dealing with non-point source garbage pollution in the countryside.

(4) Regulated environmental pollution from livestock and poultry breeding farms. During the implementation process, it plans to regulate 10 farms. After that, it is predicted to cut discharge of COD by 967t, thereby to ameliorate the water environment quality of the watershed.

(5) Repaired ecological shore protection along the river, enhanced soil moisture content on both banks of the watercourse, effectively prevented water loss and soil erosion as well as reservoir deposition and raised the yearly water runoff and guaranteed water quality improvement in the downstream.



3.1.4 Analysis of Existing Problems

(1) No applicable law

Both Zhejiang Province and Anhui Province have insufficient legal basis in implementing watershed eco-compensation. They are still exploring and have to find applicable laws to solve problems.

Zhejiang Province has relatively sufficient legal basis, mainly shown in Several Opinions on Further Improving Ecological Compensation Mechanism (ZHEZHENGFA [2005] No.44), Several Opinions on Building and Perfecting Ecological Compensation Mechanism of Hangzhou Province (HANGSHIWEIBAN [2005] No.8) and Notice of Administrative Measures for Collecting Reserve Fund for Treating Mine Ecological Environment by Zhejiang Provincial People's Government (ZHEZHEGNFA [2001] No.81), Notice of Problems in Administrative Measures for Collecting Reserve Fund for Treating Mine Ecological Environment by the General Office of Zhejiang Provincial People's Government (ZHEZHENGGBANFA [2002] No.48), and Notice of Strengthening Mine Ecological Environmental Protection and Treatment by the General Office of Zhejiang Provincial People's Government (ZHEZHENGGBANFA [2003] No.75). In Anhui Province, except Administrative Measures for Collecting and Using Fund for Mine Environment Recovery and Treatment of Anhui Province, there is no guiding document regarding ecological compensation.

As a whole, during implementation of watershed eco-compensation, the imperfect

legal system and mechanism have been a problem. No systematic framework has been built to organize and integrate policies concerning the watershed eco-compensation, so that the existing watershed eco-compensation measures cannot be taken according to laws. As a result, ecological compensation between the upstream and the downstream of the area and watershed cannot be carried out substantially. Furthermore, departments carry out measures administratively, which has resulted in insufficient compensation, or the mismatching between those getting the compensation and those in need of compensation.

(2) Disputes from compensation standard

So far, under coordination of the Ministry of Finance and the Environmental Protection Department, Zhejiang Province and Anhui Province have taken several discussions and studies on the watershed eco-compensation mechanism for Xin'anjiang River and reached common understanding in the general thinking and framework of implementation measures. They agree that the central finance shall allocate RMB 300 million as the compensation fund for Xin'anjiang River watershed environmental protection (the fund is allocated to Anhui Province for the environment protection of Xin'anjiang watershed) and that Zhejiang and Anhui shall each provide RMB 100 million as the reward /punishment fund in the examination of water environment. In practice, the mean value of primary indices of the water environment quality of the cross-province section of the recent three years is taken as the baseline value. When this value falls within a range, there will be no reward or punishment. If



such indices are better than a certain value, RMB 100 million from Zhejiang Province will be transferred to Anhui and on the contrary, RMB 100 million from Anhui Province to Zhejiang Province. Yet, they still have to negotiate regarding what to do if the water quality of the cross-border section is deteriorating year by year.

(3) Simple use of compensation fund

Seeing from implementation of the pilot project, when the upstream has got the compensation fund from the State, it only uses it for environmental protection. The ecological environmental protection of watershed, however, is a many-sided and systematic project and requires combined action and efforts of many parties. If this fund is only used for environmental protection, it will degrade use efficiency of the fund.

3.2 Case Study of Huaihe River Watershed Eco-compensation

3.2.1 Socioeconomic Conditions of Huaihe River Watershed in Henan Province

(1) Overview of water resources

Surface water resources of Huaihe River watershed in Henan Province are distributed unevenly due to the terrain and physiognomy. Their distribution agrees with that of rainfall.

The high/low runoff areas match the rich/less-rain areas. On the whole, water resources in the south are richer than those in the north, mountainous areas greater than the plain and the west greater than the east. Up to the end

of 2009, 1,401 water reservoirs have been built in the watershed, with the total capacity of 13 billion m³. The construction of gate dams, to some degree, has caused the uneven distribution of water resources. In 2009, the average precipitation in the watershed was 784.9mm, 6.8% less than the multi-year average. The surface water resource was 10.77 billion m³, the underground water resource 10.95 billion m³, the repeated resource of surface water and underground water 3.03 billion m³ and total water resource 18.69 billion m³, 24.1% less than the multi-year average. The water-producing coefficient was 0.28, average water-producing modulus 212,000m³/km², and the per capita water resource was 314m³, less than that (330m³) in Henan Province and taking up 14.3% of the national average.

The mainstream of Huaihe River originated from Taibaiding Peak, Tongbai Mountain, Tongbai County, Henan province. In the south bank, its branches include Shihe River, Zhugan River, Huanghe River, Shiguan River and Bailu River, with Shiguan River the largest one. These branches are short, have large bed slope and rich water flow. In the north bank, branches include Hongru River, Shaying River, Wohui River, Baokuai River and Tuohe River. Most branches originate from mountainous regions in west Henan Province and several from the near-level land in the south of Yellow River. They flow into Huaihe River from northwest to southeast.

(2) Economic and social situation

In 2009, population on the Huaihe River watershed in Henan Province was 59.56 million, taking up 59.8% of the provincial total, with the density of 675/km². Urban



people were 22.33 million, with the urbanization ratio of 37.5%, matching that (37.7%) of the province. Compared with 2005, the population growth was 1.16 million, with the annual average natural increase of 4.9%.

In 2009, GDP in the watershed was 1.08279 trillion, taking up 55.6% of that of the provincial total. The structure of the three industries was 15.3:53.0:31.7. The total industrial output value reached 514.52 billion, taking up 47.5% of GDP. Compared with 2005, GDP increased by 537.18 billion, with the annual average growth of 18.7%.

Huaihe River watershed in Henan Province is a major food producing area and energy source base in China. In 2009, its tillable land area and grain output respectively took up 60% and 62% of the total provincialscope. It has 48.43 million mu (1mu=667m²) effective irrigation area.

3.2.2 Pollutant Discharge in Huaihe River Watershed in Henan Province and Analysis of Pressure Faced by This Region

According to the Plan on Preventing and Controlling Water Pollution in Huaihe River Watershed (2006-2010), in 2005 in the watershed, total discharge of COD was 298,000t and of ammonia nitrogen, 46,000t. In 2010, the total discharge of COD was controlled to be 255,000t, down by 14.45%, and of ammonia nitrogen, 39,000t, down by 15.2%.

In 2009 in the watershed, the total discharge of COD was 254,900t and of ammonia nitrogen, 37,900t, down by 14.5% and 17.6% respectively compared with that in 2005. It can be seen that the discharge of COD and ammonia nitrogen fulfilled the control objectives set in the Plan. For the total discharge of COD and ammonia nitrogen of the watershed during 2006-2010, please refer to Table 2

Table 2 Total Controlled Discharge of COD and Ammonia Nitrogen in the Huaihe River Watershed in Henan Province during 2006-2010

Index	Planned goal		Progress				
	2005	2010	2006	2007	2008	2009	2009 Vs.2005
COD (10,000t)	29.8	25.5	29.9	29.1	26.96	25.49	-14.50%
Ammonia nitrogen (10,000t)	4.6	3.9	4.37	4.38	3.76	3.79	-17.60%



3.2.3 Implementation Progress of Eco-compensation of Huaihe River Watershed in Henan Province

(1) Eco-compensation framework of Huaihe River watershed in Henan Province

1) General thinking

The ecological compensation and pollution compensation mechanism of Henan Province aims to: based on analysis of features of the water environment of the watershed, define the ecological compensation and pollution compensation types of different watersheds and different administrative areas; according to the principle of "the one who has caused pollution shall make the compensation, the one who has benefited shall make the compensation and the one who has provided protection shall be benefited", further define the relation between bodies responsible for ecological compensation and pollution compensation; under the guide of local government, interested enterprises and industries of the upstream and the downstream share the eco-compensation and water environment protection responsibilities, which has effectively solved contradiction between the economic development and water ecological environment of the watershed and ensured sustainable use of water resources, thereby to maintain sustainable development of the society and economy in the upstream and downstream of the watershed.

After defining bodies responsible for ecological compensation and pollution compensation, the next step is to establish a scientific and reasonable ecological

compensation and pollution compensation standard, to lay basis for interested parties to share responsibilities of protecting the water environment of the watershed. In the pilot area in Henan Province, socioeconomic development varies region by region. As a result, in preparation of such standard, responsibilities and economic capability of interested parties shall be given full consideration. Different compensation methods shall be decided according to the local conditions during the implementation of the compensation mechanism.

2) Selection of indices of pollutants in ecological compensation

Water pollution of the watershed in Henan Province mainly comes from domestic and industrial sewage, in which, COD and ammonia nitrogen are main pollution factors. Accordingly, in control of pollutants and total discharge, COD and ammonia nitrogen shall be primary factors. According to the task assignment between Henan Provincial People's Government and cities concerned, during 2006-2010, COD and ammonia nitrogen were key examination indices, without considering heavy metals or phosphorus. This is the same case in the current pilot plan for Henan Province.

3) Watershed eco-compensation standard

For the moment, the watershed eco-compensation standard in Henan Province is carried out by two means: one is based on the pollution treatment cost and the other, based on ecological protection of the drinking water source area.

a. Watershed eco-compensation standard



based on pollution treatment cost. The pollution treatment cost characterization method based on cluster analysis is used for deciding the compensation standard. Then according to the situation of Henan Province, the operating data of urban sewage treatment plants in Henan Province are taken as the research subject. Using principles of cluster analysis, the curve relation between COD concentration and the sewage treatment cost is studied. Then, according to the water quality of Henan Province and analysis of data from sewage treatment plants (the curve relation between COD concentration and the sewage treatment cost), the sewage treatment cost of Henan Province is decided. Finally, using the concept of pollutant treatment benefit, the ratio between COD/ammonia nitrogen and the sewage treatment cost is decided, thereby to decide the compensation standard for each factor.

b. Ecological compensation standard based on ecological protection of drinking water source area

In light of characteristics of ecological compensation and functions of the drinking water source areas in Henan Province, the ecological compensation standard can be decided through the following four methods: Firstly, the cost calculation method according to the net cost input by the upstream; the drinking-water source protected zones are important protective screens to ensure security of drinking water. The water source contributing region in the upstream can ensure quality of drinking water environment and the total amount of water resources. To increase fund and policies support for the drinking water resource protected zones and to construct many ecological projects have

both conserved water source and generated ecological effect. If in the upstream the ecological construction cost is greater than the ecological benefit, the downstream shall compensate the difference to the upstream as the ecological compensation fund. Accordingly, the difference between the ecological construction cost and the ecological benefit can be used as the compensation standard based on the ecological protection of drinking water source regions.

Secondly, the cost analysis method according to water quality difference of the cross-border examination section; under the cost analysis method, water quality difference between the inbound section and outbound section of the upstream water source contributing region of the drinking water source is used to estimate the treatment cost required for improving water quality, which then will be used for calculating the treatment cost as the compensation standard by the downstream to the water source contributing region.

Thirdly, the maximum willingness-to-pay method according to the willingness of inhabitants in the intake area to pay for the value of the water resources; under this method, direct surveys will be done to learn about willingness to pay of consumers, or their choice of products or services to evaluate the value of consumer goods. The compensation standard based on ecological protection of the drinking water source area can adopt this method, to find the maximum per capita willingness to pay of drinking water consumers in the intake area and then multiply the willingness to pay by the pollution to estimate the value of drinking water resources. Finally, the compensation fund provided



by the downstream to the upstream can be decided. According to hypothesis of economic men, consumers usually select a lower compensation standard, so the compensation standard based on the willingness to pay shall be taken as the lower limit.

Fourth, the agreed compensation method through friendly negotiation between the upstream and the downstream; this method starts from the concept of impartiality. In this method, the compensation standard is decided impartially and reasonably through negotiation and coordination between interested parties, to realize a win-win result between both parties.

4) Watershed eco-compensation fund management mechanism

Currently, the Huaihe River watershed eco-compensation mechanism in Henan Province mainly adopts a compensation fund withholding bulletin mechanism. Under this mechanism, the provincial environmental monitoring station summarizes the withholding amount of the ecological compensation fund monthly, and then the provincial environmental protection department and the financial department together report the withholding information of the ecological compensation fund by city to the provincial people's government and its financial bureau and environmental protection bureau. The monitoring station collects the withholding limit of the compensation fund quarterly and the provincial environmental protection department publishes such on press conference also quarterly. This mechanism can remind cities in the province of highlighting the ecological compensation work, which is good for carrying out the ecological compensation work.

5) Laws and codes on watershed eco-compensation

Today, main laws on watershed eco-compensation in Henan Province include: Tentative Method for Ecological Compensation for Water Environment of Shaying River Watershed in Henan Province (YUZHENG BANWEN [2008] No36) issued by General Office of Henan Provincial People's Government in 2008, Measures for Ecological Compensation for Water environment of Huaihe River Watershed in Henan Province (trial) (YHUANWEN [2009] No.222) issued by the provincial environmental protection department and the provincial financial department in 2009, and the Tentative Method for Ecological Compensation for Water Environment in Henan Province (YUZHENG BAN [2010] No.9) issued by the General Office of Henan Provincial People's Government in 2010.

3.2.4 Analysis of Results of the Pilot Work in Huaihe River Watershed Eco-compensation

(1) Improvement in surface water quality

Since the enforcement of Tentative Method for Ecological Compensation for Water Environment of Shaying River Watershed in Henan Province on December 16, 2008, water environment quality in Shaying River has been improved. The water quality in 2009 Vs. in 2008 is shown in Table 3

Compared with that in 2008, in 2009, the mean concentration of COD of Shaying River reduced by 7.97% and of ammonia nitrogen, by 42.85%, indicating improved



Table 3 Monitoring Data of Examination Section of Huaihe River Watershed (Shaying River watershed) in Henan Province (mg/l)

Section	River	City	2008		2009		Variation in water quality (%)	
			COD	ammonia nitrogen	COD	ammonia nitrogen		
Chenqiao, Zhongmou	Jialu River	Zhengzhou	51.32	16.86	50.55	8.78	-1.5	-47.9
Baisha Water Reservoir	Yinghe River	Zhengzhou	13.67	0.23	13.7	0.22	0.25	-0.84
Huangpu Village, Xinzheng	Shuangji River	Zhengzhou	45.18	4.46	40.29	3.93	-10.81	-11.91
Baidukou, Fugou	Jialu River	Kaifeng	34.04	13.54	33.3	7.05	-2.17	-47.95
Mawan, Wuyang	Shahe River	Pingdingshan	18.22	1.69	15.31	1.72	-16	1.99
Yewu Highway Bridge	Lihe River	Pingdingshan	5.81	0.16	5.42	0.19	-6.65	18.49
Gaocun Bridge, Linying	Qingyi River	Xuchang	65.74	4.29	62.48	3.25	-4.97	-24.44
Wuliuzha, Linying	Yinghe River	Xuchang	—	0	17.7	0.22	—	0
Zhifang, Xihua	Yinghe River	Luohe	22.56	3.93	21.06	3.18	-6.63	-19.26
Chengwan, Xihua	Shahe River	Luohe	—	—	17	0.82	—	—
Taochengzha, Yanling	Qingyi River	Luohe	—	—	42.3	3.66	—	—
Dawang Village, Xihua	Jialu River	Zhoukou	33.27	13.35	30.98	6.33	-6.86	-52.54
Zhidian, Shenqi	Yinghe River	Zhoukou	22.06	2.96	23.03	2.17	4.39	-26.93
Average			31.19	5.59	28.7	3.19	-7.97	-42.85

water quality. For the Shahe River, the COD concentration in Mawan and Wuyang sections reduced the greatest by 16%. For the Jialu River, the concentration of ammonia nitrogen in Dawang Village and Xihua sections reduced the greatest by 52.54%. Among the six rivers, Jialu River, Shuangji River and Qingyi River saw improvement in water quality. To be detailed, in Shuangji River, the concentration of COD and ammonia nitrogen reduced by 10.81% and 11.91% respectively; for Jialu River, the two figures were 3.51% and 49.46% respectively; for Qingyi

River, 2.49% and 12.22% respectively. It can be seen that among the three rivers, concentration of COD in Shuangji River reduced the greatest and in Jialu River, the concentration of ammonia nitrogen reduced the most evidently.

(2) Analysis of social effect

With implementation of the watershed eco-compensation policies in Henan Province, an upsurge of improving water environment was initiated. Also, the local government



promoted the force and progress of preventing and controlling water pollution. On succession of implementation of tentative method for ecological compensation for water environment of Shaying River, Zhengzhou prepared 15 projects for environmental treatment of Jialu River watershed and 6 projects for environmental treatment of the Shuangji River watershed. Execution of the foregoing projects has collected and treated sewage from Jialu River and Shuangji River, continuously promoted water quality in Shuangji River and Jialu River, to ensure the outbound water meets requirements of the provincial government. Xuchang has regulated Henan Yilin Paper Industry Co., Ltd., which pollutes the outbound water, and built the shallow-layer and high-efficiency air-flotation project. Pingdingshan will upgrade and rebuild its existing sewage treatment plants, to improve the sewage treatment capacity by 70,000t/day. The foregoing work has expedited the centralized sewage treatment capacity of Henan Province and reduced discharge of key pollutants.

3.2.5 Analysis of Existing Problems

Implementation of Huaihe River watershed eco-compensation policies in Henan Province has generated notable environmental and social effect, but still has some problems and insufficiency:

- (1) Imperfect legal system; even if Henan Province has issued a series of laws for the pilot work, such policies are temporary for lack of support from the higher-level laws, so such policies cannot effectively stimulate watershed environmental protection in a long term.
- (2) Insufficient promotion and education; water environment ecological compensation is a rising economic policy in Henan Province. Some lower-level governments haven't mastered the meaning of ecological compensation; also, some enterprises and people are passive in carrying out the ecological compensation work. Some even discharge sewage on the sly, which has generated great pressure to the government.
- (3) Financial strain in environmental protection; substantive input, especially the fund input, has caused great pressure to local government. Furthermore, the local government is not the only bearing great pressure from capital input. According to provisions on ecological compensation for water environment in Henan Province, when the withheld fund is insufficient for the ecological compensation and award, the provincial-level environmental protection special fund shall be used to make up such insufficiency, which has caused pressure to the provincial-level environmental protection department.
- (4) Imperfect fund management system; for the moment, enforcement of the ecological compensation policies in Henan Province lacks an integrated fund management system, especially a fund monitoring and management system.
- (5) Lack of encouraging compensation standard; currently, the ecological compensation standards for cross-border rivers in Henan Province target at limit-exceeding sections based on the government examination, so they lack of encouragement for continuous improvement of sections meeting the standard.



4. Suggestions on Consummating Legislation on Watershed Eco-compensation

4.1 Defining Compensation Body and Compensation Object

(1) Body of General Watershed Eco-compensation

The general watershed eco-compensation means in the watershed ecosystem service provision, the benefited parties of such services shall, according to a certain compensation standard, provide compensation for the service providers. Bodies of such compensation usually include the centralized life drinking water source areas and the headwater conservation areas. In order to ensure the smooth going of general watershed eco-compensation, it is necessary to define the compensation body. The current laws, however, are ambiguous, lagging and non-systematic, so that they fail to define the general watershed eco-compensation body and consequently produce little effect during the implementation of such compensation.

Bodies of the general watershed eco-compensation include: (1) groups that have benefited from environmental protection in the watershed, the water-utilization activities include water utilization for industrial purpose, for farming and livestock breeding, for living, for hydropower generation, for tourism projects and for aquiculture and so on; (2) Individuals, enterprises or units that have discharged pollutants in their life or production and have influenced the water flow and quality of the watershed, in this case, water-utilization activities include water utilization for industrial enterprises, for

commercial/family/municipal organizations and for recreation and tourism. (3) In practice, the watershed eco-compensation body sometimes is the State, which primarily accomplishes it through financial transfer. Law of the People's Republic of China on Prevention and Control of Water Pollution [Revised] has provided legal basis for the State to make ecological compensation by means of financial transfer and defined the State to be a legal body during watershed eco-compensation.

(2) Object of General Watershed Eco-compensation

The object of watershed eco-compensation refers to a specific object that has received the watershed eco-compensation fund. To ensure providers and contributors of watershed ecological services can be rewarded, it is necessary to define the object of watershed eco-compensation. The compensation object falls into two categories: first, the ecological protectors and second, those who have decreased ecological destruction. The former include those planting and managing water-conserving forests in protected zones, those constructing and managing ecology of the upstream watershed, and those constructing and managing ecology in other areas. They can be local residents, villages or local government. The latter refer to bodies who have given up development opportunities in order to maintain a good ecological environment in the upstream of the watershed. For example, they maybe only select non-pollution projects to maintain



a good ecological condition. Inhabitants are unable to carry out aquaculture and in their plant production, they will consume fewer fertilizers, which has produced opportunity loss. The local government may suffer decrease in fiscal revenue because of incapability of developing tourism resources and attracting investors.

(3) Body and Object of Cross-border Watershed Eco-compensation

The cross-border watershed eco-compensation shall be made according to the plan for preventing and controlling watershed pollution or the water quality (water flow) agreement signed between the upstream and the downstream. In the water quality agreement, the upstream and the downstream have reciprocal rights and obligations and their role of body or object switches between them. When the upstream has performed its obligations under the water quality agreement, the downstream will be the compensation body and accordingly, the upstream, the compensation object. Otherwise, the upstream will be the compensation body and accordingly, the downstream, the compensation object. It is an important and also the hardest section of legislation for watershed eco-compensation to establish the watershed eco-compensation standard. It is important because it lays basis for providing (collecting)

4.2 Establishing Compensation Standards

It is an important and also the hardest section of legislation for watershed eco-compensation to establish the watershed

eco-compensation standard. It is important because it lays basis for providing (collecting) compensation for (from) watershed ecosystem service providers (or destroyers); it is difficult because production and living activities of human have generated harmful influence on environment from many aspects and environmental benefits are hard to be calculated.

(1) Standard for General Watershed Eco-compensation

Such standard may be established using environmental cost-benefit analysis method, under which, the ecological environmental cost can be measured in currency through a series of assessment techniques. Such techniques include the market value method, opportunity cost method, and recovery/protection cost method, shadow project, human capital approach and the willingness-to-pay method.

Such techniques, however, can only provide reference for establishing such standard. In practice, the State may issue guide for such standard and then, the localities can make the ecological compensation standards according to their respective development level and situations.

(2) Standard for Cross-border Watershed Eco-compensation

From the practice of policies on cross-border watershed eco-compensation, it can be concluded that departments that have established such policies in the hope of balancing the pollutant reduction (getting the ecological compensation fund) and the pollutant discharge (paying the ecological compensation), thereby to control discharge



of pollutants into the watershed and improve water environment. Such policies function like this: the compensation standard can stimulate areas that have a lower pollutant marginal treatment cost to reduce more pollutants and that have a higher pollutant marginal treatment costs to reduce fewer, thereby to make the pollutant marginal treatment cost in each area is the same and thereby to control the total discharge of pollutants.

For the moment, the standard for cross-border watershed eco-compensation includes the water quality compensation standard and the water quality/flow-based flux compensation standard. In establishment of compensation standards, it is a consideration whether such standards can promote areas that have a higher marginal pollutant discharge-reducing cost to reduce fewer pollutants and areas that have a lower marginal pollutant discharge-reducing cost to reduce more pollutants. According to the function of policies on cross-border watershed eco-compensation, the establishment of such standards shall consider fully the pollutant reducing cost in the areas in the watershed and the water quality (flux) objectives of the cross-border sections; analyze the best ecological compensation standard and ultimately prepare such standards according to the situation of pollutant reduction in a watershed. Or the standards are established through negotiation between the upstream and the downstream.

4.3 Compensation Means

(1) Fund Compensation

The upstream has protected water resources,

which has most benefited the downstream. Naturally, the body of fund compensation shall be the downstream government.

The common measure taken by the downstream is to regulate the water rate, which generally is composed of the engineering cost, the management cost and the resource cost. Generally speaking, the engineering cost and management cost are relatively stable, so they have little space of rising. By contrast, the resource cost can have a huge space of rising. Thus, the downstream areas can properly improve the water resource fee, which will then be allocated partially to the watershed eco-compensation fund. This method is operable. The upstream can also, referring to the action of the downstream, raise its water rate, which will then be allocated partially to the watershed eco-compensation fund. So far, the watershed eco-compensation fund can be maintained steadily. The upstream must use the compensation fund for special purposes mainly: firstly, for the water conservation, water source protection and ecological environmental construction of the upstream; secondly, water management cost; thirdly, cost of environmental protection in the water source areas.

(2) Policy Compensation

Policy compensation means the higher-level government provides rights and opportunity compensation for the lower-level government. Those receiving the compensation may, within their authorization, use priority and preferential treatment for policy making to enact innovative policies, to strengthen support and provide more preferential for the upstream in aspects of



investment projects, industrial development and fiscal levy and to promote economic development in the upstream and raise fund. It is of importance to use the system resource and policy resource for compensation, which is especially true for upstream areas lack of fund and economic strength. It is fair to say that policy is compensation.

1) Pertinent fiscal policies can be established according to features of ecological construction and environmental protection of upstream of watershed. They are applicable to large rivers. The representative of such policies is the financial transfer payment system in West China.

2) Market compensation policies shall be established to gradually foster the water right transfer market between the upstream and the downstream. Under such policies, the downstream shall pay the water resource cost according to the market price regularly. Such policies are applicable to small watersheds that involve in fewer interested parties. The watershed eco-compensation market is relatively easy to build.

3) Technical project compensation policies shall be established. Under such policies, governments of all levels in the downstream shall arrange a certain number of technical projects in the area annually, to help the upstream regions develop substitute industries, or initiate non-pollution industries, namely, ecological industries. Such policies, having a higher operating cost, are more suitable for the ecological compensation for watersheds within a province or a city.

4) Policies encouraging development in other regions shall be established. Under such policies, the local government shall allow and

support the upstream to make experiments for development in the downstream by means of offering policy preferential in land use, investor recruiting and enterprise migration; it shall guide the upstream to allocate some pollution projects that are not allowed by ecological protection in the upstream. For restrictions from administrative management systems, the development in other regions is more suitable for watershed eco-compensation in a city.

(3) Industrial Compensation

It is practical for the downstream to provide industrial projects for the upstream as a means of compensation through referring to the industrial transfer mechanism due to gradient difference in economic development. It is the best way for reducing the development gap between the upstream and the downstream and improving local living standard to develop industries and explore the capacity of the upstream. The upstream shall have a concept of "to serve the downstream is to develop itself", build a good industrial transfer platform and gather labor-intensive, resource-intensive, high-tech and low-pollution industries of the upstream and the downstream to form industrial colonies and industrial processing areas.

The industrial compensation policies shall take the watershed as a system and consider industrial layout and resource allocation within the watershed framework. Such policies will face difficulty for cross-border watersheds and be more easily carried out in a province. Yet, they may not work due to industrial policies of different regions, but for the watershed within a city, such policies will have more development space but lower operating cost.



(4) Market Compensation

The market mechanism for watershed eco-compensation can be formed only after having the following preconditions:

1) Severe contradiction between supply and demand of ecological services between the upstream and the downstream; in this case, the downstream has higher requirements on water quality or water flow, while the upstream, to chase economic interest, has set up factories, cut forests and opened up wasteland on sloping fields, which has caused water quality pollution, water loss, soil erosion. Besides, the upstream has used pesticides and fertilizers, which has caused non-point pollution. In this situation, the downstream, to get ecological effect such as better water source or sufficient water flow, may pay some ecological compensation fund for the downstream, to form an excitation mechanism for ecological protection in the upstream. Furthermore, the downstream may pay the upstream by means of agreement, requiring the upstream to produce as per ecological protection requirements.

2) Ratification from the public of functions and value of ecological services of the watershed; functions of ecological services are shown externally. The upstream and middle stream are service providers, while the downstream the benefited party of such services. The formation of a market mechanism for ecological compensation requires the public, especially the benefited party of ecological services, to be aware of functions and value of the ecological services of the watershed. According, it is indispensable to promote functions of such services and carry out relevant education and trainings.

3) Clearly-defined property right; the public or government shall have awareness of system innovation. Property right is a basic guarantee for formation of functions of ecological services in the watershed. The clearly-defined property right of land and ecological services in the watershed can build a platform of transaction for both parties. The property right of ecological services can be defined through registering with the public sector.

4) Better results of cost-benefit analysis; the formation of market is an economic behavior driven by economic interest. If the cost-benefit rate of such transaction is higher than their counterparts, this method will be more easily accepted.

With progress of marketization in China, the market compensation mechanism is supposed to be the development trend of the watershed eco-compensation mechanism. In the process, forms of eco-compensation of foreign countries may work as reference, so that China can explore the one-to-one trading compensation pattern and the market-based ecological label pattern.

It should be added that under the first three means, the government plays a leading role. The market compensation means is the development trend of watershed eco-compensation in China. The four means are basis for building watershed eco-compensation mechanisms of different levels. The foregoing has only described a logical framework of such mechanisms. In practice, the four means shall be carried out in watershed eco-compensation of different levels.



4.4 Source and Use of Compensation Fund

After defining principles, body, object and standard of the watershed eco-compensation, it is significant for ensuring smooth going of watershed eco-compensation what legal form to be used to levy the eco-compensation fund, what legal to be used for providing compensation for the object, and how to guarantee reasonable use of funds.

(1) Fund Sources

The compensation fund comes from six sources: (1) fixed source, namely, the part in the fiscal revenue to be used for watershed eco-compensation; (2) the compensation fund in project budget (including ecological construction, ecological protection, ecological development and construction of other public projects), which is decided according to requirements of project construction; (3) the eco-compensation fund from the transfer payment by the central government to the locality, which is calculated according to the financial transfer payment system and decided by the strength of the central finance; (4) the inter-government financial transfer payment between the upstream and the downstream, which is used exclusively for watershed ecological protection and environmental pollution prevention and shall be decided according to the situation of the watershed and economic development level of the upstream and the downstream. (5) Other expenses from the local fiscal revenue of the upstream and the downstream that can be used for watershed compensation; owing to different ecological functions of the watershed, different environmental protection and difference local financial

strength, this part will differ region by region. (6) Fund from the market used for watershed eco-compensation under the guide of the government.

(2) Use of Compensation Fund

At current stage, the State has no law on use of ecological compensation fund. Some local regulations are too general. In Article 7 of revised Law of the People's Republic of China on Prevention and Control of Water Pollution, it reads, "the State shall, by means of financial transfer payment, build and consummate the water environment ecological protection compensation mechanism for drinking water source conservation regions and the upstream of rivers, lakes and reservoirs", but still fails to state how to use the compensation fund. In this case, the use of compensation fund will have no legal basis. Accordingly, it is hereby suggested in the legislation for watershed eco-compensation, the local government, after receiving the compensation fund, shall use a part of it for maintaining watershed resources and protecting environment and the other part for making compensation, according to legal conditions and procedures, for units and individuals who have contributed to watershed ecological services.

4.5 Compensation Implementation Mechanisms

(1) Management of Implementation of Ecological Compensation

The legislation shall mainly include the management and monitoring authority over watershed eco-compensation, the



investigation department, investigation method, body writing the investigation report, decision and its procedures for ecological compensation, monitoring of compensation behaviors and evaluation of compensation effect. To be specific, the management, monitoring and investigation of ecological compensation shall be performed by the national and local competent departments in accordance with related laws. From application for ecological compensation to examination of such application, the investigation process, investigation means (in field or questionnaires), hearing, and query of related parties shall all be defined. The time limit for preparing the investigation reports, primary coverage and publication reason shall give full consideration to remarks or opinions regarding such reports from interested parties of the ecological environment, based on which, the ecological compensation decision shall be made. Monitoring may be carried out by means of internal administrative monitoring and the upper-level department monitoring the lower-level one.

(2) Water Quality Examination System for Cross-border Section of Watershed

Water quality examination of cross-province sections; such sections shall be decided by the Environmental Protection Department, Ministry of Water Resources and provincial/municipal people's government concerned. The body responsible for managing water quality objectives of the cross-province sections shall be defined. The Environmental Protection Department shall examine water quality of such sections according to the yearly objectives; provincial people's government shall take full responsibility for water quality objectives inside their

administrative regions and examine the water quality objectives once quarterly, with examination results checked and issued by the Environmental Protection Department.

Water quality examination of cross-city section in a province; such sections shall be decided by the provincial environmental protection competent department, the provincial water administrative competent department and the city-level people's government. Water quality objectives shall be decided according to the unit water quality objective value and the yearly flow determined by the national and provincial/municipal water pollution prevention and control plan and the provincial water environment functional areas and considering the provincial people's government's total pollutant discharge plan. Municipal people's governments shall take effective measures to cut the pollutant discharge to ensure water quality of sections can meet control objectives. The water quality objectives for cross-city watershed shall be examined once a month, with results checked and issued by the provincial environmental protection administrative competent department.

(3) Pollution Online Monitoring System Matching Watershed Eco-compensation

The provincial environmental protection administrative competent department shall organize water quality monitoring of sections. The provincial water resources departments shall organize the monitoring of water flow and flow direction of sections. Water quality, water flow and flow direction of sections are usually monitored automatically. Then, the monthly average of automatic water monitoring data approved by the provincial



environmental protection department shall be taken as the water quality objective value of the month of the section. For sections where there is no automatic monitoring station, the provincial and municipal environmental monitoring institution shall manually monitor the sections once weekly and take the monthly average of effective monitoring data as the water quality objective value of the month of the section. Water flow and flow direction shall be approved by the provincial water resource department. As the same token, for sections where there is no automatic monitoring station, the provincial and municipal hydrological resource survey institutions shall work with individuals. They may decide the monitoring frequency according to hydrographical features of rivers and decide the water flow and flow direction of the month. The provincial environmental protection department shall work with the provincial water resource department to summarize the water quality, water flow and flow direction of sections of the last month and report the monitoring results to the municipal people's government.

(4) Arbitration System for Watershed Eco-compensation

Arbitration systems will be used when interested parties disagree or oppose decisions on ecological compensation and accordingly resort to administrative reconsideration or administrative proceedings. Such systems shall state the rights and time limit to resort to administrative reconsideration to the ecological compensation competent department of the same level, the time limit to lodge a lawsuit to the people's government in case of opposition to the administrative reconsideration, and the time limit for

compulsory execution if no reconsideration applied within a time.

The arbitration system for cross-administrative-region watershed environmental protection shall be established. Disputes regarding cross-administrative-region water pollution shall be settled through negotiation between the environmental protection competent department of the higher-level people's government and the people's government concerned. If the negotiation fails, either party may submit such disputes to the watershed water pollution prevention and control institution for coordination. In case the coordination fails, either party or the watershed water pollution prevention and control institution may report to the higher-level people's government (for the cross-province disputes, to the State Council) for arbitration. Disputes arising from liabilities for damage and the compensation amount due to water pollution shall be settled by interested parties; if no agreement is reached, such disputes may be submitted to the environmental protection competent department or to arbitration institutions according to legal procedures.

The liabilities for damages and the compensation amount due to cross-province water pollution shall exercise Law of the People's Republic of China on Prevention and Control of Water Pollution. In case of oppositions against monitoring data such as water quality, water flow and flow direction of the cross-city watershed in a province, the provincial environmental monitoring organ and the provincial hydrological resource survey organ shall settle such oppositions according to relevant provisions. If the people's government of all levels and



departments concerned fail to submit reports, bulletins, or refuse to report, or falsely report the water quality and water flow, they shall bear administrative responsibilities prescribed in the law.

(5) Legal Responsibilities

Legal responsibilities mainly include the civil, administrative and criminal penalties when interested parties have violated relevant laws. To be detailed, if eco-compensation working personnel have conducted

misfeasance, negligence, malpractices for selfish or disclosure, their employers or the higher-level competent organization shall carry out administrative sanctions over them. Those found to be guilty shall be inquired for criminal responsibilities. Provisions shall be established for interested parties of the eco-compensation who have provided false information to get the ecological compensation, those who have delayed or refused to pay the eco-compensation and who have destroyed the ecological environment.



Bibliography

- 1 Dong Zhanfeng, Wang Jiannan. Quantitative Standard of Eco-compensation for the Water Source Area in the Middle Route of the South-to-North Water Transfer Project in China [J]. *Frontiers of Environmental Science & Engineering*, 2011, 5(3): 459-473.
- 2 Cheng Bin, Tian Rensheng, Dong Zhanfeng. Patterns and Assessment of the Watershed Eco-Compensation Standard Practices in China[J]. *Ecological Economy*, 2012, 4: 24-29.
- 3 Wang Junfeng, Hou Chaobo. Study on Government-oriented Basin Ecological Compensation Mechanism[J]. *China Population, Resources and Environment*, 2011, 7: 101-106.
- 4 Li Huan, On the Market Mechanism of Ecological Compensation[C]. 2006 National Institute of Environmental and Resources Law Seminar.
- 5 Danièle Perrot-Maître and Patsy Davis, Esq. Case Studies of Markets and Innovative Financial Mechanisms for Water Services from Forests[Z]. 2001.
- 6 Nels Johnson, Andy White, and Danièle Perrot-Maître. Developing markets for water services from forests: issues and lessons for innovators[R].
- 7 Zhao Chunguang. Research on China's Basin Ecological Compensation Legal System[D]. Doctoral Dissertation of Ocean University of China 2009.
- 8 Ding Min. Ecological Compensation System of Forest in Costa Rica[J]. *World Environment*, 2007 (06):66-69.
- 9 Ren Yong. Seven issues for establishing ecological compensation mechanism in China[J]. *Seven issues for establishing ecological compensation mechanism in China*, 2008, (08): 28-36.
- 10 Ecological compensation mechanism and policy research group. Ecological compensation mechanism and policy research in China[M]. Science Press. 2007.
- 11 Wang Jinnan, Zhang Huiyuan, Wan Jun. Thoughts on ecological compensation mechanism and policy framework[B]. *Chinese environmental policy*. 2007, 8(2):1-23.
- 12 National environmental economic policies pilot technology group. Annual summary report of national environmental economic policy research and pilot(2007-2011)[R]. Beijing, 2007-2012.



- 13 Kong Fanbin, Zhang Liguo, Chen Jiancheng. Study on the Characteristics, system, and evaluation of the legal system of China's ecological compensation policy[J]. Journal of Beijing Forestry University (Social Sciences), 2010, 9(1):41-47.
- 14 Chinese Academy of Sciences (CAS).China Sustainable Development Report 2008[M]. Beijing: Science Press; 2008.
- 15 Chen Xiangman, et al. On Relation between Watershed Areas and Administrative Areas and Its Optimization[J]. Human Geography, 2001, 16(4): 67-70.
- 16 Chang Miao, et al. Study on Watershed Eco-compensation Mechanism[J]. Environmental Protection, 2005, 12: 60-62.
- 17 Wang Jinnan, et al. On Ecological Compensation Mechanism and Policy[J]. Environmental Protection, 2006, 19: 24-28.
- 18 Huang Xisheng. Connotation and System of Watershed Eco-compensation[J]. Economics of Water Resources, 2008, 26(5): 65-68.
- 19 Liu Guihuan, et al. Primary Study on Watershed Eco-compensation Mechanism in Beijing, Tianjin, Hebei [J]. Chinese Journal of Population Resources and Environment, 2006, 16(4): 120-124.
- 20 Zhang Huiyuan. Design of Watershed Eco-compensation Mechanism in China [J]. Environmental Protection, 2006, 10A: 49-54.
- 21 Liu Guihuan, et al. Analysis of Practice of Watershed Eco-compensation in China [J]. Environmental Protection, 2010, (23): 26-29.
- 22 Mao Tao. Legislation of Regional Watershed Eco-compensation in China and Its Perfection [J]. Journal of Chongqing Technology and Business University (social sciences), 2010, 27(2): 99-104.
- 23 Zhao Yushan, et al. Practice Pattern of Watershed Eco-compensation in Foreign Countries and Reference Value for China [J]. World Agriculture, 2008, (4): 14-17.
- 24 Qian Shuimiao, et al. On Construction of Watershed Eco-compensation System [J]. Journal of China University of Geosciences (social sciences), 2005, 5(5): 80-84.
- 25 Yang Daobo. Study on Legal Problems in Watershed Eco-compensation [J]. Environmental Science and Technology, 2006, 29(9): 57-59.



-
- 26 Cui Guangping. Thinking of Legislation for Watershed Eco-compensation in China [J]. Environmental Protection, 2011, 1A: 36-38.
-
- 27 Yan Hai. On Legal System of Watershed Eco-compensation[C]. Proceedings of Conference of China Environmental and Resources Law Society, 2006, 919-923.
-
- 28 Liu Sidian, et al. Discussions of Several Problems in Legal System of Ecological Compensation in China [J]. Legal & Economy, 2011, (4): 57-58.
-
- 29 Cai Huilian. Legal Thinking of Ecological Compensation for Cross-watershed Water Transfer Right in China [J]. Journal of China University of Geosciences (social sciences) , 2011, 9(4): 45-49.
-
- 30 Song Lei. Legal Analysis of Ecological Compensation Systems in Watershed Comprehensive Management [J]. Environmental Science and Technology, 2009, 32(9): 182-186.
-
- 31 Zeng Na. Practice of Cross-border Watershed Eco-compensation Mechanism and Reflect Thinking [J]. Journal of Yunnan Agricultural University, 2010, 4(4): 37-40.
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