Eco-Compensation Mechanisms and Policies in China

Task Force on Eco-Compensation Mechanisms and Policies, CCICED

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Executive Summary

As China's economy has developed rapidly, ecological and environmental problems have increasingly become bottlenecks restricting the overall future sustainability of the country's socio-economic development. The Chinese government has proposed the concept of scientific development with emphasis on people centered, integrated, coordinated and sustainable development, and special attention has been put on ecological construction through various policies and means which has been contributing significantly to the improvement of ecological conditions of the country. However, policies related to ecological conservation are not readily in the place, particularly economic policies for ecological construction are still missing, leading to unequal distribution of ecological benefit and economic benefit between protectors and beneficiaries, damagers and victims. Consequently, beneficiaries are gaining from ecological benefit without bearing responsibilities and costs of deteriorating the ecology, but the protectors are not getting necessary economic incentives. The distortion of such relations brings China's ecological conservation into a very hard condition and affects coordinated development among the regions and stakeholders involved in. There is a high need to establish eco-compensation mechanism to solve those problems for readjustment of ecological benefit and economic benefit of the stakeholders, improvement of eco-environmental protection, and equable development between rural and urban, regional and social development.

Eco-compensation mechanisms have become a hot topic in the society. The representatives of the National People's Congress and the China's People's Political Consultative Conference have addressed in the resolution of the establishment of the relevant mechanism and policies over the years. The academic community has initiated research in the field of assessment of eco-system services that has provided a strong theoretical basis for eco-compensation mechanism and policy design. And the Central Government and many local governments have started to explore approaches for eco-compensation, such as eco-compensation fee of public ecological forest by SFA, SLCP and NEPP by payments of financial transfer of central government, resources tax and fee of mineral resources, mineral deposit, and watershed eco-compensation between upstream and downstream river by negotiating among local governments.

Although several successful initiatives had been carried out at national, regional and local levels, significant research still needs to be done on their theoretical underpinnings and practical implementation. Current challenges include the following:

lack of a commonly-agreed-upon definition of "eco-compensation"; the gap between the theory and practice of eco-compensation mechanisms; the need to improve the scientific understanding of ecosystem services and basis for compensation standards; the need to develop more sources of finance for these schemes; the existence of significant institutional constraints; the lack of a legal framework for accurately addressing society's and the economy's needs.

Based on the research progress and urgent needs for decision making, the China Committee for International Cooperation on Environment and Development (CCICED) established the Task Force on eco-compensation and policy research in 2005. The Task Force contains six thematic research fields including national strategy, theory and method, watershed, mineral resource development, forest and natural reserves. Summary of domestic and international experience, interview of governmental officials at central and line agencies involved in, and field surveys and several internal and international conferences have been conducted in the due course and this report makes general summary and recommendations generated from the research. They are following:

- Definition of Eco-compensation. Eco-compensation is a type of institutional arrangement to protect and sustainable use ecosystem services, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures. In other words, eco-compensation mechanism aims to protect ecological environment, improve man-nature relations. It is a public regulation aiming at adjustment of relations between the stakeholders involving in ecological conservation on the basis of ecosystem service values, cost for ecological conservation, opportunity cost, and via means of the government and market mechanism. It is needed to be noticed that eco-compensation is different with environmental pollution fees and resource exploitation fees.

- Principle of Eco-compensation. Those are: damager pays principle, user pays principle, and beneficiary pays principle, compensation to the protectors. To provide eco-compensation in accordance with local conditions and ecological types, and eco-compensation plan would have to accord with the national eco-restoration arrangement and socio-economic development plan; to make eco-compensation framework by taking into consideration of temporal scales, and the overall objective and specific objectives with time line should be reflected in the framework; A "Three Step" strategy could be adopted for eco-compensation, i.e., perfect phase of eco-funds, collateral phase between eco-fund and eco-tax, and eco-tax phase. It is expected that a perfect eco-compensation mechanism could take effect by then; To conduct pilot

studies wherever necessary, and explore relevant laws, regulations and standards for an effective eco-restoration management system, and financial management system. And relevant roles and regulations should be in place, and their operations be regulated for a large scale demonstration.

- Key fields of eco-compensation. The important areas of eco-compensation should be set thoughtfully based on the need of practice and the foundation of implementation. Meanwhile, we can, according to the range of responsibility, set down a clear priority field for which the government promotes the establishment of mechanism, i.e. eco-compensation mechanism of forest, grassland, wetland, important eco-function zones, development of mineral resources and cross-boundary medium watershed the central government focuses on. Local governments are responsible for establishing eco-compensation of urban water source and local small watershed within their administrative districts and cooperate with the central government in establishing eco-compensation of cross-boundary medium watershed. Specially, considering the regional and important eco-function zones compensation, such factors should be noticed as the difference of different regions and ecosystems, and the contribution of different elements, etc. Also, except for perfecting the existed ecological protection program, the urgent issue is to establish long-term effective mechanisms for eco-compensation

- Methods and basis for determination of compensation standards. Compensation standards could be determined following those four values: investment of the protectors and opportunity cost, gains of the beneficiaries, rehabilitation cost of the damages, and ecosystem services. According to rule of thumb, the sum of direct investment and opportunity cost should be the base-line for setting the standard, while the value of ecosystem services be considered as theoretical ceiling values for compensation. Practical standard could be determined through Game-negotiation and in accordance with the real situation of the country and the regions, for instance, levels of economic development and ecological deterioration, and dynamic adjustment is needed with consideration of ecological conservation and socio-economic development.

- To deal with several important relations in eco-compensation. ①Relations between the Central Government and local governments. The Central Government should provide policy guidance, legislative basis and financial support for local governments for establishing eco-compensation mechanism. It would also have to guide the local governments to formulate, at the first place, country wide and regional wide, inter-watershed eco-compensation mechanism. It is widely accepted that local governments are the main actors in formulating and implementing of the mechanism.

②Relations between government and market. Both the government and market play an important role in establishment of eco-compensation mechanism. However, based on the ecological conservation status and market development in China, the government plays a key role in establishing eco-compensation mechanism including policy and law, and provides support for a large scale eco-compensation. Only in some cases where providers and receivers of the compensation have been clearly identified, eco-compensation could be implemented via market approach. ③Relations between eco-compensation and poverty alleviation. Eco-compensation differentiates with poverty alleviation. And eco-compensation is not for social equality and narrowing the gap between the rich and the poor. A mixture of eco-compensation and poverty alleviation would lead to an increasing damage of ecosystems. It is vital to establish a coordination and interaction mechanism between the key protection areas and beneficial areas, and guide the beneficial areas to provide socio-economic support to protection areas. ④Relations between "blood generating" and "blood transmitting". "Blood generating" kind of compensation should be encouraged through initiating of eco-conservation and capacity rising programs, while "blood transmitting" kind of compensation could be applied for the ordinary people. ⑤Relations between the new funds and the previous funds. The priority should be given to solve the problem existing in the new funds. Only on the basis of successful management of the new funds, can the previous ones be solved. The local governments and enterprises shoulder responsibility for the new funds, while the previous funds should be solved by the central government. ⑥ Relations between integrated and sectoral platforms. An integrated eco-compensation platform dominated by the government should be established for an effective operation. However, various platforms should be encouraged at the local levels for exploration of various types of eco-compensation.

- To establish the legislation process of eco-compensation step by step. It is suggested that an eco-compensation implementation policy guideline should be formulated by the State Council recently so that to identify the scope, targets, means and standards for eco-compensation under the framework of law.

- To make perfect for financial system of eco-compensation and increase funding via various sources. Financial transferring system is a direct and ease mean for eco-compensation. But environmental impact should share a high weight and the investment in ecologically fragile and the key protection regions should be further increased. Following equality and common service principle, financial transfer to the western regions should be increased, and for the areas with ecological importance (e.g., natural reserves) or containing ecological key elements (e.g., ecological forest), purchasing by the State could be encouraged for a long term investment mechanism in

ecological important regions. An eco-compensation mechanism with consideration of people's demand for ecological services, public's willingness to pay, strengthening the initiatives of private enterprises, intensifying the communication with financial department, seeking the technique support of relative experts and establishing special fund donated by international NGOs should be set up for a diversified compensation approach.

- To management mechanism of eco-compensation. For the meantime, it is urgent to strengthen eco-compensation work and integrating projects related to eco-compensation within departments and administrative borders. The eco-compensation work across the departments and boundary should be carried out through negotiation with the coordination of the upper level organizations. For the long run, it is necessary to establish an eco-compensation management committee/group under the leadership of the State Council. And it could comprise relevant ministries, such as the Commission for Development and Reform, the Ministry of Finance, the Bureau of environmental Protection, the Bureau of Forestry, The Ministry of Irrigation, and the Ministry of Agriculture, for coordination, supervision, arbitration, reward and punishment. Several offices could be established under the umbra of the committee as line offices, and a Technical Consultative Commission consisting of experts should be set up for policy and technical consultancy. Wherever necessary, formulating local management committee/group in line with the national one.

- To strengthen scientific research on eco-compensation. Eco-compensation mechanism is a new research field with features of complexity and long-term tasks. It covers ecological protection and reconstruction and collection and utilization of relevant funds. Eco-compensation mechanism is at its early stage in China due to a low level economic development and conflicts between economic development and ecological conservation. It is therefore suggested to integrate eco-compensation issues into national key scientific research plan, for instance, techniques for eco-compensation standard, accounting of physical values of ecosystem services, conjunction of ecosystem services and eco-compensation, targets, standards, methods of eco-compensation, as well as ecological impact assessment of the resource development and key projects, etc. Moreover, ecological monitoring system research should be stressed in order to provide technical support to establish an effective eco-compensation mechanism.

General Report of Eco-compensation Mechanism and Policies in China

Task Force for Eco-compensation Mechanisms and Policies

1 Significance and necessity of establishing eco-compensation mechanism in China

As China's economy has developed rapidly, ecological and environmental problems have increasingly become bottlenecks restricting the overall future sustainability of the country's socio-economic development. The Chinese government has proposed the concept of scientific development with emphasis on people centered, integrated, coordinated and sustainable development, and special attention has been put on ecological construction through various policies and means which has been contributing significantly to the improvement of ecological conditions of the country. However, policies related to ecological conservation are not readily in the place, particularly economic policies for ecological construction are still missing, leading to unequal distribution of ecological benefit and economic benefit between protectors and beneficiaries, damagers and victims. Consequently, beneficiaries are gaining from ecological benefit without bearing responsibilities and costs of deteriorating the ecology, but the protectors are not getting necessary economic incentives. The distortion of such relations brings China's ecological conservation into a very hard condition and affects coordinated development among the regions and stakeholders involved in. There is a high need to establish eco-compensation mechanism to solve those problems for readjustment of ecological benefit and economic benefit of the stakeholders, improvement of eco-environmental protection, and equable development between rural and urban, regional and social development.

Eco-compensation mechanisms have become a hot topic in the society. The representatives of the National People's Congress and the China's People's Political Consultative Conference have addressed in the resolution of the establishment of the relevant mechanism and policies over the years. And the academic community has initiated research in the field of assessment of eco-system services that has provided a strong theoretical basis for eco-compensation mechanism and policy design. Last but not the least, the Central Government and many local governments have started to explore approaches for eco-compensation. Several laws and regulations have been promulgated, such as "Decision for fulfilling scientific development and enhancing environmental protection of the State Council" in Dec. 2005, "The compendium of the 11^{th} five-year plan for the domestic economy and social development" in 2006. These documents stress that eco-compensation mechanisms should be adopted as soon as possible. To ensure long term effects of the mechanism, the State Council has

proposed that “the eco-compensation mechanism should be on the basis of the principles of whoever develops protects, whoever damages treats, and whoever benefits treats”, indicating that China has already had a strong basis for eco-compensation mechanism in terms of political willingness, practical implications and scientific basis.

Based on the research progress and urgent needs for decision making, the China Committee for International Cooperation on Environment and Development (CCICED) established the Task Force on eco-compensation and policy research in 2005, with aims of establishing national strategies and sectoral policies for eco-compensation, and making concrete proposals and recommendations for the government. The Task Force contains six thematic research fields including national strategy, theory and method, watershed, mineral resource development, forest and natural reserves. Summary of domestic and international experience, interview of governmental officials at central and line agencies involved in, and field surveys and several internal and international conferences have been conducted in the due course and this report makes general summary and recommendations generated from the research.

2 Definition and theoretical basis of Eco-compensation

2.1 Definition and connotation

There still does not exist a relatively clear and uniform definition for eco-compensation. Based on the research conclusions and integration with the actual situation in China, eco-compensation may be defined as follows: Eco-compensation is a type of institutional arrangement to protect and sustainable use ecosystem services, and to adjust the distribution of costs and benefits between different actors and stakeholders, mainly through economic measures. In other words, eco-compensation mechanism aims to protect ecological environment, improve man-nature relations. It is a public regulation aiming at adjustment of relations between the stakeholders involving in ecological conservation on the basis of ecosystem service values, cost for ecological conservation, opportunity cost, and via means of the government and market mechanism. There are broad and narrow senses of understanding the concept: in a broad sense, the eco-compensation refers to both the incentives to the protection of ecosystem and natural resources, or the compensation to the loss of damaging ecosystem and natural resources, and charges to the environmental polluters. In a narrow sense, it refers to the first meaning as described above. In China, as a series of laws and regulations are available for pollution charges, it is therefore needed to establish an eco-compensation mechanism based on ecosystem service. This research hence adopts the narrow concept of eco-compensation.

The main contents covered in the eco-compensation are: 1) to compensate the costs of ecological conservation and restoration or damage; 2) to internalize the economic benefit externalities via economic means; 3) to compensate the opportunity costs of foregone development due to ecological conservation or restoration activities; 4) to invest in ecologically significant regions or targets. Internalization of external cost is a basic principle of eco-compensation. Protectors' investment in protection and relevant construction for improvement of ecosystem services, or their opportunity cost are considered as determines of external economy for eco-compensation, and the costs for rehabilitation of ecosystem services and opportunity cost of the victims are considered as determines of external non-economy.

As the narrow definition of eco-compensation is similar with Payment for Ecosystem Services (PES) and Payment for Ecological benefit (PEB), this report therefore uses those terminologies simultaneously.

2.2 Theoretic bases

The theories of ecological economics, environmental economics and resource economics, especially eco-environmental value theory, and the theories of externalities and public goods are the basis for the research.

2.2.1 Eco-environmental value theory

In theory, eco-compensation is an economic means to promote ecological protection. Therefore, knowledge of the characteristics and value of ecosystems and the natural environment is fundamental for implementing eco-compensation mechanisms. Policymakers and the public have long operated under the implicit assumption that natural resources and ecosystem services are inexhaustible and undegradable. However, with the worsening state of the country's environment, the importance of the environment is being increasingly recognized. The development of in-depth knowledge from the research of ecosystems, especially of ecosystem service functions, is an important support to build up eco-compensation mechanisms. Costanza and MA have played the epoch-making role in such research.

The world's ecosystems serve many functions, including supply functions, regulatory functions, cultural functions as well as support functions. When making decisions relevant to ecosystems, both human welfare as well as the intrinsic value of ecosystems should be considered at the same time.

2.2.2 Externality theory

Externality theory is the foundation for environmental and resource economics and policy. Positive/negative environmental externalities resulted if during the production

or consumption process environmental benefits/costs are created that are not fully captured by the producer or consumer of these benefits/costs. As a result, the production and consumption choices made by these actors, which are determined by their private costs and benefits from the activity, diverge from those that would be socially optimal, since a wedge exists between the private and social costs and benefits of the activity. The result of this is a range of adverse environmental outcomes, including insufficient conservation activities and excessive resource exploitation.

A. C. Pigou theorized that market mechanisms such as taxes and subsidies could be used to more closely align private and social costs and benefits in a society. Specifically, taxing or subsidizing an individual by exactly the amount of the positive/negative externality they are producing by a given activity "internalizes" the externality (i.e. the full social cost and benefit of the activity are also the individual's private cost and benefit), so that the individual's private decisions reflect socially optimal decisions. Thus, if a damager is taxed by exactly the amount of damages he creates, he would chose production and damage levels that are socially optimal. If someone who protects an important ecosystem is subsidized by exactly the amount of the public benefits created by the ecosystem, the individual's private decisions would also be socially optimal. As such, the government should make use of such "Pigouvian Taxes" when the private and social environmental costs and benefits of an activity diverge.

2.2.3 The public goods theory

Related to externalities are public goods. Pure public goods are goods that are non-competitive and non-exclusive. These two characteristics mean that the market is a poor provider of the socially optimal quantity of public goods. This is because consumers – assuming that others will also be paying for its provision – will have little incentive to pay their full "willingness to pay" for the good, resulting in the market supply being lower than what is socially optimal level. This is commonly referred to as the "free rider" problem. Another, similar type of problem is the "tragedy of the commons", which describes the situation wherein the rights governing use of a commonly used competitive good (e.g. groundwater) lack clarity and enforceability, thereby making it a *de facto* non-exclusive good, resulting in its overuse (i.e. use beyond what is socially optimal).

Due to these problems, the government is seen as the key provider of public goods. However, determining the "socially optimal" level of public goods provision requires dialogue and debate in society as a whole.

3 Current state of research and initiatives at national and international levels

3.1 Research and practice of eco-compensation abroad

Internationally, eco-compensation refers to PES or PEB, and it can be categorized into four main types（Sara J. Scherr et al. 2006, Developing future ecosystem service payment in China: Lessons learned from international experience）:

(1) Direct public payments (such as China's Natural Forest Protection Program, Grain for Green Program, and Ecological Forest Protection Program) in which the government makes payments directly to rural landowners and other providers of ecosystem services. This form of PES is the most common globally. This category may include conservation easements, where landowners are compensated to set aside part or all of their land for conservation purposes.

(2) Cap-and-Trade Schemes (such as the European Union Emissions Trading Scheme) in which a government or regulatory body first sets a limit (a "cap" or a "floor") on the amount of ecosystem degradation or pollution permitted in a given area. Firms or individuals subject to these regulations are given the options to meet their obligations either by complying directly, or by financing other landowners to undertake conservation activities that fully offset that damage. "Credits" reflecting such offsets may be traded and thus acquire a market price.

(3) Direct Private Payments: Direct private payments function much like the public payments described above, except that non-profit organizations or for-profit companies take the place of the government as the buyer of the ecosystem service in question. These payments are often referred to informally as "voluntary payments" or "voluntary markets" because the buyers engage in transactions without any regulatory incentives. Businesses and/or individual consumers may engage in non-compliant markets for reasons of philanthropy, risk management and/or in preparation for participation in a regulatory market (Hawn 2006).

(4) Eco-Certification Programs enable consumers to choose to pay a price premium for products produced in a way that is certified by an independent third party, according to standard criteria, to be ecologically friendly.

In a recent global overview of emerging markets for forest ecosystem services, over 280 cases of actual and proposed payments for four sets of ecosystem services were examined. These include 75 deals for carbon sequestration, 72 for biodiversity conservation, 61 for watershed protection, 51 for landscape beauty and 28 for sales of "bundled services". Far from being concentrated in the developed world, these cases

were drawn from a range of countries in the Americas, the Caribbean, Europe, Africa, Asia and the Pacific.

As for ecological protection relevant to agriculture, the U.S. and Europe both have programs involving land retirement for ecological restoration, in which direct payments are made to farmers for management practices that protect soil and other ecosystem services. In the 1950s, the American government created the Soil Bank Program, the precursor to today's U.S. Conservation Reserve Program, which is similar to China's 1980 desertification prevention plan. In these arrangements government play a stronger role in establishing levels of payments and compensation, and provide a vehicle for greater public participation and transparency.

Payments for watershed protection services can be grouped into several categories including water quality, water quantity, and flood control. These three categories of services, while linked, often have different beneficiaries and are furthered by different land use practices; thus, they are commonly the focus of separate markets. Public payments for all three categories of watershed services, as well as private payments for water quality and water quantity, have the potential to evolve into significant areas for pro-poor PES. As for watershed compensation, the one of the successful cases is that the Australia government promotes the watershed integrated management compensation work at local levels via government subsidy. South Africa annually invests about 0.17 billion $US for watershed protection, water quality improvement and water supply increase with combining watershed protection and restoration programs and poverty reduction actions.

As for historical ecological damage issues, the U.S government has created a new fund for ecological restoration. In Germany, a specific mineral rehabilitation company takes charge of the mineral restoration, the capital of which is composed of center government (75%) and local governments (25%); In the case of damages that occur after a law has been instated, restoration is implemented by mineral developers.

Regarding forest ecosystems, the key methods to realize the eco-compensation are: biodiversity protection, carbon sequestration and landscape beauty and recreation. Under the two largest and most well-known carbon cap and trade schemes-the European Emissions Trading Scheme (EU-ETS) and the Kyoto Clean Development Mechanism-362 million tons of CO_2 and 400 million tons of CO_2, respectively, were traded in 2005. According to Point Carbon, this was a 700 mt increase in volume over 2004 and amounted to a combined worth of $9.4 billion (Point Carbon 2006).

In a view of compensation for landscape beauty and recreations, these services often overlap with biodiversity services, and the commodity being purchased by tourists is

access rights to scenic beauty, not biodiversity per se. payments to land stewards by enterprises that cater to tourists are typically negotiated on a case-by-case basis. Furthermore, in the case of national parks, payments are often not conditional: local communities are required to curtail their activities in the park, but as compensation they receive a portion of park revenues. In terms of landscape beauty payments, the most frequent market-based mechanisms used to attach value to these services were: access rights/entrance payments such as visitor fees (50%), package tourism deals (25%) and management arrangements or projects (25%) (Landell-Mills and Porras 2002).

As for natural area protection like biodiversity protection, the eco-compensation in this field has become a good approach for the owners and managers of forest resources for their good stewardship of biodiversity. The contents in detail are as following: purchase of high-value habitat(private land acquisition, public land acquisition), payment for access to species or habitat(bio-prospecting rights, research permits, hunting, fishing or gathering permits for wild species and ecotourism use), payment for biodiversity-conserving management(conservation easements, conservation land lease, conservation concession, community concession in public protected areas and management contracts for habitat or species conservation on private farms, forests, grazing lands, tradable rights under cap & trade regulations(tradable wetland mitigation credits, tradable development rights and tradable biodiversity credits) and support biodiversity-conserving businesses(business shares in enterprises that manage for biodiversity conservation and biodiversity-friendly products). In a word, eco-compensation money is raised via government budget or funds, and it is carried out combining with the agriculture, watershed and forest research at abroad.

Above all, there is much useful experience on the theory and practice of eco-compensation that can be drawn from other countries, including how to formulate a solid legal basis for eco-compensation, how to design sound market-based instruments, how to tap into different sources of finance for conservation and how to enhance public participation. However, even for developed countries, development of the concept of PES is still at an early stage. Furthermore, there are significant differences between China and western countries in terms of culture, history, social and economic conditions. As such, we cannot simply copy the measures of foreign countries. As indicated by the forest-trends report “Around the world, policymakers and PES stakeholders highlight the fact that developing successful PES schemes is a learning process. No single set of policy tools and targets will provide a definitive solution to China’s environmental priorities and challenges.” Thus, while we learn the

useful experience aboard, we have to develop our own approaches for the establishment of eco-compensation mechanisms and policies based on Chinese particular set of conditions.

3.2 Domestic research and implementation of eco-compensation programs

Chinese experts began to carry out research on eco-compensation in the early 1990s. The assessment of various ecosystem services around China was first initiated via learning from international experience. More recently, numerous articles have been published in this field. The research conclusions show that the ecological and environmental value of ecosystem is far more than the value realized via market transactions. Some obstacles such as limitations in the current economic accounting system and market failures resulting in environmental externalities have led to continued negative impacts on ecosystems and the environment. As such, mechanisms for eco-compensation have been increasingly viewed as a potentially valuable approach, among many market-based tools, to better address conservation and environmental issues.

In a view of eco-compensation practice, namely firstly, state budget as the primary source of finance for eco-compensation cooperated by relative departments at different levels; secondly, local and regional initiatives; thirdly, participating in the global market transaction. All of these policies and implementations would provide abundant lessons and experiences for establishing eco-compensation mechanisms. In conclusion, the key aspects on eco-compensation in China are: forest, natural reserve protection, mineral and watershed.

3.2.1 Forest and nature reserve protection eco-compensation

Eco-compensation practices for forest and nature reserve conservation and restoration have been carried out for a long time. The central government has invested heavily in such practices, resulting in significant successes. In fact, in addition to the Forest Ecological Benefit Compensation Fund (FEBCF), many of the six key State Forest Development Programs could be considered as types of eco-compensation schemes for reversing long-term ecosystem degradation. The State Council, in reissuing The Notifications on the Key Issues of Economic Reforms in 1992 prepared by the State Economic Systems Reforms Commission, proposed that “the stumpage fee system and Forest Eco-compensation be established, and the utilization of forest resources be paid for.” In 1993, the State Council, once again in the Notifications on Strengthening the Tree-Planting and Greening Work, proposed “reforming the investment mechanism for tree-planting, and gradually adopted the Forest Eco-compensation

System". In 1998, the Decisions on the Revision of the Forest Law of the People's Republic of China were passed by the Second Meeting of the National People's Congress. Clause 6 of the Decisions stipulates that "A forestry fund system shall be established. The state shall set up the Forest Ecological Benefits Compensation Fund, to be used for the planting, tending, protection and management of forest and tree resources in Protection and Special-use Forests specializing in the provision of ecological benefits." The pilot implementation phase of FEBCF started from 2001 and ended in 2004. In December, 2004, a videophone conference on FEBCF claimed that it had entered the formal implementation stage around China based on the results of the 3-year pilot implementation work. The Ministry of Finance and the Ministry of Forestry promulgated Provisions on the Management of Forest Ecological Benefit Compensation Fund. This circular provided the institutional framework for establishing the FEBCF in China, and specified that the state budget would be the primary source of capital for the program.

3.2.2 Watershed eco-compensation

In terms of watershed eco-compensation, local initiatives have mainly focused on protection of drinking water sources for cities, involving management schemes between upstream locales and downstream municipalities, such as the water resources protection cooperation between Beijing municipality and Hebei province, the eco-compensation between the Guangdong Provincial Government and upstream areas of the Dongjiang River, the compensation scheme between Xinanjiang River areas and the Zhejiang Provincial Government. The key policy measures are fiscal transfers between municipal governments or the integration of relative channels of capital for compensated areas. Meanwhile, some market-based instruments of eco-compensation are being explored at local government levels, such as water resource transaction mechanisms. There is the successful case of water use rights transactions between Dongyang City and Yiwu City in Zhejiang Province. The incremental cost of increasing the supply of drinking water for Yiwu City via reservoir construction is estimated to be RMB 6/m^3 water. However, the cost is estimated to be only RMB 1/m^3 via a water-saving project in upstream Dongyang City. As such, Yiwu City decided to purchase from Dongyang City the permanent rights to 50 million cubic meters of water from the Hengjin Reservoir in Dongyang City. Similar arrangements are being developed in Ningxia Hui Autonomous Region and Inner Mongolia Autonomous Region.

Added to this, a "development relocation" eco-compensation scheme has been initiated in Zhejiang and Guangdong Provinces. In order to avoid upstream pollution and to offset the opportunity cost of foregone production of upstream areas like Panan

County, the *Jin Pan Economic Development Area for Poverty Reduction* has been established in Jinhua City of Zhejiang Province. As the production base of Panan County, the government of Jinhua City has created a package of preferential policies for this economic development area. As a result, this area's industry value increased to 0.5 billion yuan in 2003 from the production, accounting for 40% of the total financial revenue of Panan County. There are five similar cases in Zhejiang Province, some of which have been carried out and others which are about to be implemented.

3.2.3 Mineral resource development eco-compensation

Since the early 1980s, the Chinese government levied mineral resource taxes in order to create incentives for efficient and equitable resource exploitation. The Mineral Resource Compensation Fee was charged for the purpose of mineral exploration, development and the protection of state mineral resources rights. Although the compensation fees have been used for environmental restoration at central and local levels, eco-compensation issues were only given minor consideration in policy making. In particular, the Rules for Implementation of the Mineral Resources Law of the People's Republic of China (issued in 1997) stipulate specific responsibilities for mineral developers regarding water and soil conservation and restoration and environmental protection. Under these Rules, the mineral restoration fees should be handed in to the relative departments as performance bonds by mineral developers. Taking Guangxi Zhuang Autonomous Region as an example, these performance bonds (a.k.a. "mineral deposit") were used to create incentives for enterprises to minimize impacts and restore the ecological damage from their activities. If an enterprise doesn't take such measures to minimize and restore damage, the government can use this mineral deposit to hire special company to complete it. Thus, this can be viewed as a type of eco-compensation.

In many places, eco-compensation fees are levied depending on of the total quantity of mineral resource exploration or proportion of the turnover, the funds are used for treatment of eco-environment problems. As a successful case of eco-compensation, the government of Zhejiang has taken two approaches to deal with both newly built and existing mines. For newly built mines, a fund for environmental restoration is set up based on the compensation standard of cost per area of mining for offsetting environmental damage combined with the principle of "whoever exploits protects, whoever damages treats". For abandoned mines, use of this mechanism is based on the principle of "whoever benefits treats". If there are no beneficiaries, or these are hard to define, government then funds and implements environmental restoration of the abandoned mine.

3.2.4 Regional Eco-compensation

At the national level, in the early of 1980s the central government started a number of large-scale ecological construction programs. These include the National Forest Protection Program, the Sloping Land Conversion Program, the Desertification Combating Program around Beijing, the Key Shelterbelt Development Programs in the Three North Region and the Middle and Lower Reaches of the Yangtze River, the Wildlife Conservation and Nature Reserve Development Program, and the Industrial Forest Plantation Development Program. All of above programs have the definite objectives of eco-compensation, and represent hundreds of billions of RMB in investment. The state budget for western area infrastructural construction increased by 220 billion RMB between 2000 and 2003, accounting for 37% of total government bonds in the four years. Fiscal transfers dramatically increased from RMB 5.3 billion in 2000, to RMB 17 billion in 2003, to RMB 45 billion in 2004. Central government capital used for West China infrastructural construction increased from RMB 17 billion in 2000 to RMB 24 billion in 2003. The state budget on poverty reduction in West China is about RMB 17.5 billion. Although these fiscal transfers and development and assistance polices have not taken eco-compensation into consideration and are seldom used for ecological construction and protection, the Chinese government has said that it has compensated western areas for the opportunity cost of foregone economic development due to environmental protection and historical ecological environmental problems. In addition, the above mentioned six ecological programs belong to a kind of eco-compensation for long-term ecosystem degradation.

3.2.5 Local Practices on Eco-compensation

Zhejiang province is the first one to implement eco-compensation system in China. In Au 2005, the provincial government enacted “Notions for further perfection of eco-compensation mechanism”, and set up the basic principles for establishing the mechanism, i.e., “whoever benefits treats, whoever damages treats”, “making overall plans, co-development”, “development step by step, putting the difficult one at the first and the earliest one at the last”, and “implementing the mechanism simultaneously and moving forward rationally”. The major measures include: perfecting the public financial system, structural readjusting and optimizing financial payout, enhancing eco-compensation in financial transferring; stressing management system of resource fee levies for proper compensation, exploring method of eco-compensation to support development of less developed regions; emphasizing environmental treatment, establishing economic compensation system for polluters pay; exploring market based mechanism and bringing all actors into environmental

protection and ecological construction. At the implementation level, the provincial government is responsible for compensation of eight inter-regional watersheds, and the municipal and county governments pay attention to eco-compensation within their regions. At present, six cities including Hangzhou city (the provincial capital) are working on eco-compensation mechanism and related implementation issues at local levels.

Although several successful initiatives had been carried out at national, regional and local levels, significant research still needs to be done on their theoretical underpinnings and practical implementation. Current challenges include the following: lack of a commonly-agreed-upon definition of "eco-compensation"; the gap between the theory and practice of eco-compensation mechanisms; the need to improve the scientific understanding of ecosystem services and basis for compensation standards; the need to develop more sources of finance for these schemes; stakeholders' lack of information and human capital to implement these schemes; the existence of significant institutional constraints; the lack of a legal framework for accurately addressing society's and the economy's needs.

4 General Framework and Key Fields of Eco-compensation

4.1 General Framework and Key Fields of Eco-compensation

The Chinese government has been tentatively experimenting with eco-compensation for decades. The institutional framework of eco-compensation need to be established among the multi-departments with different temporal and spatial scales. There have been existing different compensation actors (Table 1). In a view of geographical scale, the issue of eco-compensation can be grouped into two types: eco-compensation at international and national levels. The international eco-compensation issue includes global forest and biodiversity conservation, pollutant transfer (industry, products and pollutants), etc.

Table 1. The regions, types, contents and methods of eco-compensation

Region	Types	Contents	Methods
International	Ecological and environmental issues at global, regional and national levels	Forest and biodiversity conservation, pollutant transfer, green-house gas emission, trans-border rivers etc.	Global purchase under multi-concession; Eco-compensation under regional and bilateral agreement; Market trading at global, regional and national scales.

National	Watershed	Compensation between upstream and downstream Compensation of cross-provincial boundary medium watershed Compensation of small watershed at local level	negotiation at local level Fiscal transfer Market transaction
	Ecosystem services	forest	Fiscal transfer of the State Eco-compensation fund; market transaction enterprises participation
		grassland	
		wetland	
		nature reserve	
		ocean	
		agriculture	
	Important eco-function zones	Water conservation Biodiversity conservation soil and water conservation, flood control …	Public finance; NGO's donation; Private enterprises participation
	Natural resources exploitation	Reclaim wasteland Vegetation rehabilitation	Beneficiary pays; Damager pays; Developer pays

The important areas of eco-compensation should be set thoughtfully based on the need of practice and the foundation of implementation. Meanwhile, we can, according to the range of responsibility, set down a clear priority field for which the government promotes the establishment of mechanism, i.e. eco-compensation mechanism of forest, grassland, wetland, important eco-function zones, development of mineral resources and cross-boundary medium watershed the central government focuses on. Local governments are responsible for establishing eco-compensation of urban water source and local small watershed within their administrative districts and cooperate with the central government in establishing eco-compensation of cross-boundary medium watershed. Specially, considering the regional and important eco-function zones compensation, such factors should be noticed as the difference of different regions and ecosystems, and the contribution of different elements, etc.

4.2 Principal Parts and Basic principles of Eco-compensation

The principal parts should be identified in accordance with the responsibilities and roles of the stakeholders involving in the ecological conservation or damages. The following three principles could be applied for compensation:

4.2.1 Damager Pays Principle

Damager Pays Principle（DPP）means that the damager should take the responsibility for the negative impact of his activities on ecosystem. This principle is appropriate for solving regional ecological problems.

4.2.2 User Pays Principle

The User Pays Principle (UPP) refers to the users of environmental resources should compensate the state or the public representatives for using the scarce resources. The UPP could be embodied in other ecological management fields at different scales, such as taxation of arable land occupation, cutting trees and non-wood resources, mineral resource exploration, the enterprises should pay for resource use fees after getting permission for the use.

4.2.3 Beneficiary Pays Principle (BPP)

According to the principle, the beneficiary should pay the provider for ecological services at upstream and downstream. For the majority of ecosystem services that are "public goods", the establishment of eco-compensation requires support from the governments. The government should make extraordinary efforts to protect natural reserves which play important roles in ecological security of the country, such as upstream, wind-break and sand-fixing areas, flood regulation areas etc. Moreover, international society shall bear responsibility, and the common resources inter- or intra- regions should be compensated by the beneficiaries in accordance with the benefit gained.

4.2.4 Compensation to the protectors

Those groups and individuals who contribute to the ecological construction should be compensated according to their investment and opportunity cost.

4.3 Methods and Basis for Determination of Compensation Standards

Compensation standards could be determined following those four values: investment of the protectors and opportunity cost, gains of the beneficiaries, rehabilitation cost of the damages, and ecosystem services.

4.3.1 Direct investment and opportunity cost of the protectors

Investment of the protectors in terms of human resources, materials and capita resources should be taken into consideration while making compensation standards. Apart from this, opportunity cost of the protectors should also be considered. In theory, the sum of direct investment and opportunity cost should be the base-line for setting the standard.

4.3.2 Gains of the Beneficiaries

A positive externality results when the benefits of conservation activities are not fully received by those who involve in these activities (e.g. if beneficiaries freely use ecological services and products without any payment). In order to internalize such externality, beneficiaries should pay full amount for ecological service providers. Thus, the eco-compensation standards can be accounted via the price and volume of market transaction.

It is simple to set the standard through market trades. Meanwhile, it initiates protector to takes good advantages of new technique to cut down the protection cost, creating a virtuous circle and promoting ecological protection.

4.3.3 Cost for rehabilitation of the damages

Resource development can cause biodiversity extinction, water loss & soil erosion, water resources and environmental pollution, and affect certain ecosystem services such as water conservation, soil and water conservation, climate regulation, etc. Thus according to the damager treats principle, the cost of pollution treatment and ecological restoration should be paid.

4.3.4 Value of Ecosystem Services

Evaluation of ecosystem services is used to calculate the value of water conservation, soil and water conservation, climate regulation, biodiversity conservation, landscape beautification, etc. Many studies on the evaluation method have been done in China and abroad. However, due to lack of standard for indicator selection and valuation of the services, as well as the huge gap between ecosystem service values and compensation capacity, the evaluation result could only be considered as theoretical ceiling values for compensation.

Practical standard could be determined through Game-negotiation and in accordance with the real situation of the country and the regions, for instance, levels of economic development and ecological deterioration, and dynamic adjustment is needed with consideration of ecological conservation and socio-economic development.

4.4 Approach and Methods of Eco-compensation

There are several means and methods for the eco-compensation. According to the compensation methods, it should be divided into compensation in cash, compensation in kind, compensation via appropriate policies and compensation via appropriate technologies and knowledge; and according to the spatial distribution of compensation, into horizontal and vertical compensation; according to spatial size,

into environmental elements compensation, regional and international compensation. And implementation bodies and their operational mechanism are cores determining the chief characters of eco-compensation method, and it can be generally categorized into two types namely government compensation and market compensation.

4.4.1 Government compensation

The government compensation mechanism is the most important and an easily to be implemented type in China currently. The government compensation mechanism considers the government or the upper level governments as the provider, and the regional and local governments and stakeholders as the compensation receivers. It aims to ensure the national ecological security, social stability, regional coordinated development, and adopts the financial subsidy, policy support, project implementation, taxation reform and talent input as the compensation methods. The government compensation mechanism includes financial transfer payment, policy support with regional differences, ecological protection projects and environmental taxation system.

4.4.2 Market compensation

The objects of the trade could be the property of the ecological and environmental elements, the ecosystem services, or the performance or quota of the environment pollution treatment. A typical market compensation mechanism includes the government payment, one-to-one transaction, market trade and ecological marks, etc.

5 Pilot Study in Selected Key Fields

5.1 Watershed Eco-compensation

Recently, a lot of money, materials and labor have been invested to protect watershed environment in order to ensure watershed ecological security and sustainable use of water resources. However, in upper reaches of most of the rivers in China is poor in economy and fragility in ecosystem, and the people living in those regions eagerly need to be alleviated from poverty strike, so there exists conflict between economic development and environmental protection in such areas. Thus, to establish watershed eco-compensation mechanism is helpful to deal with ecological and economic relationship between upstream and downstream to promote economic development and environment protection of upper reaches and realize sustainable development of the whole watershed.

The key to establish watershed eco-compensation lies in straightening the relation among the responsible bodies. The relations vary by different watershed scales. Therefore, the establishment of China’s eco-compensation will differ in accordance

with the watershed scales. But the design of watershed eco-compensation follows the same procedures, i.e., firstly, to determine the watershed scale; secondly, to determine the stakeholders of the watershed—the responsible bodies; thirdly, to calculate the compensation standard on the basis of investment and development opportunity cost of the upper reaches due to ecological protection, or to construct a platform for the parties to negotiate and come up with a compensation standard; fourthly, to choose proper eco-compensation method; fifthly, to design watershed eco-compensation policies.

The principal parts in watershed eco-compensation include beneficiaries who benefit from water uses, and individuals or enterprises who bring negative impacts on either quantity or quality of water through contamination drainage. And the receivers of watershed eco-compensation are those contributing to environment protection and sustainable use of water resources and living in the upstream and surrounding areas.

The methods of watershed eco-compensation include cash compensation, compensation in kind and policy compensation, etc.

Approaches for watershed eco-compensation are: levying tax for watershed eco-compensation, watershed eco-compensation fund, preferential credit, and overseas capital and program aid. It is obvious that the watershed eco-compensation in China is mainly carried out though government investment and only a small fraction of the investment are from private sectors. And market-based eco-compensation is at its early stage and scattered in some areas, and it is believed that market-based compensation would become an effective means of compensation in China.

Standard determination should consider the three aspects: (1) direct investment of the upstream region for ensuring water quantity and quality, including water resources reservation, treatment of environmental pollution and non-point agri-pollution, construction of urban water treatment plants, and investment in irrigation facility construction, etc. (2) indirect investment or the opportunity cost including investment in water saving, allocation of migrants, and loss in limiting industrial development, and (3) the cost of newly constructed infrastructure for water purification and water quantity guarantee such as irrigation facility, environmental protection program, which should be compensated by the downstream according to water quantity provided and the gap of economic development between the upper and down streams.

5.2 Mineral Eco-compensation

Mineral resources are indispensable raw materials for agricultural and industrial production and social-economic development. The extraction and utilization of the

mineral resources promotes economic development of China. At the same time, it also leads to serious environmental problems. Therefore, it is urgent to regulate the relations between ecological damage and protection. Although some relevant researches have been carried out in China, there are no specific rules and regulations on ecological compensation, no unified and standard management systems and compensation policy.

The overall method of establishing mineral resources eco-compensation is with reference of foreign experience and the practical situation in China, to make clear the providers and their responsibilities by taking into consideration of the previous damage and the new damage made.

The previous damage is to be taken charge by the government through establishment of Abandoned Mines Reclamation Fund. And the capital source involved includes fiscal appropriations and the Abandoned Mines Ecological Restoration Fee. The new damage must have to be burdened by the mining enterprises by granting mining licenses and paying for the ecological compensation bond. The mining enterprises should not only pay for the abandoned mines, but also the ecological compensation bond and the planning of ecological rehabilitation.

There are two forms of compensation for damaged ecological environment: cash and rehabilitation. Cash compensation is for the direct damages caused by coal exploration such as damages of on-ground objects, personnel reallocation and land occupation etc, and rehabilitation compensation is for the enterprises to rehabilitate the damaged environment back to the original state including direct rehabilitation by the enterprises and government projects.

Therefore, the mines eco-compensation fund consists of two parts: "Abandoned mines ecological restoration fund" and “Mines Ecological Compensation Bond”. The first one operates in a way that the local environmental departments or bureau of land and resources levies funds for the "Abandoned mines ecological restoration fund" and forwards it to the center government, who will establish a special account and use the fund as an earmarked fund. The second one works in a way that the mining enterprises transfers the “Mines Ecological Compensation Bond” directly to the state or opens a special bank account and put the fund in, the use of the funds will be monitored by the center government.

The standard of eco-compensation should be determined based on the cost of rehabilitation. It is feasible and reasonable as it could not only protect and restore ecosystem and environment, but also protect the basic right of victims.

5.3 Forest Eco-compensation

Forest is one of the most important terrestrial ecosystems on the earth. Apart from provision of timber and other goods, forests have vital effect on the environment and provide significant ecological services for the people. However, a larger part of the value of those ecological services could not be realized via market transactions. The only way is to internalize the external economy of forest ecological effects for partially or completely realize the values of forest ecosystem.

The study on forest eco-compensation is proved as the earliest one in the field of eco-compensation in China and lots of experience obtained is used by the other sectors. The problems remain are unclear definition of the concept, insufficient coverage, low standard for compensation, single capita source and lack of a long term compensation mechanism, etc.

According to "Management of funds for forest ecological effect compensation" issued by the State Bureau of Forest and the Ministry of Finance, the ecological benefit forest should be compensated including agroforest and special usage forest. At present, the total area of ecological effect forest is 0.104 billion ha (0.055 billion ha out of which is non-natural forest), but only 0.026 billion has been compensated by 2005. The government program such as natural forest protection and grain for green do play important role in forest eco-compensation, however, after termination of those programs, there would be no proper means to encourage the farmers to conserve the forest and prevent them from damaging the forest. Therefore, the up-coming eco-compensation mechanism shall integrate those three programs into a fund for forest eco-compensation, adopt a good fund management system and establish a long term mechanism.

The standard of forest eco-compensation should be established scientifically based on direct expense of plantation, opportunity cost for forests protection and benefits from forest ecosystem services. And the regional difference, forest types and tree species, plantation methods and the level of economic development should be taken into consideration. Recently, the standard for forest compensation is only RMB 75 /ha. It is only a subsidy from the government. Based on a research result, the value of forest ecosystem is far more than the wood itself (normally it is 5-25 times of the wood's value), if taking 10 times as an example, the compensation standard reaches 19800 RMB/ha/yr, which is unreachable in reality and could be considered only as an ceiling standard or value for compensation. The standard based on cost of forestation and opportunity cost is 4300 RMB/ha/yr and 2350 RMB/ha/yr for planned forest and existing one respectively, which could be considered as the base-line standard of eco-compensation. The standard could be increased on the basis of financial capacity

with consideration of regional characters, forest types, plantation methods and regional difference in economic development.

As for the approach and method of forest ecological effect, governmental financial transfer should be enhanced, the fiscal transfer payment for forest eco-compensation should be increased, the multiple financing channels should be developed and the system of “Ecological Taxation” should be established. The forest ecological benefit is public goods. For this reason, the government should take a leading role in compensating the cost for provision of forest ecological effects, maintaining reproduction function of ecological products for maximization of the benefit. The levy objects should include those gaining forest ecological benefits (organizations, enterprises and individuals). The levy would cover the large or medium sized reservoirs, hydroelectric plants, water plants, scenic tour spots relied on the forest landscape, the water shipping companies, fresh-water aquiculture, wildlife hunting in the forest, and coal mines in and nearby the forest region

5.4 Nature Reserve Eco-compensation

China is one of the countries with the richest biodiversity in the world. Therefore, it has been awarded the title of “the great nation of biodiversity” and “the spot of biodiversity in the world” by international natural protection organizations. In the meantime, China also faces the serious threats arose from the pressure of the largest population and the rapidest economic development. Vegetation degradation, biological invasion, overuse of the wild resources, exhausting of the water resources and the desertification lead to dozens of the wild species to the endangered verge. The establishment of nature reserve is one of the most important measures to conserve biodiversity and recover the ecological functions. But at the same time, to some extent, the establishment of nature reserve also has an adverse effect on the traditional production activity and life style of local people. So, a basic question in the management of nature reserve at present is how to coordinate and solve the contradiction between the nature protection and regional economic development.

Eco-compensation approaches for the natural reserves mainly include government purchase, government transfer payment, preferential policy, exemption of taxation, offering subsidies, exclusive funds, industry-based and region-based compensation mechanisms, project-based compensation and the support from the international society.

The compensation standard should be calculated based on the evaluation of the ecosystem services, the cost for reserves’ conservation and the loss due to protection activities.

According to case studies in natural forest reserve of Hainan province, Poyang Lake nature reserve of Jiangxi provice, Xilinguole grassland ecosystem functioning reserve of Inner Mongolia, we advocate that RMB 8250/ha can be used as a reference for eco-compensation in natural forest reserve of Hainan province, 11250 RMB 8250/ha or RMB 3300 per household for Poyang Lake nature reserve and RMB 8000 per household for Xilinguole grassland ecosystem functioning reserve.

The following table shows the outcome of pilot study in selected key fields:

Tab 3. Pilot Study in Selected Key Fields

	Watershed	Mineral resource	Forest	Nature reserve
Subject	Communities benefiting from water uses, Individuals and enterprises draining contaminate to watershed, Responsibility & obligation of the stakeholders is determined based on the size and range of the watershed.	The government is responsible for eco-compensation of abandoned mines via establishing rehabilitation funds, and the mine owner is responsible for the post law damage.	Protectors of forest resources (government, enterprises and individuals), All beneficiaries of forests ecological benefits (organizations, enterprises and individuals), Damagers of forest resources (enterprises and individuals)	Government purchases ecosystem services of nature reserves, Development of the natural reserves under the role of conservation, all beneficiaries pay (organizations, enterprises and individuals)
Approach	The government sets up a platform for negotiation of the stakeholders. Public payment, one-to-one trading, compensation in kind, policy compensation, talent compensation and ecological marks	Capital compensation, rehabilitation project	Fiscal transfer payment Tax reduction Immigration subsidy Market trading Ecological marks	Government purchases, fiscal transfer payment, policy compensation, tax mitigation, subsidy allocation, preferential credit, eco-compensation fund, project compensation, international

	are methods for compensation.			support.
Capital sources	Tax for watershed eco-compensation, watershed eco-compensation fund, preferential credit, overseas capital and program aid	Fiscal appropriations from the government for rehabilitation, Abandoned mines ecological compensation fund from the ower, Mines ecological compensation bond	To maintain and increase investment in key ecological construction, to add earmarked funds for eco-conservation, to develop the multiple financing channels, to establish the system of "Ecological Taxation"	Fiscal appropriations, multiple financing channels (NGOs, volunteers)
Standard	Direct investment and opportunity cost of upstream regions, cost of newly constructed infrastructure for environmental protection, and water quantity and quality received by the beneficiaries.	The value of damages on ecosystem, environment and natural resources, the cost of environment rehabilitation	Direct expense of plantation , opportunity cost for forests protection, and benefits from forest ecosystem services for planned and existing forest.	Ecosystem services, protection cost, damage loss.

6 Policy Recommendations for Implementation of Eco-compensation Mechanism

6.1 Establishing and perfecting the legislation process of eco-compensation step by step

The field survey shows that it is imperative to accelerate the eco-compensation legislation process in order to identify the scope, targets, means and standards for eco-compensation under the framework of law. Considering complexity of law making procedures and urgent need of eco-compensation implementation, it is suggested that three steps should be adopted in the process of eco-compensation legislation. Firstly, before the eco-compensation law is being enacted, an eco-compensation implementation policy guideline should be formulated by the State Council. Secondly, based on the policy guideline and nationwide practice, the policy guideline would be revised and finalized as "eco-compensation statute". Thirdly, on

the basis of the second stage of work, “the eco-compensation statute” would be upgrade and finally enacted as “the eco-compensation law”.

As the first step, Eco-compensation Implementation Policy Guideline should be submitted to/through the State Council. This guideline should include the following: (1) Transfer of finance is necessary and such means of transfer may include tax, funds, credits, and bond. (2) The relationship between the Central and Local governments and the scope of local governments’ initiative at the stage of implementation need clarification. (3) It is important to describe the final objective and aims in specific terms during the step-by-step process. For example, an early and smooth transition from “blood transmitting” to “blood generating” eco-compensation is suggested. (4) The rationale behind the condition for usage and validity of i) the means for transferring finance based on the regional/local agreement, and ii) utilization of market (mechanism) should also be included.

The second step includes the formulation of statute taking into account the implementation state of the nation-wide guideline. At this stage, the above-mentioned (1) to (3) concepts should be reviewed and re-arranged for a more sophisticated process of institutionalization. Relevant institutions should be examined.

As the third step, based on the implementation of the statute at the national level, the “Eco-compensation Law” should be enacted. Also, related laws should be revised at this stage.

The purposes of enacting “the eco-compensation law” is to regulate eco-compensation actions, unify eco-compensation management, and shape an authoritative, efficient and normative eco-compensation mechanism, lay a legal foundation for eco-compensation implementation, and push forward the eco-compensation implementation towards right track. The five principles that should be followed while making the law are:

(1) **Sustainable development.** To associate economic development with eco-restoration, and strengthen ecological conservation and restoration while promoting socio-economic development, and ultimately realize a coordinated development between socio-economy and eco-protection.

(2) **Adjustment of measures to local conditions, and provision of compensation by types.** To provide eco-compensation in accordance with local conditions and ecological types, and eco-compensation plan would have to accord with the national eco-restoration arrangement and socio-economic development plan.

(3) **Adjustment of measures to temporal dimension, and promotion of**

eco-compensation by phases. To make eco-compensation framework by taking into consideration of temporal scales, and the overall objective and specific objectives with time line should be reflected in the framework. A "Three Step" strategy could be adopted for eco-compensation, i.e., perfect phase of eco-funds, collateral phase between eco-fund and eco-tax, and eco-tax phase. The Steps could be completed by 2020 when the country moves into a well-off society after implementation of the three five-year plans, or 15 years. It is expected that a perfect eco-compensation mechanism could take effect by then.

(4) **Unification of the plan and its implementation by sectors.** To ensure a successful fulfillment of eco-compensation mechanism, the formulation of an "overall eco-compensation plan" should be based on the same ground. The governmental departments should be encouraged to participate in the process, and implement the plan according to their actual situation.

(5) **Pilot study associated with a step-by-step demonstration.** To conduct pilot studies wherever necessary, and explore relevant laws, regulations and standards for an effective eco-restoration management system, and financial management system. And relevant roles and regulations should be in place, and their operations be regulated for a large scale demonstration.

6.2 Dealing with several important relations in eco-compensation

(1) Relations between the Central Government and local governments. The Central Government should provide policy guidance, legislative basis and financial support for local governments for establishing eco-compensation mechanism. It would also have to guide the local governments to formulate, at the first place, country wide and regional wide, inter-watershed eco-compensation mechanism. It is widely accepted that local governments are the main actors in formulating and implementing of the mechanism. Also, when local governments create ecological compensation mechanisms, and when incentive measures to encourage implementing such mechanisms, as well as introducing compensation mechanisms over boundaries of different local governments, it is vital for central government to coordinate interest relations between different local governments, where necessary.

(2) Relations between government and market. Both the government and market play an important role in establishment of eco-compensation mechanism. However, based on the ecological conservation status and market development in China, the government plays a key role in establishing eco-compensation mechanism including policy and law, and provides support for a large scale eco-compensation. Only in some cases where providers and receivers of the compensation have been clearly

identified, eco-compensation could be implemented via market approach.

(3) Relations between eco-compensation and poverty alleviation. Eco-compensation differentiates with poverty alleviation. And eco-compensation is not for social equality and narrowing the gap between the rich and the poor. A mixture of eco-compensation and poverty alleviation would lead to an increasing damage of ecosystems. It is vital to establish a coordination and interaction mechanism between the key protection areas and beneficial areas, and guide the beneficial areas to provide socio-economic support to protection areas.

(4) Relations between "blood generating" and "blood transmitting". "Blood generating" kind of compensation should be encouraged through initiating of eco-conservation and capacity rising programs, while "blood transmitting" kind of compensation could be applied for the ordinary people.

(5) Relations between the new funds and the previous funds. The priority should be given to solve the problem existing in the new funds. Only on the basis of successful management of the new funds, can the previous ones be solved. The local governments and enterprises shoulder responsibility for the new funds, while the previous funds should be solved by the central government.

(6) Relations between integrated and sectoral platforms. An integrated eco-compensation platform dominated by the government should be established for an effective operation. However, various platforms should be encouraged at the local levels for exploration of various types of eco-compensation, particularly those related to forest, mineral resources, irrigation and environmental protection. An integrated and earmarked eco-compensation fund should also be ready and managed by different sectors via specific accounts for an effective and active participation of the departments involved in.

6.3 Enhancing efforts for financial transferring, and increasing funding via various sources

(1) **To establish eco-conservation oriented financial transferring system.** It is a direct and ease mean for eco-compensation. But environmental impact should share a high weight and the investment in ecologically fragile and the key protection regions should be further increased. Following equality and common service principle, financial transfer to the western regions should be increased, and for the areas with ecological importance (e.g., natural reserves) or containing ecological key elements (e.g., ecological forest), purchasing by the State could be encouraged for a long term investment mechanism in ecological important regions for socio-economic development and improvement of living standard of local people.

(2) **To encourage the local governments to support eco-compensation.** The local governments should not only guide the establishment of eco-compensation within their administrative border, but also support national eco-compensation programs based on their financial capacity.

(3) **To complete financial policy system of eco-compensation and develop the multiple financing channels.** The government means remains as a key one of eco-compensation in China, and market approach should be further explored. A eco-compensation mechanism with consideration of people's demand for ecological services, public's willingness to pay, strengthening the initiatives of private enterprises, intensifying the communication with financial department, seeking the technique support of relative experts and establishing special fund donated by international NGOs should be set up for a diversified compensation approach.

6.4 Improving the management mechanism of eco-compensation

For the meantime, it is urgent to strengthen eco-compensation work and integrating projects related to eco-compensation within departments and administrative borders. The eco-compensation work across the departments and boundary should be carried out through negotiation with the coordination of the upper level organizations.

For the long run, it is necessary to establish an eco-compensation management committee/group under the leadership of the State Council. And it could comprise relevant ministries, such as the Commission for Development and Reform, the Ministry of Finance, the Bureau of environmental Protection, the Bureau of Forestry, The Ministry of Irrigation, and the Ministry of Agriculture, for coordination, supervision, arbitration, reward and punishment. Several office could be established under the umbra of the committee as line offices, and a Technical Consultative Commission consisting of experts should be set up for policy and technical consultancy.

Wherever necessary, formulating local management committee/group in line with the national one.

6.5 Raising stakeholders' awareness of eco-compensation and encouraging their active participation through broad propaganda and education programs

A great attention and support to eco-compensation must be paid by the whole society. It is suggested that a series of activities related to propaganda and scientific education on eco-compensation must be conducted to raise public awareness; to clarify the relevant policies; to encourage the public actively participating in eco-compensation.

Community is the lowest and basic unit for implementation of eco-compensation mechanism. The success of eco-compensation depends directly on the knowledge, perceptions and willingness of community residents. Therefore, in the process of policy making and planning, the public participation should be encouraged and the way of "learning by doing, improving in practice" should be adopted. In the poor areas where are short of professionals and financial supports, relevant international projects should be used as a platform for capacity building of governmental agencies and local communities to promote natural protection. The targets for capacity building should also include decision makers, planners, managerial personnel and enterprise managers.

6.6 Enhancing scientific research and pilot study eco-compensation

Eco-compensation mechanism is a new research field with features of complexity and long-term tasks. It covers ecological protection and reconstruction and collection and utilization of relevant funds. Eco-compensation mechanism is at its early stage in China due to a low level economic development and conflicts between economic development and ecological conservation. It is therefore suggested to integrate eco-compensation issues into national key scientific research plan, for instance, techniques for eco-compensation standard, accounting of physical values of ecosystem services, conjunction of ecosystem services and eco-compensation, targets, standards, methods of eco-compensation, as well as ecological impact assessment of the resource development and key projects, etc. Moreover, ecological monitoring system research should be stressed in order to provide technical support to establish an effective eco-compensation mechanism.

Meanwhile, implementation via pilot studies should be enhanced positively. Based on the previous work and practices, every department should carry out pilot studies, establish eco-compensation mechanism and refine related policies actively.

Postcript

On March, 2005, the Task Force on Eco-compensation Mechanisms and Policies of China Council for International Cooperation on Environment and Development (CCICED) was established. The group focuses on establishing national strategies and sectoral policies for eco-compensation, and making concrete proposals and recommendations for the government.

The multi-disciplinary, multi-national ecological compensation mechanism and policies Task Force was led by co-chairs Academician/Professor Li Wenhua, Institute

of Geographic Sciences and Natural Resources Research (IGSNRR) of Chinese Academy of Sciences and Professor Imura, Nagoya University, Japan. The other experts include Professor Zhang Xiangshu, Prof. Ren Yong, Prof. Wang Jinnan, Prof. Hu Zhenqi, Prof. Min Qingwen, Dr Mcneely Jeffrey A, Prof. Rolf-ulrich Sprenger, Dr Sheng Fulai, Prof. Akihisa Mori, Prof. Liu Jianguo, and Prof. Friedrich Wilhelm Wissing.

The Task Force contains six sub-groups focusing on different fields of national strategy, theory and methodology, watershed, mineral resource, forest and natural reserves, respectively. The following table shows the main research members of the task force.

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Strategy and Policy Framework of Establishing Eco-compensation Mechanism in China

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1 Necessity and Significance of Establishing Eco-Compensation Mechanism in China

With the development for over 30 years, China has established comparatively perfect policy system of environmental pollution prevention, with legal and policy evidence for the management of environmental pollution. However, concerning the issues of nature and eco-conservation, China is still faced with the challenge of lacking policy structure, especially lacking relevant environmental economic policies, thus, unable to solve the problems of eco-conservation in the fields of key national eco-function zones, river basins and development of mineral resources. Behind the issues of eco-conservation and relevant pollution prevention, there is a common interest relation pattern. Namely, due to the unfair distribution of environmental interest and relevant economic interest among protectors, destructors, beneficiaries and victims, which results in the fact that the beneficiaries possess the environmental interest for free, and the protectors could not get due economic return, without economic incentives for conservation; the destroyers do not bear any responsibilities and costs for damaging the environment, the victims do not receive due economic compensation, and the persons directly responsible do not have the economic pressure of conservation. The distortion of environment and its economic benefit relation does not only put the eco-conservation of China in a difficult situation, but also threats the harmonious development among regions and different groups of people. In order to solve such issues, China should formulate a policy that could adjust the distribution relation between the environmental benefits of entities and their economic benefits, and promote the eco-conservation behaviours. This is the policy connotation and targets of eco-compensation mechanism. Therefore, the establishment of eco-compensation mechanism is both the urgent demand to protect the eco-environment effectively and the important measure to set up harmonious society. It has an important strategic position.

Currently, eco-compensation mechanism has become a hot issue attracting wide attention of all social circles. On the one hand, representatives of NPC and CPPCC have proposed bills for many times, calling for setting relevant mechanism and policies; on the other hand, lots of local governments have taken the lead in

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conducting pilot projects, actively exploring relevant experiences. In addition, the researches of the academic circles have entered into new era, transiting from researches on the theory and methodology of quantifying the value of eco-service function to the research on policy design of eco-mechanism. Therefore, in the context of implementing full-scale coordination and sustainable development approach, and setting up harmonious society, the Government of China pays high attention to the issue of setting us eco-compensation mechanism. The outline documents concerning the future direction of the environment and development in China such as the Decision of the State Council on Implementing Scientific Development Approach and Enhancing Environmental Protection issued in December 2005 and the Outline of the Eleventh Five-Year Program on National Economy and Social Development of the People's Republic of China clearly request to set up the eco-compensation mechanism as soon as possible. Overall speaking, China has the political willingness, practical foundation and scientific research foundation for setting up eco-compensation mechanism.

1.1 Case 1: Problems of Eco-Conservation in River Basins Caused by Unfair Distribution of Environmental and Economic Benefits between Upper and Lower Reaches

The utilization of water resources in rivers basins turns the upper and lower reaches into a community of benefit. The utilization of water resources has the demand on both water quantity and water quality. It is stipulated in the Constitution of the People's Republic of China and the Water Law of the People's Republic of China that the ownership of water resources belongs to the state. The state has the right to possess, utilize, benefit and distribute water resources. Residents in river basins have the right of using water, including possessing, utilizing, obtaining economic benefits and distributing water. According to the Environmental Protection Law and Water Pollution Prevention Law, the governments, organizations and residents in the river basins have the responsibility to protect the eco-environment and water environment. However, in practice, due to the differences of geological locations, the eco-environmental conservation in upper reaches, especially in the water source areas has greater impact on water quality and quantity, as well as the utilization of water resources in lower reaches, which means that on the one hand, the upper reaches may take more responsibilities and obligations of eco-environmental conservation and carry out stricter measures and standards f conservation, raise the environmental entry requirement level for the industrial development and lose some opportunities of development and rapid increase of economic income; and on the other hand, the achievements of conservation – water resources of good quality and enough quantity

will be enjoyed more by the lower reaches. When the overflow benefit of water resources caused by the eco-environmental conservation in upper reaches is possessed for free by lower reaches, the distribution relation between upper and lower reaches concerning the environmental benefit and economic benefit caused by it will be out of balance seriously. The upper reaches will thus lose the economic drive and abandon stricter protection measures and will, in the end, lead to the "common land tragedy" of water resources in river basins.

Nearly 30% of the territory in China is located in the ten river basins, including several thousand large and small rivers basins. The eco-environmental conservation in lots of the river basins is faced with the distortion of the distribution relation of environmental and economic benefits, thus seriously limiting the process of the entire environmental protection and the harmonious development between regions in China (Box 1).

1.2 Case 2: Problems of Eco-Environment and Development of Local People Caused by Mineral Resources Development

According to preliminary assessment, the total potential value of the mineral resources in China ranks the 3rd in the world. China has become a large important country of mineral resources and mining industry in the world. Over 95% of the primary energy, over 80% of the industrial raw material and over 70% of the agriculture production material in China come from mining industry. The large-scaled long-term development of mineral resources has brought about rather serious eco-destruction and environmental pollution to China that directly threats the survival and development of local residents (Box 2), and has resulted in rather serious social problems. In a development area of coal field, over 4000 local residents have appealed for over 100 times to the higher authorities for help concerning the issues of drinking water and agriculture irrigation caused by the coal development (See the Investigation and Research Report).

For many years, China has paid high attention to the establishment and improvement of the laws and regulations on comprehensive utilization and environmental treatment of mineral resources. Under the framework of Mineral Resources law, Environmental Protection Law, Land Management Law and Regulation on Land Rehabilitation, the state has promulgated and implemented Regulation on Mineral Resources Conservation and Regulation on Environmental Protection in Mines, and has set up legal systems such as land use assessment planning, environmental impact assessment, Three-Simultaneities of environmental protection system, permit system of exploration right and mining right and deadline treatment. Concerning the natures of the systems, these mandatory controlling measures do not really touch the economic

benefits of the mining enterprises, do not internalize the social cost of the development, and couldn't produce the economic mechanism stimulating enterprises to protect the environment. Therefore, theses systems do not fit in with the environmental management patterns of mineral resources development in the context of market economy[2]. This is one of the important reasons why the eco-environmental problems caused by the mineral resources development in China could not be contained effectively.

The eco-environmental problems caused by mineral resources development in China have strong characters of regions. The mineral resources are mainly located in western China. For example, the coal reserves accounts for over 60% of that in the whole country, coal-be methane accounts for 57.8%, the workable reserves of coal accounts for 25%, and workable reserves of gas accounts for 66% (Liu Tong et al, 2006). Therefore, western China is the key disaster area of eco-environmental destruction caused by mineral resources development, with lots of historical destruction. In the planned economic period, the mineral resources development enterprises were owned by the state and the profits of the enterprises were handed over to the state. However, the state didn't effectively treat the relevant eco-destruction and environmental pollution with the benefits of the mineral resources development, thus resulting in the unfair historical phenomenon that the western China contributed cheap resources to the state or other areas and bore the serious results of eco-environmental destruction. This is a typical issue that the environmental and economic benefit is not equitably distributed among regions.

1.3 Case 3: Key National Eco-Function Zones Faces Conflicts of Conservation and Development

State Environmental Protection Administration has conducted lots of investigation and researches on national eco-function zoning, and according to the importance and eco-sensitivity of the service functions of various eco-systems, identified 1458 eco-function zones with important role on protecting the national eco-security, which accounts for 22% of the national territory and 11% of the national population. The key eco-function zones include water sources conservation zones, soil conservation zones, sand-shifting controlling zones, bio-diversity conservation zones and flood storage zones.

As to the soil conservation zones and wind-shelter sand shifting control zones, China has carried out large-scaled eco-conservation projects and specific treatment programs, including land conversion projects, forestry eco-conservation projects,

[2] Although the Regulation on the Environmental Protection of Mines has put forth the cash deposit system of environmental rehabilitation in mines mine, the strength and scope the implementation is not ideal.

projects of comprehensive prevention of soil erosion, and key projects of sand shifting control. Concerning the conservation of key eco-function zones of bio-diversity, important water sources conservation and flood storage, the establishment of nature reserves is an important way. By the end of 2005, 2349 nature reserves of various levels and types had been set up in the whole country, with an area of 1.5 million km2, accounting for about 15% of the national territory, thus preliminarily setting up a reasonable network of nature reserves of complete categories and reasonable location in the whole country. In the head-source areas of rivers, important water source conservation zones, flood storage zones for rivers, sand shifting control zones and other areas with important eco-functions, 18 typical regional eco-function reserves of national level had been set up.

However, there are two outstanding issues for China in the establishment and conservation of important eco-function zones, especially nature reserves: firstly, the shortage of construction and conservation, and secondly the conflicts of conservation and development. There are two aspects for the conflicts: one is that due to the establishment of reserves, the local residents lose the natural resources as the foundation for development, even resulting in the decrease of living standard. For example, Jinxiu County is located in the nature reserve of Dayao Mountain in Jiangxi Province, where the income of the forestry farmers depending on timber and forest economic plants has decreased significantly, with the farmers turning back to poverty. There were 9,844 people in poverty in the county in 1999. By 2003, the population in poverty increased to 55,811, accounting for 37% of the total population of the county (See the Investigation and Research Report). The other aspect is that the local residents in the nature reserves are engaged in eco-conservation and provide sound eco-services to the entire country and other areas, but without due return; and they lose the development opportunities such as industrial development due to the stricter conservation requirements and standards in the reserves. It is for sure there are complicated reasons of nature, economy and social culture for the local poverty and backwardness, among which the loss of development chance due to eco-conservation is one important aspect of lots of complicated reasons.

With the improvement of the overall living standards in the entire country, especially in the context that there are vast differences of development between eastern and western China, the conflicts of conservation and development in the important eco-function zones in China such as natural reserves become more and more serious, becoming a rather serious social issue (Box 3). The conflicts of conservation and development have impact on the social equity and harmonious development in China, and seriously restrict the eco-conservation. Therefore, the establishment of the

balancing mechanism of environmental and economic benefits of important eco-function zones in the entire country is an urgent task of environmental protection and politics.

Box One:Achievements and Return of Eco-Environment Conservation in Head-Source Area of Dongjiang River

Dongjiang River originates from Ganzhou Municipality of Jiangxi Province. It flows through Guangdong Province to the Pearl River. The head-source area in Jiangxi Province transmits 2.921 billion m3 of good-quality water (normally over Grade II of national surface water standard) to Guangdong Province, accounting for 10.4% of the annual average run-off of Dongjiang River which serves as the key water source for Heyuan, Huizhou, Donguan, Shenzhen and Guangzhou of Guangdong Province and Hongkong Special Administration Region. It's related to a population over 30 million ones. It's also the lifeline for the economic development in the Pearl River Delta. Currently, the annual water supply of Dongjiang-Shenzhen engineering project (located in Shenzhen and takes water from Dongjiang River) is 2.423 billion tons, 1.1 billion tons of which is supplied to Hongkong, accounting for over 70% of the fresh water in Hongkong; 873 million tons to Shenzhen, accounting for 66% of its total water consumption; and 400 million tons to the villages and towns along Dongguan.

There are three counties under Ganzhou Municipality of Jiangxi Province located in the head-source area of Dongjiang River, namely, Xunqu, Anyuan and Dingnan. In order to provide excellent quality water to the lower reaches, the three counties have taken a series of measures of eco-environmental conservation: 1) Implementing natural forest conservation engineering project, shelter forest engineering project in Pearl River and land-conversion engineering project so as control soil erosion; 2) The traditional pillar industry in the head source of Dongjiang River is agriculture, lumbering and mineral resource development (Ganjiang Municipality including the head source of Dongjiang River has the title of "World Capital of tungsten" and "Kingdom of Rare Earth"). In order to protect the eco-environment of the source of Dongjiang River, the three counties strictly control the development activities of various mineral resources, actively readjust

the industrial structure, develop new industries with little impact on eco-environment such as eco-farming, fruits, processing of agriculture products and tourism. With strict enforcement, the three counties have closed up 390 small paper and pulp plants, small mines and small smelting plants in recent years, and have set up environmental warning system for new projects entering into the head source area. 3) Implementing eco-resettling engineering projects, and solve the sharp conflicts between the production, living and eco-environmental conservation in the core area. Up till now, Anyuan and Xunwu counties have moved 2000 residents out of the core area of the water source protection. Overall speaking, the three counties have make great efforts concerning

eco-environmental conservation in order to provide excellent quality water to the lower reaches. Compared with the requirements of the relevant policies for neighbouring areas, parts of the efforts are additional ones. The three counties have also made sacrifice of certain development opportunities and economic benefits. According to preliminary estimates, in the Tenth five-Year Plan period, the investment of eco-environmental conservation in the three counties was around 120 million Yuan. The economic loss caused by the limitation of industrial development direction and approaches was over 300 million Yuan.

The conflicts of environment and development in the source area of Dongjiang River are rather tough, and the eco-environmental conservation is faced with severe challenges. In 2004, the per capita GDP in the three counties of the source area of Dongjiang River is only 3854 Yuan, 36.75 of the average level of the entire country, and 20% of that of Guangdong Province. Even if compared with that of the entire Jiangxi Province and Heyuan of Guangdong Province (GDP of which ranks the last city in Guangdong Province) located in middle reaches of Dongjiang River, it only accounts for 47% and 74% respectively. The three counties in the source area have a population of 810,000 thousand, among which 700,000 is agriculture population. The net income of farmers in the three counties in 2003 was 1532 Yuan, accounting for 70% of that of Jiangxi Province and Ganzhou municipality, 40% of Guangdong Province and 6% of the Pearl River Delta. The population in poverty in the three counties accounts for 42% of the total population, and the economic and social development have long been ranking the last of the province and Ganzhou Municipality. Anyuan and Xunwu counties are poverty counties of national level, and Dingnan County is a poverty county of provincial level. In this context of development, especially that there is a great difference of development with the neighbouring and lower reaches areas, the local people are eager to have better-off life, and have strong wish to develop the local mineral resources, forest resources and fruits, with severe conflicts of development and conservation and heavy pressure for eco-environment. On the other hand, due to improper development in history, there are lots of historical pollution problems and tough eco-environmental situation.

Box 2: Coal Mining in Shanxi Province Resulted in Serious Impact on Eco-Environment and Local Residents

The coal mining in Shanxi Province has caused four kinds of serious impact on eco-environment as follows:

1） Water resources destruction and water pollution. The assessment results indicate that the mining of one ton coal will directly harm 2.48 tons of water resources. The annual 500 million tons of coal mining harm 1.2 billion m3 of water resources, equal to the water volume of the entire

water diversion engineering of Yellow River, with serious impact on the normal production and life of local residents who are at first short of water resources. Other investigation statistics indicates that annual waste water discharge in the coal mines of various kinds in Shanxi province is 224.909 million tons, and the discharge of waste water for per ton coal is 0.869 ton, with serious pollution to the surface water. In the meantime, the large amount of coal gangue, after being showered by rain, has caused pollution to the groundwater resources. With the impact of long-term coal mining, the mineralization and total hardness of the groundwater in Datong exceed the standards, with some harmful substance exceeding the standards by 26 times.

2）Fearsome air pollution. Statistics indicate that the emission of SO2 in the coal mines of Shanxi Province was 329,700 tons in 2003, and smoke and soot volume was 448,200 tons, accounting for 32% and 51.5% of the corresponding pollutant discharge in the entire province. The public health has been seriously threatened.

3）Land resources are seriously destructed. According to the investigation statistics, by 2004, the total mining area in Shanxi Province had hit 8,000 km2, among which the worked-out section area is 2,940 km2, and the newly subsidence area every year is about 94 km2. Currently, the secondary geological disasters of the province are related to 1,900 natural villages and a population of 950,000 people. The coal wells and mines and gangue hills have occupied a large area of land resources. Currently, the total amount of coal gangue in the entire province is 1.14 billion tons, and is increasing by over 100 million tons every year. The total amount of the cola gangue in Datong is over 130 million tons, occupying an area over 1300 hm2. The rain eluviation and dust and soot of mineral ore have led to pollution of various extent to the neighbouring areas.

4) The eco-system in mines is damaged and the loss of species resources intensifies. According to the monitoring investigation, during the 16 years from 1984 to 2000, the stumpage reserve of the forest in the coal mining areas of the source area of Qin River reduced by 30.15% compared with the non-coal mining zones. The average run-off in rivers of the province during 1980-2000 was 7.289 billion m3, with 4.151 billion m3 less than that during 1956-1979. The change of the underlaying surface by coal mining is the key reason for reducing the run-off in the rivers. Currently, the total area of the wetlands in the entire province is 358,000 hm2, with 139,000 hm2 less than that in early 1990s and 10,000 hm2 reduction annually. The dry-up of rivers and lakes makes the aqua-animals and plants lose the survival conditions, distinguishing a large amount of aqua-species.

The eco-environmental problems caused by coal mining have resulted in serious impact on the survival and development of local residents.

First of all, environmental pollution has degraded survival space, reduced life quality and increased the social burden. The first three of the ten most heavily polluted cities in China are located in Shanxi Province. Statistics indicate that in recent years, the disease rate and mortality of

lung cancer in urban and rural areas of Shanxi Province have increased by 30-50% compared with that in 1970s; malign cancer accounts for 305 of the dead of the employees in enterprises and mines; and the disease rate of respiratory and occupational disease and mortality rate have increased obviously. Secondly, it has limited the sustainable economic and social development. According to relevant studies, the loss caused by environmental pollution and eco-destruction by coal industry in Shanxi Province was 28.877 billion Yuan in 2003, accounting for about 11.55 of the GDP the province of the same year, amounting to the loss of 64.23 Yuan per ton of coal, accounting for 28% of the average price of the coal to other provinces in 2004 which is not included in the cost of coal production and reflected in the price of coal. In 2003, the loss caused by the air, water and solid waste pollution in the coal mining in Shanxi Province was about 6.2 billion Yuan, with the loss caused by environmental pollution at 13.78 Yuan per ton of coal; and the economic loss caused by eco-destruction of coal mining in 2003 was 22.677 Yuan, with the an average economic loss of eco-destruction at 50.45 Yuan per ton.

Data Source: Wang Jinnan et al, Study on Eco-Compensation Mechanism of Coal Resources Development in Shanxi Province, 2006

Box 3: Benefit Disputes of Conservation and Development in Nature Reserve of Tianmu Mountain

In May 2001, villagers of 243 families in the Bao Family Village in the Nature Reserve of Tianmu Mountain of Lin'an Municipality of Zhejiang Province suited Lin'an Municipal government to the court for non-feasance, and requested it to provide "eco-compensation".

The Nature Reserve of Tianmu Mountain was set up in 1985, being one of the important species genetic tanks. In the meantime, Tianmu Mountain is one of the head sources of Tai Lake and Qiantang River Basin. In 1993, Lin'an municipal government decided to expand the area of the reserve, increasing from the 15,000 Mu to 64,000 Mu, related to the mountainous forest land of five villages. According to the regulations of laws, the core zone and buffer zones of the nature reserve are under absolute protection, and all kinds of development activities are forbidden. In the experimental zones, it is allowed to conduct proper development. In the past, local villagers mainly depended on the plantation in forests and stalagmite as their economic sources. However, since 1993, the newly expanded parts of the Nature Reserve of Tianmu Mountain have not been defined concerning their functions, and villagers are simply forbidden to conduct development and cultivate stalagmite, which has resulted in the situation that 243 villagers have lost basic guarantee of life. The villagers argued that the government should provide corresponding economic compensation. In the context that the appeal of lots of times didn't succeed, the villager suited Lin'an municipal government for non-feasance. This is a typical case of conflicts of the

conservation and development in nature reserve, and is perhaps the first court case of eco-compensation. However, since there is no corresponding legal and policy evidence, it is difficult for the case to reach any results.

(Data Source: Cao Mingde, On the Establishment of Eco-Compensation System in China, 2006

2 Meaning and Extension of China's Concept of Eco-compensation Mechanism

After explaining the reason why China should set up the eco-compensation mechanism, we need to answer the second question – what is the eco-compensation. The meaning of the eco-compensation mechanism refers to the meaning of the concept; and the extension refers to the border of the concept, as well as the border of the policy application.

2.1 Relevant Concepts

There are three key words in the term of eco-compensation mechanism: ecology, compensation, and mechanism.

The "ecology" in the ecology refers to the state and pattern of the nature. Here, the "ecology" is related to the eco-effect, eco-service function and eco-benefit of the eco-system.

Eco-effect is a kind of impact or effect of some eco-factor on other eco-factors in the eco-system, that of various eco-factors on the entire eco-system, and that of some eco-system on other eco-systems. The eco-effect might be positive. For example, the forest could adjust the climate, and conserve the soil and water. It might be negative sometimes, such as green house effect (Dictionary of Environmental Sciences, 1991).

The eco-service function refers to the benefits human being obtain from the eco-system, including the service function of daily necessities, such as food, timber, water, fibre and so on; adjusting service function, such as adjusting the climate, floods, diseases, wastes and water quality; culture service function, such as entertainment, aesthetics, spiritual happiness; supporting service function, such as soil composition, photosynthesis, nutrient cycle and so on (Millennium Eco-system Assessment Committee, 2005). The eco-service function is the general term in the world, and normally has the abbreviation of eco-service that is similar with the so-called eco-benefit that mainly refers to the concrete value of the eco-service.

Comparatively speaking, eco-effect focuses more on the description of the natural property of the eco-system. While eco-service function reflects more of the economic and social properties and values of the eco-system.

According to the Chinese culture, “Compensation” refers to the loss of the entity in some area and the gain in some other area. The relevant “indemnity” refers to the compensation to the loss of other people or groups caused by the action of the entity (Dictionary of Chinese, 1995). Therefore, the nature of the two terms is consistent, being a kind of compensation to the loss so as to reach an ultimate balance. The compensation focuses more on the payment action from the beneficiary while the indemnity focuses on the payment action of the destructors. It means that the establishment of eco-compensation mechanism must be accompanied by relevant indemnity mechanism. They are the two aspects of one same issue.

From the point of institution, “mechanism” is a kind of institutional arrangement for fulfilling some target.

Therefore, when “eco-effect” and “compensation” are linked together, there comes the naturalism explanation to “eco-compensation”, i.e. natural ecological compensation, with the definition of the ability of bio-organism, population, community or eco-system to ease intervention, adjust its own state so as to maintain its survival when being disturbed, or the recovery ability of eco-load (Dictionary of Environmental Sciences, 1991).

When “eco-service function (eco-benefits)”, “compensation” and “mechanism” are linked together, they turn into the concept of the institution to solve the realistic problems – eco-compensation mechanism.

2.2 Core Factors to Define Concept of Eco-Compensation Mechanism

Any concept should have its unique factor to be distinguished from other concepts. That’s the value of its existence. There are lots of descriptions of the meaning of eco-compensation mechanism. However, as an independent concept, it should reflect four essential factors.

2.2.1 Position or Purpose

The concept of eco-compensation mechanism is put forth and standardized for solving specific realistic problems, but not a fantasy. As stated in Part I, in China’s policy system, there are no policy measures that could effectively solve the eco-environmental conservation problems in the fields of eco-function zones, river basins and mineral resources development, which is the specific issues to be solved by eco-compensation mechanism. The nature of the three kinds of conservation is to maintain, improve and improve the eco-service function of the eco-system, or to recover the service function of the eco-system. It’s the fundamental goal of eco-compensation mechanism, consistent with the target of the prevalent international

concept of “eco-service payment”. That’s to say, this basic positioning is to solve the problems in China and fit in with the international concept, which is convenient for the exchanges and mutual learning. The different terms are due to the only difference of culture habits and difference of the market economic development.

2.2.2 Basic Nature

The basic nature describes the property and adjustment target and direction of the eco-compensation mechanism as an environmental policy measure.

As previously stated, there is a common reason for the challenges of eco-environmental conservation in the fields of key eco-function zones, river basins and mineral resources development, namely, the distribution relation of environmental benefits and its economic benefits behind the conservation or destruction action is distorted, with the conflict of conservation and development, or the destruction bringing benefits. From the point of the theory of environmental economics, it is caused by the reason that the positive external economic eco-service value (or the overflow benefit) of the conservation activities, or the negative external economic aspects are not internalized into the private cost of the action body.

This decides that the target to be adjusted by eco-compensation mechanism and the direction of policy formulation is to correct the distribution relation of the environmental benefit and economic benefits of the entity for the eco-environmental conservation or destruction action, which is the environmental economic policy with the aspect of economic incentive. The environmental benefits here refer to the improvement of the eco-service function due to the conservation activities, or the loss of the eco-service function due to the destruction activities. The economic benefit is the market value or benefits of the eco-service function. The corrected benefit relation should be that the entity enjoying the eco-service brought about by labour should pay for it, and the entity producing the eco-service should obtain economic return. On the contrary, the entity causing the loss of the eco-service function should pay for it, and the ownership client of the eco-service main function or the entity restoring the eco-service function (such as the government) should obtain economic indemnity.

2.2.3 Proper Extension Issue

The externality decides the policy application of the eco-compensation mechanism. The identification of externality should take two factors into consideration: one is the basic position and nature of the concept, and the other is the relation with the current policies. If the externality is too small, it could not solve the problems of the same nature in reality; and if it’s too large, it would duplicate or conflict with the relevant environmental policies, or even change the structure of the current policy system, and

lead to unnecessary chaos.

Currently, the issues of too large and too small externalities co-exist in the theory circle and practice.

Some argue that historically speaking, eco-conservation and construction belong to eco-compensation, with variation according to its compensation targets and scope, and full-scale establishment of eco-compensation mechanism should be set up in the entire eco-economic system (Jia Dawu, 2006). The typical approach of the "eco-compensation" in the resources and environmental legislation in China is charging system, with utilization fee of resources development, compensation fee of resources ecology and eco-environment, management fee of resources and ecology conservation and penalty fee (Jia Qun et al, 2006). There are two risks for the wide definition of eco-compensation (mechanism): firstly, the issue of recognition, i.e. to cover or update the logic of eco-compensation the entire environmental policies of China, especially the meaning of the theoretic foundation for the environmental economic instruments such as pollution discharge fee, would only bring about chaos to the recognition of environmental management departments; and secondly, practical issue of policy formulation, namely, in case the concept of the broad sensed eco-compensation mechanism is consistent with the scope of the tax and fee system adjustment of the traditional pollution discharge fee, there is no necessity to set up the special policy of econ-compensation, and the reform of the application scope of the current policy measure will work. In reality, there're various kinds of policy measures to achieve the eco-compensation, and it generally includes the public financial policy and market instruments. In addition, there is one basic principle for the state in formulating policies – not to concoct various pretexts and duplicate economic policies, especially the charging policies.

The typical narrow explanation to eco-compensation mechanism includes: the concept that eco-concept is a kind of compensation fee for the eco-environment, i.e. the cost levied for controlling the eco-destruction (Zhang Zheng, 1995), and compensation to the eco-environmental value of the natural resources (Zhuang Guotai et al, 1995). It's obvious that the narrow definition has narrowed the scope of eco-compensation adjustment and could not solve the problems of the same nature in reality with limitation on the policy ways of compensation.

The environmental protection is China is basically divided into to major fields: environmental pollution prevention and natural eco-conservation (and construction). No matter it is quantity or structure, the policy system of environmental pollution prevention is quite profound and comprehensive, including laws, regulations and administrative management system such as the mandatory policies, environmental

economic policies, information releasing policies, voluntary agreement and public participation. On the contrary, the system of eco-conservation policy is rather weak, with serious structural shortage. On the one hand, except the legislation of resources conservation such as forest, land, mineral resources and water resources, there are no basic legislation or comprehensive legislation of eco-conservation. On the other hand, there are still no economic incentive policies based on the market mechanism. Therefore, in face of the tough eco-degradation reality, it is an urgent target for us to set up and improve the eco-conservation policy, especially the economic incentive policies.

In conclusion, when the basic position and nature of the concept of eco-compensation mechanism is defined, it is easy to find out that in accordance to the realistic demand of the eco-conservation in China, the extension of the proper concept of eco-compensation mechanism is that it is the environmental economic policy mainly focusing on eco-conservation field, with the role of economic incentives and co-existing with pollution discharge fee system. The so-called distinction of "mainly focusing on eco-conservation field" is to meet the demand of conduction environmental management according to different categories of the issues. From the point of natural pattern of eco-system and some situations in the actual management, the pollution prevention and eco-conservation are not absolutely separated or exist independently. For example, the relevant problems caused by resources development include the destruction of eco-sceneries or the eco-system structure, and the environmental pollution of water, air and soil, both of which interact with each other and result in the loss of the function of the eco-system. In the eco-environmental conservation of river basins, it is necessary to improve water quality, protect the natural vegetation and prevent industrial and living pollution. However, these will not influence co-existence and independent role of eco-compensation mechanism and the traditional environmental economic systems, such as the pollution discharge fee. Similarly, the environmental economics nature of the two is the same or similar, but it's not necessarily that the targets and fields to be adjusted will be the same. The evidence for the latter is the principle "Polluter Pays" while the former follows the principle of "Beneficiary Pays and Destructor Pays". The targeted entity of the latter is the polluter while the former focuses on the beneficiary and provider of eco-service function, as well as the action entity destructing the eco-service function.

2.2.4 Basic Methods, Evidence and Standards

When the position, nature and extension of eco-compensation mechanism is defined, there is still a critical issue, namely the approaches, evidence and standards of the compensation, i.e. how much compensation could achieve the target of improving or

recovering the eco-service function, and correct the distribution relation of the environment and its economic benefit in the field of eco-conservation. The approach here refers to the instrument identifying the evidence and standards of compensation; evidence refers to the baseline of the standards; and standards are defined with certain instrument according to specific benchmarks but not necessarily the concrete figure of actual compensation, only being a policy concept model. They solve the different sectors of the total sum of compensation, and have a progressive relation. In practice, the concrete figure of compensation is normally defined with the gambling of receivers and payers according to the demand of the receivers and the payment ability and willingness of payers.

2.2.4.1 Methods, Evidence and Standards of Valuating Value of Eco-Service Function

To valuate the eco-service function is a difficult hot issue attracting the attention of the academic circles in and abroad. If the market value of the eco-service function could be assessed and quantified accurately, it should be the best evidence for defining the standards of eco-compensation and the best foundation for setting up the market of eco-service function.

As to the meaning and categories of eco-service function, an authoritative recognition has come into being in and abroad (David Pears, 2000). The ecosystem services refer to the benefits human being obtain directly or indirectly from the eco-system, mainly including the input of useful substances and energy to the economic social system, acceptance and transformation of the wastes from the economic social system, and the services directly provided to members of human society (comfortable resources enjoyed widely by people such as the clean air and water).

For human being, the value of ecosystem services and natural capital is fairly high. However, the services provided by ecosystem is different from the services of traditional economics (in fact, it the commodity of concurrent purchase and consumption), with only a small part of it being able to be assessed in a quantitative way, sold and purchased at market, while most of the ecosystem services are public goods or standard public goods that could not enter into the market. Most of the assessment on the eco-service function focuses on the changes of the natural capital and the ecosystem services.

With the development of eco-economics, environment and natural resources economics, the ecological and economic experts have conducted lots of researches on the assessment of the changes of the natural capital and ecosystem services. In order to be distinguished from the traditional theories and approaches that ignore the value

of environmental resources, the environmental economists have redefined the value of the environmental resources, and referred to the value of the environmental resources as the total economic value, including its use value and non-use value (internal value). The so-called use value refers to the capacity of some goods to meet certain demand or predilection of people while being used or consumed. The use value could be further divided into direct use value, indirect use value and selective value. The so-called non-use value is equal to the internal property of certain commodity as some ecologists suggest, which has nothing to do with the fact whether people use it or not. Currently, the commonly accepted view holds that the existence value is its most fundamental form. And the concept of the value of eco-service function is similar to the indirect use value of environmental resources. It includes the benefits obtained indirectly from the various function provided by the environment for supporting the current production and consumption activities.

The foundation of environmental economic assessment is the payment willingness of the people for improving the environment, or the willingness to accept the indemnity for bearing the environmental loss, which is the same with the assessment of the value of eco-service function. The concrete technical assessment methods include the market value method, disease cost method, opportunity cost method, human resource capital method, production cost method and replacement cost method. There are numerous researches and studies on the assessment of the value of eco-service function, with different results. For example, Costanza estimates the total value of the 17 service functions of the ecosystem of the forests in the world hits 33268 billion US dollars every year, among which the lowest value of conserving soil is 53 billion US dollars every year while the maximum value of nitrogen cycle is 17075 billion US dollars every year (Zhang Lubiao et al, 2006). Some Chinese scholars have evaluated 7 eco-service functions of the surface water in the river basins of the entire country, and come to the conclusion the value is 11% of the GDP of the year 2000 (Zhao Tongqian et al, 2003).

Overall speaking, the theoretic identification of the types of eco-service function is rather complicated, and the assessment method for the value is not so matured and is still developing. The results of these assessment methods could not be easily accepted by the society. Therefore, although the valuating methods of eco-service function and the compensation evidence and standards defined according to the methods have extremely high theoretic value, it is not easy to apply them to the design of concrete policies of eco-compensation mechanism.

2.2.4.2 Methods, Evidence and Standards of Marginal Opportunity Cost

In reality, from the point of environmental economics, how to internalize the

externalities of the behaviour of protecting or destructing the eco-environment is the essential issue of setting up eco-compensation mechanism. Based on the issues to be solved by China's eco-compensation mechanism, there are two kinds of externalities: the improvement and added-value of the eco-service function produced in the key eco-function zones and the protection activities of the upper reaches in the river basins, i.e. the positive externalities, or referred to as external economical efficiency; and the eco-environmental destruction brought about by the mineral resources development and its unfavourable impact on the survival of the local residents and development, i.e. the negative externalities, or external uneconomical efficiency.

In the context of market economy with full-competition, it could be assumed that the eco-service function has value and could be exchanged freely at market. The evidence for the standards of eco-compensation could be concluded by looking into the production process of the commodity - eco-service function or its externalities, and the state of the marginal cost and benefits.

1) **External economical efficiency – eco-service function is improved and its value increases**

Diagram 1 indicates that when there is external economical efficiency, i.e. when the behaviour of the protector improves the service function of the eco-system, the marginal social benefit (MSB) of the results of the behaviour is larger than the marginal private (protector) benefit (MPB). In the market economic condition of full-competition and in the context that the eco-service function has its value and could be exchanged freely at market, the actual protection behaviour of the protectors is decided by the MPB and marginal cost (MC), during which the amount (including the quality and quantity) of the eco-service function produced by the protection behaviour is Q_1, and the corresponding marginal cost is P_1. Q_1 could be explained as either the eco-service amount or eco-environmental quality to meet the demand of the survival and development of the protectors, or the environmental quality or standards under the basic and fair environmental responsibilities that the social members should take according to the stipulation of national laws. However, in reality, due to the differences of geographic locations, the important of the eco-environmental service functions are not the same, for example, the nature reserves and water sources storage zones of the river basins. At this time, there are two situations that require the eco-service amount produced by the protectors is not Q_1, but Q*, for example, the state sets up eco-function zones; to improve the eco-environmental quality standards in some areas, or the beneficiary (such as the lower reaches) put forth request on higher environmental quality for its own development benefits. In these two cases, if the protector still provides eco-service, there will be the case of short supply in the society. However, from the point of maximized benefits of the protectors, the

protectors will not automatically raise the eco-service level to Q* since in that case, the marginal cost will increase to P*. The only way to raise the eco-service level provided by protectors to Q* is that the party putting forth the request for Q*, such as the government (since it puts forth the requirement on eco-function zoning) or/and the beneficiary (lower reaches), provides the protectors with the benefit compensation equal to the shadow ABC in Diagram 1. Then the protectors will benefit from the eco-services of Q* level and all parties will be satisfied and reach the best level of the society.

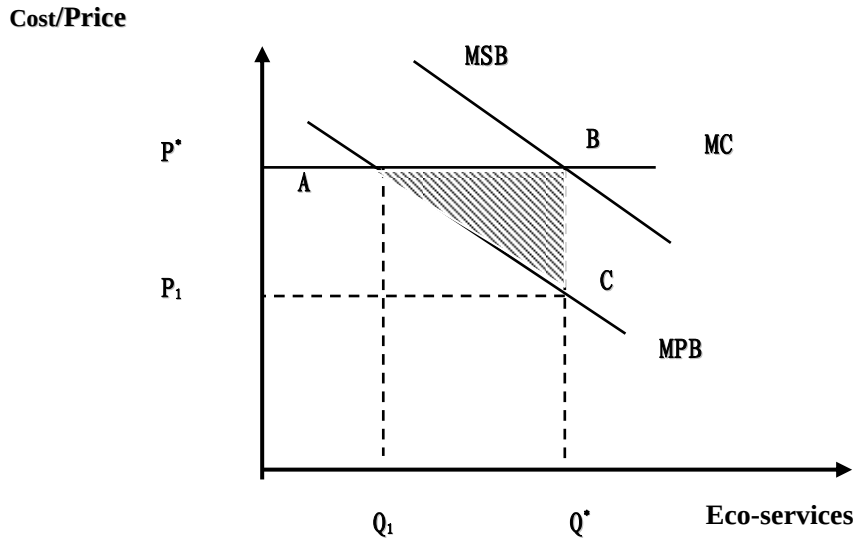

Diagram 1: Compensation for Positive Externalities

Then, how much compensation should the protectors obtain for producing the eco-services of Q* level, i.e. the area of ABC in the Diagram? It could be figured out from a simple production process in which the protectors produce eco-services.

Let's assume that the product of eco-services is C, the production cost for the protector to produce C is P (eco-conservation and conservation cost), and the final economic return is R, then the capital realization form that the protector completes a simple production process is: P-C-R, namely, the protector makes an input of cost P, produces product C, and the final due economic benefit should be R, among which R must be larger than P, otherwise, it is impossible to expand reproduction, and the protector will not conduct non-profit production.

Therefore, R is in fact a net profit R_N based on P, i.e. $R=P+R_N$. That is to say, the

beneficiary of the eco-compensation pays a sum equal to the price of R in order to purchase the product of the protector – eco-service C, and the compensation is realized.

However, in reality, this compensation amount includes an unfair issue, namely, the beneficiary pays more than he should. As Diagram 1 indicates, in order to meet the demand of self-survival and development, or the requirement of the national laws, the protector will produce the eco-service equal to Q_1 level even without the compensation, and the corresponding cost is P_1, but not P*. In other words, the beneficiary in fact need to purchase, or only need to purchase the eco-service amount equal to the difference of Q* and Q_1. In this case, the value amount of the compensation should be ΔR which is equal to the shadowed area of ABC in Diagram 1, i.e. $\Delta R = \Delta P + \Delta R_N$.

Here, ΔP is in fact the additional cost that the protector invests to the eco-construction and conservation in order to meet the demand of the beneficiary (difference between Q* and Q_1).

ΔR_N is the due net return that the protector should obtain for producing more eco-services (difference between Q* and Q_1). It could be measured by the opportunity cost (benefit) with which the protector does not produce more eco-services but other products, i.e. the development opportunity cost caused by excessive production of eco-services by the protector.

In conclusion, in the situation that the eco-conservation activities such as key eco-function zones and river basins produce external economical efficiency, the evidence of the eco-compensation includes two parts: the additional cost of the eco-construction and conservation and the loss of development opportunity cost. In practice, it is difficult to distinguish the additional cost of the protectors from the corresponding cost they should bear. Although the development opportunity cost lost by the protectors could be defined by referring to indicators such as the average profit rate of the state or local area, the average GDP growth rate, and the difference between the living level of the protectors and that of the beneficiary, there are still lots of uncertainties. However, it does not have impact on the policy value of such conceptual evidence. Otherwise, there won't be any evidence for the compensation. The concrete figure of the compensation of the two parts could be defined by the gambling based on economic bearing capacity and actual payment willingness of the beneficiary, and the demand of the protectors.

2) External Uneconomical Efficiency – Eco-Service Function is Destructed or Lost

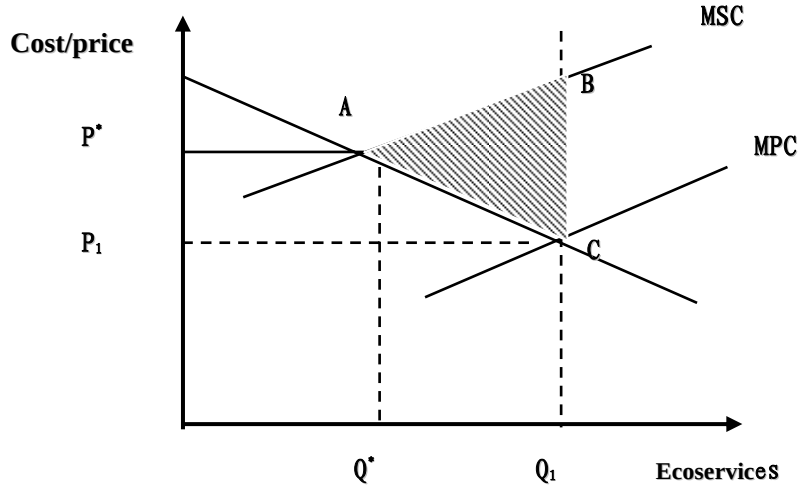

Diagram 2: Compensation for Negative Externalities

Diagram 2 indicates the relation of the marginal cost of the eco-environmental destructor and the loss of the eco-service function, such as the eco-environmental destruction in the process of mineral resources development, among which, Q* is the loss amount of the best social eco-service and Q_1 is the destruction amount the developers want to make or the actual destruction amount. Compensation is to recover Q* minus the eco-service destruction amount of Q_1. In practice, Q* minus Q_1 includes both the loss of the value caused by the eco-function destruction and the unfavourable impact on the living and development of local residents.

However, it should be noted that when the developers of mineral resources pay the compensation amount equal to the shadowed area in the diagram, the development activities of the developers will also lead to the eco-service destruction of Q* level. As to this destruction, developers could pay pollution discharge fee or eco-destruction fee by following the classical environmental economics principle – "Polluter Pays". It is sure that the environmental management principle of "Polluter Treats and Destructor Restores" could be applied in this circumstance so that the developers could treat and restore the eco-destruction. The deposit system could also be applied in this case in order to ensure the treatment and restoration is implemented. Therefore, the eco-compensation fee and pollution fee (eco-destruction fee) could co-exist and coordinate in a sound way, which is the theoretical and realistic significance analysis in diagram 2.

Concerning the compensation fee of the mineral resources developers, in practice, its evidence could be explained in two dimensions: firstly, the cost to recover or treat the large-scaled eco-scenery destruction or its eco-function that the developers are unable to treat or recover, or are caused in history; secondly, the loss of the living and development of the local residents caused by the activities.

2.3 Meaning of Eco-Compensation Mechanism

By referring to the above-mentioned 4 essential factors of the meaning of eco-compensation mechanism, it is not difficult to note that its current meaning basically only cover some or several factors, even some aspects of certain factor, being incomplete or even biased to large extent. For example:

Eco-compensation mechanism is a kind of economic measure of resources environmental protection and the driving mechanism, incentive mechanism and coordination mechanism for the benefits of environmental protection (Hong Shangqun et al, 2001)

Eco-compensation mechanism is a kind of eco-environmental compensation fee, i.e. the cost levied to control the eco-destruction (Zhang Zheng, 1995).

Eco-compensation mechanism is to compensate the eco-environmental value of the natural resources (Zhuang Guotai et al, 1995).

Eco-compensation mechanism refers to the practice that levies fee on (or compensates) the behaviour of destructing (or protecting) resources environment to raise the cost and benefit of the behaviour so as to stimulate the entity of the destruction (or protection) behaviour to reduce (or increase) the external uneconomical efficiency (or external economical efficiency) caused by its behaviours and achieve the target of protecting the resources (Mao Xianqiang et al, 2002).

There are at least four dimensions for the eco-compensation mechanism, including the compensation for eco-environmental itself, eco-environmental compensation fee, compensation to the behaviour of individual or regional conservation of eco-environment or abandoning of development opportunity, and investment to the regions or targets with important eco-value, including the eco-compensation to the important categories (such as forests) or key regions (such as western China) (China Academy of Environmental Planning, 2005).

Therefore, this study suggests that the meaning of scientific and standard eco-compensation mechanism that meets the requirements of the policies could be expressed as follows:

The eco-compensation mechanism is an institutional arrangement that aims to improve or recover the eco-system services, adjust the distribution relation of the environmental benefits and its economic benefits caused by eco-environmental conservation or destruction activities of relevant stake-holders (protectors, destructors or beneficiary), takes the internalization of the external cost caused by relevant activities as its principle, and plays a certain role of economic incentives. The

establishment of eco-compensation mechanism follows the principle of internalizing the external costs, and the evidence of the compensation to the external economic efficiency of the conservation behaviour is the additional conservation and relevant construction costs that the protectors pay for improving eco-service function and the development opportunity costs sacrificed for it; and the compensation evidence for the external uneconomical efficiency of the destruction behaviour is the cost to restore the eco-service function and the loss of development opportunities of the receivers caused by the destruction behaviour. There are two major types of policies instruments to achieve the eco-compensation mechanism: public policy and market instruments. Eco-compensation mechanism is an effective environmental economic measure to conserve the eco-environment, favourable for promoting the harmonious social development, with important strategic position.

In the above description, the first sentence basically covers the position, basic nature, externalities and principles of eco-compensation mechanism; the second further states the principles and evidence of eco-compensation, the third is the policy measure to achieve the compensation mechanism, and the fourth points out the role and significance of eco-compensation mechanism. In general, the first sentence could be the general description of the concept of eco-compensation mechanism and the core, with all the other meaning derives from this core.

3 Theoretic Foundation and Policy Significance of Establishing Eco-Compensation Mechanism

There are two purposes for analyzing the main theoretic foundation of eco-compensation mechanism: firstly, to identify the scientificalness of defining its meaning and core factor; and secondly to provide directive guidance for identifying policy instruments of achieving eco-compensation mechanism.

3.1 Nonreversibility of Utilizing Natural Resources and Environment is Ecological Foundation of Establishing Eco-Compensation Mechanism

The natural resources and eco-environment is the basic condition for human survival and development. The natural resources and eco-environment include the factor endowment resources such as land, water, biology, mineral resources and other concrete factor resources, as well as the comprehensive environmental resources such as environmental bearing capacity, scenery, climate and eco-balance adjustment.

The survival and development of human society, especially the economic activities and natural resources environment have always been linked closely together. On the one hand, the economic reproduction activities of human being have continuously

obtained the necessary natural resources from the nature, and on the other hand, these activities discharge the generated wastes into the environment and damage the environmental resources. From the point of almost unlimited growth demand of human society, the exchange relation of the substance energy of natural resources environment – social system is irreversible. It stipulates the "One Way Flow" aspect of the resources, and the natural resources are always consumed as donor (Li Jinchang, 1990).

From the point of system theory, human society and natural environment have reached certain dynamic stable balance in the long-term natural evolution. In the natural environment-social system, there exists a threshold or limitation bearing the human activity load in the natural environment. Once the impact of human activities on the natural environment exceeds the threshold, the balance of part of the system or even the entire system will be broken, and the destructed natural environment will in turn threats the development or even the existence of human society. This is the causal relation of the inter-relation and transition between the eco-potential of the natural resources environment and the economic potential of human society.

The eco-potential is mainly the natural resources of enough quantity and good quality for meeting the demand of sustaining economic growth, the sustainability established in the natural environment which is favourable to the inter-relation of human production and living, and the stability ensuring the natural environmental state frequently destructed by human activities could be restored and the natural resources utilized in the process of economic activities could be renewed (Тупыця [USSR], 1984). Only when the growth speed of the eco-potential exceeds that of economic potential growth, could the balance above-mentioned natural environment-social system be maintained.

The current actual situation of the utilization of natural resources environment in China is that the growth speed of the economic potential is far beyond that of the eco-potential, and has led to the unbalance in part or the entire natural environment-social system. It is the urgent demand currently in China to recover and maintain the destructed natural resources environment and its eco-potential. And eco-compensation is the ultimate compensation of eco-loss, and an effective system and way to maintain the eco-potential.

3.2 Definition of Ownership of Environmental Resources is Legal Principle of Establishing Eco-Compensation Mechanism

To define the ownership of environmental resources is to conduct initial distribution of the rights to occupy and utilize resources. Only with the distribution of initial rights,

shall it be possible to define who should take the corresponding due responsibilities of compensation and who could have the right to receive the compensation.

It is stipulated in China's Constitution and environmental protection laws and regulations that every person, including natural person and legal person has the fundamental obligation to conserve the ecology and maintain eco-balance in an equal way. Every person has the basic right to obtain and enjoy eco-service function in an equal way, or has the right to utilize the natural resources or eco-factors he possesses or uses to meet his basic demands, and the right to pursue or maximize benefits, or the equal development right.

However, in reality, the difference of defining the ownership of environmental resources or the initial distribution of rights has led to actual inequality of development right. In general, the eco-protectors in the upper reaches of river basins have to follow more stringent legal regulations or less right distribution, such as stricter water quality standards and so on, and their economic action have certain limitation and adjustment which in reality has resulted in partial or entire loss of the development right of these people so that the rights of the other people enjoying or benefiting from the eco-service function are protected. Therefore, there should be a kind of compensation to make up with the unbalance of the right.

In the concrete policy practice, the eco-function zoning is a kind of definition of environmental resources ownership or initial distribution of rights. Different types of eco-function zones have stipulation on the rights of the people in the zones what to do and not to do. According to this zoning, the obligation and rights of compensation and receiving the compensation under various types could be defined.

3.3 Public Goods Property is Foundation of Selecting Policy Measures of Eco-Compensation

It is generally recognized that the natural resources environment and the eco-services it supplies has the property of public goods. According to Samuelson's definition (1954), pure public goods refer to such goods that the consumption of the goods by people will not reduce the consumption of the goods by other people. Pure public goods have two basic natural properties: non-excludability and non-rivalrousness of consumption. Non-excludability refers to the fact that technically speaking, it is not easy to repel enormous beneficiaries, or the uneconomic efficiency of excludability, i.e. it is impossible to prevent the people who do not pay for it from consuming the public goods. The non-rivalrousness of consumption refers to the fact that the consumption of public goods by a person will not have impact on the effectiveness that other persons possess from the consumption of the public goods, i.e. the increase

of an additional person's consumption of the public goods will not increase the cost of the product, namely, the marginal production cost of the public goods is zero. The two properties of public goods mean that public goods are not separable in consumption. The demand or consumption is public or collective. If it is to be supplied by the market, no consumers are willing to pay for it, but prefer to wait for others to purchase it and conveniently enjoy the benefits brought about by the purchase, which is the issue of "Hitch Ride". If all the social members intend to take the ride for free, then the ultimate result would be that no one could enjoy public goods since the issue of "Hitch Ride" will lead to inadequate supply of public goods.

However, public goods are not equal to the resources possessed by the public. In reality, there is normally a kind of goods that is between public goods and private goods, referred to as standard public goods or quasi-public goods. The standard public goods could be divided into two types: one of which has the aspect of non-rivalrousness in consumption, but it is easy to exclude others, such as public bridges, public swimming pools and public cinemas, referred to as club goods; and the other type is opposite to the club goods, i.e. with rivalrousness of consumption, but could not effectively exclude the others, such as public fishing ground and pasture, normally referred to as common resources. The club goods normally tend to result in congestion, while the common goods tend to lead to tragedy of the commons, which indicates that if a kind of resources could not effectively exclude the others, it would result in the over-utilization of such resources and ultimately result in the benefit-loss of all the members.

The public goods property of the natural resources environment and the eco-services supplied by it determines that it will be faced with the issues of inadequate supply, congestion and over utilization. Eco-compensation is to stimulate the supply of eco-services, limit the over utilization of common resources and solve the congestion issue by making relevant institutional arrangement and adjust relevant production relation so as to promote the conservation of eco-environment and the development of nature and social production.

The public goods property of eco-compensation could enable us to define the entity of the compensation under different types of eco-compensation, and their rights, reliability and obligation so that the corresponding policy measures could be determined.

3.4 Theory of Externality is Basic Principle of Establishing Eco-Compensation Mechanism and Evidence of Formulating Corresponding Policy Measures

Both the pure public goods and the club goods and common resources have the common issue of externality generated in the process of supply and consumption. This is the essential issue to be solved by eco-compensation.

As to the externality theory, with the contribution of A. Marshall (1890) and Pigou, founder of Welfare Economics, it has turned into a rather comparative system and has been applied widely and deeply to the field of environmental protection.

Externality is divided into positive externality (external economical) and negative externality (external uneconomical). The positive externality refers to the fact that the production or consumption of some economic entity benefits other economic main bodies but without compensation from the latter, such as eco-service function (effects) of the eco-environmental conservation in nature reserves and upper reaches of river basins; and the negative externality refers to the fact that the production or consumption of some economic entity damages other economic main bodies but without giving compensation to the latter, such as the environmental pollution of enterprises and the eco-environmental destruction made in the process of mineral resources development.

As to the internalization of externality, there are two absolutely different approaches in the economics circle: “Pigovian Tax” and Coarse’s “Ownership”.

3.4.1 Pigovian Tax Approach

According to the theory of externality of Pigou, when the marginal private benefit (cost) deviates from the marginal social benefit (cost), it is impossible to achieve the best efficiency of resources distribution and the maximization of social welfare by relying on the free market competition. Therefore, it is necessary for the government to take proper economic policies to eliminate such deviation. The principle for the government to intervene is to levy tax on the departments whose marginal private cost is lower than the marginal social cost, and subsidize the departments whose marginal private benefit is lower than the marginal social benefit so as to internalize the impact of externality caused by the deviation of private benefit (cost) from the social benefit (cost) and maximize social welfare. This kind of taxation and subsidies is normally referred to as Pigovian Tax Policy.

3.4.2 Ownership Approach

In the theory of Pigovian Tax, externality is generally regarded as uni-directional and

could be eliminated by the intervention of the government. The new institutional economists represented by Coarse expanded the recognition on externality from new angles and with new approaches, criticized the theory of Pigovian Tax and put forth new policy approaches for solving externality.

Coarse's expansion of the recognition on externality and criticism on the theory of Pigovian Tax mainly focus on three aspects. Firstly, externality is normally not a uni-directional issue that one party damages the other, but is of mutuality. For example, according to the theory of Pigovian Tax, if the economic activities of Party A have negative impact on party B, then Party A should make compensation to Party B. However, Coarse argues that to prevent the loss of benefit of Party B will harm the benefit of Party A. Therefore, the real issue is to judge whether Party A is allowed to harm Party B or Party B is allowed to harm Party A. The key to solve the issue is how to avoid rather serious loss from the point of the entire social cost and welfare. Secondly, in the case that the transaction cost is zero, no matter Party A is allowed to harm Party B or Party B is allowed to harm Party A, it is possible to minimize the social cost and maximize the social welfare since Party A and party B could achieve Pareto efficiency of resources distribution by voluntary consultation, namely, if the transaction cost is zero and the ownership is clear, then the two parties of the transaction could internalize externality by voluntary consultation without the intervention and adjustment from the government. In this context, there is no room for Pigovian Tax. Thirdly, in the context that the transaction tax is not zero, the internalization of externality could be defined by analyzing and balancing the cost-benefit of governmental intervention and market adjustment. That is to say, the option of "Pigovian Tax" could be either effective institutional arrangement or ineffective institutional arrangement, and the key of the issue is whether the ownership is clear or not (Coarse, 1991/1960).

To put it in a simple way, if the transaction cost is zero, no matter how the ownership is defined, it is possible to achieve the most effective distribution of the resources by market transaction and voluntary consultation. If the transaction cost is not zero, the most effective distribution of resources could only be achieved with the arrangement and selection of certain institutions. This is the so-called "Coarse Theory" which explains that the governmental intervention is not the only way to solve the malfunction of the market. In certain context, the externality could be solved by market transaction or voluntary consultation instead of Pigovian Tax, and the responsibility of the government is to define and protect the ownership.

In contrast to the theory of Pigovian Tax, Coarse's theory of transaction cost emphasizes the application of market instrument to solve externality. However, there

is certain limitation for it. Firstly, in the developing countries with low marketization and the transiting countries, it is not so effective to adopt the market instruments to solve the externality. Secondly, market transaction or voluntary consultation should take transaction cost into consideration, with the condition that the transaction cost lower than pure social benefit. However, in the context that the market mechanism is not so perfect and norms are not complete, the transaction cost of voluntary consultation tends to be higher than the pure social benefit, which has limited the development of voluntary consultation. Thirdly, the premise for market transaction or voluntary consultation is clear ownership. However, it is hard to define the ownership of lots of public goods, or the cost of defining is too high, which results in the loss of the foundation for voluntary consultation.

3.4.3 Realistic Selection of Eco-Compensation Policy

The theories of Pigovian Tax and Coarse Transaction cost have strong policy significance for eco-compensation mechanism. In the actual selection of policy approaches for eco-compensation, various policy measures have different adaptive conditions and scope, and should be subdivided according to the concrete property of the public goods concerning the issues of eco-compensation and the extent of ownership. If the marginal transaction fee via governmental adjustment is lower than the marginal transaction fee via voluntary consultation, it is better to take the approach of Pigovian Tax, e.g. by levying eco-tax (fee) on the beneficiaries and destructors of eco-function so as to solve the compensation issue. On the contrary, it is better to take the ways of market transaction and voluntary consultation. If the two are equal, then the two approaches have the same value.

3.5 Theory of Environmental Resources Capital is Valuation Foundation of Establishing Eco-Compensation Mechanism and Evidence of Determining Compensation Standards

It has been debated for decades of years whether the eco-environment is the economic resource that human being depend on for its development, whether it is the capital asset with market mechanism or exchange value, or whether it could become added-value capital. In the debates, whether the environmental resources have value and how to achieve their value have been the two major aspects. With eco-environment becoming the important constraint of human survival and development and the further going of sustainable development, these issues have obtained positive answers from the mainstream economic circles.

The value of natural resources could be stated from various points of scarcity of natural resources, utility theory of value, labor theory of value, differential rent and

natural capital (Zhang Xiaodi, 1993; Shen Manhong, 2004).

The modern views generally admit that the natural environmental resources, including the natural resources as raw materials, natural environmental conditions and environmental bearing capacity are a production factor, and their scarcity extent will increase continuously along with the economic development. Scarcity is the value basis of natural resources environment and the basic condition of marketitzation.

From the point of utilization theory of value, the value of natural resources environment is a kind of subjective psychological assessment, expressing people's perception and assessment of the capacity of natural resources in meeting their desire. The value of natural resources environment comes from its utility, and its scarcity is the precondition. Its marginal utility is the yardstick to measure the value of natural resources environment.

Marx's labor theory of value believes that the value is the relation between people in the exchange of goods. The value of goods is determined by the necessary labor materialized in the goods, including the labor consumption of laborer in creating products and the necessary social time consumed on the labor target and labor materials, i.e. living labor and materialized labor. The traditional view holds that natural resources environment is not the product of labor, without value. From the point of modern view, natural resources environment has value which is human's abstract labor in the natural resources environment, with the concrete reflection that people input a great deal of materialized labor and living labor in finding, conserving, developing of natural resources environment, and promoting the eco-potential growth.

From the point of rent theory, the absolute rent is the income that the owner of land possesses with the ownership of the land. Here the "land" in fact refers to all natural resources, rent is a kind of rent of resources, and the different values of natural resources environment reflect in the rent of the resources. According to Marx's differential rent theory, the differential rent of resources is caused by the fact that the quality of the natural resources environment is different which results in situation that equal capital is invested to equal resource entity and generate the difference between the individual production price and social production price, i.e. the difference between the benefit of the natural resources investment of good quality and that of the natural resources investment of bad quality. The differential rent could be divided into two forms: I and II. The I differential rent of resources is the differential rent caused by the difference between the natural abundance ratio of the resources and the geographic location. The II differential rent of resources is brought about by the different production ratio of resources caused by the continuously supplementary investment on a same resource entity.

No matter under which theory framework mentioned above, the natural resources environment is a production factor, with the carrier of its value referred to as natural capital that is one of the organic component of fortune. The concept of the natural capital was put forth first by Paul Hawken, Amory Lovins and Hunter Lovins in 1999. They hold the opinion that besides the artificial capital, financial capital, and human resource capital, there is still the fourth capital, i.e. the natural capital which is consisted of natural resources, life system and ecology. The factors of natural capital defined by World Bank mainly include land, water, forest, oil, coal, metal and nonmetal mineral resources. However, these are only part of the services provided by natural eco-system to human being. China Academy of Sciences expanded the definition of World Bank on the meaning of natural capital, and holds that the natural capital is the general term for the natural substances and energy given to human being or utilized by human being, and the eco-services it provides. That the stocking of the natural capital maintains basically constant with the time goes by is the premise and basis for the sustainable development of human being.

One statement widely quoted in China is that natural capital mainly includes 4 aspects: (1) the natural resources that could directly enter into the current social production and reproduction process, i.e. the gross natural resources (renewable and non-renewable) and the capacity of the environmental consumption and transition of wastes (self purification of the environment); (2) the change of quality and regeneration of the natural resources (and environment), i.e. eco-potential; (3) eco-environmental quality, here, referring to the fact that various eco-factors such as the water environmental quality and air of the eco-system provide necessary environmental resources for human life and social production and consumption; and (4) the entire eco-system.

No matter which value theory it is, the assessment on the value of the eco-services function generated by the natural resources or eco-factors is the basis for achieving the value of the environmental resources. (See 2.2.4.1)

4 International Experiences of Eco-Compensation Mechanism (See Special Report on International Experiences)

4.1 Concept and Application Scope

In general, there is no such term as “eco-compensation mechanism” in the world. The conventional concept is “payment for ecological/environmental services”. As previously stated (See 2.2), the difference of the terms is caused by both culture habit and mode of thinking under the institution of market economy. The term “payment for ecological/environmental services” means that one should pay for enjoying and

utilizing the product of eco-service, fairly simple and clear, and right to the point. There is no fundamental difference between its meaning and the concept of China's eco-compensation mechanism, with the eco-service function as the core and target, and payment as instrument, and its adjustment target is also the environmental and its economic benefit relation of the protectors and beneficiaries.

Therefore, the concrete cases of the countries in implementing payment for eco-service on the environmental service of forest – the most important terrestrial eco-system, with mainly the market mechanism involved. According to the paper of *Silver Bullet or Fools' Gold? A global review of markets for forest environmental services and their impacts on the poor* by Landell-Mills, N. Porrras I T. (Zhang Lubiao et al, 2006; Landell-Mills, N. Porras I T., 2001), there have been 287 transaction cases of forest environmental services. These transaction cases are related to 4 types of environmental services, among which 75 are carbon storage, 72 bio-diversity conservation, 61 river basin conservation, 51 scenery improvement and 28 "comprehensive services". These cases do not only exist in developed areas, but all over the countries and areas in America, Caribbean, Europe, Africa and Oceania

It is sure that this does not necessarily mean that the governments of other countries do not take any measures concerning eco-compensation. On the contrary, there are lots of successful cases.

The relevant policies and field of practice mainly focus on eco-conservation related to agriculture activities, eco-conservation in mineral resources development, comprehensive river basins management, forest conservation and afforestation. Switzerland and USA have implemented measures of compensating the land retirement so as to protection the agriculture eco-environment via their agriculture legislation. There are similar policies and behaviours in EU. In 1950s, US government carried out conservation land retirement program; "conservation reserve plan"-similar to desertification prevention plan in 1980s; and New York State has issued the Huet Bill to restore forest vegetation. In the process of implementing the programs and bill, the important content is that the government provides subsidies (compensation) to local residents' loss caused by implementing the programs (cost). With the economic subsidies of the federal government, Australia has promoted the comprehensive river basin management in the provinces. South Africa has combined the river basin conservation, restoration action and poverty alleviation together, with an input of around 170 million US dollars to hire the weak groups to conduct river basin conservation, improve water quality and increase water supply.

In the field of mineral resources development, Germany and USA have the same practice. The government will take the responsibility to handle the historic

eco-destruction issues formed before the legislation. USA sets up foundations to raise funds while the central (75%) and local (25%) governments in Germany jointly provide funds and set up specific companies for mines rehabilitation specially engaged in rehabilitation. As to the destruction made after the legislation, the developers will be responsible for the treatment and rehabilitation.

Concerning the relevant compensation in the field of nature reserves such as bio-diversity conservation, it is normally jointly carried out with the fields of agriculture, river basins and forests, with few published researches and reports.

4.2 Approaches of Payment for Eco-services

Currently in the world, there are two major types of payment for ecological/environmental services: one is the purchase by the government, or referred to as public payment system; and the other is frequently adopting the market instruments, such as self-organized private transaction, open market trade, eco-labels, and user pays.

Public payment mainly refers to the ecological/environmental services necessary for the society purchased by the government and later on provided to the social members. The funds for purchasing the ecological/environmental services may come from the public financial resources, or specific tax or other financial resources controlled by the government, such as some foundations, national bonds and international aid. It should be pointed out that no matter it the payment scale or its wide scope of application, the public payment system with the governmental purchase as the core is the major form of purchasing ecological/environmental services. The typical case of public payment is the USA's conservation reserve program of cultivated land and Mexico's compensation case of forest service function.

The mode of self-organized private transaction refers to the direct transaction of between the beneficiary and payer of the ecological/environmental services, with few and clear beneficiary adaptive to ecological/environmental services. When the providers of ecological/environmental services are organized or when the total number is quite small, it is normally the one to one transaction. The two parties of the transaction determine the conditions and prices of the transaction by negotiation or through agents. The private transaction is normally limited to certain scope and transparency extent, mainly benefiting from the clear ownership and operable contracts. One-to-one transaction is normally adopted in the upper and lower reaches of the rather small river basins, the forest eco-system with clear ownership and its neighbouring benefiting areas. Sometimes some conservation organizations and commercial institutions will pay for the conservation of ecosystem, with typical

compensation cases of French Pierre mineral spring water, Columbia Kakkaw River Basin and clean water supply between New York State and upper reaches in USA.

When the number of buyers and sellers is fairly large or uncertain in the eco-service market, and the ecological/environmental services provided by ecosystem for transaction could be standardized into measurable and separable goods, such as green house gas, these indicators could enter the market for transaction, i.e. open trade method. It is necessary to point put that only when the government determines that environmental services are goods for transaction or stipulates demand rules, could this method be applied. Successful cases of open trade include emission trade of forest carbon storage, the "wet bank" of wetland protection in USA, credit loan of Australia concerning the water evaporation caused by salinity in Mullay-Darling River Basin. With the Kyoto Protocol comes into effect and the rapid development of CDM projects, there are great prospects for the compensation cases of forest carbon trade.

Eco-label is the direct payment method to achieve the payment for ecological/environmental services. In general, when a consumer of the market purchases the goods of the ordinary market, and if he is willing to purchase with higher price the goods that have been accredited to be produced in an ecologically/environmentally friendly way, the consumer is in fact paying for the ecological/environmental service provided along with the goods production by the goods producers. The key of the consumer to purchase (pay) the ecological/environmental services in such a way is to set up the accreditation system believed in by consumers. The eco-labeling system is a conventional accreditation system for environmentally friendly production in the world.

4.3 Reference and Enlightment

In conclusion, the practice of the payment for eco-services in the world is of high reference significance to China.

Firstly, as to the fundamental factor of the meaning, extension and application fields, the payment for eco-services in the world is basically similar with the concept of China's eco-compensation mechanism. This determines that the relevant behaviours in the world are of direct reference significance to China. However, since the social economic conditions, especially the development of market economy, are different, China should not simply copy some behaviours in the world.

Secondly, there are four modes of payments for eco-services in the world: public purchase, self-organized private transaction, open trade, and eco-label, with clear application conditions and characteristics which China could transplant, reform and apply.

In fact, concerning the public purchase, China's practice is unprecedented as to the scale of implementation, such as the land conversion for forest (grassland) project, natural forest conservation project and compensation funds for eco-benefit of forests.

The eco-label accreditation in China is highly developed, including environmental labeling products, organic foods, energy saving products and so on. Up till now, the environmental label has conducted accreditation of 56 major categories of products in the fields of home appliances, daily products, textile products and construction and decoration materials, with over 2000 enterprises obtaining the accreditation of China environmental label products. The annual production value of the environmental label products is over 90 billion Yuan. However, currently, China does not have clear recognition on the eco-compensation of eco-labeling system. From this point of view, China should pay high attention to the eco-compensation significance of eco-labeling system, take it intentionally as the policy instrument of eco-compensation so as to widely apply it, and encourage the important eco-function reserves and water resources conservation zones of river basins to actively restructure the industry, develop environmentally friendly products, and turned the conserved eco-advantages into industrial advantages so as to take a cleaner industrial way. For this regard, the state should promote the development of eco-labeling products by implementing preferential policies and green governmental procurement system.

As to the self-organized private trade and open market trade modes, China has only conducted single experimental exploration, without many typical successful cases. It is necessary to enhance the relevant researches and demonstration.

Thirdly, The public financial instrument and market instrument have respective adaptive conditions, both with advantages and shortcomings, supplementing each other.

The international experiences indicate that the public purchase mode is suitable for the situation with broad eco-function service scope, lots of beneficiaries or situation hard to defined, i.e. belonging to typical public goods. However, this mode has tow major risks: firstly, due to asymmetrical information, the government purchase may pay higher cost than the actual situation; and secondly, it's possible that the possibility of low efficiency of the bureaucracy, lobbying and corruption as well as the shock of prioritized fields of governmental budget will influence the mode governmental purchase.

Market instrument could be applied to the situation with few beneficiary entities and easy to define, low transaction cost and that it's easy to quantify and standardize eco-service function. Its best advantage is the high efficiency of compensation.

However, it could be found out at the same time that the conditions for applying marketization mode are rather strict, and it's necessary to have sound market environment and management system to support. In addition, the transaction cost to reach agreements may be the most important challenge.

Therefore, China's general principle for selecting eco-compensation mode is to apply different mode in different situation. There is no necessity to determine a consortium with prioritized sequences, and public purchase and market mechanism supplement each other. In the current stage without developed market mechanism, the role and mode of the government should be in the right position first, relevant market should be actively cultivated and market mode introduced.

Fourthly, The mode of public purchase should be open, transparent and flexible.

One important character of public purchase is that the main funds come from the government or other public departments, but its operation mechanism is open and flexible, not the closed loop operation of the public departments. There are four aspects of experiences in the implementation mechanism of the cases such as USA's conservation reserve plan of cultivated land that deserves the references of China: 1) Besides public funds, it is possible to widely attract social funds; 2) the determination of compensation standards should be based on market mechanism, and be adjusted continuously with the changes of the market; 3) Wide and in-depth participation of the receivers of compensation is of important significance for defining reasonable compensation standards and ensuring smooth implementation of compensation plans; and 4) NGOs or agent institutions participate in the implementation of concrete compensation plans, which is favourable for overcoming some shortcoming of the bureaucracy, such as low efficiency, corruption and lobbying.

Fifthly, the implementation of eco-compensation policies should be supported by legal guarantee and relevant policies.

No matter it is to take the mode of public payment or the eco-environmental purchase based on the market, the formulation of uni-policy is not able to achieve the targets of eco-compensation targets. There should be legal guarantee and adjustment of relevant policies. For example, the compensation plans in USA, Switzerland and other countries have been implemented under relevant legal framework. In the transaction case of clean water supply in New York, it is related with the adjustment of relevant tax and fees. In the case of eco-labeling products in EU, the adjustment of relevant product standards and environmental standards is the important basis.

5 Domestic Practice and Experiences of Eco-Compensation Mechanism

The exploration of eco-compensation practice in China started in early 1990s, with two important aspects: firstly, it was promoted by relevant ministries of the central government, and was implemented in the form of national policy; and secondly, in recent years, the local governments have actively explored the practice of it (See Special Report on Relevant Policies and Practice of Eco-Compensation in China). These policies and practice have provided abundant experiences and lessons for the establishment of eco-compensation mechanism in China.

5.1 Characters and Issues of Relevant National Policies and Practice

At national policy level, there are four types of policies related to the issue of eco-compensation more or less in a conscious or unmindful way.

The first type clearly has the purpose of eco-compensation in the policy design process.

The policies of this type include the Notice on Determining Experimental Sites of Eco-Environmental Compensation of NEPA (invalid in 2002) issued by NEPA in 1993, subsidy policy of eco-benefit forest (subsidy funds of forest eco-benefit of the central government), project of land conversion for forest and grassland, natural forest conservation project, conversion of animal husbandry for grassland project charge policy of soil and water conservation, eco-conservation project of “Sources of Three Rivers”.

1) Overall speaking, these policies have five characters and problems:

2) Most of the policies focus on eco-benefit of forests or compensation for the rehabilitation and conservation of vegetation such as forests, except that the experimental policy of NEPA in 1993 belongs to comprehensive eco-compensation policy.

3) Except that the eco-benefit forest compensation funds and charge of water and soil conservation belong to long-term policies, the implementation of most the compensation policies takes engineering or plans as carriers, with clear implementation deadline. The assurance of the long-term nature of these engineering projects and plans has turned into a key issue attracting wide attention since it is not only related to the economic benefit of the receivers of compensation, but also related to the important issue of how to consolidate the results of eco-conservations.

4) As to the nature, the compensation of relevant eco-engineering projects is the compensation for the external economical efficiency caused by protectors; and the charge of water and soil conservation is the compensation for external uneconomical efficiency.

5) Concerning the meaning or evidence, the compensation standards include the (additional) cost of construction and conservation, and the consequent loss of development opportunity of the benefit entity. However, although the evidence for determining standards is correct, it is the consensus that standards are too low, even resulting in poverty of benefit entity. In addition, the benefit entity here only includes the people directly engaged in construction and conservation, not covering the local residents who used to depend on forest resources for survival and development (such as natural forest conservation engineering and public benefit forest funds).

6) Compared with international experiences, the reasons for these issues are that there is no full and in-depth participation of the benefit entity and some NGOs in the process of design and implementation of the compensation mechanism, and feedback and amendment mechanism that continuously adjust policies according to the changes of the market.

The second type is the policies that could serve as excellent platform of establishing eco-compensation mechanism, but has not been fully utilized.

Ever since 1980s and with the improvement in mid-1990s, China has levied mineral resources tax on the development of mineral resources for adjust the differential income in the resources development and promote the reasonable development and utilization of resources. From 1994, the compensation fee of mineral resources has been levied, with the purpose to guarantee and promote the exploration, protection and reasonable development of the mineral resources, and protect the property benefit of the state concerning the mineral resources. Although there are few cases that the state and local governments use the compensation fee to treat and restore the eco-environment in the process of mineral resources, eco-compensation is not taken into consideration in the policy design. There are concrete stipulation on the water and soil conservation, land rehabilitation and environmental protection in the mining development in the Implementation Measures of the Law of Mineral Resources of the People's Republic of China that requires that the miners who do not take the responsibilities of water and soil conservation, land rehabilitation and environmental protection should pay the necessary cost for the above mentioned responsibilities, i.e. the deposit system of mine development. However, the current information indicates that the effect of the policy is not so ideal.

The third type is the policies of resources compensation, without the strict eco-compensation content, such as the compensation policy for occupying cultivated land.

The fourth type is the policies that do not have the nature of eco-compensation when being designed, but has played a certain role in practice.

Western China is an ecologically fragile area, as well as the shelter of eco-security of China. With the promotion of Great Western Development Strategy, the financial transfer of payment to Western China from the central government increases rapidly. During 2000-2003, the national bonds for the infrastructure in the west from the central government hit 220 billion Yuan, accounting for 37% of the national bonds of the period; and the transfer payment from the central governmental finance increased rapidly from 5.3 billion Yuan in 2000 to 17 billion Yuan in 2003, with the total number of 45 billion Yuan. Among the central government's funds of infrastructure, the funds used for the west increased from 17 billion Yuan in 2000 to 24 billion Yuan in 2003. During 2000-2003, the poverty alleviation funds for the west from the central government were 17.5 billion Yuan. From the point of the scale of regional compensation, although the financial transfer payment and the development aid policy have not taken the factor of eco-compensation into consideration, and are seldom used in eco-construction and conservation, they have given a kind of compensation to certain extent to the west for the development opportunity cost sacrificed for conserving the eco-environment, or bearing the cost of the historical eco-environmental problems. It is sure that this does not necessarily mean that this is the typical eco-compensation, or this is enough.

Ever since 1980s, China has carried out large-scaled eco-conservation engineering, including shelter forest system construction, soil erosion treatment, preventing desertification and so on, with the input of several hundred billion Yuan. Geologically speaking, these construction engineering projects are mostly located in western China. Similarly, from the point of large regional compensation, the investment of eco-construction by the state has certain significance of compensating the (additional) cost of the construction and conservation in western China, but not the entire compensation required. What's more, from the point of actual demand, it is far from being enough; and the geological centralization is not so high and is too scattered that has influenced the results of the compensation.

Overall speaking, China is lack of a clear policy concept of eco-compensation in the first place. Therefore, as to the compensation funds of forest eco-benefits and the eco-compensation policy with vegetation recovery and conservation engineering as the basis, the meaning of the compensation is correct, but the evidence for

determining the compensation is not clear enough, which has partially resulted in low compensation standards. In the meantime, lots of the policies that could be taken as the carrier of eco-compensation have not been made use of in a good way, such as the mineral resources tax and compensation fee policy, financial transfer payment policy and so on. Secondly, if there is no clear policy concept, there is no integrated policy framework and implementation regulation. Therefore, the current areas applying the relevant policies are not necessarily the prioritized areas that most urgently need the compensation, and different policies are not applied in the same areas, without integrated coordination, which has influenced the strength and effects of the compensation. In the meantime, the other result of lacking integrated strategies and policy framework is the relevant compensation policies have obvious characters of relevant departments, and the process of establishing and improving the policies will further enhance the character, which will prove to be a great challenge for coordinating the policies and centralizing the limited resources to achieve the targets of compensation.

In conclusion, in line with the current realistic issues in China, there is the structural shortage of policy, and the current relevant policies need to be further improved. However, there is a sound policy platform for setting up an integrated national policy system of eco-compensation mechanism.

5.2 Characters and Issues of Local Practice

Besides the implementation of the relevant state eco-compensation policies, ever since the end of 1990s, lots of the local areas have taken the lead according to the local issues and conditions in conducting the practice and exploration of eco-compensation in the fields of river basins and mineral resources development, with come successful experiences and lots of problems and difficulties.

5.2.1 Eco-Compensation in River Basins

As to the river basins, the local practice mainly focuses on the conservation of urban drinking water areas and the eco-compensation between the upper and lower reaches in small and medium river basins in the jurisdiction areas.

As to the eco-compensation in river basins, the main policy instrument applied by local governments is the financial transfer payment from the above level government to the local governments receiving the compensation, or the integration of relevant financial channels for centralized use in the compensated areas, such as the practice in Guangdong and Zhejiang Provinces. However, the compensation to the drinking water resource areas in Beijing is basically the horizontal transfer payment among the governments of the same level. In the meantime, the local governments have also

made exploration on some eco-compensation instruments based on market mechanism, such as the trade mode of water resources, with limited typical successful cases. Dongyang Municipality and Yiwu Municipality of Zhejiang Province have successfully conducted the use right trade of water resources. In order to solve the issue of drinking water resources, if Yiwu Municipality, located in the lower reaches, is to increase the water resources by constructing reservoirs, the cost of 1 m3 would be 6 Yuan while the cost in Dongyang, located in the upper reaches, to increase 1 m3 water resources in Hengjing Reservoir in its jurisdiction area is 1 Yuan by carrying out water conservation engineering project. Therefore, with consultation, Dongyang Municipality transfer the permanent use right of the water resources of 50 million m3 in Hengjing Reservoir to Yiwu located in the lower reaches. There are similar cases of water resources transaction in Ningxia Autonomous Region, Inner Mongolian Autonomous Region, i.e. the irrigation zones in the upper reaches conduct water conservation and upgrading, and sell the surplus water to the hydro-power stations to the lower reaches.

In the practice in Zhejiang, Guangdong and so on, an eco-compensation mode of "ex-situ development" was developed. In order to avoid the pollution caused by the industrial development in the upper reaches and compensate the loss of economic development in upper reaches, Jinhua Municipality of Zhejiang Province has set up "Jinpan Economic Development Zone of Poverty Alleviation" as the industrial zone for Pan'an county-the drinking water conservation zone of the municipality and give support concerning the policies and infrastructure. In 2003, the industrial production of the zone was 500 million Yuan and the profit and tax was 50 million Yuan, accounting for 40% of the financial income of Pan'an County. There are five additional municipalities and counties that have conducted or are going to carry out similar practice in Zhejiang Province.

5.2.2 Development of Mineral Resources

Since the end of 1980s, concerning the eco-environmental problems caused by the mineral resources development of coal and oil, Jiangsu, Guangxi, Fujian, Inner Mongolia, Gansu, Shaanxi and Shanxi have conducted experiment and exploration related to eco-compensation. The concrete practice is to levy certain rate of eco-compensation fee according to sale or revenue of mineral resources for the treatment of eco-environmental problems caused by the development. According to relevant regulations to be put forth by Gansu and other provinces, the development enterprises are not exempt from the responsibilities and obligation of pollution treatment and eco-rehabilitation after handing in eco-compensation fee. This policy concept fits in with the meaning of eco-compensation mechanism of mineral

resources development (See 2.2). Other areas such as Guanxi Province, levies cash deposit to stimulate enterprises to treat and restore eco-environment. If enterprises do not take measures, the government will spend the cash deposit hiring professional companies to take the treatment and restoration tasks.

As to the environmental protection of mineral resources development, the practice of Zhejiang Province is unique. For newly developed mines, the system of fund for disbursement of eco-environment of mines is set up which charges fee according to the destructed areas of the mining. In the meantime, the eco-destruction of the new mines should be solved following the principle of "Developer Protects; and Destructor Treats" so that no new pollution is untreated.

5.2.3Comprehensive Policies and Practice of Eco-Compensation

In China, Zhejiang Province is the first one to promote the practice of eco-compensation on full scale in a systematic way. In august 2005, Zhejiang Provincial government issued the Several Decisions on Further Improving Eco-Compensation Mechanism which determines the basic principles of setting up eco-compensation mechanism, i.e. the principle of "Beneficiary compensates, and victims are compensated", "Integrated coordination and common development", "Gradual progressing, first solving easy issues and later difficult ones", and "Taking multiple measures and making progress in a reasonable way". The concrete policy measures include: (1) To set up public financial system, adjust and prioritize the financial expenditure structure, and enhance the eco-compensation of financial transfer payment; (2) To enhance the management of resources fee levying and strengthen its function of eco-compensation; (3) To make active exploration on inter-regional eco-compensation, and support the less developed to speed up development; (4) To strengthen the treatment of environmental pollution and gradually set up the economic compensation system of the responsible person of eco-environmental destruction; and (5) To actively explore the eco-compensation mode and guide all walks of the society to get involved in environmental protection and eco-construction.

In the concrete implementation, Zhejiang Province has formulated the scheme of graded implementation, namely, the provincial government is mainly responsible for the implementation of eco-compensation in the 8 major trans-regional river basins, and municipal and county level governments are responsible for solving the eco-compensation issues within the regions. Currently, there are 6 municipalities such as Hangzhou that have formulated or are formulating the policies of eco-compensation mechanism of the region, and promote relevant practice.

5.2.4 Experiences and Problems

The current relevant local practice in China is of important significance of revelation for recognizing and setting up national eco-compensation mechanism:

1) Provided that the benefit entity is clear, and the benefit relation of the beneficiary and protector is clear, it is easy to set up the mechanism by consultation, such as the case of eco-compensation in the drinking water resources conservation area in Beijing and Hebei province;

2) Market-based mechanism has great potential especially in small river basins in the same jurisdiction region, with high efficiency, for example the water resources transaction mode of Dongyang-Yiwu in Zhejiang Province;

3) For larger river basins, the upper, middle and lower reaches are related to a large area, with lots of stakeholders, and the benefit relation is hard to define. Therefore, the coordination of the above government and the public financial instrument are of utmost importance to setting up the eco-compensation mechanism;

4) As to the public financial instruments, Zhejiang province has adjusted and prioritized financial expenditure structure, enhance the eco-compensation of the financial transfer payment, especially that the municipalities and counties of Hangzhou have integrated the relevant funds of over ten items such as the financial transfer payment, subsidies, eco-construction funds, subsidies of environmental protection, subsidies of urban construction, poverty alleviation funds and water resources construction, and set up the specific fund of eco-compensation, which is of sound significance of revelation for the state and other local areas in solving the issue of raising public funds for eco-compensation, namely, when the fields and areas to be compensated are defined and planned in an integrated way, the use of the funds from various channels should be integrated and adjusted, and the limited funds should be gathered to solve key problems;

5) The governmental development aid and the economic cooperation of the beneficiary and conservation main bodies is a sound method, such as the “ex-situ development mode”, which could be applied specifically concerning the loss of development opportunities due to the eco-conservation action;

6) The policy design of Zhejiang concerning the gradual improvement of the economic compensation system for eco-destructors is highly valuable. The compensation mechanism and the compensation mechanism are the two aspects

of one issue. Provided that the initial rights and liabilities are defined, the relation of the beneficiary to the protector is compensation relation, and the destructor to victim is indemnity relation. In a same contract, the transition of protector and destructor is determined by the fact whether the promised responsibilities are completed or not;

7) As to the establishment of eco-compensation mechanism of mineral resources, a conventional policy concept in lots of local areas in China is to levy the compensation fee, and at the same time apply the principle that of "Developer Protects, and Destructor Treats", without waiving the treatment and protection responsibilities of the developers, especially the developers of new mines after paying the fees. Deposit system is helpful for implementing the system;

8) In the early stage of establishing eco-compensation mechanism, the guiding role of the government is very critical. Once the government pays high attention, with certain financial strength, and there is the policy demand in the society, the eco-compensation mechanism could be set up. Zhejiang province is a typical case. The experiences of Zhejiang also indicate that the clear responsibilities of eco-environmental conservation of the government and the establishment of strict supervision and examination system are the important protection measures for the smooth implementation of eco-compensation mechanism and achieving the targets of compensation.

However, it should be noted in the meantime that the practice in lots of local areas is still at the initial stage, with lots of problems and challenges, mainly as the following three aspects:

1) There are no legal and policy evidence. The local governments have difficulties in promoting the establishment of eco-compensation mechanism. Currently, there is no legislation on eco-compensation, without relevant national policy documents. Therefore, the relevant local practice is completely autonomous, without legal and policy evident. It is difficult to promote it on full scale, and only experimental pilot projects could be conducted in part of the areas or for some issues. Even if Zhejiang province has issue relevant policies, it is also faced with the same problem. Another example is that some local governments have levied eco-compensation fee of various forms on the development of mineral resources. However, strictly speaking, there is the risk for such practice to violate laws. It is sure that according to relevant laws and regulations, the levy of cash deposit for the treatment of eco-environment of the mines is reasonable;

2) Without the coordination mechanism of the central government, it's impossible to

set up the eco-compensation mechanism in lots of the important trans-border river basins and eco-function zones. Currently, what the delegates of NPC and CPPCC, local governments and all walks of the society call for most urgently concerning the establishment of eco-compensation mechanism is the compensation issue of trans-provincial river basins, including the Dongjiang River Basin of Guangdong and Jiangxi provinces, Xijiang River Basin of Guangxi and Guangdong, Xinanjiang River Basin of Anhui and Zhejiang provinces, Hanjiang River Basin of Shaanxi and Hubei provinces, and Hei River Basins of Gansu and Inner Mongolia, also including the major rivers such as Yangtze River, Yellow River and Huai River. In these trans-provincial river basins, the benefit conflicts of the upper and lower reaches are rather serious, with the upper reaches have stronger feeling and the lower reaches trying to avoid such issues. Without the coordination of the central government, the local governments could almost do nothing about this issue;

3) There are fade zones and barriers of both the theories and technologies for the local practice. Eco-compensation is a new issue, with the understanding of its meaning and determination of its evidence and standards remaining at the study stage. Therefore, the relevant practice in some local areas is aimless to certain extent, with the simple intention to raise funds in the name of eco-compensation for solving environmental problems in some fields. Even in the areas with standard practice, the current eco-compensation mechanism is mainly to provide funds of eco-construction and conservation to the compensated areas, without compensating the cost of development opportunities. Therefore, governments of some compensated areas tend to think they need the funds for eco-construction and conservation, and the funds and aid for raising the local development capacity and social welfare, which is the issue that the local people pay more attention to in the poverty stage. Another example is that as to the eco-compensation of mineral resources development, some local area has replaced the eco-compensation mechanism with fees or deposit, and exempted the responsibilities of the developers to treat and restore the eco-environment. In addition, currently when most of the local areas are determining the standards of eco-compensation, they mainly depend on the financial strength of the government, without technical capacity to conduct scientific calculation and assessment.

6 Prioritized Fields of China's Eco-compensation Mechanism, Legal Evidence and Policy Instrument

6.1 Types and Prioritized Fields of Eco-compensation

At present there is no uniform division of the types of eco-compensation in the domestic academic circle. That is mainly due to different dividing standards and goals. The policy meaning of final division is various, having no favorable practical effect.

For example, according to different main bodies of the compensated, China Academy of Environmental Planning (in 2005) divided eco-compensation into national compensation, resource interest-related compensation, self-compensation and social compensation. The former three belong to interest-related compensation, with the feature of compulsory compensation while social compensation belongs to non-interest-related compensation, with the feature of self-compensation. Meanwhile, there is another division from the angle of policy choice: western compensation, eco-function zone compensation, river basin compensation and factor compensation, etc. (China Academy of Environmental Planning, 2005)

Sheng Man Hong and Lu Jing (2004) made a detailed division of eco-compensation types according to different standards:

(1) According to the object of compensation, there are the compensation for those who make contribution to the eco-conservation, the compensation for those who suffer losses in the eco-destruction and the compensation for those who reduce the degree of eco-destruction; （2） From the angle of areas and regions, there is compensation between the upper and lower reaches and compensation between departments; (3) From the degree of government's intervention, there are government's strong intervention compensation mechanism and government's weak intervention compensation mechanism; (4) From the effect of compensation, there are "blood-transfused" compensation and "blood-generating" compensation.

Standard is the premise for the division of eco-compensation types. The determination of standard is based on two goals: one is to help to understand existing problems; and the other is favorable to set down policies, i.e. classification itself has a certain policy meaning. Therefore, classification can be multi-layer, but it must be a framework system.

6.1.1 Types of Eco-compensation Issues

According to the above principle, eco-compensation issues can, first of all, be classified into three layers according to geographical scale and their characters so that we can have full appreciation of the practical problems; and then they can be

classified into the fourth layer according to public property, which reflects the policy approach to solve different problems (Table 1).

From the geographical scale and character, eco-compensation issues can first be divided into two kinds: international eco-compensation and domestic (China's) eco-compensation.

International compensation includes eco-compensation caused by the conservation of global forestry and biodiversity, pollution transfer (industry, products and pollutants) and cross-boundary waters.

The domestic eco-compensation mainly includes the following four types;

Regional compensation. China's regional compensation arises from two reasons: one is that some regions become an important barrier to national eco-environment safety, for example, the western region; and the other is that China's planned economy system caused many development zones to transport large amount of cheap resources, but to bear the danger of eco-environment destruction and have no practical benefit from development, such as western region and northeast region.

a) **Important eco-function zone compensation**. China has 1458 eco-function zones which are important to safeguard national eco-safety, including water sources conservation zones, soil conservation zones, wind-shelter sand-shifting zones, biodiversity conservation zones and flood storage zones, with a share of 22% of the national territory and 11% of the whole population (refer to section 1).

b) **River basin eco-compensation**. River basins can be further classified into four two-layer types. (1) Seven big rivers such as the Yangtze River and the Yellow River, etc. The biggest feature of these rivers is that the river basins cover a few and a dozen provinces. The definition of beneficiaries and protected zones is quite difficult and the compensation is quite complicated. (2) Cross-provincial boundary medium river basins. The feature of this type is medium-scale river basins of cross-two provinces or cities with clear relationship between beneficiary and protector, covering no more than three provinces or cities at most, otherwise the definition of interest will be as complicated as that of rivers. These types of river basins cover Dongjiang River Basin across Guangdong and Jiangxi, Xijiang River Basin across Guangxi and Guangdong, Xinanjiang River Basin across Anhui and Zhejiang, Hanjiang River Basin across Shaanxi and Hubei, Heihe River Basin across Qinhai, Gansu and Inner Mongolia, etc. (3) Urban drinking water. The feature of this type: the first covers the important issue of drinking water; the second only covers two entities of interest: water resource protecting zone and drinking water supplying zone. The two zones may be under the same administrative district or belong to two different. (4) Small

river basins within local administrative districts. One of the features is the river basins are small, with clear interest relationship. Another feature is that it is easier for the governments within the administrative districts to coordinate their interest relationship.

c) **Eco-factor Compensation**. The first three types basically belong to different eco-economic system types. The fourth is the eco-compensation mechanism types based on factors of ecosystem, e.g. development of mineral resources, water resources and land resources, etc.

There are two factors determining the policy approach to the above compensation: one is the degree of clear relationship between entities of interest, or the number of entities of interest; the other is the nature of eco-service function entities of protectors offer and beneficiaries enjoy, i.e. the property of public goods. In effect the two are interchangeable. Therefore, it is necessary to reclassify the above problems according to the property of public goods so that the policy approach to the establishment of eco-compensation mechanism can be shown.

According to the nature of competition and exclusion of consumption, goods are divided into two kinds in economics: public and private goods. Between them can be divided quasi-public and quasi-private goods. According this theory, the existing problems can be classified as the fourth layer.

1) The Eco-compensation Type of Pure Public Goods: Partial International Compensation, Regional Compensation and National Important Eco-function Zone Compensation

The pure public goods have two natures of consumptive non-excludability and non-rivalrousness at the same time. The eco-service function and status of national important eco-function zones are to safeguard and maintain national eco-safety. From the angle of non-excludability, it is impossible to exclude others from obtaining and enjoying eco-service offered by eco-conservation of these zones; from the angle of consumptive non-rivalrousness, in the overall situation, adding one person will not affect the eco-service others pay for. Therefore, pure public goods are typical of the eco-service of national important eco-function zones. According to the theory of public goods, the eco-service should be purchased by all the beneficiaries, or by their representative — the government. The government's purchase fund should come from public income, i.e. paid either by public finance or by Pigovian Tax - the income levied from eco-tax. Partial International Compensation, such as conservation of global forestry and biodiversity, and China's Regional Compensation, also has the nature of pure public goods.

Eco-services produced by the conservation of global forestry and biodiversity should be purchased by all the beneficiary countries, often through multilateral agreements. Concerning the eco-service which can be quantified and standardized, such as the function of absorbing carbon dioxide, the compensation can be made by opening market trade, for example, CDM and emission trade mechanism under Kyoto Protocol.

2） Eco-compensation Type of Quasi-Public Goods

As stated in 3.3., in reality, there exist a large number of goods between pure public goods and private goods, called quasi-public goods, including club goods and common resources.

The eco-services produced from the conservation of upper reaches of river basins mainly represent the sufficient supply of superior water resources. From the nature of consumption, it is competitive; from the boundary of river basins, the consumption can also be somewhat exclusive. But from the inside of river basins, it is impossible to be exclusive. Therefore, the river basin eco-compensation is part of quasi-public goods, together with the nature of common goods and club goods. If we take it into account that it is not so easy to define the relationship between the number of entities concerned and their interest, then we can think that big rivers bear more of the nature of common resources; cross-provincial boundary medium rivers, urban drinking water source, and small rivers within local administrative districts bear more of the nature of club goods. Public purchase and market transaction are the same important to this type of eco-compensation. The choice of the concrete policy approach depends on the implementation facilities and the desire of entities of interest. But whatever choice made, the coordination of the upper-level government is essential, especially the function of making a platform with which entities of interest can reach compensation agreement along Coarse's approach.

3) The Eco-compensation Type of Quasi-Private Goods: Compensation of factors

Eco-compensation of the development of mineral resources has the nature of quasi-private goods. The process of mineral resources development and its goods bear the nature of private goods. Most of the pollution problems caused by them belong to spot-source pollution, whose responsibility is fairly clear, but on the other hand, it has a certain nature of public goods, for the ownership of mineral resources belong to the state. The effect of ecological problems caused in the mineral resources development partly bears the nature of public goods. In general, in the development of mineral resources, the relationship between destroyer and victim is fairly clear, mainly the

interest relationship among the principal and responsible of eco-environment — the government, developer and local residents. Regarding this type of eco-compensation, classical taxation system is a good policy choice.

Table 1 Types of eco-compensation issues and their property of public goods and policy approaches

I： Global scale	**II： National scale and nature of issues**	**III: Regional scale and nature of issues**	**V： Property of public goods**	**Policy approaches**
International compensation	Conservation of global forestry and biodiversity, pollution transfer and cross-boundary rivers, etc.		Most of them belong to pure public goods	Global purchase under multilateral agreements, purchase under regional and bilateral agreements and purchase from various organizations, including transactions of global or regional markets
Domestic compensation	Regional compensation	West, northeast, etc.	Pure public goods	Mainly by national (public) purchase
	Compensation of important eco-function zones	Water sources conservation zones, biodiversity conservation zones, wind-shelter sand-shifting control zones, soil conservation zones, flood storage zones	Pure public goods	Mainly by national (public) purchase
	River basin compensation	Seven rivers in China, such as the Yangtze River, the Yellow River, etc.	Quasi-public goods: public resources	Mainly by national (public) purchase

		Cross-provincial boundary medium river basins, e.g. Dangjiang River Basin, Xinanjiang River Basin, Hanjiang River Basin and Heihe River Basin, etc.	Quasi-public goods: public resources and club goods	Combination of public purchase and market transaction, but upper-level government's coordination is essentially important.
		Urban drinking water source	Quasi-public goods: public resources or club goods	Combination of public purchase and market transaction, but upper-level government's coordination is essentially important.
		Small river basins within local administrative districts	Quasi-public goods: public resources or club goods	Combination of public purchase and market transaction, but upper-level government's coordination is essentially important.
	Compensation of eco-factors	Development of mineral resources, water and land resources, etc.	Quasi-private goods	Principle of developers' responsibility under government regulations

6.1.2 Prioritized Field of Establishment of Eco-Compensation Mechanism and Government's Responsibility

Obviously, international compensation is not the one considered at the present stage in China.

From the relativity of various eco-compensation problems facing China, regional compensation and big-river compensation are not taken as priority areas, for if important eco-function zones and eco-compensation mechanism of resources development are established, the problem of regional compensation can be solved to a large extent, because the geographical distribution of the three is almost identical, mainly the western region, including the northeast. In addition, the first two are the

reason why the third part needs compensation. The objects of big-river compensation are centered on river source and some of upper reaches, which basically belong to important national eco-function zones. Therefore, the establishment of eco-compensation mechanism of important eco-function zones can basically cover big-river compensation areas.

Regarding the remaining 5 issues: National Important Eco-function zones, Cross-provincial Boundary Medium Rivers, Urban Drinking Water Sources, Small River Basins within Local Administrative Districts and Development of Mineral Resources, it is quite difficult to determine "who has the superiority".

For example, from the urgency of ecological problems, national important eco-function zones and development of mineral resources roughly belong to one category; the other three may belong to another category. From the effect range of ecological issues, important eco-function zones are the biggest; next, cross-boundary medium river basins, urban drinking water source and development of mineral resources; and last and smallest, small river basins. From the degree of difficulty of mechanism establishment, different policy approaches will show different degrees of suitability to different issues. Approaches of public purchase and market transaction are suitable to all small river basins, but they are not completely the same with other issues.

Therefore, it is quite difficult to determine a sequence of superiority with a uniform standard. Even if such an order is obtained, it is not necessarily good to practice.

However, we can, according to the range of responsibility, set down a clear priority field for which the government promotes the establishment of mechanism, i.e. eco-compensation mechanism of important eco-function zones, development of mineral resources and cross-boundary medium river basins the central government focuses on. In important eco-function zones, national nature reserves zones and water conservation zones are taken as priority. Local governments are responsible for establishing eco-compensation mechanism of urban water source and local small river basins within their administrative districts and cooperate with the central government in establishing compensation mechanism of cross-boundary medium river basins. In that case, each side has its own priority and can easily adopt feasible approaches to different issues. In this way can they improve gradually and push forward on a full scale.

6.2 Legal and Policy Evidence and Safeguard System for Establishment of Eco-compensation Mechanism

In the practice of the overall establishment of eco-compensation mechanism, the

questions of why compensation must be made, and who is to be compensated are two basic questions all the time. To rectify the environment and their relation of interest of protectors and beneficiaries is the economics explanation to the two issues. That beneficiaries compensate protectors of important eco-function zones and protectors of upper reaches is the explanation to the practical application of the two issues, which leads to another general question: where on earth are the beneficiaries and the compensated? Who are they in effect? Otherwise, any region, person or organization can ask for the demand of compensation, or raise the reason for not offering compensation money. Therefore, defining national eco-function zones and economic development zones is the best way to solve the above problems.

There are two important purposes for national eco-function zoning: one is to determine key eco-function zones and highly eco-sensitive areas which are important to safeguard national eco-safety; and the other is to guide the adjustment of industrial structure, to develop and protect resources reasonably by ecological law in order to avoid the economic development at the sacrifice of ecological environment and blind development of resources and intensify eco-support ability of regional social development and promote regional sustainable development. It is clearly stipulated in " Outline of the 11th Five Year Plan for Development of National Economy and Society of the People's Republic of China" (shortened as "Plan Outline"), according to resources environment bearing capability, density of the current development and development potential, to consider as a whole the future population distribution of our country, economic distribution, land utilization and pattern of towns; divide the national territory into four functional zones: optimal development, priority development, limited development and prohibitive development; adjust and improve regional policy and evaluation of political achievements according to the position of entities and form a reasonable development structure.

Eco-function zoning is defined by the system analysis of the feature of distribution of China's ecosystem space, the determination of main eco-problems in the zones, the importance of eco-service function and differentiating law of eco-sensitive space. They are set down as program of regional eco-functional sub-zones. Eco-functional sub-zones are the evidence for determining four main functional zones, such as optimal development, priority development, limited development and prohibitive development, which are the position for the economic development of eco-function zones.

According to the result of State Environmental Protection Administration's recent division of national eco-function zoning, the whole country is divided into 3 big eco-zones, 50 eco-zones, 206 eco-sub-zones; on this basis, according to

eco-sensitivity, types of eco-service function and their importance, 1458 important eco-function zones are chosen, including water conservation zones, soil conservation zones, wind-shelter sand-shifting zones, biodiversity conservation zones and flood storage zones. According to “Plan Outline”, national nature reserves are prohibitive development zones; other important eco-function zones are limited ones.

Therefore, eco-functional sub-zones clearly determine the region and group which receive or pay for eco-compensation, and meanwhile, provide requirements of eco-environment protection; economic entities based on eco-functional sub-zones define why these zones are compensated or the reason for economic development of payment. That is the legal and policy evidence for the establishment of eco-compensation mechanism in China. Therefore, the Chinese government should approve the plan for the defining of national eco-function zones as soon as possible and research and promulgate the corresponding plan for the division of economic development zones.

Meanwhile, the Chinese government should also bring the establishment of eco-compensation mechanism into law of environmental protection or other relative laws, adding the lawful pushing force in the practice. Under the situation of immature legislation condition and timing, special policy papers can be issued in the form of State Council’s decision or guideline ideas to promote the progress of China’s establishment of eco-compensation mechanism.

In the prohibitive or limited development fields of important eco-function zones, the traditional idea of GDP should be abandoned first; the accounting system of green national economy should be applied; and green calculating system of political achievement of local officials should be set up. These are not only the important safeguard measures of practical implementation of the strategy of ecological and economic functional sub-zones, but also the key system of smoothly pushing the establishment of eco-compensation mechanism.

6.3 Policy Instruments for Establishing Eco-compensation Mechanism

According to experiences home and abroad and the current policy structure, there are two categories including 9 policy instruments which can be used to meet the purpose of making eco-compensation, but their suitability for five kinds of eco-compensation problems China is faced with is quite different (Table 2). In addition, the nine policy tools do not take eco-compensation as the only or main policy; they often use these policies to meet the requirements of eco-compensation.

Public Policies

There are different understanding and defining of public policies. For example, from the policy purpose, those policies offering social public goods and service can be called public policy. The public policy here is defined according to public resources and public power the policy depends on, for the result of eco-compensation is almost of public goods; market means sometimes can also supply public goods.

1) Public Financial Policy

There are there kinds of financial policies of public expenditure depending on regular income to meet the purpose of eco-compensation.

One is vertical financial transfer payment, i.e. the regular financial transfer from central government to local government, or from local upper-level government to lower-level government. This policy is adaptive to the eco-compensation from the state to the important eco-function zones so as to achieve the opportunity cost of economic development sacrificed at eco-environmental conservation. As to the eco-compensation of medium river basins of cross-provincial border, urban drinking water resources areas, small river basins within the administrative zones and mineral resources development, it is not encouraged to transfer payment from the central government to the local areas due to the responsibility relation, or not possible to do so due to the financial constraints. Concerning the vertical transfer of payment within local administrative zones, the local governments are suggested not to apply it frequently by depending on the local conditions, and the policies with closer relation to the relevant stakeholders and liability entities should be adopted. It is sure that if the upper reaches of cross-provincial border belong to national key eco-function zones or the large-scaled historical mineral resources development has caused serious eco-environmental problems in some areas, the policy to transfer financial payment from the central government to local areas could be applied.

Two is the policy for eco-construction and conservation investment, including central and local governments' investment, which is mainly applicable to eco-compensation of national eco-function zones, and the extra investment cost of construction and conservation in order to meet requirements of higher eco-environment of functional zones. The principle of the policy for eco-construction and conservation of local governments is the same as the principle of the policy for local vertical financial transfer payment.

Third is local same-level governments' financial transfer payment, which is applicable to the eco-compensation of cross-provincial boundary medium river basins, urban drinking water source and small river basins within administrative districts. Different

from vertical financial transfer payment in meaning, the financial transfer payment made by beneficiary local governments to protected local governments should include extra investment cost of eco-construction and protection and the lost development opportunity cost at the same time. Of course, if other means, such as economic cooperation, realize the second compensation, vertical transfer payment can focus on the first content. If other means play a subsidiary and intensifying role, transfer payment still need to include the two compensation contents.

2) Tax Fee and Special Fund

Tax fee is the economic means to internalize external cost and to encourage entities to change their behavior, and it is also the important source of governments' finance. Eco-tax is levied on all citizens and organizations and a special fund is set up to fulfill national responsibility of eco-compensation, which is a good policy direction. But considering China's current reform thought of financial tax policy, it is fairly difficult to levy new tax, which takes time.

However, regarding grave eco-environment problems caused by the development of mineral resources, it is quite necessary to levy eco-compensation fee or to add eco-compensation fee on the basis of the existing resources compensation fee. We can use the income from the levy to set up a special fund, which can, in turn, be used to father large-scale eco-environment problems caused by the development of mineral resources and the historic remaining problems.

3) Policies for Preferential Tax, the Poverty Reduction and Development Aid

To offer preferential tax, improve the poverty reduction and develop aid in the compensated zones is the important subsidiary means of eco-compensation policy, which is mainly intended to compensate the loss of development opportunity cost. Preferential tax includes the adjustment of the share of tax and the reduction and exemption of tax. To incline and focus the policy of helping the poor and developing aid towards the compensated zones can play a role of eco-compensation. The policy of national preferential tax, poverty reduction and development aid inclines national important eco-function zones; and local relative policy can incline their compensated zones.

4) Policy of Economic Cooperation

To carry out economic cooperation is the important subsidiary policy for solving eco-compensation problems of cross-provincial boundary medium river basins, urban drinking water source and small river basins within administrative districts. Its purpose is to compensate the loss of development opportunity cost of the upper

reaches areas. According to local experience, the form of economic cooperation is various, such as establishment of “ex-situ development” zones, investment of cleaner industry development project, training of personnel resources, creation of employment, etc.

Market Means

According to domestic and overseas experiences, the current eco-compensation market means which can be used are one-to-one market transaction, quota market transaction and eco-label, etc.

1) One-to-one Market Transaction

When the beneficiary and protector, the relations between them, especially one-to-one situation, are defined clearly, market transaction of eco-service can directly be conducted through negotiations. This model is applicable to eco-compensation problems of cross-provincial boundary medium river basins, urban drinking water source and small river basins within administrative districts. As eco-services of river basins most directly and comprehensively represents the sufficient superior water the upper reaches zones supply, the water resources transaction between the governments of upper and lower reaches is the main form of this transaction. Of course, water resources transaction can also be done between enterprises and communities.

2) Quota Market Transaction

When the number of buyers and sellers in the eco-service market is large or unclear, and the eco-services for transaction ecosystem supplies can be quantified as standard, divisible goods, such as green house gas, these targets can go into market for transaction, i.e. open trade form. In the eco-compensation field of important eco-function zones, China should actively explore the model of quota market transaction, such as CDM projects, quota biodiversity conservation and wetland conservation transaction mechanism under “UNFCCC” and “Kyoto Protocol”. In the exploration, it is essential how to convert the compensation object of eco-service into quantifiable and divisible transaction unit (similar to quantity of pollutants).

3）Eco-label

Eco-label system is a widely-developed system, which can be used as a creative policy tool in the eco-function zones and eco-compensation of river basins. Here in a broad sense, eco-label goods and service include both eco-label of products, such as ecological (organic) farming products, and eco-label of tourist scenery and cultural or biological heritage spots. Therefore, eco-functional reserves and larger water source conservation zones of river basins are encouraged to actively develop eco-label goods

and services, to convert local ecological advantage into industrial advantage and to ask consumers to pay for the cost of eco-compensation.

7 China's Financial Policy and Management System Design in Establishment of Eco-compensation Mechanism

We learn from the above analysis that public financial policy plays a widespread and important role in China's establishment of eco-compensation mechanism. According to the direction of the reform of China's public financial policy, financial system policy shall be reformed to bring the content of eco-compensation into the vertical financial transfer payment system from the central government to local governments; financial expenditure policy shall be adjusted; horizontal financial transfer payment of eco-compensation shall be made between relative local governments; and it is feasible to adjust financial income policy and set up national eco-compensation special fund. In order to ensure the effective implementation of this financial policy, it is necessary to set up financial management system regarding eco-compensation at first.

Table 2 Establishment of policy tool of eco-compensation mechanism

			Important eco-function zones	**Cross-provincial medium river basins**	**Urban drinking water source**	**Small river basins within administrative districts**	**Development of mineral resources**
Relationship between entities of interest and responsibility	Entities of the compensated		Governments and residents in the functional zones	Governments and residents in the upper reaches	Governments and residents in the drinking water source conservation zones	Governments and residents in the upper reaches	Governments and residents in the developing zones
	Entities of compensation		All the beneficiaries outside functional zones - central government	Governments and residents in the lower reaches	Governments and residents in the water-used cities	Governments and residents in the lower reaches	Developers
	Upper-level government			State coordination and partial compensation	Coordination from urban upper-level governments	Coordination from upper-level governments	State's promulgation of laws, organization and implementation and partial compensation
Public	Financial policy	Vertical financial transfer payment	Suitable	Fairly suitable (if the upper reaches of a river basin is national important eco-function zones)	Not recommended	Not recommended	Not recommended (unless the grave problems caused by historic reasons)

policy		Eco-construction and protection investment	Suitable	Fairly suitable (if the upper reaches of a river basin is national important eco-function zones)	Not recommended	Not recommended	Not recommended (unless the grave problems caused by historic reasons)
		Horizontal financial transfer payment		Suitable	Suitable	Suitable	
	Tax, fee and special fund		Fairly suitable				Suitable
	Poverty alleviation, preferential tax and development aid		Suitable	Fairly suitable (if the upper reaches of river basins is national important eco-function zones)	Adopted by the upper-level government	Adopted by the upper-level government	Not recommended (unless the grave problems caused by historic reasons)
	Economic cooperation			Suitable	Suitable	Suitable	Fairly suitable (between developers and local areas)
Market means	One-to-one market transaction (water resources transaction)			Suitable	Suitable	Suitable	
	Quota market transaction		Fairly suitable (e.g. carbon sink)				
	Eco-label (such as organic agricultural products, tourist and cultural mark)		Suitable	Fairly suitable	Fairly suitable		

7.1 Design of China's Eco-Compensation Management System

A new system or special organization is needed to coordinate and manage the following four things:

Firstly, eco-compensation mechanism is not only the routine means of environmental protection, but directly covers some important issues of the relations between environment and economic interest which are re-adjusted in many respects, whose effect is wide and far-reaching. It is the important scale to fulfill scientific development outlook and set up a harmonious society. Therefore it is necessary to handle it seriously and scientifically.

Secondly, eco-compensation policy is not a certain or several independent policies; most of them are dependent on existing policies of many departments and national comprehensive policies, covering interest of many departments, and national eco-functional and economic development sub-zones, needing comprehensive coordination.

Thirdly, the form of some urgent eco-compensation mechanism (such as river basins) and the establishment of the platform for entities of interest need the coordination from the upper-level government.

Fourthly, once the state and local areas establish public financial compensation policy (such as financial transfer payment and special funds), they need supervision and management and achievement evaluation.

Therefore, it is recommended that under the State Council, an eco-compensation committee be set up to be responsible for coordinating the above four items, arbitrating relative disputes and offering advice for some important decisions. The committee is made up of State Environmental Protection Administration, National Development and Reform Committee, Ministry of Finance, Ministry of Water Resources, Ministry of Agriculture and State Forestry Administration, etc. An office is set under the committee as its standing organization. Considering its nature, the office can be set inside State Environmental Protection Administration. In addition to the Office, a technical advisory committee consisting of specialists could also be set responsible for scientific advice for relative policies and affairs.

For some provinces and municipalities with huge amount of eco-compensation workload, the corresponding organizations can be set up with reference to the National Eco-compensation Committee.

7.2 Eco-compensation Reform of Vertical Financial Transfer Payment System

There are two key issues in the central government's reform about local vertical financial transfer payment so as to exert eco-compensative role for national important eco-function zones: the evidence and standard for adjustment; and what targets used to measure the evidence.

7.2.1 Evidence and Standard of Adjustment

As stated above, the content of the realization of vertical financial transfer payment mechanism is to compensate protectors for the loss of development opportunity cost, and therefore, development opportunity cost is the fundamental evidence for the adjustment of transfer payment system.

Opportunity cost is a theoretical idea. It is difficult to calculate it accurately. From the concrete practice, the opportunity cost that protectors' pay is finally reflected in the change of industrial structure, the loss of government's income ability and the reduction of people's living standard. China's current financial transfer payment system has taken into full account the factors, such as industrial structure of compensated zones and financial income ability. But at present, finance handles the industrial structure in the routine way. Its basic presumption is the economic structure of these zones is formed by history, which in effect denies the effect of eco-functional division on local economic structure.

Therefore, considering the opportunity cost based on this, two targets should be taken into account: one is the decrease degree of people's living standard; and the other is the relative cost of establishing the industrial structure in agreement with national requirement and ecological environment. In order to have the existing financial policies dovetail, the existing central government's transfer payment system is recommended to be accordingly improved by adding factors and adjusting coefficients so as to reflect the requirement of eco-compensation.

7.2.2 The Adjusted Factors

According to the above thought, it is recommended that Ministry of Finance add three factors in the reform of transfer payment so as to enable the central government to have eco-compensation function towards local financial transfer payment. This kind of reform will also give local governments a clear policy signal that ecological environmental protection can also get benefit so that the enthusiasm for protection will be intensified.

(1) **The Expenditure of the Rural Social Safety**. In the spirit of social development pattern and the central government's establishment of the new

countryside, this factor will be, sooner or later, brought into the range of the central government's transfer payment. But before that, by setting up a rural minimum safety system, a certain compensation is made to the degree of the lowering of people's living standard because of eco-function so as to ensure that the people in the eco-function zones have a long effective system after the loss of some development opportunities, which is very meaningful.

(2) **Factors of Eco-function zones.** In general, the bigger the eco-function zone, the stronger the productive eco-functional service. Therefore, the national territory of the eco-function zones is considered a factor of the central government's transfer payment, which can better meet the requirements of the function of eco-compensation and the reform of the Ministry of Finance.

As different functional zones produce different eco-services, in theory, areas of same coverage and different eco-function zones should enjoy eco-compensation of different standards. However, reform will be perfected in the progress. Therefore, at the initial stage, it is recommended that concerning the national territory the standard of population density (for example, 5 people/square km) be taken as resident zone and non-resident zone. The resident zone bears the productive task of eco-function. When determining the factor, both eco-service function and financial bearing ability should be taken into account.

(3) The Index of Modernization. The factor of modernization reflects both the level of economic development of a zone and the gap of "cleaner industrial structure" and "conventional industry structure" caused by its production of eco-service. Therefore, using this target to represent the loss of industrial development opportunity cost because of the protection of ecological environment is fairly symbolic.

Currently, China Academy of Sciences conducts calculation of the modernization index for every province in China every year, and publishes the results. It is of highly operational to define a reasonable co-efficiency by taking into the financial bearing capacity into consideration based on it.

7.3 Design of Horizontal Financial Transfer Payment System of Eco-compensation

Just like the design of vertical financial transfer payment, the evidence and standard of adjustment and the measuring target are still the key to the design of horizontal financial transfer payment system of eco-compensation.

As stated above, horizontal financial transfer payment of eco-compensation occurs mainly between the upper and lower reaches of river basins. There are two bases for this conclusion: the extra investment cost of construction and conservation the local

governments and residents of upper reaches pay for the protection of the environment; and the loss of the development opportunity cost because of conservation.

The extra investment cost can be quantified. According to the requirement of upper-reach water quality from lower reach and the upper reach plan for ecological construction and conservation, the cost of ecological construction and conservation to reach the standard can be calculated; meanwhile, as the basis of the same water quality of upper and lower reaches, the corresponding cost can also be calculated. The gap between them is the extra cost.

Concerning the loss of development opportunity cost, in the same way we can take account of the gap between the industrial structure level of upper and lower reaches and that of similar zones, governments' financial income level and residents' living standard.

In the real determination of transfer payment amount, the real mechanism is that the governments of upper and lower reaches determine through negotiations on the basis of the above. When development opportunity cost can be compensated in other forms, e.g. economic cooperation, the evidence for horizontal transfer payment can mainly take the extra cost into account.

In the negotiations between governments of upper and lower reaches, the real negotiating representatives can be the eco-compensation committee under them. At that time the eco-compensation committee under the upper-level government needs to play an important role of coordination and arbitration.

As to the form of payment, different from the vertical transfer payment, the horizontal transfer payment is not a direct transfer, but goes first into the account of the eco-compensation of the upper-level government, and a special fund is set up. The fund is jointly supervised and managed by the eco-compensation committee in the fund place and the eco-compensation committee of the two governments in the horizontal transfer. The compensated areas (the upper reaches) need to apply for the utilization of the fund according to the special plan for environmental protection in concrete projects and can use the fund after the approval of the representative of the joint supervision and management. If the transfer payment includes the compensation for development, the applied project can also include the purpose of developing and improving local welfare level.

The main purpose of such arrangements made in the form of horizontal financial transfer payment is to ensure the correct expenditure and more transparency of the paid fund of the local compensated governments. Meanwhile, in the form of fund

management, social fund can be raised, such as donation, aid without return, etc.

7.4 Design of National Eco-compensation Special Fund

The purpose of establishing National Eco-compensation Special Fund is to fulfill the implementation of national eco-compensation task and to set up regular fund source. It has three functions:

Firstly, consolidate the fund through different channels which play a certain role in the eco-compensation, eliminate the malpractice from eco-compensation policy, and focus on the use direction, field and zone and improve the efficiency of the use of limited resources;

Secondly, adjust the use direction of eco-compensation policy which can play a certain role; and expand policy range to achieve eco-compensation purpose;

Thirdly, increase the new fund source and raise the ability of national eco-compensation.

According to China's financial policy reform requirement, the establishment of national eco-compensation fund shall stick to two principles. Firstly, lessen the burden of enterprises and raise people's income. At least citizens' burden shall not increase and the improvement of social welfare can't be affected. The collection of fund needs to be adjusted and reformed under the existing channel framework. Secondly, to tap the new fund source must be in agreement with the principle of external cost of internal social economic activity, e.g. look for a channel under the thought of the onerous use of resources in the financial reform.

Therefore, the main fund source of national eco-compensation fund includes the following four channels:

1) Bring all the fund of the central government's annual eco-construction and conservation projects into the fund and as the current account; and increase by a certain proportion as per the range of financial income increase;

2) Learn from the experience of Zhejiang province, put a certain percentage of national special subsidy of forestry, water conservancy and helping the poor and relative fees (e.g. water resources fee, soil conservancy fee) into the fund, and make good use of the part which can play a role in the eco-compensation function;

3) According to the thought of the onerous use of resources and the reality of the grave eco-environment caused by development, levy eco-compensation fee of mineral resources or increase the amount on the basis of the existing eco-compensation fee and put all the income into the fund;

4) The fund receives social donation and overseas development aid, etc.

There are mainly three aspects in the use of the fund:

Firstly, eco-construction and conservation. A five-year plan for national eco-environment construction and conservation is set up on the basis of the division of main function zones of national eco-function and economic development. The fund supplies money to the construction and conservation projects determined by the plan. Eco-environment construction and conservation plan includes construction and conservation of vegetation, nature reserves zones, biodiversity conservation zones, soil conservancy zones, wind-shelter sand-shifting zones, etc. In that case, all the eco-construction and conservation projects are carried out under the uniform national plan and take national important eco-function zones as target so as to avoid the separate situation of "planting trees in the west, damming a river in the east, closing a mountain pass in the south and no measures when necessary in the north" and try to raise the efficiency of resources allocation.

Secondly, fund is used to solve and restore eco-environment problems caused by large-scale or historically remaining mineral resources development.

Thirdly, fund is used to make eco-compensation in other fields and zones.

From the above we can see that the establishment of the eco-compensation fund will not affect the vested right and interest of different departments of using the fund under the existing system; it will only change the form of use, i.e. under the uniform national plan, the money will be channeled out of a special fund, but still be used by different departments as per responsibility and plan; meanwhile, this fund is a regular monetary channel which ensures the steady source of money. Therefore, this kind of reform will not meet with too much resistance.

Local governments can refer to national eco-compensation fund to establish local eco-compensation fund.

8 Strategy and Policy Framework of China's Establishment of Eco-compensation Mechanism

Strategy and policy framework refer to the road-map for China's establishment of eco-compensation mechanism. As stated above, the strategy and policy framework of China's establishment of eco-compensation mechanism should include the following seven parts:

1) Strategic Orientation, Object and Principle

The strategic orientation of establishment of eco-compensation mechanism: The establishment of eco-compensation mechanism in China is not only the key

measures of perfecting environmental policy and protecting environment, but also the implementation of scientific outlook and the important approach to the establishment of a harmonious society, to which the Chinese government should attach much importance.

The practical object of establishment of eco-compensation mechanism is to solve problems of eco-environmental conservation in some important eco-function zones, river basins and development of mineral resources are faced with, to restore, improve and maintain eco-service function of the ecosystem. The strategic object is to adjust distribution relation of environment and economic interest between the relative entities of these fields, coordinate the contradiction between eco-environment protection and development and promote harmonious development. The working object is to spend 5 to 10 years setting up the policy framework of China's eco-compensation so as to enable the effect of eco-compensation policy to keep pace with the overall establishment of a fairly wealthy society.

The two principles should be followed when establishing eco-compensation mechanism: the first one is to adjust the relation of distribution between environment and economic interest of entities of interest as the core, to take internalization of relative eco-conservation and external cost of destruction as a basis, to have the purpose of economic encouragement and stick to the principle that "beneficiaries or destroyers pay, protectors or victims are compensated; and secondly, to take reform and improvement of the current relevant policies as basis, and gradually set up new compensation system.

The strategic measures to establish eco-compensation mechanism: to devote about 3 three years selecting priority fields in the whole country (e.g. important functional zones, medium cross-provincial boundary river basins such as water resources reservation zones and nature reserves zones, etc.) to conduct national and local pilot projects, with priority on exploring policy experiences of the establishment of upper-level government coordinating mechanism and local horizontal financial transfer payment and market mechanism. Meanwhile, at the national layer, to conduct research and reform of important public financial policies (e.g. financial transfer payment); study and formulate national eco-compensation comprehensive guiding policies (e.g. State Council's papers) and some new public policies (e.g. special national eco-compensation projects); and study and set up eco-compensation management system, etc. On the basis of pilot model and special project research, about 5 years will be devoted in preliminarily setting up key policies of eco-compensation, gradually establishing framework systems and promoting the work of eco-compensation on a large scale.

2) Prioritized Fields of Establishing Eco-compensation Mechanism

The central government shall put priority on solving problems of important eco-functional areas, eco-compensation of development of mineral resources and cross-provincial boundary medium valleys. Important functional areas take national protection areas and water source storage as priority. Local governments are mainly responsible for establishing eco-compensation mechanism of urban water source and small valleys within their own administrative districts and cooperating with the central government in establishing eco-compensation of cross-boundary medium valleys.

3) Legal and Policy Evidence for Establishing Eco-compensation Mechanism

The Chinese government should approve the plan for the division of national eco-function zones as soon as possible and study and promulgate the corresponding plan for the division of economic development zones.

Meanwhile, the Chinese government should also bring establishment of eco-compensation mechanism into environmental law or relative laws, and intensify the lawful driving force of practice. Under the immature condition of legislation and timing, the special policy papers in the form of State Council's decision or guiding idea to push the progress of China's establishment of eco-compensation mechanism.

Concerning important eco-function zones or prohibitive and limited development areas, the traditional idea of "GDP as the top one" should be abandoned; the system of green national economic accounting should be carried out and the evaluation system of local officials' green achievements should be set up.

4) Evidence and Standard of Eco-compensation

Firstly, concerning the compensating types of external economy caused by eco-conservation such as important eco-function zones and river basins, the evidence for eco-compensation should include eco-construction, extra cost of conservation and loss of development opportunity cost. In practice, there can be no strict distinction between the extra cost paid by protectors and the corresponding cost borne by them; and the determination of the cost of loss of protectors' development opportunity may refer to national or local average development level, the gap between protectors' living standard and beneficiaries' living standard. The concrete standard numerical value of the compensation of the two parts could be based on beneficiaries' economic bearing ability, practical payment desire and protectors' requirement, which are determined through negotiations.

Secondly, concerning the compensating types of external non-economical efficiency caused by development of mineral resources, the evidence for the relative policy of

compensation has also two meanings: the first refers to the cost of eco-function to restore or treat large-scale destructive eco-scenery that developers cannot treat or restore, or caused by history; and the second refers to the loss of local residents' lives and development caused by development of mineral resources. In the process of implementing compensation, developers are not exempted from the responsibility of treating and restoring point-source pollution and point-source ecology destruction caused by development.

5) Policy Means of Eco-compensation

According to domestic and overseas experiences and policy structure, there are two categories of nine policy means that can be applied to the purpose of practical eco-compensation.

Public financial policy category includes: (1) vertical financial transfer payment policy; (2) investment policy of eco-construction and conservation; (3) financial transfer payment between same-level governments; (4) tax and special fund; (5) preferential tax, poverty alleviation and development aid policy; and (6) economic cooperation policy.

The category of market instrument includes: (1) one-to-one market transaction; (2) quota market transaction; and (3) eco-label.

6) Responsibility Compensation Mechanism

Eco-compensation mechanism and relative responsibility compensation mechanism are the two sides of a coin, and they are complementary and cannot lack each other. Responsibility compensation mechanism is a punitive mechanism for those who enjoy economic interest of eco-compensation mechanism, but do not fulfill eco-environmental conservation responsibilities and obligations.

7) The Management System of Eco-compensation

National Eco-compensation Committee consisting of relative ministries and committees under the State Council is responsible for the coordination, supervision, arbitration, punishment and encouragement of eco-compensation. Where necessary, it could refer to the national system pattern to set up local eco-compensation management system.

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Theories & Methods of Eco-Compensation

Chinese Academy for Environmental Planning[1]

The objective of this special subject - the study of eco-compensation theories and methods - is to lay the theoretical foundation and develop the methods for eco-compensation, offering the theoretical and methodological support for establishing and improving the eco-compensation mechanism in China.

Research has been conducted in the following five areas: the theoretical system, the international and domestic practices and progresses, the responsibility system, the compensation standard and the compensation methods. And meanwhile the international and domestic experiences in eco-compensation have been surveyed and analyzed. On the basis of the research and taking into account the national realities, the working group suggested that the government-market relationship, and the relationship between emerging and existing problems, need to be sorted out for the sake of eco-compensation mechanism. The working group hereby proposes five major eco-compensation mechanisms.

1 Theoretical System of Eco-compensation

(1) Concept and Policy Scope of Eco-compensation

Eco-compensation is an institutional arrangement which aims at protecting the service function of ecological system and promoting the harmony between human and nature, is based on ecological service value or costs of eco-protection, eco-destroy and loss of development opportunity, to adjust the economic interest relationship among the ecological protectors, beneficiaries and destroyers by employing the instruments of finance, tax and charge, and market instruments.

To be specific, eco-compensation may fall into three levels. First, eco-compensation represents an instrument for internalization of the externalities of ecological environment that are deployed to demonstrate the external effect of environmental protection by controlling, through eco-compensation, the external costs of environmental disruptions resulting from development of resources; Secondly, eco-compensation represents an economic means designed to drive the ecological and environmental protection, reform the financial and taxation systems in favor of the protection of ecological environment and optimize the social and economic activities and resources; Thirdly, eco-compensation represents an institution designed to facilitate harmonious regional development and promote the enthusiasm and efficiency of environmental protection by setting up regional eco-compensation mechanisms based on the externality and regionality of the ecological environment.

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(2) Theoretical Basis and Methodology of Eco-compensation

The theoretical basis of ecological environment covers the following aspects: 1) the ecological environment is a system of multiple values. The fact that these values are not fully covered in the current price system of resources constitutes the root cause for eco-compensation; 2) Powerful supports are provided for the quantitative measurement of the values of the ecological environment thanks to the growing recognition and the improving methods of evaluation of the ecological services. 3) Due to the externality of the ecological environment, control of the external costs and demonstration of the external earnings of ecological environment are where the formulation process of eco-compensation policies should start from. 4) The key issue to be settled is to define the ownership of resources through legislation since the eco-asset theory is the basis on which the eco-compensation policies can be implemented under the support of the market mechanism; 5) With the obvious features of public goods residing in the ecological environment, the public administration policies will be essentially reinforced thanks to the establishment of the eco-compensation mechanisms.

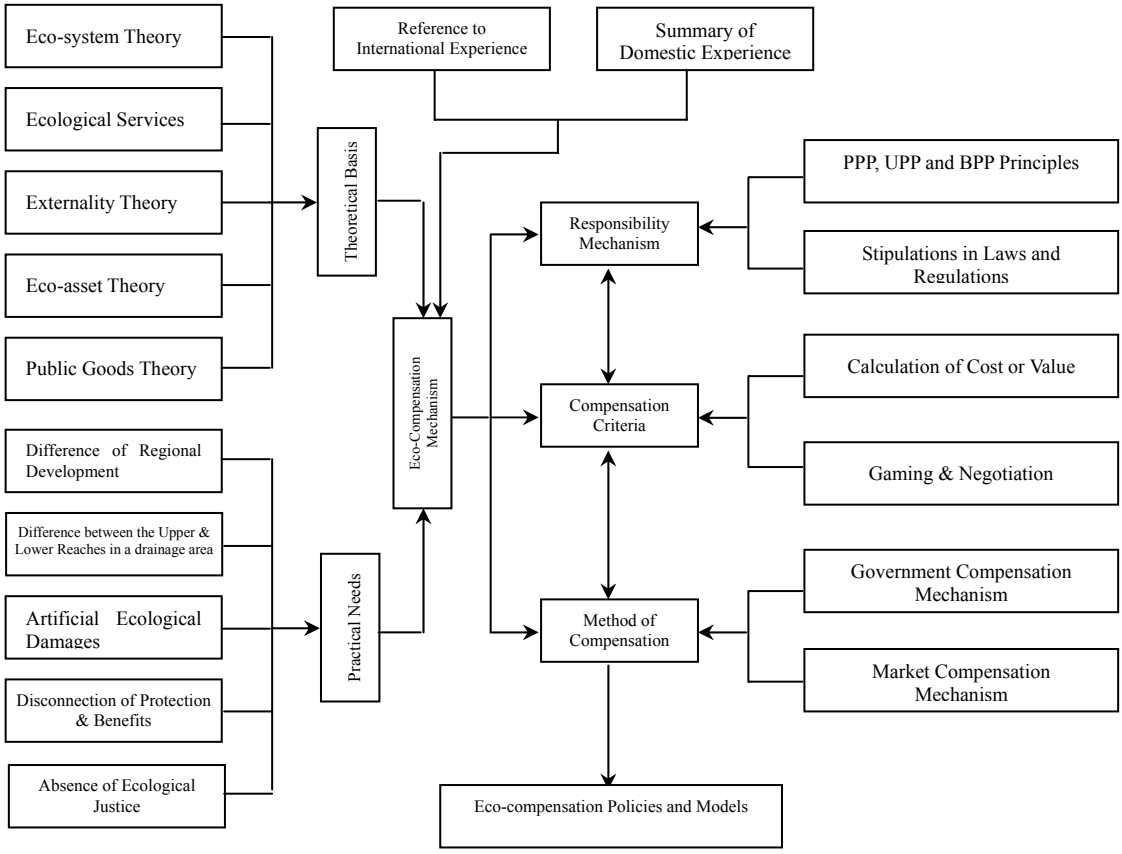

Fig. 1 Theoretical and Methodological Systems of Eco-compensation

The eco-compensation mechanism is composed of three key components: responsibility mechanism, compensation criteria and compensation methods. The

responsibility mechanism defines the identities of and the responsibilities to be borne by the interested parties in the eco-compensation mechanism. The responsibilities borne by the interested parties may be defined following the property right system and the PPP (Polluter Pays Principle), UPP (User Pays Principle) and BPP (Beneficiary Pays Principle) in addition to the specific requirements of the applicable laws.

The compensation criteria may either be identified based on the evaluation and calculation of the cost of environmental treatment (i.e. input in environmental protection) and the loss caused to the ecological environment (the value of ecological services) or, as another option, through gaming and negotiations between both interested parties.

The methods and approaches of compensation may be defined in accordance with many systems. However, the key factors involved therein are the compensation subjects and operational mechanisms. Based on the difference between the subject and the operational mechanisms of such compensation, eco-compensation may fall into two major categories, i.e. government compensation and market compensation.

2 International and Domestic Practices & Experiences

(1) International Experiences

In the related international organizations and the developed countries, eco-compensation often means to compensate for the occupation of the natural environment, i.e. to maintain the ecological services to a certain level through eco-compensation. Payment for ecological (environmental) services, , i.e. the act of payment by the beneficiaries to the providers of the ecological (environmental) services, however, is a concept having a similar meaning with the “eco-compensation" widely concerned by all walks of life in China. The subjects of such payment may either be individuals, enterprises or regions or the government. In the former case, e.g. a number of projects concerning the payments for environmental services within certain drainage areas as financed by the World Bank in Central America and Southeast Asia, a cooperation agreement is usually signed and the individuals, enterprises or the regions shall pay for the environmental services that they benefit from. In the latter case, however, the national governments, in most of the cases, will pay for and purchase some of the significant ecological regions or ecological systems, e.g. purchase of the national parks in the U.S. In addition to the development of mineral and water resources, for example, the national governments of the U.S and Sweden also provide compensation for acts of production for the purpose of protecting the agricultural environment.

The key factors leading to the success of the international eco-compensation lie in the facts that: 1) most of the countries have a relatively perfect national property right system that makes easy the compensation by means of the market mechanism; 2) many external costs of resource development can be internalized thanks to the consummate laws and regulations; 3) the governments have a strong paying ability and are able to purchase the important ecological systems or ecological services; 4) a well-developed mechanism is available for public participation and negotiation and the eco-compensation policies in implementation can adequately reflect the positions and interests of all interested parties.

(2) Domestic Experiences

In the past two decades, diversified eco-compensation practices were developed and a large number of rewarding experiences were acquired in China and the government played a leading role in the establishment and promotion of eco-compensation. On the one hand, compensations are provided directly using the financial instruments, typically the compensations for the acts of protecting the ecological elements like ecological forests and compensations provided through the implementation of key ecological construction projects such as the natural forest protection and sloping land conversion programs. On the other hand, eco-compensation funds are raised by adjusting the tax and tariff policies, changing the market signals and raising the costs of ecological disruptions and occupation. On April 1st, 2006, the Chinese Government adjusted the items, rates and related policies of the existing excise taxes and started to impose taxes on disposable chopsticks and large displacement automobiles, marking a small step forward towards green tax system. Another approach to eco-compensation is to consummate the management regulations and push some ecological services to the market to realize their values through market transactions, such as the carbon credits fully developed and realized via the CDM mechanism in China as well as the local experiences in realizing the values of ecological protection through water right transactions.

The major problems existing in the Chinese practices of eco-compensation include: 1) the legal system, institutional framework and mechanism regarding environment management are incomplete and it is difficult to set up a definite responsibility mechanism for eco-protection and eco-compensation based on the partitioned management system; 2) the unsound market mechanism is too weak to be applicable in eco-compensation; 3) further efforts are needed to reinforce the government's leading role in eco-compensation and a system is needed to evaluate the performance of the eco-compensation policies; 4) the eco-compensation, which does not involve enough public participation, cannot truly reflect the interests of the public in eco-compensation.

3 Responsibility Mechanism of Eco-compensation

(1) Basic Principles for Defining Eco-compensation Responsibilities

The identities and responsibilities of the related subjects in different stages, at different levels and in different scopes should be identified and defined based on different eco-compensation responsibility principles. In the sector of environmental pollution treatment, the Polluter Pays Principle (PPP) should be followed so that those who pollute and damage the environment shall be held responsible for the environmental treatment and restoration. Users and occupiers of the ecological resources within the scope of the ecological restoration ability and the environment self-purification capacity are theoretically not required to bear the expenses of the ecological environment treatment. However, since the ecological and environmental resources are scarce resources, the occupiers should provide compensation in this regard to the nation or the representatives of the public interests following the User Pays Principle (UPP). The Beneficiary Pays Principle (BPP) should be followed for eco-compensation of larger scope between different regions or the upper and lower reaches of a drainage area so that those who benefit from eco-compensation shall make such compensation. The key responsibilities of compensation for typical public goods shall be borne by the national government while those for public resources within a certain region or drainage area shall be shared by all beneficiaries following a certain mechanism.

(2) Legal Arrangements for the Responsibility Mechanism of Eco-compensation in China

The PPP, BPP and UPP principles present a preliminary framework and basic clew for the responsibility mechanism of eco-compensation, which, however, needs to be defined under the restraints of the related laws and regulations. The legal principles concerning eco-compensation mainly include the principles of legislation, the responsible parties and the restraint mechanism.

The specific laws of China concerning both environmental protection and resource development stipulate that the resource developers are obliged to protect the ecological environment while many other statutes and policy documents include requirements for supports to and compensation for ecological protection and construction activities as well as the specific methods applicable in providing such supports and compensation. In addition, stipulations are also available on the scope, subject, object, methods and criteria of such compensation. These laws, statutes and policies will serve as the basis for the implementation of eco-compensation. However, the present system of laws and regulations are still not complete and consummate and the main problems include: (1) The rights, obligations and

responsibilities of the interested parties as well as the content, methods and criteria of the eco-compensation are not precisely defined; (2) The emerging issues concerning and methods of ecological protection have no effective legal supports due to the time lag between the legislation process and the ecological protection and construction activities; (3) The stipulations regarding ecological protection and compensation as included in some important laws and regulations, such as the Water Law and the Mineral Resources Law, are not as adequate as they are supposed to be; (4) The rigid stipulations in the respective laws and regulations need further supplements from some flexible policies established and adjusted to the local conditions. However, the most outstanding problem at the moment is that there are no necessary laws and regulations supporting that eco-compensation be carried out by means of economic instruments to drive the protection of the ecological environment while the Environmental Protection Law of China only stipulates, as a means of compulsory control, that the local governments at all levels are responsible for ecological protection and the environmental quality and shall take actions to improve the environmental quality within the areas under their jurisdictions.

(3) Essentials for the Establishment of the Responsibility Mechanism of Eco-compensation in China

1. The fundamental principles of the responsibility mechanism of eco-compensation should be defined. The fundamental principles required for establishing the responsibility mechanism of eco-compensation should take the ecological interests as the keynote and the ecological equity and justice as the yardstick to make sure that such compensation gives attention to the ecological interests of both the present generation but also the future generations and helps promote the intragenerational equity, the intergenerational equity as well as the natural equity. The PPP, UPP and BPP principles shall be enforced regarding different scenarios and the efficiency principle of ecological protection, i.e. the principle of transferring the ecological protection input to regions or sectors with higher marginal efficiency, shall be enforced simultaneously.

2. The subjects and objects of the eco-compensation should be defined. As the fundamental basis for handling the various events of eco-compensation, laws should be regarded by the various interested parties as the criteria for defining their identities and their authorities and responsibilities. Therefore, further actions are needed to improve the related legal systems to include more precise stipulations on the identities and responsibilities of the interested parties.

3. The compensation responsibility mechanism should be reinforced based on different methods of compensation. Emphasis should be given to the compensation

responsibilities borne by the interested parties when balancing the compensation by the national government against the compensation by the interested parties; the subjects of the compulsory compensation responsibilities should be defined as a priority when balancing the compulsory compensation against the voluntary compensation; the compensation responsibilities borne by the subjects of the market behaviors should be specified as a priority when balancing the government compensation against the market compensation.

4. The property right system for environmental resources should be further improved. The interested parties' responsibilities to make compensation and their rights to get compensation can be defined by means of property right. At the moment, China's property right system for environmental resources is still not complete and consummate and further actions are required to carry out the initial assignment of the property rights of environmental resources and improve its license system.

4 Eco-compensation Criteria

(1) Two Basic Options for Assessment of Eco-compensation Criteria

The criteria of compensation for the spillover effect of ecological protection may be assessed based on either the evaluation of the ecological (environmental) services or the calculation of the loss of the opportunity cost. The assessment of the criteria of compensation for the external cost of the development activities, however, may be based on either the calculation of the loss of ecological (environmental) values or the calculation of the costs of environmental treatment and ecological restoration. The basic rule is that the theoretical criteria of eco-compensation as defined should be lower than the loss of the ecological (environmental) value and the value of the ecological (environmental) services but higher than or equal to the opportunity cost or the cost of restoration and treatment.

The ecological (environmental) values and the (opportunity) cost may be calculated in many ways and different ways produce results that are significantly different and hardly possible to be agreed by the interested parties. In practice, it is oftentimes a more proven and valid way of defining the compensation criteria to have the interested parties negotiates and agrees on a calculation-based compensation criteria. Government intervention is required to reduce the inequities in the criteria defined through negotiation as a result of information asymmetry and unequal negotiations between the advantaged and the disadvantaged.

(2) Technical Considerations in Defining the Regional Eco-compensation Criteria

The eco-compensation criteria between different regions (such as different provinces)

are more difficult to define. Theoretically, such criteria may be assessed based on the following considerations: 1) The responsibilities to make compensation and the rights to accept compensation undertaken by the various regions may be defined based on the deficit or surplus of ecological footprint; 2) the responsibilities and criteria regarding eco-compensation may be defined based on the equal ecological protection responsibilities (such as forest coverage, area of nature reserves, etc); 3) criteria of the eco-compensation due may be defined based on equivalent public service levels.

(3) Technical Considerations in Defining the Criteria of Eco-compensation within a Drainage Area

In contrast, the criteria of eco-compensation within a drainage area may be defined using a number of proven ways: 1) taking the efforts made to realize the water quality standard at the upper reaches as the criteria, mainly including investments in conserve water resources projects, comprehensive environmental pollution treatment projects, non-point agricultural pollution treatment projects, urban wastewater treatment facilities construction projects and water conservancy facility construction projects implemented at the upper reaches; 2) taking the calculated loss or additional costs possibly arising at the lower reaches due to the failure to get water of conforming quality from the upper reaches as the criteria; 3) The lower reaches shall provide some compensation to the upper reaches for new ecological protection and construction projects, comprehensive environmental pollution treatment projects and new water conservancy facilities and other new projects implemented by the upper reaches as necessary to further improve the quality and quantity of the water environment.

(4) Technical Considerations in Defining the Compensation Criteria for the Ecological and Environmental Elements

Speaking of the methods applicable in defining the compensation criteria for the ecological and environmental elements, the first option is to take the costs arising from the efforts in controlling and restoring the ecological and environmental damages caused by resource development as the criteria. For example, the compensation criteria for development of mineral resources shall not be lower than the costs of the environmental control and ecological restoration activities carried out to the mines. The second option is to take the opportunity costs of protecting the ecological and environmental elements as a criterion of calculation. For example, the compensation criteria for ecological forests shall not be lower than the level of economic earnings from deforestation. The third option is that the national government may set forth uniform compensation criteria for initial acquisition and

occupation of environmental and ecological resources.

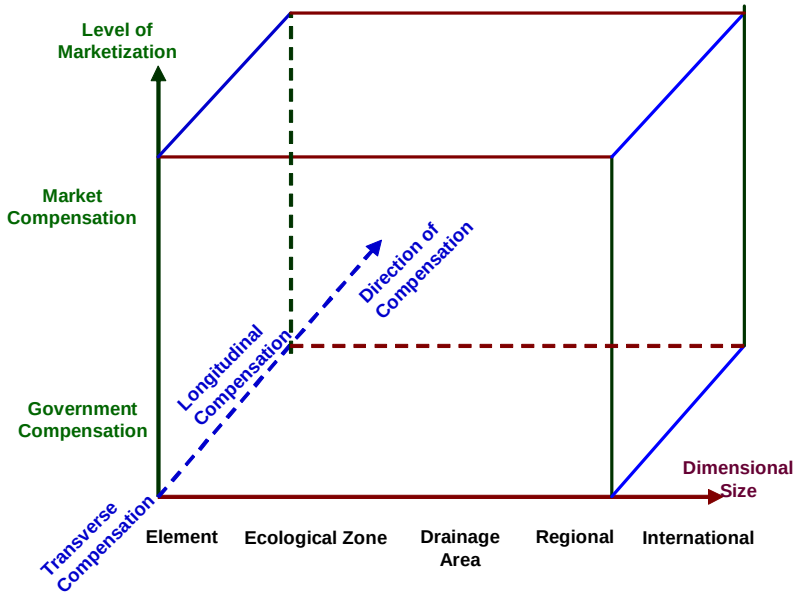

Figure 2: Classification of Ecological Compensation Methods

5 Methods and Approaches of Eco-compensation

(1) Characteristics of Classification

Eco-compensation can be realized using a large number of methods and approaches, which may be classified into different systems according to different criteria. For example, they may be classified into compensation in fund, compensation in kind, compensation in policy and compensation in intelligence based on the mechanism of compensation; longitudinal compensation and transverse compensation based on the compensation partition; or ecological and environmental element based compensation, drainage area based compensation, regional compensation and international compensation based on the dimensional sizes. The subject and the operating mechanism of the eco-compensation are the key factors deciding the nature and characteristics of the mechanism of eco-compensation, which, based on the difference of the subject and the operating mechanism, may be classified into government compensation and market compensation.

The government compensation mechanism is the key form of eco-compensation at the present time and is also a type of compensation of great expectations for many sectors. This strongly policy-oriented mechanism has definite objectives and is easy to mobilize. However, the government compensation mechanism also has limitations that are hard to overcome, including the inflexible system, the difficulty in defining the compensation criteria, the high management and operation costs, the excessive fiscal pressure on the government, and so on. This type of compensation mechanism

may also be troubled with government failure upon its application in many fields of ecological and environmental protection.

The market compensation mechanism can rely on the market rules to standardize the market behaviors and reduce the cost and realize the value of ecological protection through market transaction by pushing the ecological services or environmental protection benefits as a package to the market. Compared with the government compensation mechanism, the market compensation mechanism features in flexible ways of compensation, low management and operation cost, wide scope of application and so on. However, information asymmetry and excessively high cost of transaction may produce impacts on the operation of the market compensation mechanism. In addition, it is hardly possible to overcome the blindness, locality and short-termness of the transactions involved in the market compensation mechanism in an independent way.

(2) Major Categories

As the most important mechanism of eco-compensation at the present stage, government compensation mechanism is also an easy-to-mobilize mechanism at the present stage. The major methods involved in government compensation include fiscal transfer, environment-friendly tax policy, direct implementation of ecological protection and construction projects and preferential regional development policies. Since China has not included eco-compensation as a key impact factor into its fiscal transfer system and has only made minor progress towards the green tax system, there is still a large room for further adjustments in these regards. Improvement and promotion of ecological services are not yet regarded as the key objectives of the ecological protection and construction projects and the national government has defined the region-based guidance policies in favor of ecological protection and restoration as the key point of innovation in the "11th Five-year Plan" period.

The typical market compensation mechanisms include government payment, one-to-one transaction, market trading and eco-marks. The objects of trade may be the ownership of the ecological and environmental elements, the ecological and environmental services or the environmental pollution treatment performance or quota. The government payment mechanism is mainly applied to the ecological (environmental) elements or services, such as investments in projects implemented to protect the ecological forests, the national nature reserves and the ecological function zones, which are of paramount importance to a nation's ecological safety. The one-to-one transaction mechanism is mainly applied in scenarios with specific beneficiaries and providers of ecological (environmental) services. In such cases, both parties will negotiate face-to-face to set up a compensation mechanism. The

market trading mechanism, such as the carbon credits, is mostly an extension of the ecological environment protection quota system and, theoretically, compensation for nature reserves and ecological forests may also be realized through quota trading. Eco-marks are marks attached to environment-friendly products, such as organic food and green products, to place such products on an advantageous position on market and materialize the value and benefits of ecological protection.

6 Solutions & Recommendations

(1) Well-established relationship between the following pairs is a prerequisite to a well-established eco-compensation mechanism

Focused efforts should be made to properly define the following relationships in addition to the aforementioned relationships between government and market, ecological payment and damage compensation, upper reaches and lower reaches, calculation criteria and agreed criteria, fiscal compensation fund and social compensation fund:

1) Central Government and the Local Governments: Besides the policies and legal basis provided to the local governments in establishing the eco-compensation mechanisms, the central government also guides the establishment of some national, regional or interprovincial drainage area eco-compensation mechanisms and provides certain financial supports to the local ecological construction and compensation activities. The local governments, on the other side, are the bodies responsible for establishing and implementing the eco-compensation mechanisms.

2) Integrated Platform and Sectored Platform: An integrated and government-oriented eco-compensation platform would be the best choice from the perspective of operational efficiency. However, coming to the practical operation, adoption of diversified platforms fitting the local conditions should be encouraged and overemphasis on an integrated eco-compensation platform should be discouraged. Although an integrated eco-compensation fund may be set up at the right time and in the right conditions, the specific projects may still be operated on a sectored basis to promote the enthusiasm of the participating sectors.

3) Emerging Problems and Existing Problems: An eco-compensation policy should be constituted following such an order of priority that allows for prior settlement of new problems. Proper settlement of existing problems relies on proper control of the growth rate of emerging problems. While the local governments and enterprises are held responsible for the emerging problems, more supports are required from the national government to settle the existing problems.

4) Eco-compensation and Poverty Relief: Eco-compensation is not equal to poverty

relief since the objectives, means and methods involved therein are not identical. Social equity and income gap are not the key objectives of eco-compensation and confusion of eco-compensation and poverty relief will produce a negative effect --- encouragement in ecological damages.

5) "Hematogenesis-oriented" compensation and "hematometachysis-oriented" compensation: No efforts should be spared to allow for "hehmatogenesis-oriented" compensation and convert the eco-compensation into a project designed to protect the local ecological environment or promote the local capacity of development while the "hematometachysis-oriented" compensation should benefit the grass roots farmers to the best possibility.

(2) Solutions and Recommendations on Establishment of Eco-compensation Mechanisms

Diversified compensation methods and approaches are required in China to address its diversified ecological problems and eco-compensation demands. However, the national government should construct five eco-compensation mechanisms described as follows:

1) A fiscal transfer payment system in favor of ecological and environmental protection should be constructed. Fiscal transfer payment is the most direct and easy-to-implement means of eco-compensation. The specific measures include: increasing the weight of the ecological and environmental impact factors in fiscal transfer payment; increasing the level of supports granted to regions of ecological importance and with excellent effect of ecological protection; increasing the fiscal transfer payment to the middle and western parts of China following the principle of equal public services; enforcing the national purchase approach on important ecological regions (such as nature reserves) or ecological elements (such as national ecological forests); and establishing an integrated fund of sustainable development by integrating the existing ecological protection funds.

2) An environment-friendly tax system should be constructed. A tax system that is friendly to the ecological environment will become a long-term approach to facilitate better protection of the ecological environment. The resource tax system should be further improved by expanding the incidence of taxation and taking the level of ecological damages caused by resource development as the tax base; ecological (environmental) taxes, including general environmental tax, direct pollution tax and polluting product tax should be levied; the existing tax system should be reformed to have the green concept integrated so as to raise the tax rate of products of high pollution and high consumption, provide a preferential tax system for green products and optimize the social and economic activities and the

consumption pattern.

3) A national eco-compensation policy based on the primary functional zones should be formulated. Systematic eco-compensation policies should be formulated according to the functions assigned to the four primary functional zones and the restricted development zones and prohibited development zones should be configured with stronger compensation functions. The restricted development zones and prohibited development zones should be entitled to increased fiscal transfer payment intended for public services and eco-compensation so as to allow the local residents with an access to equalized fundamental public services. The national investment programs should include as one of its key areas the public utility construction and ecological and environmental protection projects in the restricted and prohibited development zones. Greater importance shall be attached to ecological and environmental protection upon evaluating and examining the performance and achievements of a government in the restricted development zones. Ecological and environmental protection should be taken as a major part of such evaluation and examination on prohibited development zones.

4) A system should be constructed to internalize the ecological or environmental costs arising in the production process of the enterprises. A system should be set up for the performance bond intended to guarantee proper control of environmental pollutions and ecological restoration; the enterprise cost calculation system in China should be reformed to incorporate the enterprises' input in pollution control and ecological restoration as a part of their product costs so as to provide the enterprises and the society with true product prices; a system should be set up to include as a part of the ecological elements and ensure the paid use of the environmental resource and ecological occupation. Incentive policies should be made to encourage the enterprises to reduce the consumption of environmental resources and ecological occupation on a continuous basis; the ecological and environmental costs should be incorporated into the enterprises' product costs to facilitate fundamental change of the ways of product development and manufacturing in China.

5) A drainage area compensation mechanism should be established. As an eco-compensation field receiving the most concern and deserving prior efforts to make a breakthrough, drainage area eco-compensation should be carried out with the water quality and volume control as its core task. Environmental agreements effective to the entire drainage area should be established through negotiation between the interested parties at the upper and lower reaches and different water quality and volume requirements should be defined for the same drainage area. Compensation actions, such as fiscal transfer payment, project-based supports, translocation development, comprehensive treatment and environmental service payment, should be enforced provided that the water quality and volume are

guaranteed. The national government and the related authorities need to set up and improve the initial allocation and trading system of water rights and the water environment functional zoning management system and provide the interested parties in the drainage area with channels, platforms and policy basis for negotiation as well as arbitration services regarding environmental issues.

Watershed Eco-compensation Mechanism and Policy Design

Chinese Academy for Environmental Planning [1.]

The objective of this special subject is to: On the basis of international and domestic experiences in eco-compensation in recent years, explore eco-compensation mechanism and relevant policies which conform to the watershed realities, and propose national eco-compensation mechanism and regulatory system that aim for protecting water source zone. The sites that were chosen for case study are Guangdong-Jiangxi Dongjiang watershed, Guanting reservoir watershed in the Beijing, Tianjin and north of Hebei Province, and Zhengjiang-Anhui Xin'anjiang watershed. Centering on the above objective, this paper will conduct research in the following aspects.

1 Introduction

On the principle that the ecological benefits should be shared by upper and lower reaches and the eco-environment should be jointly developed by upper and lower reaches, watershed eco-compensation, through regulatory measures, requires the parties who benefit from the eco-environment protection to pay. A good design of policies and regulations will eliminate the free ride phenomenon in the eco-environment – the special kind of public goods, and encourage sufficient supply of watershed eco-environment. Through policy innovation, the investors of the eco-environment will be reasonably repaid to encourage the upper and lower reaches to invest in eco-environment protection and increase the value of eco-environment.

2 Summary of Recent Domestic and International Experiences in Watershed Eco-compensation

2.1 Summary of International Experiences

Currently there are four major watershed eco-compensation models internationally, i.e., one-on-one trading compensations, market compensation guided by government, ecological mark and public payment led by government. No matter whether it's in developed countries or developing countries, government-leading public payment is the major payment means. To choose public payment or market-oriented means is restricted by the compensation object, i.e., the nature and characteristics of ecological service offered by specific watershed. Because the ecological services offered by watersheds vary greatly, and so do the social economy features, any country may not pay for the ecological service with only one kind of payment. In reality, people always apply all the possible means and try to maximize economic

[1.] Leader of team: Zhang huiyuan; members: Liu guihuan, Ge chazhong, Wang xiahui, Xu kaipeng

efficiency.

2.2 Summary of Domestic Practices

Currently the watershed eco-compensations in China are carried out at three levels. First is the national project to protect the eco-environment of rivers in west China. Second is the trans-watershed water rights trading and fiscal transfer which is dominated by government in Zhejiang province. Third is the watershed eco-compensation system built by Fujian provincial government. It's fair to say that in China, the watershed eco-compensation is mainly carried out through government investment or fiscal transfer dominated by government and only a small fraction of the investment is from privately owned fund. And market-based eco-compensations are scattered in some areas at a quasi-market or half market status. The free trade market has not yet formed. Along with the extensive implementation of watershed eco-compensation in China, market-based compensation would become an effective means of compensation.

3 Case Study of Watershed Eco-compensation

3.1 Dongjiang Watershed Eco-compensation Mechanism Design

3.1.1 Basis for Dongjiang watershed eco-compensation

(1) Dongjiang source zone provides quality water resource for lower reaches, making significant contribution to the social economy development of Guangdong and Hong Kong.

(2) In order to provide quality water source, the source zone has invested a great deal into the eco-environment, and also restricted the economy development.

(3) The social economy development of the source zone society is far behind its surrounding areas and lower reach regions

3.1.2 Dongjiang watershed eco-compensation standard

(1) Compensate the investment in ecological protection and construction in the source zones: In order to protect water quality and eco-environment at Dongjiang source zone, during the Tenth Five-Year Plan alone, the source zone government and residents have invested RMB 226.93 million in ecological immigration, sloping land conversion, water and soil conservation, comprehensive environment pollution control and mine reclamation. During the Eleventh Five-Year Plan, another RMB 1.42 billion will be invested in ecological protection and construction. And meanwhile, more considerations should be given to the management and maintenance cost of eco-environment.

(2) Compensate the source zone for loss of development opportunity. Dongjiang source zone people's actions to protect the eco-environment, such as closing off the mountains for forest conservation, prohibiting lopping of wildwood, reducing woods processing and restricting mining, prohibiting establishment of environment-polluting enterprises, cost the area up to RMB 2.48 billion and thousands of employment opportunities. And meanwhile, more considerations must be given to the loss of future development opportunities in the course of eco-environment protection.

(3) Compensate the source zone in accordance with the standard of Maple Tree Dam reservoir in Guangdong province. Maple Tree Dam reservoir is the closest one to Dongjiang source zone in Guangdong province. To some extent, this reservoir is the first section that benefits from the stable and high quality water from Dongjiang source. Therefore, it is the reservoir operator's duty to compensate Dongjiang source zone in the light of the local compensation measures. Maple Tree Dam reservoir generates 520 million KW electricity annually. In the light of the Heyuan Municipality's compensation standard, RMB 0.01 per KW out of the electricity fee, or by Chongqing's experience, 1% of the electricity income generated by the reservoir, should be invested in source zone for water and soil conservation.

(4) Dongshen reservoir is also a main body that benefits from the eco-environment protection in the source zone. Based on the fact that the annual water quantity into Dongjiang from Dongjiang source zone accounts for 10.4% of the total quantity, it is suggested that RMB 260 million out of the RMB 2.5 billion, the amount Hong Kong pays Guangdong each year, should be collected as eco-compensation tax and invested in Dongjiang source zone's ecological development. Additionally, drawing on the experience of Chongqing, 1% of the income from water supply, which is an annual 1.323 billion cubic meters from Dongshen reservoir to Shenzhen and Dongguan, should be provided to source zone for water and soil conservation.

(5) A proportion of the water price or increment of water price will be collected from lower reach beneficiary areas to serve as the source for the compensation funding. Information shows that, in 2004, the average water price in 36 medium to large-sized cities is RMB 1.4/ton. Except Shenzhen, which charges a price higher than average (RMB1.95), all the other cities like Huizhou (RMB 0.88), at the lower reach of Dongjiang, and Guangzhou (RMB 0.9) etc. charge water prices lower than average, and some even lower than water prices in the three counties of Dongjiang source zone (RMB 1.2). The water price level does not correspond to the region's economic development level. Thereafter, there is much leeway for water prices raising in the Dongjian lower reach regions in Guangdong province, giving enough proportion to be collected and invested in the eco-compensation in Dongjiang source zone.

Meanwhile, this will send a clear message to other regions, urging people to treasure water and conserve water resource, and helping us build a resource-conserving and environment-friendly society.

3.1.3 Clarify responsibilities of stakeholders in Dongjiang watershed

Dongjiang watershed eco-compensation mechanism will be built on the platform of ecological function protection area at the upper reach of Dongjiang. The responsibities and duties of the state, the upstream Jiangxi province and the downstream Guangdong province should be well defined.

(1) State responsibility: Should increase the fiscal transfer for Dongjiang source zone. E1stablish the national level specific eco-environment compensation fund progressively; Coordinate the trans-provincial compensation.

(2) Guangdong responsibility: Reflected in three aspects. First is to establish special account for source zone eco-compensation. The fund is collected partially from water price adjustment and partially from the social donation; second is to build up technical support system; third is to set up organization to monitor the use of eco-compensation fund.

(3) Jiangxi responsibility: Reflected in 5 aspects. First is to establish enforcement organization of eco-compensation; Second is to recognize Dongjiang source zone's special ecological function positioning and not to evaluate its contribution by GDP alone; Third is to put Dongjiang Source zone eco-environment protection and social economic development into Jiangxi province planning agenda and offer support from project, funding, capacity and policy perspectives. Fourth is to reinforce self-supervising mechanism to strictly inspect the implementation of eco-environment protection by the three counties in Dongjiang source zone, provide technical and policy guidance in time and establish responsibility system. Fifth is to improve mass education in the source zone.

3.2 Watershed Eco-compensation Mechanism Design for Beijing, Tianjin and North of Hebei Province

3.2.1 Establish Eco-compensation Fund

(1) Funding standard: Integrate ecological construction fund of upper reach of Guanting reservoir to establish eco-compensation fund for upper reach of Guanting reservoir. The fund is mainly collected from Beijing, Hebei and Zhangjiakou, in proportion to the three locale's GDP per capita.

(2) Fund sources: Beijing: Raising water price to RMB 1.6/ m3 from the original RMB 1.1/ m3. If 600 million ton of tap water is sold annually, a total of RMB 960

million will be collected each year. After the water price is raised, 50% of the extra money, i.e., RMB 480 million, can be put into watershed eco-compensation fund to meet the above Beijing funding standard. Hebei province: The RMB 84 million of eco-compensation amounts paid by Hebei can be appropriated to the account of Zhangjiaokou's department through the trans-provincial fiscal transfer. Zhangjiakou Municipality: Water price is raised by RMB 0.2/m3 to RMB 0.8/m3. The sale of tap water is to be 50 million ton which can contribute RMB 40 million of water resource funds every year to meet the above Zhangjiaokou funding standard.

(3) Establish monitoring and management system for watershed eco-compensation fund. The relevant organizations, such as the environmental and hydraulic departments of the three parties, will jointly monitor the fulfillment of the upper reach eco-compensation fund. Among the parties, Zhangjiakou, at the upper reach of Guanting reservoir, is the main body to implement the watershed eco-compensation fund. It is required to ensure the watershed eco-compensation fund to be in place.

3.2.2 Formulate Preferential Policies

(1) Public fiscal policy of eco-compensation: Formulate the financial support policies to enable the central government, Beijing, Tianjian and Hebei share the cost of medium to large scale projects of ecological construction and water resource environment protection. The central government, the lower reaches and the local government of those regions who directly benefit from the projects, need to appropriate certain amount of money each year. And meanwhile the current subsidies and allowances will be integrated to set up special eco-compensation fund to be used to compensate loss of regional water rights of use, loss of ecological forestry land rights of use, loss caused by restricted traditional industry development, loss caused by high water-consuming agriculture, loss caused by heightened surface water quality standard, local economic loss caused by heightened ecological function area standard, ecological projects management cost and natural protection area management cost. For the national ecological protection projects in the area, the central government needs to pay certain amount of management and maintenance fee. The salary of the maintenance staff for the ecological projects should be paid by the project owning organizations.

(2) Market compensation policies: Explore mechanism for water rights transfer between the upper and lower reaches. The lower reach will pay the regional water resource fee periodically at the market price. The prices of water and wastewater treatment at the lower reach regions will be increased to subsidize the regions that bear the losses due to the restricted traditional industry development and the high water-consuming agriculture.

(3) Technical project compensation policies and watersheds “development at different locations” : The central government and regional governments of lower reaches will arrange an appropriate number of technical projects in the area every year to help Beijing, Tianjin and North Hebei develop alternative industries, or to give immediate subsidy to those pollution-free projects; Establish trans-regional experimental development zones; Lower reach government should give preferential treatment to the experimental development zones in terms of land use, attracting investment, enterprise relocating, etc; The projects with pollution which cannot be arranged in the upper reaches can be set up within the development zone. The upper reach should be helped to escape from poverty.

3.3 Eco-compensation Mechanism Design for Xin’anjiang Watershed

3.3.1 Analyze compensation cost

The compensation cost analysis of water resource conservation and ecological protection of upper reaches is based on the direct cost and indirect cost of conservation and protection. The direct cost is the direct investment in water resource conservation and ecological protection, including manpower, material resources and financial resources; The indirect cost is the potential loss the water source protection area encounters when the region decides to restrict the development of some industries and shut down the enterprise in order to protect Xin’anjiang water resource and ecological service functions. Furthermore, immigration cost should be taken into consideration.

3.3.2 Estimate compensation standard

Based on the research results of China Hydraulic Research Institute, by calculating the actual investment of Xin’anjiang upper reach between 1996 and 2004 and introducing water quantity proportion coefficient and water quality revising coefficient, it is estimated the lower reach regions need to share an investment of RMB 663 million. It is forecasted that by 2010, the upper reach region needs to put in annual investment of up to RMB 827 million in ecological construction and protection and the lower reach regions need to share RMB 289 million. By 2020, the upper reach regions needs to put in RMB 943 million, and in order to prevent the watershed ecology from deteriorating, the lower reach regions need to share RMB 329 million.

3.3.3 Establish compensation mechanism

Given the theoretical calculation of the amount Xin’anjiang lower reach should share to protect upper reach eco-environment, and considering the acceptability of the

upper and lower reaches, it is proposed that the target of the joint development by the upper and lower reaches is to preserve water quality in Thousand Island Lake and protect the strategic water resource in Eastern China. The responsibility-sharing mechanism for Xin'anjiang ecology enables the upper and lower reaches to share the benefit from drainage ecology protection.

(1) Define the scope of Xin'anjiang watershed of joint development. The joint development area includes the entire Xin'anjiang watershed, i.e., Jiande Municipality and Chun'an County (which belong to Hangzhou Municipality, Zhejiang province), Tunxi District of Huangshan Municipality of Anhui province, Huizhou District, Xiuning County, Guo County and Jixi County of Xuancheng District. The area may also include other potential water consuming zones in the lower reach.

(2) Determine the main bodies of joint development, including the governments, enterprises and individuals of the upper and lower reaches.

(3) Determine an eco-compensation standard that's acceptable to both upper and lower reaches by considering the theoretical standard and the willingness of lower reaches to pay.

(4) Establish coordination organization for ecological sharing under the guidance of the state.

(5) Discuss ecological co-development model. First is to enhance fiscal transfer, which is dominated by the state, to provide subsidy to the organizations which can promote eco-environment protection. Second is to decide the tax of the co-development and sharing. Third is to establish ecological co-development funding which mainly comes from the local government financing, water price allocation from beneficiary areas, aid and donation from international organizations, non-government organizations, eco-environment protection organizations and individuals. Fourth is to apply preferential loan to ecological co-development, adopt low-interest or interest-free policy for the eco-environment protection and harness projects. Fifth is to form one-on-one support relationship between upper and lower reaches. The lower reach will help the upper reach develop alternative industries.

(6) Set forth policies and measures to ensure the smooth implementation of ecological co-development mechanism.

4 China Watershed Eco-compensation Mechanism and Policy Design

4.1 Policy Demand and Practice Difficulty China Faces when Conduct Watershed Eco-compensation

4.1.1 Policy demand

(1) From the nation's perspective, watershed eco-compensation should propose strategies from the following five aspects:

(2) Watershed eco-compensation should be effectively integrated with the initial water rights allocation. National initial water rights system and water rights transfer system should be established.

(3) As a government control means, functional partition of water environment needs to incorporate economic compensation means;

(4) The state should formulate relevant policies to put the ecological protection projects high on the agenda of national and local government fiscal transfer.

(5) Under the guidance of national macroscopic policy, industrial structure of watershed upper-lower reaches region should be vigorously adjusted. And project support should be treated as one of the keys to establishing eco-compensation mechanism.

(6) Between provinces, the policy demand for eco-compensation is to clarify responsibilities. Under the national level guidance, in order to make eco-compensation mechanism operational, the coordination between regions is the key. For the watershed trans-provincial eco-compensation, the policy is required to be more flexible to improve the eco-compensation mechanism.

4.1.2 Practice difficulties

(1) Who will take the responsibility: Usually the upper reach regions insist the one who benefits should pay, and the lower reach regions insist that the one who pollutes should harness.

(2) Compensation standard: The watershed ecological service function evaluation is the key to making compensation standard. The actual operation and the deviation in the final results is usually big.

(3) Trade cost: Imbalanced information makes the trade cost prohibitively high for market compensation mechanism.

(4) Coordination among the beneficiaries: It is hard to satisfy the requirements of all the parties involved in compensation. The compensation planning and feasibility analysis should make it acceptable to every party in order to meet the compensation target.

4.2 Watershed Eco-compensation Mechanism Design

Through discussion of theory and analysis of preceding cases, we think the key to establishing watershed eco-compensation mechanism lies in straightening the relation among the responsibility main bodies. The relations differ based on the different watershed scales. Therefore, the establishment of China floating eco-compensation mechanism will differ in accordance with the watershed scale. But the designs of watershed eco-compensation mechanism for all the areas follow the same line of thinking, i.e., first is to determine the watershed scale; second is to determine the stakeholders of the watershed – the responsibility main bodies; third is to calculate the compensation standard on the basis of investment and development opportunity loss of the upper reaches in the course of ecological protection, or to construct a platform for the parties to negotiate and come up with a compensation standard; fourth is to choose proper eco-compensation method; fifth is to design different watershed ecology compensation policies.

4.2.1 Design trans-provincial watershed eco-compensation mechanism

The key of trans-provincial compensation is the coordination and communication between provinces. The coordination is usually regulated by central government who sets up a platform for trans-provincial compensation and defines the responsibilities and duties of the upper and lower reaches. The lower reaches are the main body responsible for the watershed eco-compensation, and the upper reaches are the main body to be compensated. The upper and lower reaches should drive eco-an environment agreement. The major compensation means should be the fiscal transfer dominated by central government.

4.2.2 Design eco-compensation mechanism across municipalities within the province

Trans-municipal watershed eco-compensation is mainly promoted by provincial-level government who will coordinate the cities to solve the watershed eco-compensation problem. Under the current circumstances of China, trans-municipal watershed eco-compensation should also be based on the watershed environment agreement. When the administrative border section in the watershed is reached, if the requirement in the agreement is met, the lower reach must provide eco-compensation to the upper reach, otherwise if the requirement in the agreement

is not reached, the upper reach must provide eco-compensation to the lower reach. The compensation methods must be adjusted to local conditions based on the watershed environment agreement.

4.2.3 Design compensation mechanism across counties within the municipality

Under the coordination of higher level environmental department, the watershed environment agreement is reached to clarify the water quality requirement and determine compensation standard based on water quality. The eco-compensation across counties within the same municipality is relatively easier to implement. First, automatic monitoring stations for leaving and entering water will be set up at the boarder in the watershed across the adjacent counties. Second, pollution protection administrative department will determine the allowed deviation of water quality leaving the county and entering the county in the relevant years. Finally, based on the data from the water quality monitoring stations on the border, the higher level environment or combined departments will conduct inspection. If the leaving water quality is better than that of the entering water or they are the same, this city (municipality) is considered to have positive impact on the water environment and the lower reach should provide financial compensation. Otherwise this county (municipality) is considered to have negative impact on the water environment and the upper reach neighbors should provide financial compensation.

4.3 Watershed Eco-compensation Methods

4.3.1 Fund compensation

For lower reaches, the water price, usually composed of project cost, management cost and resource cost, is exposed to adjustment. In general terms, project cost and management cost are fixed, leaving little leeway for rising. The resource cost, however, has a larger room for adjustment. Therefore, the lower reach regions may raise water resource price properly and a proportion of the fund will be appropriated into watershed eco-compensation fund. This method is easy to operate. Drawing on the experience of the lower reaches, the upper reaches may also increase the water price and put a proportion of the increment into watershed eco-compensation fund. So far, the watershed eco-compensation fund has got a steady source. Watershed upper reaches must ensure the special compensation fund to be used properly. There are three major directions for the use of fund: first is the upper reach water-saving projects, water resource protection and eco-environment improvement; second is the water maintenance; third is water resource zone environment protection.

4.3.2 Policy compensation

Policy compensation is the power given to the lower level government and is also

opportunity compensation. The party who receives the compensation can map out a series of policies of privilege and preferential treatment to support the upper reach regions in terms of investment projects, industry development and financial taxation, etc. to promote the upper reach region economic development and fund raising. Taking advantage of policy resource to compensate is very important, especially in the upper reach regions where there is a lack of funding and the economic development lags behind. Policy itself is a kind of compensation.

(1) Formulate financial policies based on the characteristics of the upper reach region ecological construction and environment protection.

Formulate market compensation policy to cultivate the water rights transfer market between the upper and lower reaches. The lower reaches are to pay for regional water resource cost periodically at the market price.

(2) Formulate technical projects compensation policies. The governments of the lower reach regions should roll out a certain number of technical projects in their regions to help the upper reach regions develop alternative industries, or to subsidize the launch of pollution-free projects to help the ecological industry development at the upper reaches.

(3) Formulate policies to encourage "development at different locations". It is to allow the upper reach regions to develop experimental zones in the lower reach regions. The local government should give preferential treatment in terms of land use, attracting investment and enterprise relocating to guide the implementation of the polluting projects which cannot be carried out at the upper reaches.

4.3.3 Industrial compensation

Drawing reference from the industrial transfer mechanism, which was triggered by imbalanced economic development, a practical option will be for the lower reaches to compensate the higher reaches through specific industrial projects.

Improving the upper reach's industries and enhancing its self-helping ability are the best way to reduce development gap between the upper and lower reaches and improve the local people's living standard. The upper reach should follow the principle of "serving the lower reach is helping ourselves" to set up an excellent platform on which to develop the labor-intensive, resource-based, high-tech and low pollution industries to form industrial groups and processing industry zones.

4.3.4 Market compensation

The formation of watershed eco-compensation market needs the following pre-conditions:

(1) There is a sharp contradiction between upper reach supply and lower each demand of ecological services. The lower reaches have high requirement on water quality or quantity, and the upper reaches however, in the pursuit of economic benefit, set up factories, fell forest, assart on the slope land to add greatly to the water pollution and increase loss of water and land. And the wide application of fertilizer and pesticide creates further surface source pollution.

(2) The public recognition of watershed ecological service function and value. The upper and middle reaches are the provider of the services, and the lower reaches are the service receivers. The formation of the eco-compensation market mechanism needs the public recognition, especially the recognition from the services receivers, of the watershed ecological service function and value.

(3) The property rights are clearly defined. The public or government should have a consciousness of institutional innovation. Property right is the basic for guaranteeing the watershed ecological service function. Clear property rights of the watershed land and ecological services will provide a good trading platform for buyers and sellers.

The market has good cost effectiveness. Formation of market is an economic action driven by economic benefit. If the cost effectiveness of the market approach is better than that of any other approaches, this approach is easier to be accepted.

Along with Chinese marketization making headway, market compensation mechanism should become the development tendency of watershed eco-compensation mechanism in China. Foreign experiences can be incorporated to explore the one-on-one trading compensation model and the market-based ecological mark model.

4.4 Suggestion to National Policies of Watershed Eco-compensation

4.4.1 Establish initial water rights allocation and trading system

The watershed eco-compensation mechanism and methods, as explored above, are tinged with strong administrative intervention, which conform to the current national reality. Along with the improvement of market economy, the long term watershed eco-compensation mechanism should be market-driven. The future method will help to achieve upper reach benefit through water rights trading between regions.

Currently, the international cases of market-driven watershed eco-compensation are on rise. Involving water quality improvement, runoff quantity adjustment, groundwater level adjustment and soil pollution control, these cases were successful experiment within relatively small scope and there were government coordination in these cases. Therefore, it is suggested that the state carry out experimental projects to

progressively explore watershed water rights trade at different levels.

4.4.2 Reinforce function management of watershed water environment

All the upper and lower reach regions have equal rights to use the water resource and water environment, also have equal responsibilities to protect the water resource and water environment. Through consultation, the local governments of upper and lower reaches can reach "watershed environment agreement". The watershed water environment protection should be monitored and implemented through administrative measures; Corresponding award and punishment should be conducted through economic measures. Subsidy will be provided to the regions within the watershed once the water quality target is reached, and punishment will be executed if the target cannot be met after the subsidize, in which case, the upper reach should be required to compensate the lower reach.

4.4.3 Establish consultation platform and arbitration system for watershed upper and lower reaches

As the buyer or the go-between of watershed, the "public goods", the higher level government takes the responsibility for coordinating the benefit relationship between the upper and lower reaches, and building consultation platform for upper and lower reaches watershed ecological protection. For the watershed of major rivers, the consultation platform between upper and lower reaches should be established under the frame of national ecological safety, giving full consideration to the significance of big rivers' ecological significance across the whole country. For the small to medium-sized watersheds, under the guidance of central government and by taking into account the ecological function of the upper reaches, the upper and lower reaches should jointly develop a target of ecological protection - which is acceptable to both of upper and lower reaches, and set up the consultation platform.

Establish trans-regional arbitration system for watershed environmental protection. The trans-regional water pollution dispute is to be solved by the senior administrative department through organizing the related governments to work on the solution. Once the consultation fails, either party of the dispute can appeal to the watershed prevention organization's water pollution department. If the dispute still can not get solved, either party of the dispute or the watershed water pollution prevention organization will appeal to higher level government (to State Department if the dispute is at the provincial-level) to be arbitrated. The dispute of liability and compensation amount should be solved through consultation among the involved parties. Once the consultation fails, corresponding environmental protection administrative organizations should be involved or relevant regulatory laws should be applied to arbitrate.

4.4.4 Establish system to allocate watershed environment protection fund

Establish the system to allocate watershed environment protection fund based on watershed scale.

Trans-provincial level watershed: The state and the provinces where the upper and lower are located will jointly set up watershed eco-compensation fund which will be used for upper reach ecological construction and environment pollution control. The special account will be set up in the upper reach province and the fund will be put into specific projects. The state has authorization to audit the fund use and the relevant departments from the upper and lower reaches will keep track of the fund use.

Provincial watershed: The upper and lower reaches will jointly set up the fund for watershed ecological construction and environment protection. The fund will be appropriated into account of the upper reach and put into specific projects. The province and the relevant municipalities or counties will have rights to keep track of the fund use.

Municipal watershed: Watershed upper and lower reaches will jointly set up "seed fund" for comprehensive protection of watershed environment. The fund is to be used for upper reach ecological construction and environment protection. The fund will be allocated to the projects by strictly following the requirements specified in the watershed environment agreement.

4.4.5 Reinforce experimental "development at different locations" within watershed

Carry out the experimental development at different locations, and conduct "self-helping" compensation. Find suitable zone within the lower reaches for the upper reaches, which will be jointly developed by the upper and lower reaches to form a long-term mechanism for the upper reach regions' development. And meanwhile, under the guidance of national macroscopic policy, vigorously adjust the industrial structure of the upper and lower reach regions, and emphasize project support.

4.4.6 Strengthen legislation of the watershed ecological protection

Strengthen legislation of the watershed ecological protection to establish law basis for watershed eco-compensation mechanism. In order to guarantee the long term stable fiscal transfer led by government to enhance the support for poverty-stricken upper reach environmental protection, rules need to be defined in the law. Specific ecological protection law will be formulated to regulate and manage the development and management of watershed resource, protection and construction of

watershed eco-environment, investment and compensation for watershed to ensure the successful establishment of watershed compensation mechanism.

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Mineral Resources Eco-compensation Mechanisms and Policies

China University of Mining and Technology (Beijing) [1.]

1. Introduction

1.1 Motivation of the Research

Mineral resources are indispensable materials for agricultural and industrial production and social-economic development. In China, ninety-five percent of primary energy, eighty percent of industrial raw material and over seventy percent of agricultural production materials are derived from its mineral resources. Thus, the mining of mineral resources has become an important fundamental industry for the national economy. China is rich in mineral resources. 171 mineral resources are found throughout the country, the sites of 158 of which have been confirmed at the beginning of the year 2003. Among the 158 mineral resources, there are 10 kinds of energy minerals, 54 metallic minerals, 91 non-metallic minerals and 3 other aqueous minerals. There are about 20,000 mineral producing regions. China produces 2 billion tones of coal, 0.2 billion tons of iron, and over 12 million tons of 10 other non-ferrous metals annually. Therefore, China has become a key producer in both the field of mineral resources and the mining industry in the world. Based on preliminary assessments, the potential value of the mineral resources in China ranks third in the world (over 20 minerals are in superiority). China is one of the few countries that have a vast amount of resources and a wide range of mining industries.

The extraction and utilization of the mineral resources promotes the economic development of China. At the same time, it also leads to serious environmental impact. Mineral resources are usually found under the surface. The location of mines cannot be chosen freely like other industrial sites such as factories. So the extraction and utilization of the mineral resources inevitably occupies and destroys a large area of land. It also causes serious environmental damage, such as landscape damage, soil erosion, landslides, water pollution, poisoning of fish, destruction of wildlife habitats and damage of buildings and property of citizens or farmers. Therefore, it is urgent that the relations between ecological damage and protection are regulated. Meanwhile, reclamation of the ecological environment in mining areas should be carried out.

The ecological compensation mechanisms are the process of arranging and regulating the interests between the ecology damagers and its preservers. The core of this system is to charge the ecology damagers and beneficiaries and give economic

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compensation to its preservers. It is an effective promoting mechanism, aiming to ensure that resources and the environment can be exploited properly and in a sustainable manner to reach the ultimate goal of coordinating economic development, environmental protection and the promotion of sustainable development. In the early twentieth century, Western countries began to pay attention to the ecological damage caused by mineral mining. They responded by issuing several effective laws, mechanisms and management methods. There has also been some research and practices carried out in China. As yet, there are no specific rules and regulations on ecological compensation, no unified and standard management systems and no unified and effective ecological compensation policy system. Western countries have paid increasing attention to the ecological environment in mining areas and the problem of resource and environment has become a limiting factor of social and economic development. It is evident that the study and formation of ecological compensation mechanisms and environmental policies due to mineral mining activities has become a very urgent matter to further China's drive for economic and environmental sustainability.

1.2 Aim and Task of the Project

1.2.1 Aim of the Project:

The aim of this project is to present the method, the standard and the procedure of ecological compensation due to mineral mining. It also includes related suggestions on policies, laws and regulations.

1.2.2 Task of the Projects:

Revision of eco-compensation mechanisms and policies due to mineral mining in China and abroad.

Revision of the environmental impact of mineral mining and its rehabilitation in China.

Development of the principle and the method of setting up eco-compensation mechanisms due to mineral mining in China.

Presentation the eco-compensation mechanisms due to mineral mining

Presentation the suggestions on policies, laws and regulations of the eco-compensation due to mineral mining

2. The experience of eco-compensation in China and abroad

2.1 The experience of EC due to mineral mining abroad

Based on the study of papers and practice of eco-compensation mechanism abroad,

this study found that foreign industrial countries paid much attention to the mining environmental impacts in the early 20's of last century and accumulated abundant experience in establishing ecological compensation mechanisms and policies, especially in identifying responsibilities, findings and standards of ecological compensation and reclamation just as follows:

- ✓ 1920's: Starting reclamation practice
- ✓ 1950~60's: legislation and mining permit
- ✓ 1970's: reclamation has become a sysmatic engineering.
- ✓ 1980's: great progress and active field

The eco-compensation mechanism and policies of foreign countries were summarized:

(1) Identifying responsibilities clearly: The responsibilities of eco-compensation depend on the pre-law and post law. The government is responsible for eco-compensation of pre-law damaged eco-environment (abandoned mines) and the mine owner is responsible for the post law eco-environment damage.

(2) The money of eco-compensation for abandoned mine is from the fund called "abandoned mine reclamation fund", which is governmental fund consisted of many sources of funding. One of funding is collected from the active mines based on the standards: $0.35 /ton for surface mines; $0.15/ton or 10% of sales price for underground mines and $0.10 or 2% of sales price for lignite.

(3) The eco-compensation of damaged environment for post-law is from the mine owner. Usually, the mine owners restore the damaged eco-environment by himself. The government asked the mine owner to hand in the performance bond so that the damaged eco-environment can be restored definitely.

(4) The standard of reclamation is strict.

2.2 The experience of EC due to mineral mining in China

There are not national specific regulations and policies on EC yet; some researches and local practice are mainly related to followings:

- ✓ eco-compensation fees
- ✓ performance bonds system

- ✓ taxes and fees of mineral resources

2.2.1 eco-compensation fees

The levies of eco-compensation fees Start in 1983 in Yunnan province and enter into the flood tide in the 1990s, 14provinces and 145 counties start making experiments such as Guangxi 、Fujian、Jiangsu etc.; At the same time, this study group proposes some suggestion for the standard of eco-compensation fees just as follows:

① levy 5%～7% of the price on harmful heavy metal and radioactivity matter such as hydrargyrum, arsenic, lead etc.

② levy 4%～6% of the price on other metal mineral products affecting environment slightly。

③ levy 2%～4% of the price on the nonmetal products jeopardizing the environment。

④ levy 1%～3% of the price on the nonmetal products affecting the environment slightly 。

Even though the eco-compensation plays some roles in repairing the ecological environment, there are still lots of rubs:

(1) No special law system. Though there were some regulations and policies about environment protection, but the specific laws for the eco-compensation are still lacked. Some regions have begun the practices of ecological compensation and performance bonds. But the implementation of results was less satisfactory due to many reasons. Some provinces have to cancel the eco-compensation fee because of the lack of warranty.

(2) No clear liability of Compensation. At present, the eco-compensation work doesn't carry out the principle--- "who destroys, who compensates; who gets benefit, who pays for compensation". The government, who should be the regulator, has replaced the destroyers' obligations so that the restoration of the ecological environment is always in a passive position. The eco-compensation mainly relies on finance from central government. The rehabilitation projects have to be done by the government.

(3) No uniform standards. Even if some regions have tried to set up the performance bonds and eco-compensation fee, the standards of eco-compensation fees made by the local governments are different.

2.2.2 Performance bonds

In the near years, many provinces such as Yunnan, Guangdong, Zhejiang province

etc issue and implement relevant environmental protection rules and push the performance bonds system to test.; however, the mining permit system and the mining environmental evaluation system can't have effort to ensure the implementation of performance bonds. Furthermore, the collection objects are not definite: new damage and old damage are not identified clearly, and the collection standards and scopes are not unified.

2.2.3 Taxes and fees of mineral resources

There are several taxes and fees about mineral resources, among which three taxes and fees have compensation nature:

Resource taxes and fees	Aims of the collection	Compensation
The resource tax	Embodying the pay to use resource principle and adjusting earnings	It can be looked upon as the source of the eco-compensation, but mainly compensate the use value of the natural sources。
The resource compensation fee	Compensation for the exploitation expenses	Mainly for the cost of exploration
The use fee of the exploration right and mining right	the use fee of resource	It has the resource value compensation trait.
The price of the exploration right	Take back the prophase prospect invest	There are no compensation for resource value

From that we can see that, the current mineral resource taxes and fees are mainly for the compensation of resource value and exploration cost, not focus on eco-compensation. Further, the tax rate of mineral resources is so low that it can't play the role of protecting or rehabilitating the eco-environment. The tax rate of mineral resources just as follows: Crude oil (8~30 Yuan/ton), gas (2~15 Yuan / m3), coal (0.3~5 Yuan/ton), other non-metallic mineral ore (0.5~20 Yuan/ton, or Yuan / m3), black metal mining ore (2~30 Yuan/ton), non-ferrous mine ore (0.4~30 Yuan/ton), salt (2~60 Yuan/ton). This rate is far lower than the 8%-12.5% in American tax system in which the tax rate of crude oil is 12.5%, surface coal mining is 12.5%, and underground coal mining is 8%)

3 The impact of mineral mining on environment and its rehabilitation in China

3.1 The impact of mineral mining on environment

In accordance with the geological concept of the Earthphere, the study respectively analyzes the mining impact on aerosphere, biosphere, hydrosphere and lithosphere(figure 1 below). The direct and main damage to ecological environment is the destruction of surface biosphere. The mineral mining inevitably results land damage and soil and vegetation destruction, which will decrease the productivity of ecological environment and induce the air pollution. Even though the impact of aerosphere from mineral mining is not main damage, air pollution caused by dust and harmful gases in mineral mining will destroy the soil and the surface ecological system. The exploitation of mineral resources also induces the damage of water system, especially the ground water damage. The damage of water system not only effects the biosphere, but also effects the living and health of the residents in mining area. The impacts of water system damage exist in other sections. Therefore, the key of compensation and rehabilitation should focus on the surface ecological environment and water system.

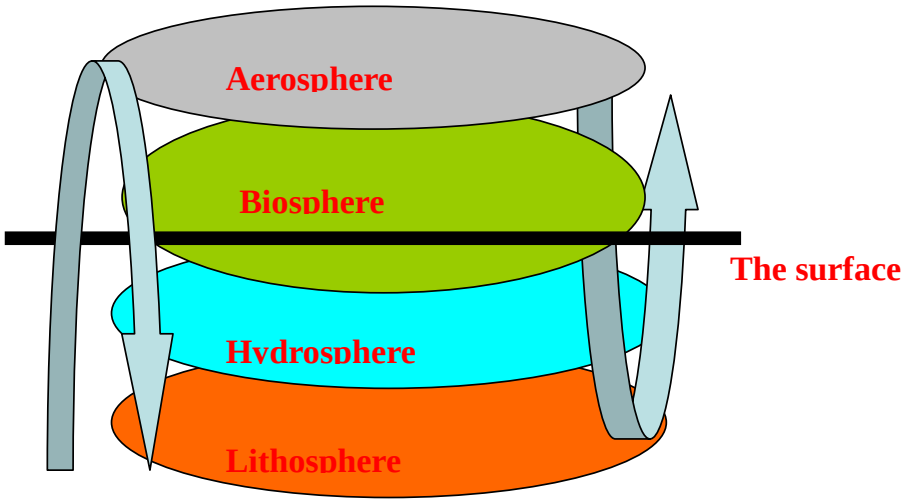

Fig.1: The impact of manorial mining on ecological environment

3.2 The eco-environment rehabilitation in china

Based on the field investigation and review of the study and practice on the impact of mineral mining on environment and its rehabilitation in China, the environmental factors affected by mining activities and the district characteristics of major ecological damage were identified. The damaged degree of the eco-environment duo to mining activities and reclamation practice of mine sites were also introduced. A

cost of reclamation engineering for repairing the damaged land ecosystem in different regions was presented (see table 1), which is the basis for determining the standard of eco-compensation and most of mine owners are willing to pay for it and can afford it.

Table 1: Cost of reclamation engineering in different regions Unit: RMB

Regions hypsography	Southeast coastal area	Central Bohai Sea Area	Northeast	Central area	Southwest region	Loess Plateau Area	Northwest
Plain	4400	3640	5180	5200	5300	4440	4460
Hills mountain	6550	4580	6230	6740	6980	5460	5140

Notes:

Southeast coastal area: Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan

Central Bohai Sea Area: Beijing, Tianjin, Shandong, Hebei, Liaoning

Northeast: Heilongjiang, Jilin, Inner Mongolia eastern

Central area: Henan, Anhui, Hubei, Hunan, Jiangxi

Southwest region: Chongqing, Sichuan, Yunnan, Guizhou, Guangxi

Loess plateau area: Shanxi, Shaanxi, Ningxia, Gansu eastern south nine cities states

Northwest: (Xinjiang, Inner Mongolia West County, Gansu offer five cities

4 The principle and method of setting up eco-compensation mechanisms due to mineral mining in China

4.1 The main principles

We present four key principles for eco-compensation mechanisms due to the mineral mining in China.

(1) Polluter-pays principle.

The most important principle is “who damaged, who pay for the eco-compensation”. The government is responsible for the old eco-environment damage due to mining activities, which mainly produced by some abandoned mines and under the condition of planned economy in the past. However, the new mine owners and active mine owners should be responsible for the new eco-environment damage. They must reclaim and compensate the new damage.

(2) Treat the “new damage” and “old damage” respectively

The “old damage” means the eco-environment damage before one definite law

was executed. The “new damage” means the eco-environment damage after one definite law was executed. It is the key to identify responsibility for eco-compensation. The boundary line of the “new damage” and “old damage” can be the year 1989 in which the law of land reclamation was issued or be the year 1998 in which the mining industry put into the free market.

(3) Rehabilitating the eco-environment of the mines is the aim of EC rather than payment of compensation

In the past, most of environmental protection policies are related to get some money from the environmental damagers. The aim of setting up the eco-compensation is not to pay economic compensations for the victims but to protect natural resources and environment and rehabilitate the inevitable ecological damage caused by the mineral exploitation consciously. If someone who damages the environments can rehabilitate the environment completely, we do not need his any payment.

(4) The standard of EC should be based on the cost of rehabilitating the eco-environment.

Theoretically, the standard of eco-compensation should be base on the losing value of environmental resources. The theoretical model of eco-compensation is as follows:

$$F = \sum_{i=1}^{n} k \cdot V_i \qquad (1)$$

F——Eco-compensation due to mining activities

n——The total number of factors of eco-environment damage such as land, water, atmosphere, landscape functions and other direct or indirect factors of eco-environment damage.

Vi——the losing value of the number i factor of eco-environment damage

k——the modify coefficient.

It is quite difficult to determine the losing value of various ecological damage factors in the theoretical model, our study tries to determine the ecological compensation by the reclamation cost because the latter is easy to practice and implement.

This study analyzes respectively the mining impact on aerosphere, biosphere, hydrosphere and lithosphere just as above, and finds that the crux of ecological

compensation focuses on two parts. One is the hydrosphere (mainly the destruction of groundwater resources); the other is the surface biosphere (mainly the environmental damage in the space from over surface 10 meter to undersurface 10 meter). Therefore, our study suggests that the ecological compensation standard should based on reclamation costs of biosphere and groundwater. Namely, mining ecological compensation model simplifies as:

$$F = V1 + V2 + Ce \qquad (2)$$

F——Mining ecological compensation fee

V1——the reclamation costs of surface biosphere, mainly the costs of land reclamation and ecological restoration

V2——the reclamation costs of groundwater

Ce—— compensation for the opportunity cost

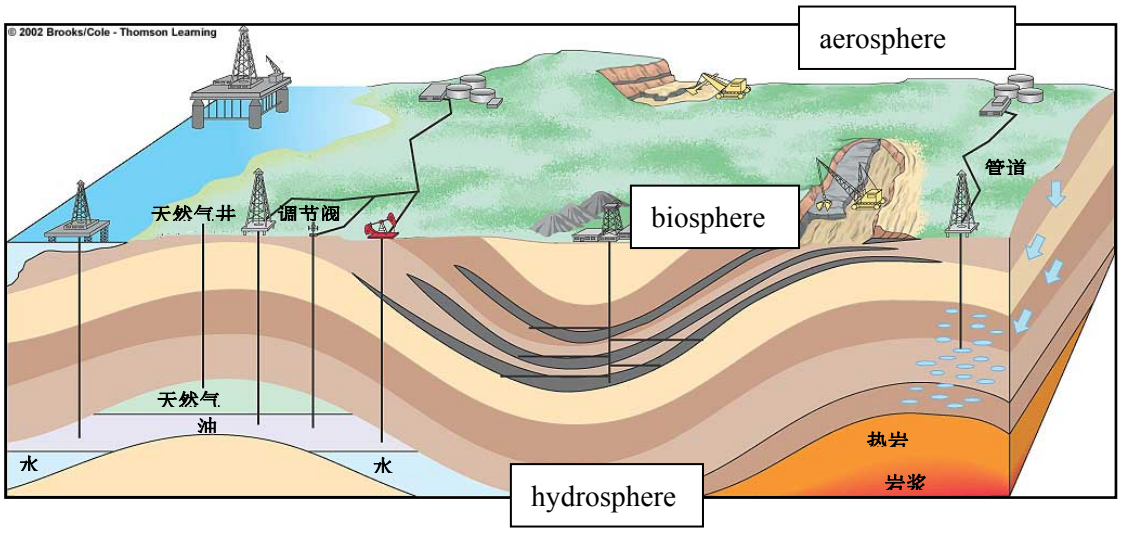

Fig.2 Eco-environment effect caused by mineral exploitation

4.2 The method of establishing ecological compensation mechanism

With the reference of foreign experience and the practical situation of China, the study put forwards the overall methods of establishing ecological compensation mechanisms. Our first task is to make sure of the clear undertaker, responsibilities and the ambit of liability. The environmental damage is sorted in two parts: the old damage and the new damage. The old damage is taken charge by the government through the establishment of Abandoned Mines Reclamation Fund. The new damage must be burdened by the mining enterprises absolutely by means of granting mining licenses and paying for the ecological compensation bond. The mining enterprises should not only pay for the abandoned mines compensation fee, but also refer the ecological compensation bond and the planning of ecological rehabilitation.

Therefore, the mines ecological compensation fund consists of two parts: "Abandoned mines ecological restoration fund" and “Mines Ecological Compensation Bond”. On one side, the local environment department or bureau of land and resources levies funding for the "Abandoned mines ecological restoration fund" and turns in the center government, who establishes a special account as an earmarked fund. On the other side, the mining enterprises turn the “Mines Ecological Compensation Bond” in the state directly or open a special bank account and put the fund in, which will be monitored by the center government.

5 The design of ecological compensation mechanism

The mineral resources in china are rich and in possession of wide varieties. Various mining methods of mineral resources have different impact on the ecological environment; accordingly the damage need distinct compensation amounts. Therefore, the study selects the most important energy -- coal mineral resources as the object of research and case study.

5.1 Establishment of eco- compensation mechanism of coal mining in China

(1) The study makes sure of the clear undertaker, responsibilities and the ambit of liability. The environmental damage sorts in two parts: the old damage and new damage. The old damage, namely the damage arising from the past planned economy conditions, is taken charge to compensate and rehabilitate by the government. The new damage, which is occurred under the conditions of the market economy, must be burdened to compensate and rehabilitate by the mining enterprises absolutely. The dividable line between old damages and the damages could be a specific time such the 1989 (issued the stipulation of land reclamation), 1998 (the free market for coal mining) or the time issued a specific law and regulation.

(2) Classification of eco-compensation: Mine eco-compensation consists of two parts: the compensation for the new environmental damages and the compensation for the old environmental damages.

(3) Payment mode of eco-compensation: Exception of paying cash to the victim (easily identified) of some eco-environment damages such as compensation for young seedling in the damaged land, damaged buildings and other properties, payment of eco-compensation should be the restoration of the damaged eco-environment to the desired state which is equal to or better than its pre-mining conditions, which is called performance compensation.

(4) The eco-compensation for the old damages due to coal mining: Local and central government is responsible for the eco-compensation for the old damages due to coal

mining by means of establishment of the “Abandoned mines ecological restoration fund”. The main sources of the fund as follows:

Fiscal payment from governmental revenue.

active mining enterprises pay for the old eco-environment damages, which is a kind of compulsory donations for compensating the mistakes of past mining activities and less than 1% of sale price;

Donations from international and domestic fund organizations and other sustentation fund

(5) The eco-compensation for the new damage due to coal mining：The active mining enterprises are responsible for the new damages absolutely. The compensation for the new damages includes two parts: cash compensation and performance bonds with restoration engineering. Cash compensation is the payment to the victim (easily identified) of some eco-environment damages such as compensation for young seedling in the damaged land, damaged buildings and other properties. The performance bonds

Ensure the restoration of the damaged eco-environment to the desired state which is equal to or better than its pre-mining conditions. For the sake of preventing the mining enterprises refusing the responsibilities of ecological rehabilitation, the compensation for the ecological rehabilitation adopts the way of putting performance bonds in banks, which belong to the enterprises and are monitored by the government. If they rehabilitate the environment and lands to the criterion the government ordained, and pass the auditing of the reclamation planning and the investment begets, the enterprises can retake parts of the performance bonds. When the work of rehabilitation has been done entirely, the all-out performance bonds will be returned. If the mining enterprises can not do the restoration work or do not meet the restoration standards, the full of the fund or partial fund could be used for other units who have the ability to restore the eco-environment to the standards.

(6) Mode of getting the funds: There are two funds: one is the “Abandoned mines ecological restoration fund” for eco-compensation of old damages. The other is the performance bonds for eco-compensation of new damages. All the funds could be levied at a fixed fee rate (RMB/t) or percentage rate based on sale price.

5.2 The standard of eco-compensation

5.2.1 The standards for the new environmental damage due to coal mining-----“Performance bonds.

.Because the compensation for the new damage includes two parts: cash

compensation for the easily identified victim of direct damages and performance compensation with restoration engineering, the standard of compensation is also classified into the two parts.

Some related laws have determined the cash compensation standards for the victims of direct damage. The key is the standard of performance bond.

Based on the above study, the compensation standards should be the cost of ecological restoration. The restoration costs are primarily groundwater restoration costs and the cost of rehabilitation of the surface biosphere. It is difficult to determine the costs of groundwater restoration compensation at present. So this study take the cost of rehabilitation of the surface biosphere as the basis of making eco-compensation standards. Because the surface biosphere rehabilitation is mainly the costs of the land reclamation and ecological restoration, the costs of the land reclamation and ecological restoration is the key of the standards of the compensation for coal mining damage.

A cost of reclamation engineering for repairing the damaged land ecosystem in different regions was presented (see table 1), which is the basis for determining the standard of eco-compensation. The values in the table 1 are only the direct cost of the engineering of recovering the land ecosystem. Based on the practical experiences, at least 3 times of the direct cost are need for restoring the eco-environment perfectly. Thus, eco-compensation for the new damaged environment (the performance bonds) is presented in Table 6 and Table 7, which is 2-15yuan per ton of coal output or 2%-4% of sale price.

Table 6: Predicted compensation standards for coal mining activities at fixed rate

Region hypsography	Southeast Coastal Area	Central Bohai Sea Area	Northeast	Central area	Southwest region	Loess Plateau Area	Northwest
Plain	5.28	4.37	6.21	6.24	6.36	5.33	5.35
Hills mountain	7.86	5.5	7.48	8.09	8.38	6.55	6.16

Unit: RMB/T

Table 7: Predicted compensation standards for coal mining activities based on sale price

Region	Southeast coastal area	Central Bohai Sea Area	Northeast	Central area	Southwest region	Loess plateau area	Northwest

hypsography							
Plain	2.20	1.82	1.59	2.60	2.65	2.22	2.23
Hills mountain	3.28	2.29	3.12	3.37	3.49	2.73	2.57

Unit: per price of coal

5.2.2 The compensation standards for the old coal mining damages

Government is responsible for restore the old damages by establishment of a "abandoned mines ecological restoration fund". The compensation standards are based on actual rehabilitation costs. Just as above research, the main sources of fund come from the government payment and the ecological compensation fees which are levied from the active mining enterprises. The study suggests that the compensation fees are levied less than 1% of the coal sale price once every year or once every month from active mines. All compensations fees turn in the state and are earmarked to defray various expenditures of the rehabilitation for the old damage.

5.3 The procedures of eco-compensation

The study put forward the procedures of ecological compensations for the old and the new coal mining damage respectively.

5.3.1 The procedure of eco-compensation for the old damage

(1) The governmental department taking charge of the "abandoned mines ecological restoration fund" issues the aim and plan of eco-environment rehabilitation every year.

(2) The municipal environmental departments or land resource management departments in which the abandoned mines are located apply for the abandoned mines rehabilitation projects and the feasibility study reports to the local provincial governments in charge of the work which include the area, present situation, the time of rehabilitation, planning and the concrete scheme etc.

(3) The local provincial environment departments or land resource management departments examine the feasibility reports preliminarily and confirm the projects put into effects which have priority.

(4) Plan and design the abandoned mines rehabilitation projects having priority chosen by each province more concretely and apply to the country government in charge of the "abandoned mines ecological restoration fund".

(5) The country government in charge of the "abandoned mines ecological

restoration fund" examines and approves the planning of the project together with other relevant departments and experts employed.

(6) The approved projects are determined the performed subjects by inviting bids and are allocated the approved rehabilitation funds.

(7) Supervise, check and approve the projects.

5.3.2 The procedure of eco-compensation for the new damage

(1)The new mining enterprises should sign the written contract with the administrative department in charge of the guarantee deposit and pay the performance bonds in one month after get the mining permit. Otherwise they will not be registered.

(2)The miners who have got the mining permits before the eco-compensation mechanism should make up the performance bonds, which are calculated from the day they got the mining permits to now, within one month after the eco-compensation mechanism beginning.

(3) The performance bonds can be paid off once or in installments. The miner should pay off the performance bonds once if the valid time of mining permit is within three years. Otherwise can choice installment plan.

(4) The enterprises must submit the mining plan of the next year on December 30th every year and determine the mining damage area and the sum of the performance bonds.

(5) The enterprises put the performance bonds into the specific bank accounts in the first three months each year. The performance bonds are supervised by the government and managed by the banks.

(6) The enterprises can submit the quarterly project plan to the department in charge of the guarantee deposits and draw some guarantee deposits to rehabilitate the eco-environment. But it cannot be over 50 percent of the gross quota.

(7) The enterprises which have finished part of the eco-environment project can submit the acceptance application to the environment or land resources departments above county level carrying the guarantee deposits payment certificates. The relevant departments organize and check the projects.

(8)If the projects are approved, the miners will get the approve certificates and can apply for paid back part or all performance bonds. There are two cases:

If the rehabilitated area is smaller than the applied one in last year, the performance bonds will be paid back according to the real area. And the rehabilitated area will be

added up to the next year.

If the damaged area is larger than the applied one in last year, the performance bonds will be paid back according to the real area. The miner must pay the performance bonds for the damaged area beyond the applied mining next year.

(9) If the projects are not approved, the check department will sign the rehabilitation notice and order the enterprises to rehabilitate. If the miners refuse to rehabilitate, the performance bonds and relative interests will not be paid back. The local land and resource bureau will use the performance bonds to rehabilitate eco-environment.

(10) Every three years, the land or environment department will organize experts to check and approve the rehabilitation projects except the enterprises apply voluntarily. Those who don't report the mining plan accurately, or can't reach the rehabilitation criterion or can't finish the rehabilitation will be withdrawn mining permit and their performance bonds will not be paid back. The performance bonds will be drawn in the government specific account and be used to rehabilitate the ecological environment by bids openly.

(11) Before the miner stop mining or closing pit, he must finish the eco-environment rehabilitation. If the rehabilitation projects are approved, all the performance bonds and the interest will be paid back.

(12) If the miner cannot finish the eco-environment rehabilitation after stop mining or closing pit, his right of applying for new mining permit will be deprived.

(13) If the miner changes the mining area or the mineral sorts, the sum of the performance bonds should be checked again according to the changed area or the main mineral sorts.

6 Suggestions

(1) Set up a specific office to manage eco-environment rehabilitation of mining areas in the Ministry of Land and Resources.

Currently, different bureaus are responsible for different eco-environment damages, which is not beneficial to the collection of the eco-compensation fee and the rehabilitation of the eco-environment. A specific office should be set up in the Ministry of Land and Resources with the assistance of other bureau from different government ministries such as State Environmental Protection Administration, Ministry of Finance, etc.

(2) Identify the property right of the mineral resources and the rehabilitation duty of the active mine owners.

Although the state has issued some relevant laws about the environment protection, the responsible part of the rehabilitation is not very clear so that the obligation of restoring damaged mine environment is still the government. Duo to the lack of eco-compensation law, the eco-compensation capital always has to rely on the state finance, and the mining companies burden rarely the cost of rehabilitation. Most mining areas have suffered the bottleneck of capital of rehabilitation because the local finance, the only source of eco-compensation fee, is not enough to deal with serious eco-environment damage problem. So it is the first step to setting up eco-compensation mechanism to identify the property right of the mineral resources and the duty of rehabilitation of damaged eco-environment. The rehabilitation liabilities of government and enterprises should be clear. The government is responsible for the old eco-environment damage due to mining activities, which mainly produced by some abandoned mines. The new mine owners and active mine owners should be responsible for the new eco-environment damage.

(3) Establish a specific capital channel for eco-compensation by integrating existed mineral resources fees and taxes.

Now the active mine owners have faced to varied mineral resource fee and tax, which sit heavy on the mine owners; and the tanglesome tax system has no advantage to fiscal input to the environment protect. Hence, the study group suggests that the state should integrate kinds of tax and fees which are relative to the mineral resources and environmental protect.

Proposed scheme 1 is: establishing an "abandoned mines ecological restoration fund" in Offices under that State Council or Ministry of Land Resources, which is used to restore the old damage. The main sources of this fund as follows ① fiscal payment from governmental revenue, which come from three parts: firstly, the state augments the fiscal fund used to rehabilitate the old damage; secondly, the state integrate current mineral sources fees and taxes as the fiscal expenditures for old damage; thirdly, the state launch national bonds for the mine protection and put the bonds into the “abandoned mines fund. ② active mining enterprises pay for the old eco-environment damages, which is a kind of compulsory donations for compensating the mistakes of past mining activities and less than 1% of sale price. ③ donations from international and domestic fund organizations and other sustentation fund. ④ others

Proposed scheme 2 is: the state enlarge the scope of mineral resources taxes, and set up a new tax item such as ecological tax for mineral resources, whose tax rate will be advanced gradually, so that the destructive behaviors to the eco-environment can be restricted and avoided. The ecological tax for mineral resources should not only

reflect the own value of nature resources, but also be treated as the main fiscal payment for environment protection and rehabilitation of the old damage.

4) Establish Eco-Compensation System and Performance Appraisal System to ensure the restoration of abandoned mines by government.

Linking with assessment quota and evaluation measures built by ecological provinces, the foundation of Eco-Compensation System and Performance Appraisal System will play a positive role to promote the using of abandoned mines restoration funds and the special financial assistance. Meanwhile, it's also helpful to build the scientific rewards and punishment system which would track performance of those funds.

5) Establishing the mining permits system and the "performance bond" mechanism in order to regulate the eco-compensation in effect.

The mining permit system has been put into practice in China, but the license for mining is usually sanctioned with the view of the resources protection and management. The state must combine mining permit system with the eco-compensation mechanism. The applicants who want to mine must hand in the environmental impact statement and reclamation planning; otherwise, they will not be granted the mining permit. In addition, the mine owner who did not implement the reclamation tasks will be not allowed to mine the new mineral resources anymore.

To ensure the implement of reclamation tasks, mine owners must pay performance bonds forwardly before they get the licenses, whose standards are 2-15yuan per ton of coal output or 2%-4% of sale price. The performance bonds are usually put in the bank, which belong to the mine owners, and monitored by the governments. The mine owners can't retake parts of the performance bonds until they rehabilitate the damage to the environmental indicators the government constitutes. When the tasks of rehabilitation have been done entirely, the all-out performance bonds will be returned.

(6) Develop the environmental protection industry, and constitute preferential policies for Pollution abatement enterprises

Mining enterprises, especially small and medium enterprises in the coal mining may not have the capacity to restore all kinds of eco-environment. In this condition, the mine owners can commit the rehabilitation tasks to professional environmental protecting enterprises. Environmental protection enterprises not only have professional skills, but bring economy of scale effectiveness which results in alleviating the burden of the coal mining enterprises. In addition, the pollution

abatement enterprises and other company in the environmental protection industry participating in the eco-compensation will expand the financing channels.

(7) Establish eco-compensation incentives to encourage the participation of private capital in ecological reconstruction

Be profitable is the ultimate goal for enterprises. So that is understandable that restoration activities for enterprises will be driven to be more active with profit-oriented approach. Therefore, that is doable if we reward mining enterprise the priority to use the renewed land or issue them abandoned mines mining rights residually, and encourage the active participation of individual enterprises or restored civil governmental abandoned mines.

(8) Develop coal accounting system in Mining Corporation and constitute kinds of environmental policies to promote the reasonable use of mineral resources

At present, the mining corporation can not bring the eco-compensation and reclamation fees into the coal accounting system.

Local governments should actively constitute kinds of environmental policies to promote the reasonable use of mineral resources, and reduce the environmental damage in the mining process environmental damage to the minimum. For instance, the fund of coal price adjustment in Shanxi province treats the rate of coal iterative mining (65%) as a dividing line. If the iterative mining rate is more than 65%, the corporate is free; otherwise, the coal mine corporate have to pay 0-30 Yuan in the fund. The fund of coal price adjustment is to encourage the use of advanced mining technology and improve the reasonable utilization of mineral resources. The fund of coal price adjustment will be earmarked for resources and the eco- environment conservation.

7 Conclusion

（1）Because of many types of mineral resources and geological conditions, it is difficult to built EC mechanism for all the mineral resources. So we suggest that we can choose the EC for coal mining as the preferential study field.

（2）Based on many kinds of environmental protection laws and “the stipulation of land reclamation”, “the law of eco-environment rehabilitation in mining areas” should be issured as soon as possible in order to identify the liability and standard .

（3）Reform coal accounting system in Mining Corporation and add the eco-compensation fees and rehabilitation cost to the cost accounting of mining corporation.

（4）Enforcement office should be set up in the Ministry of Land and Resources with

the assistance of State Environmental Protection Administration, which take charge for drawing the law of EC, planning and applying EC mechanism, and supervision.

（5） EC for mineral mining should followfollowing principles: ①Who damaged, who reclaimed; ②Treat “old damage” and “new damage” respectively; ③ The standard of EC should based on the cost of restoring the eco-environment damage ④The main aim of eco-compensation is eco-environmental restoration

（6）set up "abandoned mines ecological compensation fund" to compensate and rehabilitate the old damage

（7）The new damage must be burdened by new mine owners and active mine owners by means of paying for performance bonds in banks, which are levied by 2-15yuan per ton of coal output or 2%-4% of sale price. The local land resources bureau identifies the specific amounts.

（8）The state must combine mining permit system with the eco-compensation mechanism. The applicants who want to mine must hand in the environmental impact statement and reclamation planning; otherwise, they will not be granted the mining permit. In addition, the mine owner who did not implement the reclamation tasks will be not allowed to mine the new mineral resources anymore.

Forest Eco-compensation Mechanisms and Policy Options

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1 Introduction

1.1 Importance of establishment of eco-compensation for forest ecosystems

China is a country with a vast territory and a large population but limited forest resources, so the available per capita forest area and the per capita forest stock volume rank after No. 120 in the world. In the past few decades, the Chinese government emphasized on timber production but ignored forest ecosystem protection, thus resulting in sharp decline in quality of natural forests. Moreover, due to insufficient budget and little incentive of private sector for forest restoration, the situation has been worsening. Fortunately, the government's policy currently changes from merely economic-oriented actions as logging to forest restoration integrating of environmental benefits to economic interests.

Forest resources are mainly distributed in the economically less developed regions in China. On the contrary, the beneficiaries of forest ecological benefits are located in downstream regions where the economy is relatively well developed. Because of limited utilization of protected natural and ecological protective forests, forestry farmers and local people have to lose their develop opportunities to protect forests. On the other hand, the whole society benefit from forests ecological services freely. Thus, there have been existed the unfair phenomena of "the minority bears burdens but the society benefits and the poor make contributions but the rich enjoy". Therefore, it is particularly important to the issue of how to establish forest eco-compensation (FEC) mechanism which could raise the money for forest restoration and promote the public incentive for forest protection.

In fact, some programs of the six key State Forest development Programs[2] implemented by Chinese government could be considered as a means of eco-compensation. The central government invested public fund to directly compensate forest managers and farmers who forgo economic revenues for ecological benefits in the above forest construction programs. As we all know, only depending on government financing for forest eco-compensation will result in great burden to government and insufficient of payment and compensation to farmers. This poses a challenge to Chinese government to establish a new and effective financial mechanism for eco-compensation in China.

[1] Leader of team: Li wenhua; members: Li shidong, Li fen, Liu moucheng
[2] The National Forest Protection Program(NEPP); the Sloping Land Conversion Program(SLCP) etc

1.2 Research objectives

The purpose of this study is as following:

- to review the historical development of forest eco-compensation at the global scale
- to evaluate current status and policy issues on forest eco-compensation in China
- to put forward preliminary recommendations and perspectives for improvement of forest eco-compensation
- to provide reference to other fields such as eco-compensation in watershed, mining, natural reserve, and
- to summarize experience and lessons drawn from forest eco-compensation for establishment of a general eco-compensation framework in China.

1.3 Approaches and methods

Since setting up of the research group in March 2005, the following tasks have been completed:

- literature review
- collection of information related to eco-compensation in forest sector
- organization of workshops with experts, relevant organization(Forest Trends) and interviews with farmers and workers depending on the forest for living
- discussions with decision makers at various levels
- field surveys in selected provinces and cities including Heilongjiang, Hainan, Tibetan Autonomous Region and Beijing municipality
- systemization and assessment of the existing policies.

2 General review of the current status in China and abroad

2.1 State of the arts research and experiences abroad

Studies on internalizing the externality of environmental goods and services began in the mid 19th century. The Pigouvian tax of the classic welfare economics proposes the State's intervention via taxation (A.C Pigou,1971). Due to the positive externalities generated by forests' ecological benefits, Pigouvian tax has been transferred into a fiscal subsidy to forest owners. From then on, the externality of public goods became a key issue of welfare economic researches (Bator,1958; Head,1962; Bird,1987). However, research of forest ecological benefits has been initiated since the late 19th century. Botanist in Germany proposed a natural

management theory, and ecological benefits of the forest have been drawn attention. After a century's exploration, research on forest ecological benefits compensation tended to be mature in the late 20th century. And the book *Nature's services: societal dependence on natural ecosystems* (Daily, 1997) brought a new era on ecosystem services research. At the same year, a paper published in *Nature* named *the value of the world's ecosystem services and natural capita* (Costanza, 1997) evaluated the global forests ecosystem services (Tab 1).

Tab 1. Evaluation of global f annual forests ecosystem services functions

Ecosystem Services	Value ($\$yr^{-1}\times10^{9}$)
Gas regulation	—
Climate regulation	683.740
Disturbance regulation	9.50
Water regulation	11.40
Water conservation	15.20
check winds and control sand	465.50
Soil formation	38.00
Nutrient cycling	1751.80
Miligation of air pollution	422.39
Pollination	—
Biological control	11.82
Refugia	—
Timber products	208.55
Raw materials	672.38
Genetic resources	77.90
Recreation	319.18
Culture	9.71
Total value	4705.71

Recently, there have been an increasing number of evaluations on forests ecosystem services, and the evaluation methods include market valuation, opportunity cost, shadow price, replace project, travel-cost, preventive expenditures, property value and so on. Especially after the Environmental Development Conference in 1992, practices on ecological benefits compensation have been initiated.

Figure 1 shows the effects of a positive or beneficial externality. People living in the up-river afforest provide water with certain quantity and quality to down-river inhabitants as free of charge. In this case, the marginal private benefit (MPB) is less than the marginal social or public benefit (MSB) by the amount of the marginal external benefit (MEB). So, the market will end up at the quantity Q_1, instead of the

efficient quantity Q. Thus, if positive externality is not compensated, it will reduce the welfare of the entire society.

Figure 2 shows the effects of a negative externality. The marginal private cost (MPC) is less than the marginal social or public cost (MSC) by the amount of the marginal external cost (MEC). So, the market will end up at the quantity Q_1, instead of the efficient quantity Q.

Externalities are important in economics because they may lead to economic inefficiency. Because the producers of externalities do not have an incentive to take into account the effect of their actions on the others, the outcome will be inefficient. There will be too much activity that causes negative externalities such as deforests and not enough activity that creates positive externalities such as afforest which can bring an optimal outcome.

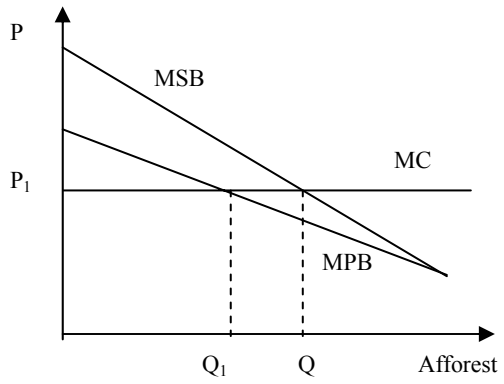

Fig 1. Positive externality of afforest

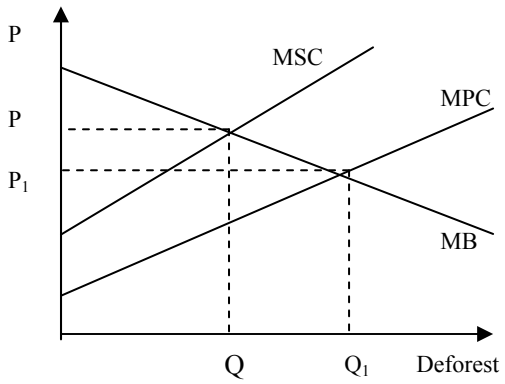

Fig 2. Negative externality of deforest

In compensation for forest's ecological benefits, there are mainly two types of arrangements internationally, namely public fiscal payment and market-based instruments. It is believed that fiscal arrangement is prone to a number of shortcomings, such as high transaction cost, low efficiency in fund use and ambiguity in target beneficiaries. Nowadays, international research institutions focus on developing a relatively well-developed market infrastructure and market-based instruments for forest ecological services payment.

Forest-trends and Katoomba have done many researches on market-based compensation. They have hosted many conferences on forests ecosystem services in Australia, Canada, Brazil, British and Japan. The conference discussed many issues including carbon sequestration, biodiversity conservation, watershed protection, landscape beauty, and the legal system needed by construction of forests ecosystem services markets (Lan et al, 2002). In 2002, Landell-Millls and I.Porras discussed the

spreading phenomenon of markets for environmental services in the forest sector. In total, 287 instances were received from developed and developing countries in terms of payments for forest environmental services such as carbon sequestration, biodiversity conservation, watershed protection and landscape beauty. Due to differences of the commodities, characteristics of participants, level of competition, payment mechanisms, geographical extent of trading, level of maturity and the degree to which markets are embedded in a broader institutional context, markets vary tremendously between locations and in services provided.

More over, some experts and scholars studied the trade market of forest ecosystem services. For instance, Daniele Perrot-Maitre (2001) summarized the trade cases of forests' watershed services. Nels Johnson (2001) concluded market mechanism of forests' watershed services. Robert (2003) proposed economic framework to evaluate forests ecosystem services. Gouyon (2003) reviewed markets of forests ecosystem services and considered market as an effective tool to internalize the forests ecological benefits. Rosales (2004) analyzed some issues in ecological compensation and practices in Asia. Francisco (2003) concluded experience of payment to ecosystem services in the Philippines. Suyanto (2004) reviewed the development of market of forests ecosystem services in Indonesia. Reyes (2002) analyzed ecological compensation mechanism of watershed services in Costarica.

Table1 and 2 show forest ecological benefits compensation actions taken by some of the countries.

Tab 2. Methods of FEC abroad

Form	Country	Methods
Government investment	USA	Based on public fiscal payment, government provides compensation fund to maintain and promote forest ecological benefits.
	Britain	Government invests and provides a preferential loan.
	Germany	Based on the alternative schemes, budget mechanism is used in state-owned ecological protective forests.
Government subsidy	Austria	A subsidy is provided to forest managers if the forest is close to a natural status.
	Britain	A subsidy is provided to conifer manager.
	France	State Forest Fund provides capital.
	Finland	A preferential loan is provided to forest managers.
Tax Reduction	France	Duty exemption and tax allowance is reduced in 10-30 years for different species.

	Finland	Income tax is exempted in 15 years for reforestation, and tax-free for forests with an area below 200 hm^2.
	Germany	Tax is reduced for forests privately or collectively owned.
Ecological benefits tax	Canada	Charges/fees are collected on beneficiaries (organizations, enterprises and individuals) of forest ecological benefits according to whoever-benefits-pays principle.
	The EU	A CO_2 Tax is levied to realize ecological benefits compensation.
	USA	A pasturage tax is levied in state-owned forests to renew, conserve and improve the pasture.
	Columbia	Beneficiaries and polluters pay.
	Japan	Tax water users to compensate upriver forest owners.
Market-based instruments	Costa Rica	Carbon bonds are developed by government. CTO's valid for 20 years is sold to investors abroad to pay the corresponding CO_2 reduction needed.
	German	Ecological account is established to sell forest ecological benefits legally.

Tab 3.Market instruments for FEC abroad

	Contents
Business Planning	Business planning is emerging as a fundamental tool to achieve the financial sustainability of FEC. The first step is to produce a clear analysis of financial situation and opportunities for new revenues through formulating a business plan. Secondly, developing and implementing a business plan requires significant commitment, effort, and organizational leadership. Thirdly, business plan will therefore continue to be modified and adapted to ensure applicability to local contexts.
Carbon sinks and carbon transactions	Carbon transactions mean the trading process that CO_2 emission (company or country) pay to forest owners or managers for forest ecological benefit. A reasonable prosperous industry has been established in trading "certified emission reductions" under the CDM of the Kyoto protocol. Forest carbon trading is a tremendous potential market for environmental services payment that could provide market-based instruments for forest ecological benefit and reduce capital shortage pressure in the process of forest management.
Eco-tourism	Eco-tourism can provide a significant source of revenue for ecological protection without undermining biodiversity objectives. Firstly, to maximize the benefits of sustainable tourism activities, an appropriate user fee system must be established; Secondly, it is proposed that local forest managers are not trained to do tourism themselves, but instead, are trained to understand the industry so as to ensure establishment of an effective visitor's management framework for their respective

	protection areas. Tourism services should preferably be developed and operated by professional organizations and businesses.
Eco-labeling of forest products	Certification schemes are being used as an incentive for both producers and consumers. Over the past 10 years, some 50 million ha in more than 60 countries have been certified according to FSC standards. The FSC-labeling scheme is preferred by buyers' groups in the UK, the Netherlands, Belgium, Austria, America, Germany, Brazil, which have committed themselves to selling only independently certified timber and timber products. The motivation of forest certification is rooted from the demands of international market such as furniture making and other timber products.
Trust and endowment funds	There are over 100 kinds of environmental funds around the world, which are fall into three categories: endowment fund, sinking funds and revolving funds. Many of these funds provide direct financial support for ecological protection and supporting research and other related initiatives. These categories are interlinked with each other, each kind of fund maybe part of the other kinds. The governing bodies of the trust fund include the Trust Management Board, Local Community Steering Committee and Technical Advisory Committee. The Board hired a resource development specialist to invest and provide funds for forest resource conservation. Furthermore, it is important to introduce a broad multi-stakeholder participatory process funded by various sources and to enhance the expertise necessary for protection activities.

Through collection and analysis of compensation forms and methods of forest ecological benefits abroad, some inspirations are drawn on sustainable management of forest resource.

- Public financial capital is a major means to pay for the forest ecosystem service, because beneficiaries of forest ecosystem service are the whole society. In China, a forest would be classified as either ecological protective forest or commercial forest. For the commercial forest, it could realize its value via market transition. However for ecological protective forest, it is invested by public fiscal investment from central and local governments.

- It is an effective method requiring the beneficiaries to pay for the forest ecological benefits, or to reduce and exempt the tax for forestation. The payers include damagers to forest ecosystem and beneficiaries from forest ecological services.

- The marketable manner of forest eco-compensation could be adopted if the necessary conditions are met such as the clear ownership of ecological protective forest, the accountability of ecological benefit and a low transaction cost.

Above all, there are many good international lessons on the theoretical and practices of forest eco-compensation can be drawn, such as tough legal base and law executing rigorously, sound market-based instruments and multiply financing channels, enhancing public participation and exploring global market. Even for developed country, payment for ecological services is still in its infancy. Furthermore, there are clearly differences on culture, history, social and economic attitudes at international and national scales. We could not copy the measures of foreign countries. Such as the forest-trends report pointed out "Around the world, policymakers and PES stakeholders highlight the fact that developing successful PES schemes is a learning process. . . No single set of policy tools and targets will provide a definitive solution to China's environmental priorities and challenges." Thus, we should search a path suitable for forest eco-compensation closely combing with Chinese local conditions based on the international experiences.

2.2 General review on forest eco-compensation in China

2.2.1 Theoretical research on forest eco-compensation

The domestic theory on forest ecological compensation is on the basis of forest ecosystem service and its value evaluation. Since early 1980's, the researches on forest ecosystem services have been sprung up around the whole China including the evaluation of energy flow, physical quantity and value of biology(LI Jin-chang,1999;LI Wen-hua,2002; OUYANG Zhi-yun, ZHAO Tong-qian,2004; TAN Rong,2005). At the same period, the forestry experts outspread the researches on forest resources accounting. These researches put focus on the forest product value accounting, and take into account of the ecological and environmental valuation of ecosystem.(JIANG Yan-ling, ZHOU Guang-sheng,1995; HOU Yuan-zhao, ZHANG Ying,1995; WU Shui-rong,2001; LIU Can,2002).Since 1990, the experts have begun the researches on forest ecological compensation on several aspects such as theory, policy-making and implementation (ZHANG Zheng,1995; WANG Xue-jun etal,1996; LI Ai-nian, 2001; WEN Zuo-min, 2002; XING Li,2005).With the aim of protecting ecological condition and maintaining social equity, the manager of forest should be compensated to solve the externality problem of ecological services as a result of market failure.

With the requirement for establishing forest eco-compensation scheme, synthesize forums and special researches have been sprung up including workshop on payment schemes for environmental services of CCICED task force on forests and grasslands in 2002; workshop on forest environmental services payment schemes supported by Forest-trends in 2002; the round table conference on ecological compensation supported by WWF and IIED in 2005; workshop on ecological compensation

mechanism and its policy design organized by Chinese Academy for Environmental Planning(CAEP) in 2005, reflecting that the Chinese government attachés great importance to the research on forest ecological compensation.

Nowadays, the FEC research have been focused on the following aspects such as research on the feasibility and necessity of FECS(Zhou Dajun,1993; Chen Qin,2001), the complexity of compensation(Jiang hai,1997, Zhou Xiaofeng,1999), the basic theory of FECS(Zhang Xiumei,1999; Chen Qin,2000),the standards of compensation(Liu Cai,1999;Shi Dejin,2001); the approaches of compensation(Liu Cai,1999; Shi Dejin,2001), the management and use of compensation funds(Xu Yiliang,1999;Zhou Hong,2003),the improvement of FECS(Chen Genchang,2002; Xu Jintao,2002; Sun Changjin,2002),the compensation mechanism and policy analysis of NFPP, SLCP and FEBS during the implementation(Chen Qin,2001; Huang Fuxiang,2002). There is no doubt that the above work serves as a strong basis for further research on FECS.

To evaluate the ecosystem service of forest, the conception of use value and compensation value of forest and their relations are given as below:

$B=A\times h$, $h=B/A$

Where,

B is the compensation value of forest; A is the use value of forest; h is the multiple of B to A.

Many experts and research institutes have estimated the value of h, which is valued as 13.3 by the Forest Administration of Beijing; 12.2 by the Environmental Protection Administration of Jilin province; 14 by Forest Administration of Fujian province. Based on the calculating outcome, h ranges from 10 to 20.

The use value of forest depends on the value of timber. Therefore, the use value of A is calculated as follows:

$A=C\times L\times P$

Where,

C is the area of forest land

L is timber productivity of woodland

P is timber price

In China, the research on the theory and methodology of forest ecological benefit value assessment is still on the way and it is lack of recognized and well-established accounting method. On the other hand, the researchers apply directly international

price and methods without taking into consideration of social and economic conditions of China. Therefore, the outcomes could not be recognized and applied by academia, policy-making department and public.

In conclusions, existing forest eco-compensation is not based on the scientific value of forest, but on the government's finance. According to this, the government should pay more attention to diversify the compensation capital resources so as to reduce the government's burden and deliver reasonable compensation to the providers of ecological benefit.

2.2.2 Conceptual framework of forest eco-compensation

In China, the concept of FEC can be understood in different hierarchies; namely Macro-, Medium- and Micro-level.

- Macro-level concept: Macro-level includes all the measures and financial supports with the aim at restoration of degradation forest ecosystems. Majority of the forest resources in China belong to the government with a small proportion to collective farmers. Due to unreasonable exploitation over the past years, the forest resources were deteriorated significantly. The government has invested a great deal of money for restoring ecological services of the forest ecosystems. Direct investment of the State in macro-concept of FEC is about 43 billion yuan per year, which covers six key forest programs, establishment of natural protection area, forestry park building, forest disease and insect control and so on.

- Micro-level concept: it refers to a narrow sense of FEC. The forest is classified into ecological protective forest and economic forest in China. According to the concept, the forest eco-compensation means compensation for ecological protective forest. In *forest law,* it is specified that the forest eco-compensation fund be used to subsidize rangers and managers for planting, tending, protecting and managing forest resources and woods for shelter forests and special-purpose forests. A total of 2 billion yuan is provided for FECS each year by the State, the compensation standard is 75 yuan /hm^2.

- Medium-level concept: It is related to a number of forest protection programs, such as natural forest protection program (NFPP), sloping land conversion program (SLCP) and the key ecological protective forest program.

Tab 4. The polices and regulations of FECS in China

	Time	**Department**	**Rule/regulation/polices**

Natural forests protection program	1998	Ministry of Finance	Management of earmarked funds for NFPP
	1999	SFA	Accounting of the ecological forests of NFPP
	1999	SFA	Regulations on the financial management of NFPP
	2001	SFA	Regulations on the financial management of NFPP in the key areas
	2001	SFA	Management of NFPP in the key areas
	2001	SFA	Inspection and evaluation of SLCP
	2001	SFA	Management of NFPP
Sloping land conversion program	2000	State Council	Concerns for further implementation of SLCP
	2001	SFA	Inspection and evaluation of SLCP
	2002	State Council	Concerns on policies perfection of SLCP
	2002	National People's Congress	Decree on SLCP
	2003	SFA	Regulations on the supervision of SLCP
Key Ecological Forest Construction	2001	Ministry of Finance/ SFA	Designation of key ecological forests
	2004	Ministry of Finance/ SFA	Management of FECF in China
	2005	Local Governments	Scheme on the implementation of FECS
	2005	Local Governments	Management of key ecological forests
	2005	Local governments	Monitoring and management of FECF

Note: SFA is the abbreviation of State Forest of Administration

The medium-concept of FEC is an integrated method to adjust the inter-subjective relationship between the utilization and the protection of forest ecological environment. It is a mechanism that forest stewards and managment shall be compensated by state financial capital or other manners. Direct investment of the State in macro-concept of FEC is about 30 billion yuan per year.

For the sake of easy to understood, the relationship between macro-level concept, medi-level concept and micro-level concept is shown as follows:

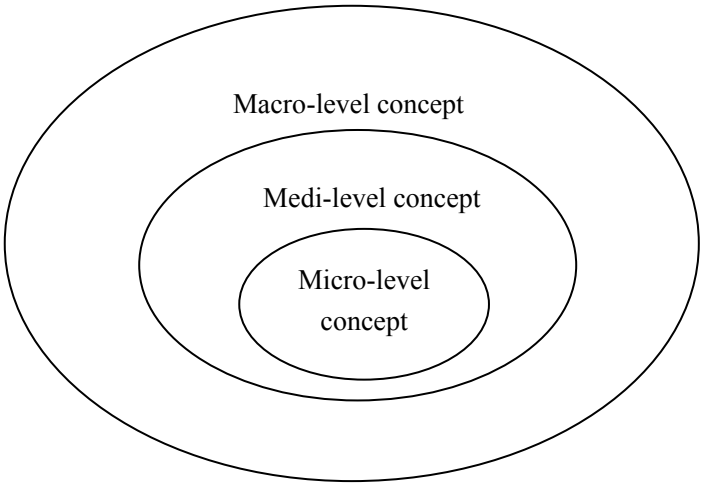

Fig 3. The relationship between macro-concept, medi-concept and micro-concept of FEC

(In this report, considering the research target and actual conditions, medi-level concept of FEC is adopted)

Overall, the establishment of FECS means China's forestry has entered a new development stage, putting to an end of the history of providing ecological benefits without compensation for ecological services. Both initiatives significantly encouraged public to participate in forest protection, and provided public benefit forests as a stable base for long-term sustainable development.

3 The implementation of FECS in China

3.1 The history of establishing the FECS in China

The process of establishing FECS can be roughly grouped into the following three phases in China:

Phase I(1978～1998):Initiating Phase

Since 1978, economic reform and opening up to the world has been started in China, from then on, the externality of forest ecological benefit was remarkably shown up in the market economy. Starting from the late 1980s and early 1990s, a deepening appreciation of the value of forests ecological benefits has resulted in discussions of establishing the FECS. In 1992, the State Council, in reissuing the *Notifications on the Key Issues of Economic Reforms* in 1992 prepared by the State Economic Systems Reforms Commission, proposed that "the stumpage fee system and the FES be established, and the utilization of forest resources be paid for." In 1993 the State Council, once again in the Notifications on Strengthening the Tree-Planting and Greening Work, proposed "reforming the investment mechanism for tree-planting, and gradually adopted the FECS".

Overall，attention was put on discussion of FEC concept and trial implementation in limited area in Phase I. The discussions were held at a broad level, no concrete results were reached during this phase regarding financial source and standards for compensation.

Phase Ⅱ(1998～2004): Pilot Implementation Phase

According to the above-mentioned concept of FEC, the programs included in this pilot implement phase are NFPP, SLCP and key ecological protective forest program.

- The pilot implementation phase of NFPP started from 1998 and ended in 1999. After the flood disaster in 1998, the State has made an important decision to implement natural forest protection program for the sake of sustainable development, due to ecological deterioration caused by over-exploitation of natural forest. Great efforts have been made to restore forest by implementing NFPP via the following countermeasures: logging ban in the natural forests, reducing the commercial forest timber production, providing alternative employment for state-owned forestry workers and so on.

- The pilot implementation phase of SLCP started from 1999 and ended in 2001.After visiting six provinces in the western region in the autumn of 1999, the ex-premier Zhu Rongji put forward the idea of the SLCP. The main objective of the SLCP is to mitigate water and soil erosion by converting steep slope cropland and some decertified land to forest land and grassland in the key ecological protected area. Subsequently, pilot implementation for the SLCP was firstly carried out in Sichuan, Shaanxi, and Gansu provinces.

- At the beginning of 2001, the pilot implementation of FEC was carried out. The state invested 1 billion yuan/year as the forest ecological benefit subsidy fund. A total of 133 thousands hm^2 of protection and special-use forests in 685 counties and 24 national-level nature reserves in 11 provinces have been selected. The subsidy standard is 75 yuan /hm^2/year, mainly for the conservation and management of the key ecological protective forests.

Phase Ⅲ(2004～present): Formal Implementation Phase

NFPP: In December 2000, the State Council approved two scenarios about NFPP, namely *Natural Forest Protection Program Implementation Scenario in the Upper and Middle Reaches of the Yangtze River and the Yellow River*, *Natural Forest Protection Program Implementation Scenario in Northeast China and Inner Mongolia,* which meant the NFPP has entered the formal implementation stage. The NFPP was gradually made perfect during the later implementation process.

SLCP: the videophone conference on SLCP claimed that SLCP entered a formal implementation stage around China in January 2002 on the basis of pilot implementation work.

FECS: the FECS was established on the basis of a three-year's pilot implementation in December 2004. Establishment of FECS is of great importance to the development of forest sector. In the process of establishing FECS in China, the government had enacted a series of rules and regulations as a stable legal base for the implementation of FECS (Tab 4).

3.2 The public fiscal transfer measures for FECS

3.2.1 Natural Forest Protection Program (NFPP)

- The target of NEPP: the Project of NEPP would make a contribution to the growth and restoration of natural forest through logging prohibition, inducing commercial timber production and reemployment program of the forestry staff in a planned way. The natural forests include the primeval forest, natural secondary forest, key protection forest and special-use forest.

- The coverage of NEPP: In October 2000, the State Council approved the Program for Natural Forest Protection in the upper and middle reaches of the Yangtze River and the Yellow River, which covers 17 provinces and autonomous regions, including northeastern China, Inner Mongolia as well as other provinces. The natural forest areas covered by the NEPP were 73 million hm^2, accounting for 69% of the country's total.

- The financial investment of NEPP: the state invested 10.17 billion yuan to the project during the pilot implementation from 1998 to 1999; based on it, the total capital investment would reach 96.2 billion yuan (78.4 billion yuan by central government, 17.8 billion yuan by local government) from 2000 to 2010, with a total amount reaching 106.4 billion yuan.

The funds of NFPP comprise of "infrastructure construction input" and "special capital input", with 18 billion yuan for the infrastructure, and 78.2 billion yuan for special financial capital input, accounting for 18.8% and 81.3% respectively(Fig. 3). Infrastructure construction input includes the following aspects: (1) logging prohibition, (2) forestation by aerial seeding (3) forestation by manpower (4) nursery construction and (5) forest fire prevention, etc. The subsidy standard is 210 yuan/hm^2 for logging prohibition for 5 years; 750 yuan/hm^2 for forestation by aerial seeding; 3000 yuan/hm^2 for forestation by manpower in upper reaches of the Yangtze River and 4500 yuan/hm^2 in the upper and middle reaches of the Yellow river.

The special capital inputs are used for (1) forest tending, (2) staff pensions of state-owned enterprise, (3) compensation of laid-off workers, and (4) compensation to local governments for lost revenue.

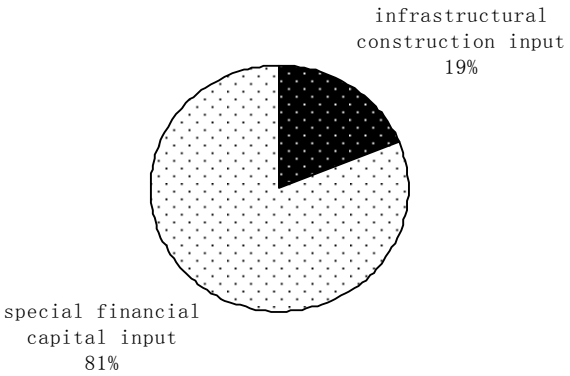

Fig 4. Capital investment structure of NFPP

3.2.2 Sloping Land Conversion Program（SLCP）

- The target of SLCP: The main objective of the project is to reduce soil erosion by converting cropland on steep slopes and some degraded land into grassland and forestland. In 1999, Sloping Land Conversion Program（SLCP）began pilot. According to *The Enforcement Regulations of Forest Law of the People's Republic of China* enacted in 2000, sloping land above 25°should be afforested or returned back to grassland. 12 provinces with severe soil erosion and serious sandstorm had been selected for pilot.

- The coverage of SLCP: the project covers 25 provinces. The forest area of SLCP implementation increased 22.93×10^6 hm^2 from 1995 to 2005, including 9×10^6 hm^2 of afforested land converted from farmland, 12.6×10^6 hm^2 of waste hills and un-reclaimed lands suitable of forestation and 1.33×10^6 hm^2 of mountain area sealed for forestation. The non-farming land of structure of SLCP is shown(Fig 5):

- The financial investment of SLCP: The total investment in this program has reached 103 billion yuan by the end of 2005. SLCP stipulates that farmers who convert degraded and steep sloping cropland into either “ecological protective forests”(defined by the State Forestry Administration as timber-producing forests), or “economic forests” (orchards, or plantations of trees with medical value)will be compensated with an annual in-kind subsidy of grain, a cash subsidy and free saplings, at the beginning of the planting period. The grain subsidy is set at 2250 kg/ hm^2) in the Yangtze River Basin, and 1500kg/hm^2 in the Yellow River Basin. The cash subsidy is 300 yuan/hm^2 per year. Both grain and cash subsidies are for 8 years if ecological protective forests are planted and for 5 years if economic forests are planted.

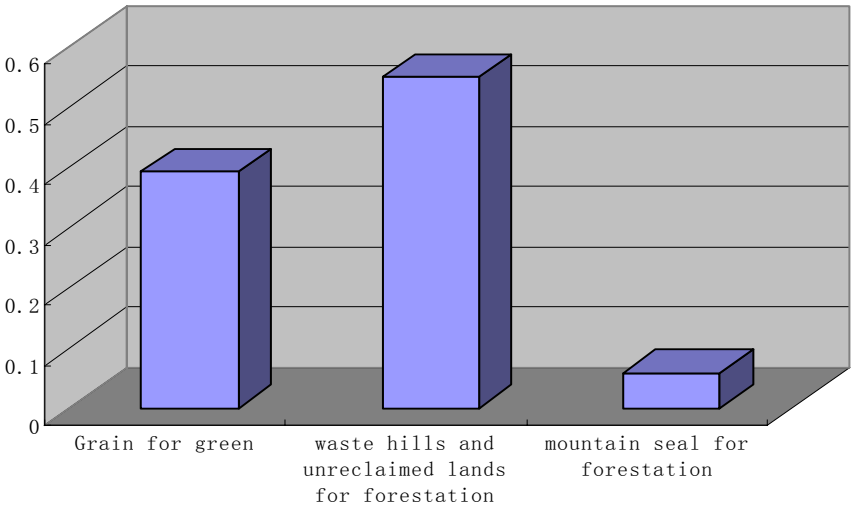

Fig 5. The forestation assignment structure of SLCP

3.2.3 The Forest eco-compensation Fund (FECF)

- The target of FECF: the FECF is used for the planting, tending, protecting and managing the forest resources and it must be used for the said special purpose.

- The coverage of FECF: Based on a nationwide assessment conducted in 2001, the Ministry of Finance and the State Forestry Administration have chosen 658 pilot counties and 24 national-level nature reserves in 11 provinces for this subsidy pilot. The project came into operation in 2004, and the pilot work was further expanded to the areas that have important ecological protective forests throughout China. And the area covered by the ecological protective forest was adjusted from 13 million hm^2 to 26 million hm^2.

- The financial investment of FECF: Starting from 2004, the total compensation fund was increased from one billion yuan to two billion yuan. Current compensation standard is 75 yuan/hm^2/year to the key state nurseries and nature reserves in the forest sector. The 75 yuan/ hm^2/year subsidy has been divided into two parts, that is, 67.5 yuan/hm^2/year of subsidy payment would give to the forest farmers for their service, replanting, soil preparation and tending, and 7.5 yuan/hm^2/year of public payment would be kept by local forestry departments for general forest protection such as fire prevention, insect and disease control and resource monitoring.

The programs about FECS are listed as below (Tab 5).

3.3 The market-based instruments for FEC

As for the market-based instruments, carbon transactions is an effective measures for enlarge the finance channel for FEC. Carbon sink is one of ecological

Tab 5. The programs about FEC

	Pilot time	Scope	Regions	Subsidy input(hm^2/year)
NFPP	1998 ～ 1999	The primeval forest, natural secondary forest, key protection forest, special-use forest	In the upper and middle reaches of the Yangtze River and the Yellow River.18 provinces and autonomous regions, including Inner Mongolia, Henan and so on. The natural forest areas covered by the NEPP was 107 million hm^2	Total input:106.4 billion yuan (1998-1999) The input for sealing mountain for forestation : 210 yuan forestation by aerial seeding:750 yuan Plantation: 3000 yuan (in the upper reaches of the Yangtze river);4500yuan(in the upper and middle reaches of the Yellow River.)
SLCP	1999 ～ 2001	Sloping land above 25°in areas subject to soil erosion and sandstorm and damages	25 provinces in the upper reaches of the Yangtze River, the upper and middle reaches of the Yellow River and Xinjiang production and construction corps. 22.93 million hm^2 lands	Total input: 103 billion yuan（1999～2005） free saplings subsidy: 750 yuan; Life subsidy: 300 yuan Grain supplies: 2250 kg (in the Upper Reaches of the Yangtze River); 1500kg (in the Upper and Middle Reaches of the Yellow River.)
FECF	2001 ～ 2004	the stocked forest of key public ecological forest and spares forests, shrub forests and new planting sites in serious desertification and water and soil loss area	covering 26 million hm^2 around China	total input: 50 billion yuan（2001～2005） subsidy: 67.5 yuan public management:7.5 yuan

services of forest. It means the ability of forest to absorb and store carbon dioxide. The wood absorbs a large number of carbon dioxide through photosynthesis so as to

reduce greenhouse effect. As a means of emission reduction of company in the CDM project, carbon trading has been gradually improved with the progress of Kyoto Protocol and Afforestation Project. The Kyoto Protocol claims the developed countries could get the emission allowance through implementing the projects of emission reduction (or sinks increase) in developing countries. As for developed countries, this mechanism can provide a cost-effective way of emission reduction at a low cost. On the other hand, as for developing countries, the invisible "carbon sinks" could enter into market to realize its valuation except for visible goods such as forest products and timber products.

China is one of the big countries with dense forest. The forestland area totals 2.85×10^8 hm^2 and the forest area is up to 1.75×10^8 hm^2. The forest cover rate is about 18.21% and forest growing stock is $1.25\times10^{10}m^3$. Based on the research, forest could absorb 1.6 ton CO_2 and release 1.2ton O_2 while producing one-ton dry matter. Also, forest could absorb 350Kg CO_2 while growing $1m^3$ forest stock. Therefore, carbon offset transactions could eventually form a largely booming market for environmental services trading and provide a market-based instrument for financing ecological protective forests development. Extension of the carbon trading system definitely promotes the sustainable development of forestry the ecological security.

Since 2003, a series of extension work of the carbon trading in China has been conducted such as the dissemination of knowledge of climate change and carbon sinks, promoting capacity building of local governments and relevant researches and pilot implementation of forestry carbon trading, and actively participating in the international climate change progress, especially building up good cooperation relationship with international NGOs such as TNC (The Natural Conservancy), CI(Conservation International). All of these works moved forward with forest carbon transactions in China. Nowadays, there are seven carbon trading projects in China, including Guangxi, Yunnan, Sichuan, Inner Mongolia, Hebei, Shanxi and Liaoning (Tab 6).

From the global range, the carbon trading projects based on CDM are very limited. However, transactions outside any regulatory framework have sprung up around the globe, namely "non-Kyoto market". There is tremendous market potential for carbon transactions on "non-Kyoto market". We will try to learn from international experiences, exploring the non-Kyoto market and promoting the carbon trading mechanism. China has become the hot spot of foreign investment in carbon trading via CDM afforestation projects. Being a biggest developing country and afforestation country, China has tremendous potential market and enormous competitiveness on forestry carbon transactions cooperation around the globe range.

Tab 6.The implementation of seven programs about carbon transactions in China

Pilot area	Invest party	Capital (10^4\$)	Afforestation area (hm^2)	Investment per area (\$/hm^2)	Contents
Inner Mongolia	Italy	153	3000	510	The Inner Mongolia signed a contract with Italy that Total CO_2 emission reduction belongs to Italy after 2012. After first period of validity, the contract is automatically continue to another 5-year.
Guangxi	Carbon Finance in world bank	200	4000	500	The carbon financing documents presented to Carbon Finance committee, applying for ratification of afforestation and reafforestation projects. According to the contract, Total CO2 reduction emission belongs to World bank during 15 year, those belong to Guangxi after 15 years.
Yunnan, Sichuan	3M Company America	300			Building up demonstration projects of carbon transition combining forest vegetation recovery with ecological diversity protection. The project putting focus on developing multi-benefit of forest including biodiversity, carbon sinks and community development
Liaoning	Japan	18			According to the projects of CIM small-scale afforestation, the relative statistics about the pilot forestry is collected. Through accounting the quantity of absorbing CO2, the carbon sinks will be sell to Japanese enterprises as emission rights. The incomes of selling carbon sinks will be used to tending defending forestry.
Hebei, Shanxi	Netherlands Finland				To outspread carbons sinks projects via negotiations between Netherlands, Finland and relative international organizations and Hebei and Shanxi provinces

From the point view of eco-compensation, the forest ecological services with externality characteristic could be realized via carbon transactions between developed and developing countries. As an important means of promoting the proceedings of ecological services market, the carbon trading gives the significant inspiration to establishing long-term and effective forest eco-compensation mechanisms.

3.4 The achievement and experiences

Since the implementation of forest eco-compensation in China, it has done significant benefit to ecological protection and has been recognized as vital lessons to eco-compensation work of other fields such as watersheds and mineral. Along with the outspread of forest eco-compensation, the public awareness of forest ecological protection should be aroused to promote the forest resources recovery. The forest area and forest growing stock has been greatly increased and the ecological conditions have been remarkably improved. Taking Hainan province for example, the forest canopy density has increased from 0.42 to 0.51 as one of the index of forest distribution quality. The conditions of forest vegetation in ecological fragile zone have primarily recovered.

Above all, the forest eco-compensation mechanism has made enormous contribution to the forestry theory and practice and to the sustainable development of economic and society in China. However, the pilot implementation of forest eco-compensation mainly relied on direct payment by public finance. Viewing the whole implementation progress, it belongs to a government behavior. In the long run, forest eco-compensation should be achieved via market transactions mechanism. The forest carbon transactions could provide a new vision and approach for promoting the mechanism innovation of forestry development.

3.5 Typical case studies on forest eco-compensation

In order to investigate the implementation of forest eco-compensation, we chose the typical areas for field study, investigating the grass-roots problems, gaining first-hand information (Fig 6). Based on above work, we tried to find out the approaches to resolve the problems. With the aims to compare compensation standards among different regions in diversified economic development degree, we made a difference research between different regions.

The investigation area are including north China area, northeast area, east China area, south China coastland, southeast plateau area and northwest area, covering the characteristic of the economic and social development and forest resources of different regions in the whole China.

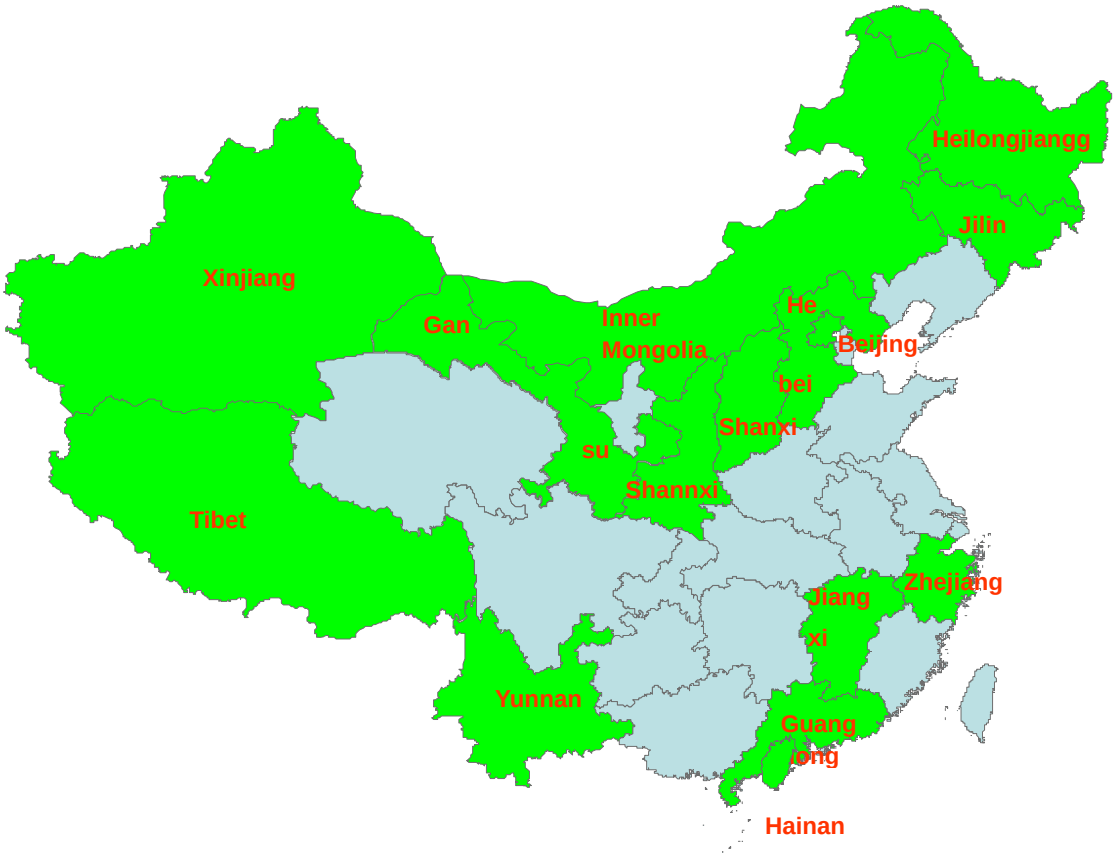

Fig 6. The typical investigation areas on FECS

Through the investigation, it is claimed that various local governments such as Beijing, Guangdong, Zhejiang attached great importance to the ecological construction and set up the local forest eco-compensation mechanisms combining with local conditions. Although some places are still lack of forest eco-compensation financing, the implementation primarily spring up the construction and development of local ecological protective forest and benefit the community and individuals who manage ecological protective forest.

The form and content of forest eco-compensation fund are different in various regions, which are mainly relied on economic development level of local conditions. There are two financing sources of forest eco-compensation fund in China, namely central government and local government. The compensation standards of various regions are different as a result of differential local financing income (Tab 7) such as 315 yuan/hm^2/year in Beijing, 120 yuan/ hm^2/year in Guangdong and Zhejiang. However, the standard is low as 75 yuan/hm^2/year in some provinces of western China like xinjiang, gansu and shanxi. In a word, the subsidy standards in wealthy regions like east coastal area are generally higher than poor regions like northwest area as a result of local government financing. However, the forest in poor regions needs much more protection. According to the statistic of CFA in 1998, there are 2772 state's own forest farms belonging to poverty level, accounting for 66% of the

whole forest farms. The beneficiary of ecological benefit are mainly the middle and lower reaches of a river regions and wealthy coastal areas, the economic development level in which are much higher than that in ecological public forest and nature forest manage areas. Above all, the government should strengthen the investment in the poor regions like northeast and southwest area.

In wealthy regions, with the scientific technique development, the management efficiency of public forest has been greatly improved as means of digital and information management and capacity building of trained personnel.

On the contrast, the regions with bad nature and weather conditions such as Tibet are facing difficulty in the course of construction and management of ecological protective forest including high protection costs, partial management institution and human resource scarcity

According to the investigation, there have been existed the common difficulty in both developed regions and less developed regions, that is the insufficiency of compensation funds. In some degree, the difficulty has hindered the proceedings of forest eco-compensation mechanism.

Tab 7. The implementation of FEC

Regions	Pro	Public forest area (10^4 hm^2)	Center gov capital (10^4yuan)	Local gov capital (10^4yuan)	Compensation standards (yuan/ hm^2)		Implementation
					center gov	local gov	
North China	Beijing	24	1763	5643	75+245	315	Local training of mountain ecological forest management person; establishing management information system; adjustment of industry structure; maturity a series of legal and regulations
	Hebei	126.6	9500		75		Strengthening the responsibility conscious; enhancing the management of public ecological forest; distribution and use of compensation fund; exploring the effective management ways, running pattern and policy

	Shanxi	16.1	1233		75		Enhancing capacity building of manager, specific responsibility; promoting the compensation proceedings via negotiation between forest department and finance department; strengthening supervise and management; carrying out the mode of capital budget; building up special account on various level governments
	Inner Mongonlia	515.4	38657.4	1455	75	45	Enhancing capacity building of manager; implementing government's goal responsibility mechanism; outspreading the compensation work via field survey; distributing management assignment; building up management system and promulgating compensation scheme.
North east	Hei Long Jiang	167	12500		75		Distributing the responsibility areas of management; adjusting the management mode; establishing management system of capital; strengthening management and supervise of capital; developing under-forest economic Putting emphasis on local training; providing technique and information
	Jilin	140	11500	300	75	45	Distributing compensation forest land and management responsibility; strengthening capacity building; enhancing organize and management; perfecting work institute; outspreading training; building up capital management mechanism
East China	Zhe Jiang	63.3	4750	2850	75+45	120	Distributing the responsibility of forest management; establishing dynamic monitoring system of key public ecological forest; carrying out dynamic management; building up forest compensation fund; ensuring the capital purpose and subsidy object; concerning the benefit of investor and operator; special capital on forest compensation by local government; investment on protection and compensation to forest on reservoir by water power department

	Jiangxi	126.6	9500	3021	75	30-75	Strengthening capacity building; distributing responsibility of management; picking out forest tender; enhancing capital management; putting focus on propagandize; improving ecological protection awareness
South China	Guangdong	345	25875	15525	75+45	120	Distributing responsibility of management; perfecting management institute; picking out forest tender; building up files database; promulgating regional capital management ordinance of forest eco-compensation; establishing public ecological forest project construction management mechanism
	Hainan	32	2395	386	75	30	Strengthening the capital management; building up policy and legal system; establishing files database; enhancing scientific support; intensifying eco-compensation education; improving public awareness
South west	Yunnan	107	8200	800	75	45	Strengthening capacity building; distributing responsibility management; promulgating implementation scheme; improving the ability of forest tender; putting focus on forest compensation capital management; establishing a sound system for assigning responsibility; intensifying propagandize of forest compensation; improving public awareness
	Tibet	97	7078		75	45	Perfecting management mode; building up capital implementation rules of forest compensation; lack of investment on forestry ecological construction; technique people shortage;
North west	Xinjiang	203.3	15250		75		Establishing the standards of forest tender; distributing forest compensation responsibility; intensifying facility construction; improving management conditions and management ability; enhancing society supervise; strengthening forest tender training; putting focus on forest compensation capital management

	Gansu	133.3	10000		75		Checking up key public ecological forest areas; building up compensation standards; strengthening training on forest tender; improving technique of forest tender; distributing responsibility of management; putting focus on capital supervise of forest compensation
	Shannxi	221 （Planning）	15774 （budget）				Attaching great importance to forest eco-compensation; constituting working groups; planning the statistical work on key public ecological forest area

Based on the analysis of information derived from field survey [1](see appendix Ⅱ in detail), we drew the following conclusions,

- **Positive impacts on farmers' livelihood**

The household survey results show that Forest eco-compensation Scheme has major positive impacts on the livelihoods of villagers. According to the investigation, 70% of households claimed that the policy of ecological protective forest did benefit to improving their living standard (Fig 7). The key ecological protective forest construction program is fundamentally correct in focusing on the connection between rural poverty and environmental degradation. The program is also a welcome initiative to combat the serious problems such as environmental degradation, rural poverty, inconvenient transportation and information shortage. Overall, the FECS can be seen as a success.

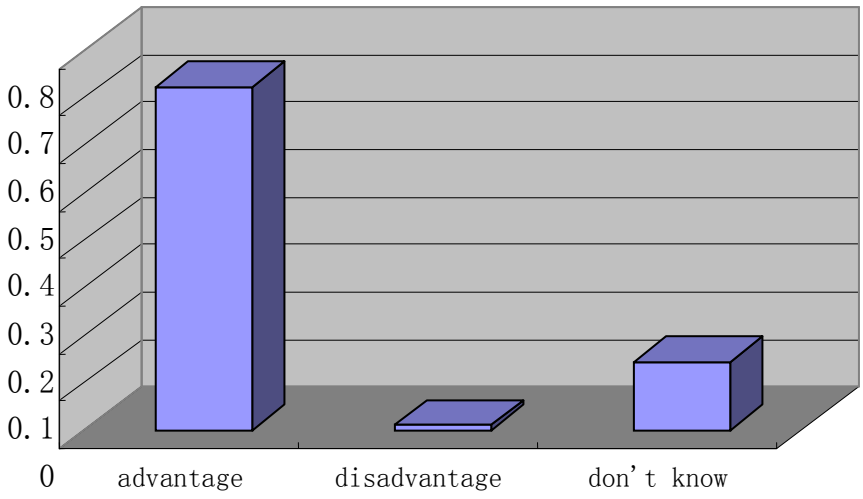

Fig 7. Farmer's evaluation on the policy of public

[1] Household surveys were conducted in Hainan. 12 villages were visited, and these visits resulted in over 120 completed household surveys. These surveys proved to be crucial in understanding the living standard in these villages and the impacts of the FEBCS.

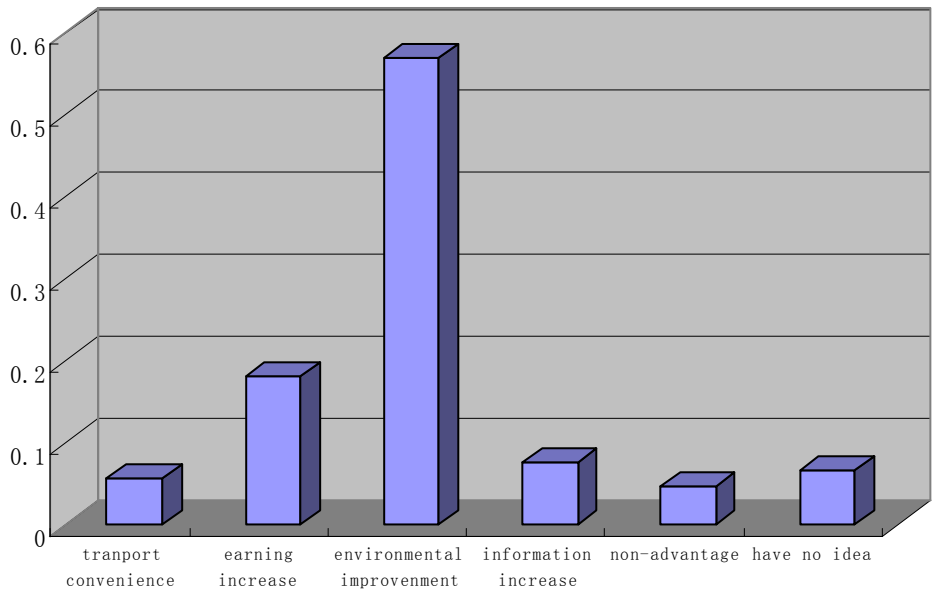

Fig 8. The farmer's evaluation on ecological protective forest subsidy

- **Capital scarcity, a hindrance to both rural development and the ecological protective forest construction**

Based on the household surveys, 53% people considered that their living conditions have been improved because of implementation of ecological protective forest, on the other hand, 30% people thought that their living condition have been worsening (Fig 9). In the process of implementation, capital scarcity has become a hindrance to both the rural development and the ecological protective forest construction. Information insufficiency is on the second place and it is an urgent issue to be addressed. Besides, there are other negative factors holding back the implementation of the program such as food insecurity, lower level education and backward in techniques of ecological forest protection.

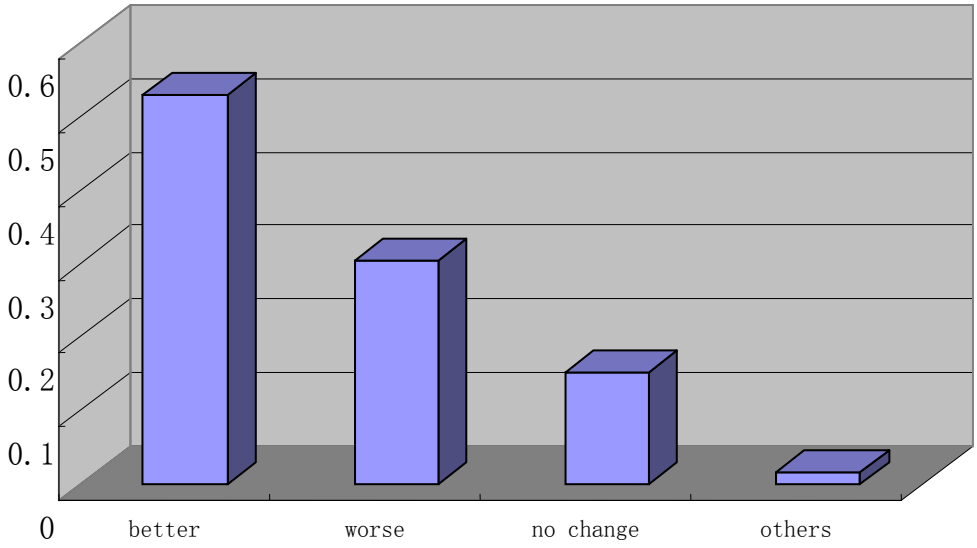

Fig 9. The investigation on living quality during the implementation of public ecological forest policy

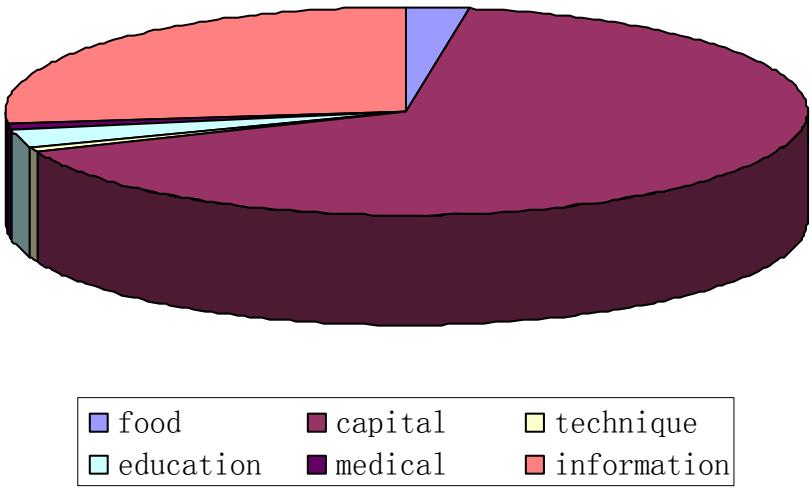

Fig 10. Diagram showing the structure of the farmer's existing problems

- **Insufficient propaganda of FECS**

Through the household survey, it is clear that propaganda of FECS is insufficient, which made the farmers unfamiliar with the relevant regulations. These setbacks would have restricted the outspread of program implementation. Therefore, the government should pay more attention to strengthen this work. The countermeasures adopted to resolve this problem include: to increase financial input, to get more useful technique information, to strengthen infrastructure construction, and to adjust industrial structure for developing follow-up industries. Only by doing so can we realize the large prospects of tri-win for economy, society and ecology via combining ecological protection with farmers' income increase.

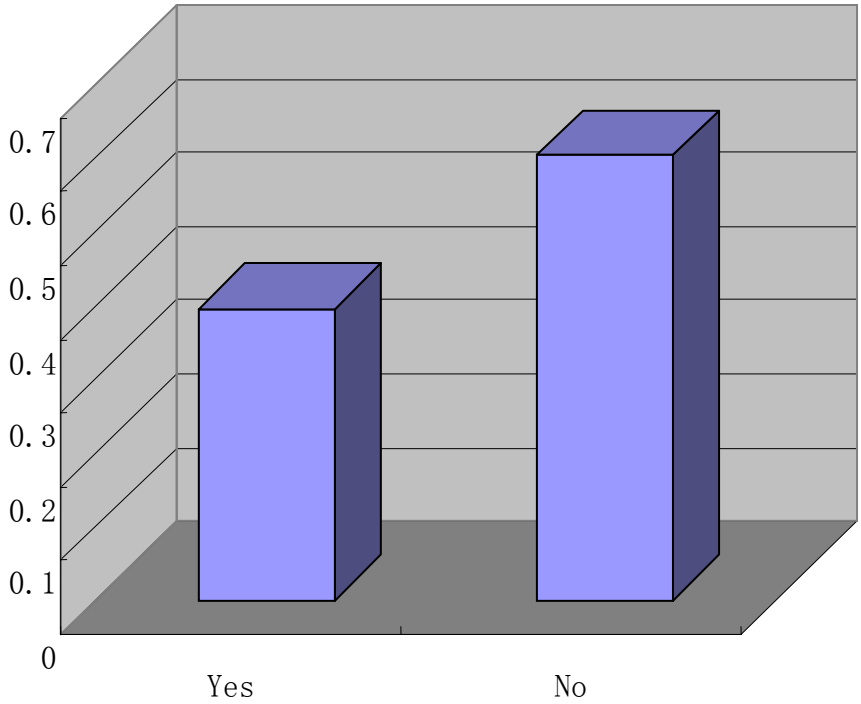

Fig 11. The investigation on farmers' knowledge about relative polices of public ecological protective forest

It is claimed that the establishment of FEC has been improved gradually. The process is a dynamic evolution combining with the actual conditions of China, and a transformation from forest ecological benefit subsidies to forest eco-compensation funds.

FEBSF subsidizes owners for managing their forests as ecological protective forest. Subsidy is different in nature from compensation. FEBSF is just a subsidy scheme. However, FECS can provide a mechanism for the realization of the market value of the environmental benefits of ecological protective forests.

4 The main problems in FECS

Since the establishment of FECS, there are many insufficiencies in the actual implementation. It can be roughly grouped into the following problems:

4.1 Unreconciled defining of forest eco-compensation

It is more than ten years since the appeal of building up forest eco-compensation scheme was put forward as the research on it has never stopped. Although the theory on forest eco-compensation has been well demonstrated, the sound policy framework has not yet shaped in practice. The main cause is that the common recognition on forest eco-compensation has not been reached. However, the defining of forest eco-compensation is the base of the whole institution. There would be existed a series of issues as the confusion of character, goal and scope without reaching the common recognition. In a word, correctly recognizing the defining is the key issue to build up the forest eco-compensation mechanism.

4.2 lower subsidy standard

The standard of subsidy is too low, so it is difficult to achieve the goals of compensation and reflect the true value of FEB. There is no clear reason why the standard of subsidy is set at 75 yuan/ hm^2/year. The subsidy is not enough to pay for the forest planting and tending because planting ecological protective forest would take some 3529.5 yuan/ hm^2 whereas tending them would cost at least 150 yuan/ hm^2/year according to certain non-official statistics. In this research, we have appraised the present standard of FEC. We have only evaluated forest carbon sequestration taking no account its other potential value in line with the principle of insufficiency compensation. The carbon sequestration in several surveyed regions is calculated using biomass method [1](Tab 8). The subsidy standard is static. The present standard is 75 yuan/ha/year and the subsidy period is limited to 5 or 8 years according to the local conditions. The economic development in China has resulted in the rise of the income level rapidly; however, the subsidy for the farmers still remains at the previous level. So, the subsidy standard should be raised along with the economic

[1] The calculation process is attached to the report.

development.

According to the data, the average value of forest carbon sequestration is 40.2 \$/ hm^2, which is over 3 times of the subsidy. Therefore, the fund from State Finance only serves as a type of symbol, even not enough to pay the day-to-day management. Furthermore, in economically underdeveloped regions, the local fiscal co-financing has not been fixed frequently and couldn't put into effect. Only depending on fiscal subsidies to compensate FEC brings heavy pressure on State Finance. Once the revenue decrease or the expenditure increase, the fund could not ensure supply and sustainability. It is thus necessary for decision makers to seriously consider seeking other approaches to realize the value compensation of FEC.

Tab 8. The value of carbon sequestration in the whole nation and the surveyed regions

Region	Area (10^4 hm^2)	Accum (10^8 m^3)	Carbon quantity （10^3 t）	The total value of carbon sequestration (10^6 \$)	Unit value of carbon sequestration (\$/ hm^2)
China	26329.5	124.9	21,396	10600	40.2
Beijing	90.4	0.1	21	10.5	11.7
Hei Longjiag	2131.2	15.6	2833	1417	66.5
Hainan	170.0	0.7	127	63.5	31.8
Tibet	1260.7	20.9	3026	1510	119.7

NOTE: The parameter are supplied by Professor Zhang Xiaoquan of Institute of Forest Ecology, Environment and Protection, CAF

4.3 Inadequate area of forest eco-compensation

As for compensation area, the coverage area of ecological protective forest is 1.04×10^8 hm^2 of the whole country, but only 0.26×10^8 hm^2 of it is funded by state finance. So there have been existed the big gap between the protected ecological forest and non-protected ecological forest. The Chinese government adopts measures to enlarge the coverage area of forest eco-compensation. In terms of the planning of State Forestry Administration, the forest ecological benefit fund will increase from 2 billions yuan to 3 billions yuan by 2006, from 270 millions hm^2 to 400 hm^2 by coverage area. Until 2007, the capital will up to 4 billions yuan, the current public forest of NFPP will ascribe to central forest eco-compensation.

Forest provides not only living base but also the main source of income. The local farmers depend highly on the forest for living. Meanwhile, the local government regards the forest as the key resource of the financial revenue. After carrying on the forest protection, the area of commercial forest will reduce considerably which will

not only cut down the income directly, but also affect the other correlative industries, such as timber processing, transporting and selling, and then further reduce the income of the farmer. Currently, the farmers in mountainous area are not rich and their life still remains at a survival requirement stage for the most part. The main intentions of the forestry are to get direct economic benefit and escape poverty towards well-off conditions. While establishing FEC, except the direct subsidies for the farmers, the preferential economic policies will help the farmers change the agricultural structure and the production methods .Moreover, the multipurpose forest utilizations should be found to achieve the best incorporation among the social, economic and ecological benefits in mountainous area.

4.4 Unsound management framework on FECS

As a newly-built scheme for ecological management, the forest eco-compensation scheme has currently faced many challenges such as lacking of relative policies-making conditions, shortage of capital management and deficiency in government budget in the primary stage of FECS. In addition, the problems among cross-departments and cross-provinces (cities) are rather difficult to deal with.

4.5 Insufficiency of market-based regime for FECS

Forest eco-compensation firstly brings eco-compensation on forest ecological product and services into finance system, and it is the big progress. As for current eco-compensation, it is mainly relied on china's state financial capacity. Therefore, how to realize the indeed eco-compensation would take considerable long time.

It is unpractical that the forest eco-compensation is totally provided by government as central government and local government can't support such tremendous compensation finance. Building operable mechanism to ensure the sustainability of capital resource is essential. The key to implementation of forest eco-compensation should be based on well-developed market infrastructure, creating market for ecological services payment with the aim at alleviating government finance pressure. The tremendous challenge of constructing market-based mechanism of forest ecological benefic compensation is to combine public benefic with private incentive initiatives.

Nowadays, market-based forest ecological services transactions is still less studied. There have been few cases of such transactions, just mainly on watershed services transactions and carbon sequestration trading. How to build the market for forest ecological services payment should be systematically and deeply studied such as the objects, subjects and range of transactions. Under the condition of economic globalization, China should enter into the global market of forest ecological services

transactions, fostering the transactions mechanisms gradually, diversifying the market channels. Based on the above work, the market infrastructure of forest ecological services transactions would be established gradually. Meanwhile, it is believed that government plays a important role in the process of building market infrastructure including establishing corresponding policy framework, operable regime system and management system of various levels, maintaining market transactions order, capturing public willingness to pay and encouraging and promoting private enterprises to enter into market.

4.6 Lack of scientific bases for accounting systems

As a new environmental management system, the compensation mechanism is still confronted with numerous difficulties and constraints. There are serious imperfections in the lateral compensation management, such as the insolvable problems among provinces (autonomous regions, municipalities), among industries, and among departments. And that the theories and methods of valuation are at their explorative stage, there are no perfect accounting system recognized generally and which is the techno-restrict to FEC. Most of the accounting methods are directly from the international fixed price or methods which are disjointed with our social and economic situations, and have resulted in the defects of low reliability and poor operability. As a consequence the accounting outcomes are hard to be identified by academia, management departments and the public, and adopted by management and decision-making sectors.

4.7 Defective laws and regulations on FECS

There is no well-developed law basis for FEC. The laws and regulations currently in effect are mostly for emergency use. The legislation is done in haste. Owing to the lack of appropriate measures, the local compensation tasks are rather difficult to develop smoothly and effectively.

5 Standards accounting of forest eco-compensation

5.1 Classification of forest

According to the *Provision on the management of FECF* the Ministry of Finance and SFA together publicized in 2004, ecological protective forest are classified for protection forest and special- use forest. Protection forest includes four types named water conservation forest, soil protection forest, sand control forest and riparian protection forest. And special-use forest includes ago-forest and nature reserve forest (Tab 9). It is necessary to expand the scope of FEC to all of forests afforested or reforested in NEEP, Nature Reserve and SLOP with the progress of FECF mechanism, so that forest ecosystem could be restored rapidly and provide more and

more ecological and social benefits.

Tab 9. Types of Forest

	Type Group	Type	Classification Standard	Compensation Principle
Ecological Forest	Protection Forest	Water Conservation Forest	Forests aim to conserve water, improve hydrology, regular water circular, prevent river, lake & reservoir sedimentation and protect water source location.	Because of the limited funds, a insufficient compensation principle is proper. Water price adjustment is a effective tool to internalize the externality.
		Soil Protection Forest	Forests aim to decrease runoff, reduce water off, prevent erosion and maintain soil fertility.	Expect fees for planting, tending, protecting and managing forest resources, it should be pay for damages of water and soil protection projects.
		Sand Control Forest	Forests aim to reduce wind speed, prevent wind erosion, control sand and protect farmland, orchard, economic crop and pasture.	Such forests will be pay according the effect of protection.
		Riparian Protection Forest	Forests aim to prevent riparian from wave eroding and fix riverbed.	Government should pay compensation fees for forest land expropriation and unemployed forest workers.
	Special-use Forest	National Defense Forest	Forests needed by national defense.	Government pay compensation according to cost of planting, tending, protecting and managing
		Nature Reserve Forest	Forests aimed to protect rare flora and fauna, typical bio-community and natural landscape.	The central government financial and local budgetary allocation , beneficiaries (organizations, enterprises and individuals) pay.
SLOP	Ecological Forest		Forests aimed to maintain and improve ecological environment, maintain ecological balance, protect biodiversity and so on.	Compensated for 8 years. Some key ecological forests in important ecological location should be included in FECF and other ecological forests could be managed to certain extent.
	Economic Forest		Forests aimed to produce fruits, medicine, oil, drink and materials.	Compensated for 5 years. And 5 years later, government could adjust policies so as farmers could get more income.
NEEP	Natural Forest		Forests which have spontaneously generated itself on the location and which consist of naturally immigrant tree species and strains. Natural forests	Compensation for natural forests should cover the expense of tending and managing, the direct financial loss associated with restricted utilization.

		can be more or less influenced by culture, but the forests must not have been subject to regeneration by sowing or planting	Compensation for man-made forests should cover the expense of planting, tending and managing. According to different forest type, tree species and age, compensation for natural and man-made forests should be different, and the standard of natural forest compensation is 1~3 times more than man-made forest's.
	Man-made Forest	Forests seeded and planted by human.	

5.2 Compensation standard

On the basis of specialized forest eco-compensation, the standard of compensation should be established scientifically. And these need to be considered:

- Direct expense of plantation. It is direct economic investment for forests, i.e. cost of plantation for new planted forests and cost of tending for existed forests.
- Opportunity cost for forests protection. As ecological protection demands, some economic development opportunity must be dropped and it will affect the social and economic development.
- Benefits of forest ecosystem services. It should be considered in compensation standard establishment. It should be the upper limit of eco-compensation. According to researches above, benefits of forest ecosystem services are about 10 times more than direct benefits.

Above all, considered with direct investment, opportunity cost and forest ecosystem services, and a simple FEC standard is reckoned primarily (Tab 10).

Tab10. Forest eco-compensation standard

Type	Compensation standard			
	Floor level			Upper level
	Opportunity cost (yuan/hm^2/year)	Direct cost (yuan/hm^2/year)	Total cost (yuan/hm^2/year)	Ecosystem service (yuan/hm^2/year)
New planted forests	2200	2100	4300	19880
Existed forests	2200	150	2350	19880

Note: forest ecosystem services are about 10 times more than direct benefits. Direct benefit of timber is: 800 × 3.55 × 0.7=1988 yuan/hm^2 (3.55 m3/year is annual growth, 0.7 is timber-produced rate， price per unit is 800 yuan); ecosystem service benefit is: 1988 ×10=19880 yuan/hm2; opportunity cost of NEEP and ecological protective forests is the benefit from timber production, that is 1988 yuan/hm^2, and opportunity cost of SLOP is benefit from

crop production, that is 1875×1.4=2625 yuan/hm^2 (every hectare land produce 125 Kg crop and the unit price is 1.4 yuan); direct expense of new plantation forests is 2100 yuan/hm^2, and management cost of existed forests is 150 yuan/hm^2.

5.3 Adopting the principle of "adapting to local conditions" combing with rigor and flexibility for FEC

The following factors should be concerned while establishing a concrete standard of forest eco-compensation:

- Regional difference. Ecosystem services are different in different region, so the importance and difference of ecosystem should be concerned when standard establishment. Some important eco-function region, such as water conservation, biodiversity protection, should be emphasized.
- Forest type and tree species. Different forest type and tree species cost different plantation expense and have different ecological benefits. Moreover, different age and stand of the same tree species also have different ecological functions.
- Plantation way. There are several ways to plantation in China, such as sealing mountain for forestation, forestation by aerial seeding, plantation by manpower and so on. And different ways cost different expenses.
- The level of economic. The level of economic development is different in different region and it is the base of compensation standard establishment.

Recently, the standard of FEC is only 75 yuan/hm^2 and there is a big gap between it with the outcome in the table 10. It is not a compensation arrangement to forest owners or landholders cost incurred by maintaining their forests for ecological protection; rather, it subsidizes owners/managers for managing their forests like ecological protective forests. Subsidy is different in nature from compensation. The government should classify forests and specialize forest eco-compensation step by step, according to the financial ability and different forest type, tree species, plantation ways and the level of economic, so as to reach the real FEC.

6 Preliminary recommendations and perspectives

6.1 Defining forest eco-compensation

Since the defining of forest eco-compensation is the base of the whole institution, there would be existed a series of issues as the confusion of character, goal and scope without reaching the common recognition. Therefore, correctly recognizing the defining is the key issue to build up the forest eco-compensation mechanism. This research put focus on the conceptual framework of forest eco-compensation, and put

forward the definite concept of forest eco-compensation. The research shows that forest eco-compensation should include Sloping Land Conversion Plan, Nature forestry Protection Program and Public Ecological Forest Benefic Fund System and give primary guideline to outspread the forest eco-compensation in the future.

6.2 Increasing the fiscal transfer payment and enlarging multiply financing channel for FEC

Firstly, Increasing the fiscal transfer payment. The fiscal transfer payment of FEC could be regarded as the payment for labor of protecting and reconstructing ecological environment. It encourages and subsidizes managers for managing their forests as ecological protective forests and sacrificing their economic self-interests. Of cause, the payment is usually inadequacy and only a subsidy or encouragement. The fiscal transfer payment is looked upon as a "blood transfusion" compensation which has played an important role in promoting the eco-environmental protection and reconstruction. We must improve the "blood transfusion" subsidy mechanism further and increase the supports to the under developed regions but with better eco-environment in order to make them become the true ecological barriers of China. On the one hand, the structure of fiscal transfer payment can be adjusted. The eco-compensation fund, on the other hand, can be used as a new channel of fiscal transfer payment. Now, the transfer payment of eco-compensation keeps within the financial budget mostly. It is rather difficult to continue arranging large funds for eco-environmental protection in the financial budget. The government will need to consider exploring new sources of capitals.

Secondly, Enlarging multiply financing channels for FEC. The forest eco-compensation could not only rely on the government financing. In order to implement the FEC effectively, a series of work should be carried out: protecting the farmers' economic benefit, increasing their enthusiasm, improving the compensation types. Under the eco-compensation framework, It is the key to diversified the compensation channel via enlarging the consumption demand, catching the willingness to pay of public, strengthening the initiatives of private enterprises, adjusting industries structure, adopting preferential polices, intensifying the communication with financial department, seeking the technique support of relative experts and establishing special fund donated by international NGOs.

Thirdly, Establishing "ecological taxation". As we all know, the forest ecological benefit belongs to public goods. For this reason，the government should levy "Ecological Tax" to generate adequate and sustainable revenues for implementing the FECS. The tax will compensate the production costs of FEC but not to subsidize the managers only for managing their ecological protective forests and to keep the reproduction of

ecological goods. In addition, if the compensation fee is charged from the beneficiaries directly, the implementation costs would be high for the transaction costs. If the government levies “Ecological Tax” to compensate FEB, the cost is relative low. The “Ecological Tax” is a new concept in China. According to the relevant laws and the national conditions, by using the experience of other countries for reference, there are some tentative plans for “Ecological Tax” levy as follows: Levy objects, All beneficiaries of FEB (organizations, enterprises and individuals) should pay “Ecological Tax” in China. Levy scope, The large or medium sized reservoirs, hydroelectric plants, water plants, scenic tour spots relied on the forest landscape, the water shipping companies, fresh-water aquiculture, wildlife collection in forest region, and coal mines nearby the forest region.

6.3 Exploring new eco-compensation mechanism actively

It is very important to improve the eco-compensation mechanism, especially to explore the “blood generating” mechanism to enable beneficiaries to make full use of their economic potential, enthusiasm and subjectivity. This “blood generating” mechanism will transform the external compensation into the power of self-accumulation and self-development so as to settle the conflict between the economic development and the resource protection. The establishment of “blood forming” mechanism is a complementary to the present one and an innovation to the development modes as well. The key of the “blood generating” mechanism is to establish a platform for underdeveloped regions. The mechanism will provide more opportunities and play an activating role, thus mobilizing the enthusiasm of the whole society to participate in the ecological construction.

Therefore, appropriate policies and laws should be made to allow the headstream protection zones and ecologically fragile regions to introduce business and develop economy in other regions. The profit will be returned to support the eco-environmental protection, reconstruction and other social welfare services. It is thus of great advantage to stimulate those key eco-protection regions (or limited industries development regions) to develop local economy and increase financial revenue, so as to form the “blood forming” mechanism of self-accumulation and self-development. Only when development promoting protection and protection promoting development could result in the “win-win” situation of economy and environment.

6.4 “Three-stage” strategy of Forest Eco-compensation Mechanism (FECM)

It will take 15 years of three “five-year-plan” period until the affluent society and ecological conditions breaking a deadlock in 2020 to accomplish “three-stage”

strategy of FEBSF and get a truly completed FEC.

- Improvement stage of current system (extending the scale, raising the standard, and refining the policy)：From 2006 to 2010, FESF is established and the scale is extended gradually, and through a complete set of effective measures the forest management and protection system is normalized. A series of management mechanisms will be explored to ensure safety in funds operation and the utilization benefit of the subsidies. The local regulations about *Operating project of FEC* and *controlling measure of FEC* should be established according to the regional actual situation so that FEC has rules to follow and operate canonically.

- Transitional stage（the double tracks of subsidy funds and ecological tax)：from 2011 to 2015, the ecological tax system should be regarded as the main form of FEC and regularized as laws. The subsidy fund from state finance should be transferred to "ecological tax" stage gradually.

- Abolishing stage（FEC will accomplish its historical mission and ecological tax will begin to operate independently)：From 2016 to 2020, mechanism of FEC funding will be formed and the eco-environment will have been improved. Also, a series of operable forest management modes and fund management mechanisms will have been established to normalize the forest ecological resource management. Therefore, FEC will have accomplished its historical mission，and the ecological tax system should be in place. The ecological tax mechanism will have had a long-term stability because the tax has double functions of macro-regulation and financing and more legal validity as well. The economic function of ecological tax will have protected the forest effectively and promoted the development of forest ecological function.

Considering with the above accounting and the planning or "three-stage" strategy for FEC, there is a big gap between current standard of 75 yuan/hm^2 and theoretical standard of 2350 yuan/hm^2 (the floor level of current standards). The government could adopt measures to compensating the providers for forest eco-compensation by stages taken current economic development level and government financial into consideration. Considering the feasibility of suggesting policies, the following advises are given:

Phase Ⅰ (2006-2009) According to the capacity of government finance, the standards of forest eco-compensation could be increased up from the current standards to 150 yuan/hm^2 (5 yuan/mu) to 750 yuan/hm^2 (50 yuan/mu). The Chinese fiscal income break through 3,000 billions yuan in 2006, and it will reach 3560 billions yuan based on the annual increase rate by 9%, however the capital of forest eco-compensation only cover 41.5 billions yuan. Thus, the government budget could totally meet the demand of it.

Phase Ⅱ (2009-2012) With the rapid development of economy and improvement of policy framework, the standards of forest eco-compensation could add the opportunity cost into the standards of primary stage. The standards should increase from 750 yuan/hm^2(50 yuan/mu) to 1500 yuan/hm^2(100 yuan/mu). Until 2012, the fiscal income of government up to 4610 billions yuan, and the need of capital of forest eco-compensation is only 83 billions yuan.

Phase Ⅲ (2012-2015), the policy of forest eco-compensation has been improved gradually. In order to reach the real sense of forest eco-compensation, the standards should achieve the floor level of theoretical compensation standard by 2350 yuan/hm^2 (156 yuan/mu) in this stage. Realize the all around well-being society, the finance income could up to 6000 billions yuan in 2015, until then the need of capital for forest eco-compensation is about 130 billions yuan.

6.5 Promulgating The Regulations of FEC

We should form an authentic, efficient and canonical management mechanism via normalizing FEC and integrating the management ways. Perfecting legal system could provide better guarantee to promote the institutionalization of FEC. By way of publishing *the regulations of FEC*, on the one hand, the management of FEC could be strengthened and the "beneficiaries-to-pay principle" could be used to expand the fund resources of FEC for poverty-stricken zones, On the other hand, the cooperation of different departments could be improved and the laws or policies could be put into effect systematically.

6.6 Enacting The General Plan of FEC

The plan will persist in the principle of sustainable development and regard both the economic development and the forest eco-protection as equally important issues to promote them to develop in perfect harmony. In the plan, the regionalization of FEC will meet the layout of forest ecological reconstruction and the plan of national economy and social development. The goals of the plan will reflect the stages and guidelines to ensure the forest ecological reconstruction with the leading role via the plan implementation.

6.7 Raising the awareness of FEC and encouraging the farmers' participation

Everybody ought to be concerned about FEC. The popular scientific education and the public propaganda should be made to heighten the awareness of the masses and promote the public at large to participate in the protection and reconstruction of forest. To make the FECS effective, there should be a strong perception that the farmers are really participating in the system and understanding the policies of FEC. Also, it is

necessary to more clearly define their responsibilities, rights, benefits and the benefit allocation so that the awareness of the eco-compensation could be heightened. The farmers, the grass-roots units of forest management, will take part in specialized training and raise working efficiency of protecting forest.

6.8 Strengthening researching on forest eco-compensation

Although the FEC is a new research topic, it is significantly important to the economic and society development. As for its complexity, the FEC should be placed on the government scientific planning, putting focus on the compensation standards system. Based on above research work, the forest eco-compensation mechanism could be established effectively.

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Ecological Compensation and Policy Design of Natural Reserves in China

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1 Introduction

1.1 Purpose and significance

IUCN has defined the protected area as territory or ocean areas specifically for reserving and protecting biodiversity, natural and cultural resources through law or other efficient measures. The nature reserve in China refers to "the specific areas for conserving different kinds of ecosystems or natural environmental conditions, conserving the biodiversity, rescuing endangered wild species and protecting the natural heritage", which include different kinds of ecosystem and the areas with precious and rare animal and plant species and habitats for migratory bird reproduction, wintering and migration as well as the places where wild relatives are raised and cultivated. The nature reserves also include geologic profile, the fossil producing area, the glacier, the geological landforms, the waterfalls, the hot springs, the volcano, the aerolite sites, the islands and the exquisite-scenery natural resort and special agricultural landscape.

Located at 50°E. longitude and 50° N. latitude, China covers a broad area extending from basin, plain, hill to the world ridge of Himalayas Mountains. There are many tropical rain forests, subtropical forests, temperate forests, and altiplano forests, and the sea, fresh water lakes, humid and semi-humid regions, arid and semi-arid regions, and the deserts within the Chinese territory. The favorable geographic, climate and vegetation conditions have bred the richest biodiversity in the world. It is not only the basis for China’s economic development and the people's health, but also has provided the important ecological value for the entire world. China is one of the countries with the richest biodiversity in the world. Therefore, it has been offered the title as “the great nation of biodiversity” and "the spot of biodiversity in the world" by international natural protection organizations.

Moreover, China faces serious threats rising from the pressure of the huge population and the rapid economic development. The vegetation degradation, biological invasion, overuse of the wild resources, exhausting of water resources and the desertification do lead to dozens of the wild species to an endangered verge. It is reveals in the China Species Red List that the degree of spices facing annihilation is

[1] Leader of team: Min qingwen; members: Zhen lin, Yang guangmei, Zhang dan

far more serious than usually estimated. Species already under threats or would-be under threats are: over 40% and 7% of Mammalia, over 11% and 8% of birds, over 16% and 17% of crawling, and over 30% and 13% of amphibious. After accessing to the WTO and success in 2008 Summer Olympic Games bid, China is attracting more and more attentions from the world. However, biodiversity in China is to increasingly suffer new threats and challenges.

Affected by harsh natural conditions and human activities in particular, the room hosting species is destroyed and the biodiversity is reducing and the ecological environment is degraded. The establishment of nature reserve is one of the most important measures to conserve biodiversity and recover the ecological functions. But at the same time, to some extent, the establishment of nature reserve also has an adverse effect to the traditional production activity and life style of local people. So, a basic question remains in the management of nature reserve at present is how to coordinate the contradiction between the nature protection for commonwealth and the regional economic development.

This case study aims to analyze the experiences and problems facing practitioners at home and abroad through literature review, field survey, expert consultation. It analyzes the socioeconomic and ecological effects of the nature reserves, proposes a general framework for financing and management, and policy enforcement of the ecological compensation. It is expected that the research will provide a solid foundation for the establishment of eco-compensation mechanism of nature reserves in China.

1.2 Research Contents

1.2.1 Eco-compensation policies and management experiences of nature reserves

Based on the successful experiences in the management of domestic and foreign nature reserves, particularly foreign policies and measures for the eco-compensation of nature reserves are summarized and the existing problems facing China' nature reserve protection are reviewed

1.2.2 Meaning and theoretical basis of eco-compensation

Meaning and theoretical basis of eco-compensation are analyzed based on the comprehensive analysis of the problems in the management of different kinds of nature reserves, especially the problems in fund management, conflicts between community development and reserves' protection.

1.2.3 Assessment of socio-economic and ecological impact of nature reserves

Through field investigation, the influences of the nature reserves on the local traditional culture, life style and production activities have been analyzed. Through material analysis and questionnaire survey, the influences of nature reserve on local economic development, industry development and industry structure have also been analyzed.

1.2.4 Design of policy framework for eco-compensation

On the basis of comprehensive analysis of socio-economic conditions and ecosystem status, the objectives, benefits, and the stakeholders of nature reserves have been identified, which formulated a groundwork for designing eco-compensation framework including principles, identification of providers and receivers, sources of funds and management measures of eco-compensation funds.

1.2.5 Policies and management measures for nature reserves of China

Based on domestic and international experiences, theoretical analysis and case studies, the policy and management system of ecological compensation in nature reserves of China have been sorted out.

1.3 Methodology

On the basis of literature review, field surveys were conducted and special emphasis was put on nature reserves' management, socio-economic and ecological influences, financing mechanism as well as the eco-compensation policies.

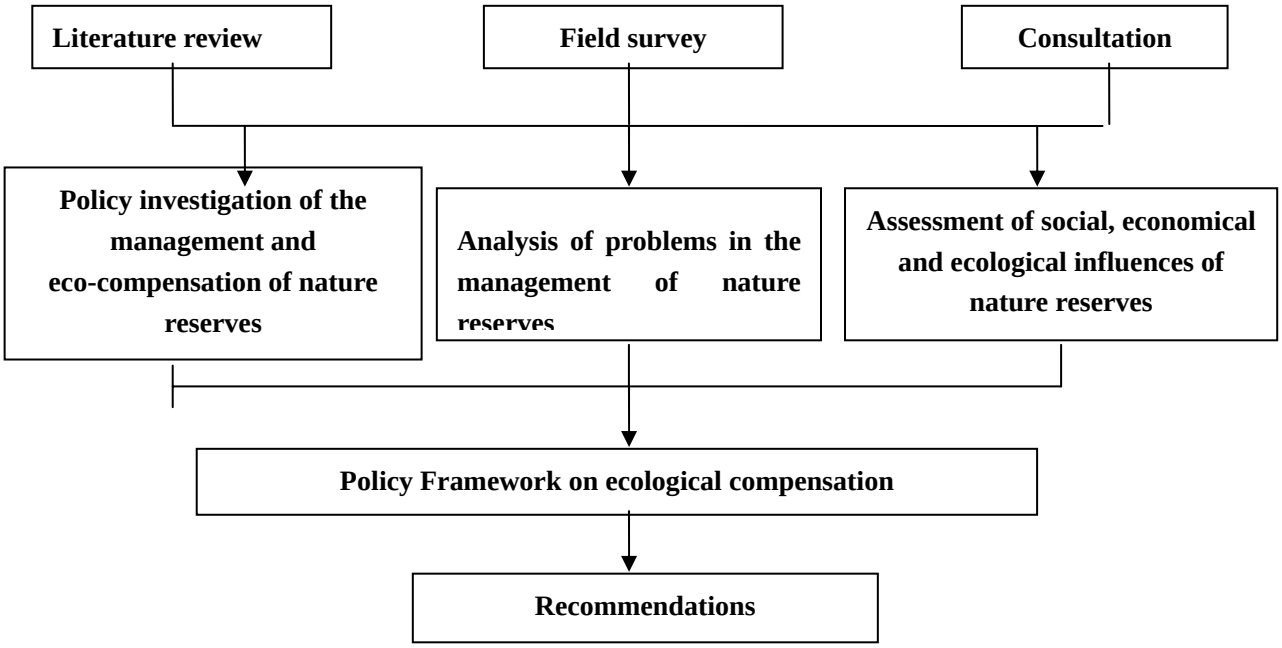

Fig.1 Research framework of ecological compensation in nature reserves

Through consultation with that State Environmental Protection Administration of China、the State Forestry Administration of China and MAB-China National Committee, three to five typical nature reserves in different regions have been selected as study areas. Consulting work will be done through workshops and interviews. The general research framework is as shown in fig. 1.

1.4 Major Research Activities

After the kick-off meeting held on September 8th of 2005, the following activities have been implemented by the research group on Eco-compensation for Nature Reserve:

- Perfecting the work plan：According to experts' comments, the work plan for field investigation in three nature reserves (Hainan Forest Nature Reserve, Jiangxi Poyang Lake Wetland Nature Reserve and Inner Mongolia Grassland Eco-Functioning Reserve) has been adjusted.

- Collecting information：Some experiences and research achievements about nature reserve management, especially ecological compensation for nature reserve were systematically collected and analyzed. And the reports had been completed.

- Investigating management agencies: The members of the group discussed with some officials and managers with the State Environmental Protection Administration, the State Forestry Administration, WWF-China about the current situation and management problems facing China's nature reserve and discussed the possibility to implement ecological compensation in nature reserve. Information has also been collected from some local agencies like the Department of Resources Management and Environmental Protection of Hainan Province and Hainan Provincial Forestry Administration, Bureau of Environmental Protection and Mountain-River-Lake office of Jiangxi Provinve, Bureau of Environmental Protection and nature reserve management department of Inner Mongolia.

- Field investigation and data analysis: A field investigation in Xilinguole grassland of Inner Mongulia was conducted from July 18th to August 12th, 2005. Informal discussion was done with some grassland restoration and management departments. About 300 herdsmen household questionnaire and 250 tourists' questionnaire have been collected. From May 1st to 15th, 2006，A supplementary investigation was conducted at grassland and nature reserve management department, enterprises and herdsmen. About 280 herdsmen

questionnaire and 50 entrepreneur questionnaire have been collected. From December 12th to 19th, 2005, under the help of the Department of Resources Management and Environmental Protection of Hainan Province, a field survey in Hainan Province was conducted. Information was collected from some officers, managers from provincial and county levels; it includes resources management, environmental protection and forestry and nature reserve management. About 120 questionnaires were obtained from managers and farmers and local farmers in Wenchang County, Wuzhishan City, Qiongzhong County. From April 21st to 27th, 2006, under the help of Mountain-River-Lake office of Jiangxi Province, a field investigation was conducted by two members of the group. Information was collected from some officials and managers at provincial and county resources management, environmental protection, forestry and nature reserve management sectors and local farmers. About 104 questionnaires from local people and 5 questionnaires from the manager were obtained.

2 Significances of Ecological Compensation in Nature reserves

2.1 As an important mean dealing with fund shortage

In China, the management of Nature reserves is implemented by different rankings, which divides into state level and local levels according to their importance. Local ranks include those at county level, municipal level, and province level. But in our country many of state-owned nature reserves are managed by local governments, some managed by the municipal and county even township level government. The problem is that management rights are not entrusted to local governments, and the main restrict is lack of funds. And there therefore exists problems of dislocation of responsibilities among the management agencies. Most local management agencies cannot guarantee the investment in the Nature reserves, such as those located in the poverty stricken area (Han Nianyong, 2000).

Shortage of financial support in Nature reserves is a universal problem, but it's more severe in China. According to the investigation at 108 state-level parks conducted by West Central Municipal Conference (WCMC) in 1993 and in 1995, the average sum of funds (including operation cost and infrastructure investment) is 893US$/km^2, while it is 2058US$/km^2 in developed countries and 157US$/km^{2}in developing countries（Alexander,1999）. Results of the investigation in 85 Nature reserves (including 46 state-level nature reserves) of China in 1999 showed that average sum of fund is 52.7US$/km^2(including operation cost and infrastructure investment, government input and self money-earning) (Han Nianyong, 2000). Fund shortage is the biggest barrier for the development of Nature reserves in China, while ecological

Compensation is a way to resolve this problem using economic incentives.

Box 1. Analysis of current financing shortage in Chinese Nature Reserves

The fund shortage is the main bottleneck for development of nature reserve. This can be well illustrated from the following facts:

1 Fund from state and local level is far from sufficient.

According to an estimation from <Report on National Biology Diversity in China>, despite the fact that the cumulatively total investment to nature reserves all over the nation is about 1.59×10^9 RMB per year, the financial source in nature reserves is still in a poor condition. According to the investigation conducted by Xu Haigen in 1998 the national and local governments' fund only contributes 55.57% of the total income of nature reserve. The financing support from the local governments of some national nature reserves cannot even pay the salary and material benefits of staff. For instance, the Changbaishan Nature Reserve receives 4×10^6 RMB financing support while it has to pay 7×10^6 RMB for the salary and material cost of staff. Moreover the nature reserves studied in this program are enjoying a comparatively more generous financing support due to their good reputation both at home and abroad.

2 The investment is unequally distributed among the nature reserves

Generally speaking, those national nature reserves attract much more funds than local ones due to their importance and reputation. For instance, the Xishuangbanna National Nature Reserve received funds about 4.4×10^6 RMB from governments while another local Daweishan Nature Reserve, which is also in Yunnan province, received only 3.7×10^5; the Baishuijiang National Nature Reserve received funds about 1.41×10^6 RMB from governments while another local Heihe Nature Reserve, which is also located in Gansu province, received only 2×10^4 RMB.

Another differentia lies on the gap between different areas. Those nature reserves locating in provinces which are comparatively developed in economy receive more funds than others. For instance, the Neilinting-Futian National Nature Reserve in Guangdong province received funds about 2.9×10^6 RMB, while another Guizhou Maolan National Nature Reserve, which also belongs to the Forestry System, received only 2.8×10^5 RMB.

3 The problems evoked by insufficient investment in nature reserves

For the majority of nature reserves the serious difficulties in financial support blocks the normal operation including trivial patrol, fireproofing, propaganda, community conservation activities and research.

The investment insufficiency evoke many problems, one of the consequences is the imperfect organization. Up to the end of 1997, there were 360 nature reserves not having management structure, accounting for 38.19% of the total nature reserves in China. And another results of

insufficient investment is that the intensifying contradiction between the resources development and the protection. Some nature reserves carries out the so-called eco-tourism activity. The information given by the committee of Man and Biosphere Programme in China demonstrated that 22% nature reserves in China has been destroyed as a result of eco-tourism development, and 11% tourism resources appear to have been degenerating. The third sequent is poor management capability of the managers.

Confronted with economic pressure, about 80% of nature reserves have generated income to various extend. The forms of obtaining additional income include crop and plant cultivation, fish breeding and poultry raising, tourism and service, industrial production and manufacture, resource harvest and resource compensation etc, in which tourism and service, resource harvest and resource compensation are the primary forms, accounting for 50%, 20%, 10% of the total annual net income respectively. Such development pattern illustrates that nature reserves are capable of fully utilizing the advantage of resources of their own to improve the economic vitality.

The revenue of entrance tickets is the primary income of tourism, accounting for 85.76% of the entire tourist industry. This indicates that the operation methods of tourism in nature reserve are quite simple and the tourist income is rather unitary, being in the initial stage.

The income of resource harvest stems mainly from cutting forests and woods and clearing up fallen trees, withered trees and decayed trees, which constitutes 89.79% to the income from resource harvest. However, such mode of obtaining additional income contradicts and violates the protection objective of the nature reserves. This mode is not feasible after implementing the project of natural forests preservation.

Although 80% of the nature reserves generated income through various channels, there are major discrepancies among different reserves. As to areas with rich tourist resources, their income generated often outnumbers the average value. However, cutting forests and woods is not the major source of income because of the implementation of natural forests preservation project. About 71% reserves generated far less income than the average value (about 440 thousand RMB), which cannot support their survival. Apart from very few areas with extremely rich tourist resources, the main income of most reserves depends primarily on investment from the national and local governments rather than the income created by themselves.

Reference: Xu Haigen, 2001

2.2 As an effective method to broaden financing channels

At the present time, investing channels in the nature reserves in the country can be classified into three sources, they are competent authority, local government and society investment.

Competent authorities investment are mainly from forest bureau (investing in

subordinate nature reserve, infrastructure and special subsidy input in important nature reserve), and State Environment Protection Administration (supervising and management of nature reserve all over the country, including infrastructure investment and special operating expense subsidy. The amount of special operation expenses in this special operation expenses). In addition, Agriculture Ministry (investing in the major grassland reserves and aquatic reserves), State Oceanic Administration (investment in several state oceanic reserves) and the Ministry of Land and Resources play a supplementary role.

Investment from local governments are the financial input into the local nature reserve conducted by department of provincial, municipal and county governments, including infrastructure input, staff operation expenses and special operation expenses.

Investment from the society is all the investments outside the government fiscal and competent authority, including traverse government investment (mostly special programs in nature reserve approved by the Ministry of Science and Technology, the Ministry of Communication or Tourism Bureau etc), social group and individual investment (mainly the contribution from community participation and the investment by developing special resources in nature reserve through cooperation and joint venture), foreign investment (including all subsidies and science and technology cooperation from U.N related institutions, international conservation organizations, multi-lateral and bilateral aiding institutions, foreign NGOs or individual (Xue Dayuan, 1995)

Nature reserves are characterized with public product production, which induce the heavy dependence on the public investment and charity. Most of the nature reserves have relied on the governmental institute for construction and management of public goods, the property of service provision and private product supply have not been fully manifested. Governmental institutions and charity organizations should be the main channels of nature reserves. And eco-compensation mechanism can form a overall framework to infuse the above channel and broaden existing financing channels following the rules of “beneficiary pays, damager pays and protector compensated”

2.3 As a way to coordinate relation between protection and development

In China, some nature reserves are situated at the economic developed regions with large population, others are situated in the less developed area. So the strong needs of economic development become the biggest challenge for nature reserve protection, especially in local community. According to statistics of 1997, 224 out of 926 Nature

reserves are located in the counties of national poverty, 80% Nature reserves are in the western area, many Nature reserves had both poverty and environment problems. The results of investigation in 85 Nature reserves showed: the average population insides the nature reserves is 1.44 $\times 10^4$, while approximately 5.9×10^4 are living at the surrounding nature reserve. The average population density in 85 Nature reserves is 5.75 persons per km^2, which is 1.8 times of that in Canada and 2.4 times of that in Australia. Obviously, Nature reserves in China have been facing the problems of huge population pressure and economic development, which extremely increased the difficulty for protection and management (Han Nianyong, 2000).

However former policies applied in nature reserve have put emphasis on the negative impacts of local communities on the protection of nature reserve, the socio-economic influences of nature reserve on local communities have been ignored. Local resource utility model are changing and forbidding unsustainable resource use, while substitute development model has not been recommended to local community, which induced constant conflicts due to protection and development. The main reasons are that the targets of nature reserve management are strongly emphasized on natural protection and ignored the importance of economic development. Although some communities have participated in and formed the corporation organization with nature reserve management department, but it has failed to use the economic measures, so it has limited effects on the problems. Eco-compensation is an efficient economic measure to mediate the relationships between protection and development.

Box 2 Disputes of protection and development in Tianmushan Nature Reserve

In May of 2001, 243 households of local farmer in Baojia Village have taken judicial proceedings against Tianmushan Nature Reserve of Lin'an in Zhejiang Province. Lin'an government has been sued for act of omission, and "eco-compensation" has been requested

Tianmushan Nature Reserve has been approved to set in 1985, which is one of the important species genetic pools. Tianmu Mountain is the head stream of Taihu watershed and Tiantang River watershed. In 1993, the area of nature reserve has been expanded from 1.5×10^4 Chinese mu to 6.4×10^4 mu by Lin'an government, including the mountainous forestry land of five villages. The core and buffer region of nature reserve must be completely protected according to the law, all developments have been stopped, while moderate development in test region of nature reserve is permitted. In the past, local farmers are lived by planting and collecting stalagmite in forest land. But after 1993, the newly expanded area solely forbidding the planting and collecting of stalagmite, causing 243 households have lost the life security. Local community appealed that the local governments should give them economic compensation. But they failed to draw enough attention. So they took juridical proceedings for the act of omission of Lin'an government. This is a typical case of conflicts between protection and development in nature reserve. This may also be

the first eco-compensation lawsuit, but failed to be tackled with for lack of relevant law and policy instructions.

Source：Legal Daily. http:// www.legaldaily.com.cn/gb/content/ 2002-05/13/content_ 36581.htm

Box 3 Struggle in "ecologically isolated island "

***Wa* ethnic group has lived in Awa Mountain for generations, living a** slash - and - burn cultivating, hunting and grazing life. In the ecological protection regions, few local residents are dared to offence the law, but a bigger threat is the conflict between the survival and protection.

Local resident Bao Jianhua have lost his most treasured property- cattle because of tiger attack in nature reserve. "When I found my cattle remained a skeleton and head with her eyes stared at me, I can't help crying".

For the residents at less developed areas, wild beasts intrusions have hitting them when they are down. Some residents even lost their crop for living while there is no other income source. Yunnan province has put forth a serial of compensation standard in order to make up the loss of local residents due to wild animals. But due to the fiscal difficulties, all the subsidies are failed to cash.

In China, thousands of nature reserves have been established, most of them are located in western impoverished regions. Local residents have contributed their land living by generations, local government have assumed the duties of protection. It is hard to arouse the enthusiasm to protect when there are no signs of direct benefits. It is critical to increase the income of local residents and reduce the dependence on nature resources.

http://review.jcrb.com.cn/ournews/asp/readNews.asp?id=137896 xinhuanet

3 Theoretical bases of the eco-compensation in nature reserves

3.1 Ecosystem services value theory

In the long run, the thought of limitlessness of resources and valueless of environment has embedded in peoples' minds. However, with the aggravation of environmental damage, people have gradually recognized that environment has important value. The in-depth knowledge and research of ecosystem value, especially of ecosystem service function value, is the important support to build up eco-compensation mechanism, and reflecting ecosystem market value.

Nature reserve is a special area combing the nature resources characteristics and ecological properties, which improves regional even global ecological environmental conditions and provides the material and environmental basis for human beings and other species. Nature reserve possesses ecosystem service and economic values,

which have the potential to supply human beings with food and other resources as well as the biodiversity and tourism leisure. This has huge economic, ecological and social benefits. Sustainable development is dependent on all the ecosystem services and its sustainable supply. Nature reserve can be critical to achieve those purposes. When making decisions relevant to nature reserve, human welfare and the intrinsic value of ecosystem should be considered.

3.2 Public goods theory

Public goods are the products or services satisfying the public needs and characterized by public consumption. Public goods has the following two basic characteristics: non-competitive and non-exclusive. Nature reserve and its ecological services have the attribution of public goods. The two characteristics means that if the public goods is provided in the market, a person who chooses to receive the benefits of a "public goods" or "positive externality" without contributing to paying the costs of producing those benefits, that is the so-call "free rider" issue. If everyone wants to become "free rider", then the outcome is that nobody would possess the public goods due to its insufficient supply. The characteristics of public goods provide a necessary and rational basis for the government interference (Wu Jian et al. 2006).

3.3 **Externality theory**

Externalities (or spillover effects) occur when firms or people impose costs or benefits on others outside the market place, that is, when private costs or benefits do not equal social costs or benefits. If private benefits are fewer than social benefits, external economies occur; if social costs are higher than the private costs, external diseconomies occur. The specialty of nature reserves makes the natural conservation have both external economies and external diseconomies.

(1) External economies of the resource protection in nature reserves: The main task of nature reserves is to conserve ecosystems or wild species which have important functions and values, and to provide kinds of products and services, such as wild species, genetic materials and other physical products; biodiversity conversation, crop pollination, water purification, landscape enjoyment and other services, thus having typical characteristics of external economies. At the same time, nature reserves can increase economic incomes of the local inhabitants. The development of folk customs and tourism can create many employment opportunities for the local people, enlarge the sales market of the native products, and increase economic incomes of the local inhabitants, all of which can improve the overall living standards of the local residents. In addition, nature reserves can promote the revival of the local cultures.

(2) External diseconomies of the protection of nature reserves: In the core zone and buffer zone of nature reserves, protection is absolutely carried out and all operating and developing activities are forbidden, while in the experiment zone limited operating and developing activities are permitted. In this situation, the protection of nature reserves is realized at the expense of local people's reliance on the original resource environment and normal development opportunities, thus having obvious external diseconomies. Owing to lack of money, there are at present widespread behaviors aiming to self-money earning in nature reserves such as tourism development. However, the tourism development can bring about serious damages to the original natural and ecological environment. In addition, due to the drive of economic benefits, tourism developers often distort original cultures during the process of developing resources of the folk custom tourism, and then force the formation of market oriented cultures and crafts, which is contrary to the veracity of the culture. Furthermore, the shock of modern civilization has changed the traditional life style of the local residents, and the tourism development has few effects on improving the living standards of the local people.

4 Study and practice of eco-compensation in nature reserves

4.1 Lessons learned from international biodiversity protection

Across the world, the growing scarcity of ecosystem services has led to a flurry of conservation innovations over the past decade in the form of payment schemes and nascent markets for these services. Lessons has shown how to move from the theoretical valuation of ecosystem service benefits to the actual creation of markets with real, in-hand financial payments between users and producers of ecosystem services. The areas of water flow/quantity, flood and disaster prevention or mitigation, protection of water quality, biodiversity, carbon sequestration and storage, and landscape beauty and recreation have been widely developed, which have many lessons to be learnt for eco-compensation in nature reserve, especially the areas of biodiversity, landscape beauty and recreation are closely connected with nature reserves.

Forest Trends has summarized the approaches emerging to remunerate financially the owners and managers of forest resources for their good stewardship of biodiversity (Table 1). A 2002 IIED study on forest biodiversity protection services in 33 countries found that the main buyers of biodiversity services (in declining order of prevalence) were private corporations, international NGOs and research institutes, donors, governments and private individuals. Of these, 73 percent were international, and the rest were distributed among regional, national and local buyers. International and many national actors demanding biodiversity protection services

tend to focus on the most diversified habitats (in terms of species numbers), or those perceived to be under the greatest threat globally(high number of endemic species where habitat area has greatly declined). Types and methods of forest biodiversity protection undoubtedly provide good lessons for other types of nature reserve biodiversity protection.

Table 1 Types of payments for biodiversity protection

Purchase of High-Value Habitat
● Private land acquisition(purchase by private buyers or NGOs explicitly for biodiversity conservation) ● Public land acquisition (purchase by government agency explicitly for biodiversity conservation)
Payment for Access to Species or Habitat
● Bioprospecting rights(rights to collect, test and use genetic material from a designated area) ● Research permits (right to collect specimens, take measurements in area) ● Hunting, fishing or gathering permits for wild species ● Ecotourism use (rights to enter area, observe wildlife, camp or hike)
Payment for Biodiversity-Conserving Management
● Conservation easements (owner paid to use and manage defined piece of land only for conservation purposes; restrictions are usually in perpetuity and transferable upon sale of the land) ● Conservation land lease (owner paid to use and manage defined piece of land for conservation purposes, for defined period of time) ● Conservation concession(public forest agency is paid to maintain a defined area under conservation uses only; comparable to a forest logging concession) ● Community concession in public protected areas (individuals or communities are allocated use rights to a defined area of forest or grassland, in return for commitment to protect the area from practices that harm biodiversity) ● Management contracts for habitat or species conservation on private farms, forests, grazing lands (contract that details biodiversity management activities, and payments links to the achievement of specified objects)
Tradable Rights under CAP& Trade Regulations
● Tradable wetland mitigation credits (credits from wetland conservation or restoration that can be used to offset obligations of developers to maintain a minimum area of natural wetlands in defined region) ● Tradable development rights(rights allocated to develop only a limited total area of natural habitat within a defined region) ● Tradable biodiversity credits (credits representing areas of biodiversity protection or enhancement, that can be purchased by developers to ensure they meet a minimum standard of biodiversity protection)
Support Biodiversity-Conserving Businesses
● Business sharing in enterprises involving in biodiversity conservation ● Biodiversity-friendly products (eco-labeling)

Source: Scherr, White and Khare

Landscape beauty and recreation services are often overlap with biodiversity services, but the commodity being purchased by tourists is an access right to scenic beauty, not biodiversity per se. in a review of landscape beauty payments, the most frequent market-based mechanisms used to attach value to these services were: access rights/entrance payments such as visitor fees (50%), package tourism deal (25%), and management arrangements or projects (25%).

In nature reserve local communities are forbidden to use their traditional resources. Their economic activities are limited for protection, which brings about negative effects and huge opportunity cost to local residents that need to be compensated.

Lessons from developed countries has manifested that private payment has shown upward trend in the region with high income, good institutional system. Government should play a more effective role in the poor and remote regions where private proposition has limit power. A realistic field this kind is the nature reserve in china in order to protect them from damage and improve the management in a cost-effect way. As the main stakeholders, local communities have come into being and supervised and managed the nature reserve effectively.

There are three ways to coordinate the relationship between protection and development within nature reserve. They are traditional way, public way and new liberate way. From traditional point of view communities are deemed as the direct threats of biodiversity protection in nature reserve, while from public point of view the participation and rights of communities are thought as an important aspect in the protection of nature reserve. In new liberate way the overlapping of organizations, market and policies are considered as the main reasons of biodiversity losses.

Eco-compensation of nature reserve is mainly realized by government and market ways. Public measure is the main payment in developed and developing countries. It is also an effective way for the communities taking actively part in the management of nature reserve. Other payment measures are indirect compensation for stakeholders to apply the compensation mechanism based on the standard and objectives determined by government, such as carbon emission payment, private company payment and NGO payment as well as the eco-labeling et al. Such kinds of compensation are realized by contract of buyer and seller with no interference of government (ITTO，2004).

Box 4. Typical ecological practice in selected countries

1. Experiences from USA

Under heavy pressures of severe floods and sandstorm plagues occurred during the periods of 1920-1930, federal government of the United States of America chosen the policy of land conversion, in which those who converted their farmland into grass and forest land were given compensation by government and the compensation was conducted with the principle of abidance by farmers' willingness and market economic laws. The land conversion plan was implemented with several stages and offering of contracts with farmers according to the different goals. When

the contract was expiring farmers decided whether to continue the contract for next stage according to market situation.

US government adopted a tendering process to implement the land conversion program with 4 steps: 1) signing general contract; 2) submission of tendering documents including farmers' application and expected amount of compensation; 3) assessment of application documents for tendering according to environmental benefit index and adjusted compensation standards; 4) submission of tendering result for approval. The tendering mechanism embodied the principle of willingness and competition. This means that if farmers' expected amount for compensation in application documents is higher than government's standards, farmers have right not to make contract or are not chosen as contractors by government. The rate of compensation is decided by supply and demand situation between buyer (government) and sellers (farmers) of ecological benefits[11].

2 Experiences from Brazil

In the process of rehabilitating degraded forest and increasing nature reserve area Brazil successfully exerted economic incentive mechanism. Of which, 3 typical means are: ecological value-adding taxation, perpetual private ownership of natural heritage reserve and trading right of resource storage.

The ecological value-adding taxation as a mean of ecological compensation abides by the principle of "protector getting benefits". In Brazil 6 states have practiced ecological value-adding taxation system. Brazil government stipulated that 25 percent of ecological value-adding taxation is allocated to those states where the nature reserves have been established and sustainable development policies have been implemented. Allocation standards of ecological value-adding taxation were decided by each state themselves. The amount of allocation of ecological value-adding taxation was decided according to the percentage of selling taxation, nature reserve area as well as the level and quality of protection. In addition, taxation exemption policy was implemented in rural areas where private natural heritage projects were conducted. Priorities were given to the regions with natural heritage reserves in the process of environment funds allocation and rural credit grade evaluation. All these policies have offered an incentive mechanism for landowner or land operator conducting private nature reserve.

The plan of trading right of resource storage refers to the trades conducted by private organizations under government permission and coordination. For example, in Brazil the constitution stipulated that forest coverage rate in the land along with Amazon River watershed for every landowner must be kept above 80 percent for the purpose of protecting biodiversity. But due to the disparity of marginal production of land, the phenomena of clearing forest for cropping have occurred occasionally. For efficient use of land resources, government allows those who get higher profits from agricultural production to buy forest clearance right from those who kept the

[11] CCICED forest and grassland workshop, 2002.

forest coverage rate in their land above 80 percent. This system makes the forest coverage rate in whole area above stipulate standards and is in favor of increasing land use efficiency and ecological benefits with a lower trading cost.

3 Experiences from Sweden

In Sweden, 90 percent of farmers get ecological compensation (20 percent in whole Europe) and the amount of compensation is based on quantitative increase of biodiversity. In 1993, Swaziland conducted an ecological compensation project and the result shows that the number of locust and cricket and other endangered insects in the area with project is significantly higher than the area without project. The result further certified the important role that ecological compensation plays in the process of nature reserve protection. Ecological contribution such as increase of fallow land and sustainable use of grassland can get corresponding compensation (Duelli, et al, 2003). Biodiversity was estimated by assessing species richness and species evenness of four taxonomic groups. Local government allocates ecological compensation funds to farmers in order to encourage them to protect biodiversity (Eva, 2006). The Netherlands government incorporated the ecological compensation plan into the project of infrastructure building (Cuperus, et al, 2001). Karin et al (2002) calculated the compensation cost of ecological protection in Germany through economic-ecological model as basis of policy formulation.

3 Other experiences

The main compensation measures are government payment and public payment. Government payment is the direct compensation through determination of compensation objective, range and standard. For example, 90 percent of farmers are compensated based on the quantified biodiversity. In Sweden, eco-compensation standard is determined by ecological contribution. the ecological benefits of the increment of fallow and non-intensive usage of grassland will be compensated (Duelli et al, 2003). Local government allocate eco-compensation fund depending on the biodiversity to encourage local residents to protect the species in steppe area (Eva, 2006). In Holland eco-compensation are applied in infrastructure instruction, such as the highway instruction (Cuperus, et al, 2001). Karin et al. (2002) has used the eco-economic model to determine the compensation standard of species protection in German, which form the basis for the species protection policy. Environmental payment of North America and Europe to protect the wild species are the largest scale of government payment. (ITTO, 2004). Other payment such as forest restoration payment in Coast Rica (24 $/hm2.a), nature reserve payment in Brazil and Mexico. In developing countries 150×10^6 $ has been put into the biodiversity protection in nature reserve (ITTO, 2003)

Source: (Min Qingwen et al. 2006)

4.2 Practices of ecological compensation of nature reserves in China

Ecological compensation mechanism has provided a sound ground in terms of theory and practice for raising funds for the nature reserve and attracted great attentions from decision makers and academic scholars. The China's ecological compensation research can be traced back to the 1970s. At that time the funds for nature reserve was a hot potato. For example, the Qingcheng Mountain, located at 60 kilometers of the east to the capital city of Sichuan province, is a famous religion resort in China. Due to lacking of protection funds the resort management was weak and illegal logging was rampant at a time. For this reason, Chengdu municipal government decided to allocate 30 percent of revenue from the resort tourism income for forest patrolling and the management situation in the resort was improved dramatically. Nationwide symposium on ecological compensation was held in Leshan Mountain in Sichuan province in October 1989. It is a milestone for China's ecological compensation research. In 1998, China set up ecological compensation funds for forest protection. It is the first time China listed the clues relating to ecological compensation in the law. In 2001, the pilots of ecological compensation system were conducted in 24 national nature reserves. It provided models for China's nature reserve setting. Since 2005, nationwide supervision and inspection involving 2056 nature reserves out of 23 provinces, municipalities and autonomous regions have been conducted by SEPA at all levels. The results showed that an array of problems is facing China's nature reserve management. The key is the conflicts between resource exploitation and protection. The solution for existing problems should be rested on raising funds. On one hand, government should increase investment in nature reserve protection. On the other hand, raising funds from whole society is a successful way worthy to borrow from foreign countries.

4.3 Research basis of ecological compensation of nature reserves in China

Studies on ecological compensation of nature reserve initiated in the late 1990s associated with the environment protection movement and the system of financial transfer. Researches on issues related to management, investment and evaluation of nature reserve laid a solid foundation for studies of ecological compensation mechanism of nature reserve. Wu Xiaoqing (2002) conducted a research on ecological compensation mechanism involving compensation targets, basis, amount, approach, compensation fee collection, allocation, use and supervision et al, for the first time setting the framework for ecological compensation of nature reserve. Deng Rui (2005) explored the ecological compensation mechanism of tropic rainforest in Xishuangbanna of RMBnan province. Through analyzing the existing problems in the area such as the nature reserve segment, lacking of development plan and

insufficient investment, he proposed that on the basis of scientific and reasonable mechanism for ecological compensation, the conflicts between development and protection, long-term benefits and short-term benefits, local benefits and national benefits should be solved. Some measures such as increasing financial transfer from central government, enhancing law enforcement, applying international aid, introducing commercial operation as well as raising funds for environment protection through issuing lottery were also proposed(Scherr, Milder and Bracer 2006).

Zhang Jinghe (2005) advocated that implementation of ecological compensation policy in surrounding area of nature reserve is the key to coordinate economic development and resource protection. A proposed measurable model should be formed based on ecological footprint of eco-tourism in Juzaigou nature reserve. He proposed that residents' direct losses from land conversion should be the minimum standard for compensation with a rate of 2159 RMB for each household and 472 RMB for each person; ecological value from land conversion should be the maximum standard with a rate of 7142 RMB for each household and 1561 RMB for each person; the disparity of ecological footprint between local residents and tourists can be used to identify the compensation standard with a proposed rate of 4983 RMB RMB for each household and 1088 RMB for each person. This proposal can be borrowed by similar area in identification of ecological compensation standards.

5 Procedures of eco-compensation for nature reserves

5.1 Basic principles for the eco-compensation of nature reserves

Integrated with the survey analysis, the eco-compensation in nature reserves should follow the following principles:

(1) Fairness. Providers and recipients of the compensation funds should be clearly identified. Such policies should be adopted as "beneficiaries pay", "saboteurs restore" and "protectors benefit". To put it differently, those who have enjoyed and used the ecological services should pay for the compensation funds and those who have protected and sacrificed for the ecological services should be paid.

(2) Science. The compensation approaches and standards should be scientifically determined. The ecosystem services, protection costs, and losses caused by the protection should be comprehensively considered.

(3) Dynamics. The standards of the eco-compensation should be dynamic, that is to say, varying according to the development level of the economy and the living standards of people. At the same time, we should try the best of our ability to establish a long-run effective mechanism, and to gradually realize the sustainable development of nature reserves by changing the industry structure and the life style.

(4) Difference. Differences between different ecological types, between economic development levels of different regions, and between different protection intensities should totally be taken into account.

(5) Transparency. Special funds for the eco-compensation should be established, uniformly managed by the management bureau in nature reserves, and only used for the compensation purpose. In addition, the punishment mechanism should be set up. Resource users should be imposed tax and those who have damaged the environment should be levied a higher fine than the resource users.

(6) Negotiation. The interests of all stakeholders should be balanced. The compensation standards should not embody the ecological services, protection costs and losses only, but they should also consider the development level and the bearing capability of the current social economy.

5.2 Identification of providers and receivers of the compensation in nature reserves

Generally, locations of nature reserves and important ecological function areas mostly belong to the country. However, owing to various reasons, there are always some residents inhabiting in the inner parts or surrounding parts of such locations. For a long time, these inhabitants have been cultivating, hunting and grazing to support themselves relying on the local resources. However, these activities have also brought certain or even worse impacts on the ecosystem.

Such a kind of ecological services is always public. As a result, these services might be enjoyed by a large area, a country or even the whole world. At the same time, they might also exert an influence on other regions or other industries such as the ecotourism. Thus, the providers of the compensation should be identified at different levels: the global ecological services should be provided necessary supports by related national organizations; the national should be realized through the purchase of the national government; the regional should be properly compensated by the beneficial regions; and the industries which have developed through the ecological protection should also make necessary contributions.

5.3 Determination of the compensation standards in nature reserves

On the basis of ecosystem evaluation: If the compensation standards are determined by the evaluation standards of the ecosystem services, there is a prerequisite that the important services of nature reserves and ecological function areas should be ascertained and assessed and the market mechanism should be improved. This method really helps establish an incentive mechanism aiming to rectify, protect and construct. However, several problems have hindered the real popularization of this

method at present. The first is that the evaluation of the ecosystem services is pretty uncertain. The second is that the ascertainment of the key or important services is full of subjectivity. So it is recommended that the standard determined by this method as a theoretical up-limit of eco-compensation.

On the basis of protection cost: If the compensation standards are determined by the standards of the cost protection, it is a realistic way to carry out the compensation in nature reserves and ecological functioning areas. It is necessary to make a cost accounting on manpower and material resources needed in the implementation of the nature reserve management.

On the basis of protection loss: If the compensation standards are determined by the standards of the protection loss, it is a popular way at present, particularly used in the implementation of the ecological migration during the process of constructing nature reserves and ecological function areas. Protection losses include direct economic losses as well as the indirect opportunity losses for future development due to protection measures.

On the basis of Willingness To Pay or Willingness To Accept compensation of Contingent Valuation Method: In the research of some nature reserves and ecological function areas, contingent valuation method (CVM) was used to estimate the willingness to accept (WTA) of the quality losses of the ecological environment. By directly requesting the WTA or WTA of the stakeholders to determine eco-compensation standard can manifest the “Public Participation” thoughts and take into consideration of public opinions in policy making.

5.4 Financing channels and compensation approaches

5.4.1 Government purchase, government transfer payment, preferential policy, exemption of taxation and offering subsidies

It is a common sense and basic duty that government should provide the public goods. Nature reserve as a public goods means that government should be the prime provider. As far as the level of government and management duty is concerned, it is determined by the external benefits of nature reserve.

Generally, nature reserves with a certain beneficial region belong to local public goods; while nature reserve with multi-beneficial regions even all over the countries belongs to country-wide public goods. The cost of nature reserve should be determined by the beneficial regions and allocated the financing responsibilities among different levels of government by ways of government purchase, government transfer payment, preferential policy, exemption of taxation and offering subsidies to ensure effective management of nature reserve (Wu Jian, 2006) .

5.4.2 To set up industry-based and regional-based compensation mechanisms according to the use and the damage of the ecological resources

Nature reserve can provide ecosystem services with various beneficiaries. Those industries and regions that benefit from and damage the ecosystem services should pay for the efforts and opportunity costs of the ecological protection and restoration. By designing eco-compensation mechanism the external cost can be internalized to resolve the "hitchhiking or soliciting free riding" phenomenon[12] in the ecosystem service consumption and reward and encourage the activities of ecological protection and restoration by economic incentives.

5.4.3To set up project-based compensation

Nowadays most of the ecological protection and restoration projects are implemented in nature reserve, such as the wild animal and plant protection, Natural forest protection project, Desertification control project in the vicinity of Beijing and Tianjin, and the forest protection in northern China, et al. In addition, management organizations of nature reserve should diverse their financing channels by seeking for sponsors for biodiversity protection and carbon sequestration projects, e.g., World Bank, UNEP, WWF, et al.

54.4 To set up earmarked funds for eco-compensation

All the funds under the framework of eco-compensation mechanism, especially the donation from international and domestic organization, enterprises, private individual, can uniformly set up an earmarked fund for eco-compensation and fund management committee consisting of members recommended by the fund providers and management organization. Fund management should follow the rules for an earmarked fund, and special emphasis should be put on the usage of the fund. The usage of the fund should depend on the principles of eco-compensation and scientific objectives of nature reserve and willingness of the donors.

6 Case Study on eco-compensation in typical nature reserves

6.1 Case Study 1: Eco-compensation in Tonggulin and Wuzhishan natural forest reserve of Hainan province

Box 5: Background of Tongguling and Wuzhishan natural forest reserve of Hainan provinc 1 Background of Tonggulin natural reserve

The Tonggulin natural reserve, located in Longlou town of Wenchang city, was approved to be a

[12] Meaning that some people are getting benefit derived from the payment made by the others.

county-level natural reserve by Wenchang county government in June 1983 with a total area of 967.7 ha. In 1985, it was expanded with an addition of 333.3 ha continent-based area and 32 ha offshore area. The total area in the reserve reached 1333 ha. In 1988, the provincial government listed the Tonggulin natural reserve as the key provincial natural reserve and its coverage area was enlarged including parts of sea area with rich corals (figure 1). Currently, the total coverage area of Tonggulin natural reserve is about 44 square kilometers, of which, 13.33 square kilometers of continent-based area and 30.67 square kilometers of ocean-based area. There is no human settlement and less human intervention in the reserve. The targets to be protected are the wild flora and fauna and their habitats, geographical and topographical resources, corals and seafloor biome. The reserve is a comprehensive one featured with reserve types of wild flora and fauna, forest-ecosystem, geography and topography, ocean and offshore ecosystem, with a total of 908 kinds of flora species and 10 kinds of wild animal species, 20 kinds of wild birds as well as other species of continent and ocean.

The reserve is with an annual average temperature of 23.9℃ and annual precipitation of 1495 mm (Baofang station) and annual evaporation of 1761.2mm. The reserve is surrounded by 25 villages subordinated to Shanhai village committee and Honghai village committee. The total population in Tonggulin (Longlou town) is 18966, of which, Shanhai village committee has a population of 2238 and Honghai has 2549. The economic activity is featured with plantation of vegetables, fruits and fishery. Per capita income is 3067 RMB annually.

In 1990, “Tonggulin Management Station for Natural Reserve” was established by Wenchang county government, affiliated to the County Bureau of Environment and Resources. The number of staff stipulated by government is 5 and actual on-job staff number is 4, of them, 2 persons hold a high school educational attainment, one with junior high school and one graduated from primary school. They are in charge of daily affaires and conduct patrolling activities. In addition, the County Bureau of Environment and Resources and Longgang Town government appointed responsible persons for the management of the natural reserve. The reserve area was classified into three areas, namely core area, buffering area and experimental area and carried out “three-area management system” with three kinds of different policies. In core reserve area, management and patrolling activities as well as approved scientific survey and observation are allowed. In buffering area, some activities such as scientific research, school and academic workshop, specimen collection are allowed under the condition of permitted by management department, no environmental damage to the reserve as well as limited visiting and tour. Experiment area allows activities conducted in terms of scientific research, school and academic workshop, visiting, eco-tourism, domestication and reproduction of endangered wild plants and animals. The management station holds twice propaganda activities to disseminate knowledge relating to the environment protection.

2 Background of Wuzhishan natural reserve

Wuzhishan natural reserve was set up in 1985, approved by the state council as a national-level natural reserve subsidiary to Hainan Provincial Forest Bureau. The reserve is located in the central part of the province at18°48′59″-18°59′07″ N and 109°32′03″-109°43′19″ E. The summit of Wuzhishang Mountain is about 1867m above sea level. The reserve covers an area of Wuzhaishang city and 8-village committees of 5 towns out of Qunshan County. Wuzhishan Mountain is the center of the reserve and total protection area is 13435.9 ha. The main protection targets are tropic rainforest ecosystem and wild animals. Wuzhishan reserve has 7000 ha of well-protected primitive forest and 524 kinds of wild animals, accounting for 22 percent of its kind nationwide.

The reserve is featured by tropic monsoon weather and with 1300-1800mm of annual precipitation and 22.4°C of annual average temperature. Forest cropping with medicine herbs is the main sources of local farmers' income. The economic development in the reserve area is far lagging behind nation's average level, with an annual per capita income of 1800 RMB.

Management Bureau of Wuzhishan Natural Reserve, located in Shuiman town of Wuzhishan city, is responsible for the daily management affaires and forest security. The Bureau has 4 grassroots protection stations and one management center and 20 local farmers' is hired as its patroller. The illegal logging and poaching have been controlled in the recent years. The ecosystem in most buffering area and experiment area has been recovering gradually with replacement of natural forest. The Management Bureau of Wuzhishan Natural Reserve has actively cooperated with media, through newspaper, TV and magazine et al, to propagate and disseminate information relating to natural reserve protection in order to raise awareness of ecological protection.

Source: Progress report of Wenchang county in 2005 (unpublished); The Eleventh five-year plan of Wuzhishan (unpublished)

6.1.1 Impacts of Natural Reserve on Local Communities

In the questionnaire survey, questions related to farmers' livelihood were designed to gather information. The survey result shows that most respondents engage in crop production for their subsistence. However, the income from industry is higher than the others. The main source of local farmers' income is the wage got through finding a temporary job in local small enterprises or big cities. All respondents do not get any compensation money from the reserve. Of which, 70 percent of respondents don't know the compensation policy; 30 percent of respondents know the policy, but they never get any compensation money from the government. Only few respondents get job opportunities from the reserve. In Wuzhishang natural reserve, 15 percent of respondents get jobs relating to the reserve, of which, 10 percent in forest industry, 5 percent in tourism. Their incomes from the reserve-related job are very low, accounting for a sixth of their total income (300-500 RMB RMB per year). The local

farmers have to engage in other economic activities for their subsistence. For example, 50 percent of respondents in Tonggulin natural reserve are conducting activities such as forest logging, rocks and sands extraction, which is not friendly to the environment of the reserve. The survey found that all respondents think they should get regular compensation from government, of which, 75 percent are eager getting compensation in cash and give a proposed sum of compensation. 10 percent of respondents propose 400 RMB RMB per month; 20 percent of respondents propose 600 RMB RMB per month; 20 percent of respondents propose 800 RMB RMB per month; 30 percent of respondents propose 1,000 RMB RMB per month; 20 percent of respondents propose 1,500 RMB RMB per month.

Most respondents advocated the establishment of natural reserves and perceived that it can improve environment and transportation conditions, improve water quality, and vegetation coverage area, increase number of wild animals and so on. However, they think that establishment of natural reserve bring not effects on their livelihood. There are not significant changes in farmers' income before and after the establishment of the natural reserves. It implies that enormous efforts need to be paid to make the most farmers get benefits from the natural resaves. As for the reasons of some respondents choosing "No Idea", it probably rooted on two aspects: firstly, because the establishment of the natural reserve has few affects on their subsistence they cannot make exact judgment for answering the question; secondly they did not experience the questionnaire survey like this, so it is difficult for them to choose right answers during a short time periods.

Most of the respondents have no idea about the impacts of their settlement on the reserve protection. Only parts of them perceived no impacts. It indicated that the establishment of the natural reserve has no significant benefit conflicts with the local residents. It is necessary to pay further efforts to promote local resident's participation in the natural reserve protection and reminder them the role they should play and the role the reserve take part in local economic development.

6.1.2 Eco-compensation standard determination

As for the Hainan forest nature reserve, the compensation standard is determined referring to the opportunity cost of returning crop to forest and the willingness to accept compensation. In the project area, rice is the main crop planted with an annual yield of 400 kg per mu. The annual output is 400-700 RMB per mu reducing the cost of fertilizer and labor. So the opportunity cost is 880-1540 RMB per household per year. WTA is obtained from household questionnaire. 120 household participated in the survey, 95 percent of respondents are for the compensation of 500-1500 RMB per household with cash. Most of farmers have worked out the standard based on the potential influence on their income. The compensation standard of 1000 RMB per household

are put forward with the consideration of difference between plantation and breeding. As for the potential farmers in the project, 550 RMB per mu is recommended as one of the compensation standard, which is the annual average income.

6.1.3 Sources of eco-compensation fund

With the consideration of the property of the nature reserve in Hainan province, government should be regarded as the main fund source. The main measures are as follows: (1) governmental financing transference, preferential policy, exemption of taxation and offering subsidies in the state level. Nowadays ecological benefit compensation of forest is 5 RMB per mu, and this fund is used for salary payment. (2) To set up industry-based and region-based compensation mechanisms according to the use and the damage of the ecological resources. (3) To set up the project-based compensation. To set up necessary project based on the ecological protection need, such as the nature forest protection project. Local residents can choose to participate in the project to get compensation. Eco-migration can also be considered as a potential project.

6.1.4 Analysis of problems facing the nature reserves

Solving the problems facing local farmers is the key to further development. The survey results indicated that lacking of financial support is the most evident problems in local economic development and farmers' welfare, especially the declining trend of income from the natural reserve; followed by insufficiency of health care, education (in Tonggulin) and poverty-eradication techniques. The problems facing local farmers in Wuzhishan are more critical than Tonggulin because Wuzhishan is one of national poverty-stricken area and with less developed infrastructure and development ground. The most concern related to their development is not the source but the amount of finance. It is verified by the low index of resource-use limitation.

Institutional survey showed that the main problems on the management of natural reserve are inadequate financial support, followed by lacking of skilled staff and low staff income. Currently the financial sources of the management institutions of the natural reserves in Hainan province mainly are special funds from central government, local governments' budget and revenues generated by the reserve's business activities such as tourism ticket. Because of financial difficulties of local government and insufficient funds from central government, the investment to the natural reserve is not enough to support its infrastructure building and staff salary and welfare. The natural reserves are forced to be managed with double functions in terms of management and doing business in order to generate revenues to fill financial gap. For instance, Wuzhishan Management Bureau of Natural Reserve regularly gets only 700,000 RMB from provincial budget per year, which is not enough to cover the expenditures of 38 staffers' salary and necessary daily overhead.

Therefore, the bureau has to run business such as tourism and hotel to earn incomes to reduce deficit, which is weakening bureau ‘s management function and increasing the conflicts between natural reserve protection and resources use. Furthermore, due to lacking of skilled managerial staff, the bureau has to hire local farmers as patrolling staff with very low wage (300-400 RMB per month). The direct result is the patrolling responsibility cannot be fully fulfilled.

The problem existing in the natural reserve protection is that the policies and regulations cannot be fully enforced. In 1979, China enacted “the Law of Environment Protection”. In 1982, the state council enacted “the regulation of fine collection for pollutant disposal”. Recently the revised regulation for pollutants discharge clearly stipulated the amount of fine collection, management responsibility and use of fine, which embodied the principle of polluter pays. However, the necessary compensation fees have not been collected from the resource users under the framework of principle. The environmental losses are becoming more and more serious. For example, in 2000, estimated economic losses in Hainan province due to environment damage is about 5.94 trillion RMB RMB, accounting for 11.5 percent of its GDP, of which, 18 million RMB from land sandification, 46 million from mining, 11 million from river and reservoir silt and 5.82 trillion from flooding and typhoon disaster.

Another problem in natural reserve management is that counterpart funds from local government cannot be allocated regularly. Central government earmarks special funds to natural reserve with the standard of 5 RMB per mu annually and local government is asked to allocate the same amount as ecological compensation funds. However, the local government did not give a single coin to the natural reserve and the funds from central government were used for overhead of staff salary and daily expenditures.

Low efficiency and lacking of skilled staff are main reasons of weak enforcement of government policy. The management bureau of natural reserve is affiliated to local government and the director of the bureau is normally the same person as leader of local government department. Simultaneously staffs in the bureau are doing part-time job while they have other position in local government department. So reserve management and ecological issues were not given great importance. For instance, local residents are informed of compensation policy, but they did never get any compensation money from government. In Tonggulin and Wuzhishan natural reserve, about 52 percent and 85 percent of residents respectively are aware of the government policy and the importance of natural reserve through newspaper and TV, but the bureau did not motivate local residents to actively participate in the protection activities. As a result, the conflicts between residents and the natural

reserve are increasing gradually and the natural reserve is isolated from the whole society.

6.1.5 Farmers' attitude towards management models of the natural reserve

The vast majority of respondents support existing management model (table 2). But this result is not consistent with that of key informants' interview, in which most of interviewees advocated co-management model by local community and government. Lacking understanding of existing management system is the main reasons why most of farmers support the existing management model. In Wuzhishan natural reserve, some farmers who took part in special training support co-management model and others advocate existing management model due to their unawareness of management regime. Most respondents support the option that compensation funds should be allocated by county government or village committee, which implies they fully trust government and village committee.

Table 2: Farmers' attitude towards management model

Natural reserve	Management bureau	Co-management	Township government	Village committee	No idea	Compensation funds allocation			
						Management bureau	County government	Township government	Village committee
Tonggulin	55 (93.2%)	0	3 (5.1%)	0	1 (1.7%)	24 (40.7%)	35 (59.3%)	0	0
Wuzhishan	17 (85.0%)	1 (5.0%)	0	2 (10.0%)	0	6 (30%)	0	2 (10%)	8 (40%)
Houdao									

Co-management: managed by community residents and professional staff appointed by government department.

6.2 Case Study 2: Eco-compensation in Poyang Lake nature reserve of Jiangxi province

Box 6. Background information of Poyang lake nature reserve

Wetland is one of most important human habitats with the richest biodiversities. Wetland, forestland and ocean are defined as the three main categories of ecosystems by the world natural conservation outlines compiled by IUCN, UNEP and WWF. Wetland is playing an indispensable role in resisting flooding, regulating runoff, improving climate condition, mitigating pollution and protecting biodiversity as well as maintaining regional ecological balance. Since the 1950's, China has been striving for protecting its wetland resources and established the natural reserves as a way to control ecological environment deterioration and protect biodiversity. However,

because of its huge population it is impossible for China to relocate the residents inside natural reserves. Therefore, most natural reserves in China are inclusive with residential sites, in which the residents depend on the natural resources for their livelihood and their living and development are indispensably contradictive to the purpose of the reserve protection.

Poyang Lake and its surrounding regions comprise Nanchang City, Nanchang Couty, Xinjiang County, Jinxian County, Jujiang City, Yongxiu County, Dean County, Xingzi County, Duchang County, Hukou County, Yugan County, Poyang County with a total land area of 20289.50 square kilometer and a population of 8.86 million. Of which, the rural population is 5.99 million, accounting for 67.69 percent of the total. Arable land and wetland in the surrounding areas are two main types of land use pattern, in which the two usually are competitive within the flooding risk areas.

Poyang Lake is the largest freshwater Lake in China and one of the most important wetland in the world. The shape and water table of the Lake varies among the seasons, with a 13 meters gap of water table between water-rich season and water-poor season. Because of its fertile land and rich bio-resources, the Poyang Lake is an important place for white crane and orient white crane living through the winter. Poyang national natural reserve, established in 1988, is located in the west of Poyang Lake with coverage of 22400 ha and consists of nine main Lakes, which are: Dahuchi Lake, Dacha Lake, Xiang Lake, Zhonghuchi Lake, Meixi Lake, Bnag Lake, Sha Lake, Zhushi Lake. The reserve, with the intact natural landscape and rich diversity, is the key habitats for rare water-birds. From October to March of the coming year, nearly one million migratory birds of 310 species are living there throughout winter. Of which, 98 percent of white crane worldwide, 159 species of typical wetland birds and 13 endangered species worldwide inhabit there in winter season. The reserve is called the “Kingdom for crane” and “Paradise for rare waterfowl” with 10 species of national first-class protection, 44 species of national second-class protection, 5 phytoplankton species, 102 hydrophily-vascular-plant species, 47 zooplankton species, 227 insect species, 56 mollusk species and 45 wild mammalian animals species.

In 1998, a severe flooding disaster occurred in the middle reaches of the Yangtze River brought enormous economic losses and life losses and offered grieved lessons to local people. Since then, the environmental impacts of mal-practices of converting lake area into arable land have been emerging gradually. Therefore, the Jiangxi provincial government issued a series of documents relating to the after-flooding reconstruction and flooding control from the source region. The government documents stipulated clearly that the farmers who migrate outside lake areas and convert farmland into wetland can get compensation funds from government and

enjoy the policy of tax exemption. In 2000, the State Council issued a decree entitled "Temporary Compensating Measures for Storing Flooding Water"

Since 1998, China has conducted a series of flooding prevention projects including the projects of converting farmland into lake area. In the land conversion projects, 221,000 households with a population of 908,200 moved outside the lake area, the government has invested 353.2 billion RMB and the total area of land conversion reached 86,000 ha. In the early stage (1995-2000) of the implementation of the land conversion projects, land use in Poyang lake regions presented a trend that farmland decreased greatly and wetland increased sharply with a farmland decrease of 202.20 square kilometers and a wetland increase of 210.68 square kilometers. In the late stage (2000-2005) of land conversion projects, the effects of governmental policy were weakening gradually and the land use emerged a trend of reversion. The farmland increased by 59.34 square kilometers and the wetland decreased by 60.33 square kilometers during the period. In December of 2005, the State Council issued a decree entitled "Practicing Scientific Development Outlook and Strengthening Environment Protection", in which it is pointed out that ecological project such as farmland conversion into lake area should be conducted continuously in the future.

Source: Wang Xiaohong et al. (2004)

6.2.1 Social and economical effects of nature reserve

The main income sources of households surveyed are fishery, accounting for 43 percent of their total income; the income from crop growth and animal rising occupy 21 percent and from crop growth, animal raising and non-farm activities account for 21 percent. Per capita annual income from these three kinds of sources is 3897, 4123 and 5453 RMB, respectively. About 59 per cent of households thought that their annual per capita income decreased by 1500 to 2000 RMB RMB compared with that before the establishment of the Poyang natural reserve. The main reasons for the income decrease are: 1) after converting farmland into lake area, the decrease of farmland caused a decline of income from agriculture; 2) restriction of activities such as fishing, hunting and haymaking caused income decline; 3) increased number of birds taking crop and vegetable as food caused a declining agricultural harvest. Since the founding of migratory birds protection base in Poyang natural reserve, October to next March is the important period for migratory birds protection, so any activities such as fishing in the lake area have been banned. From March 20 to June 30, the fishing activities have been banned for the sake of raising fry. Therefore, the available time for fishing is only 3-4 months and it has seriously affected local residents' living and production and the phenomenon of human and birds competing for food are extremely evident. 4) Most of the wetlands growing grass have been

banned for raising animals. Therefore, great impacts have been raised to husbandry production. 5) Endemics have been coming back because of bird's protection. The occurrence of schistosome disease has presented an increase trend in recent years. Population suffering schistosome disease in Wucheng town accounts for 60 percent of the total population. About 21 percent of the respondents thought that there is no much more change in their annual income, and 20 per cent of the respondents thought that there is an income increase which is mainly from non-farm activities such as working in urban or food processing factories.

The vast majority of households surveyed hold a positive attitude towards the effects of natural reserve establishment on environment change. They thought that main targets for protection have been reversed in recent years. For example, 69 per cent of the respondents thought that the number of birds have been increasing; 20 per cent of respondents thought that the number of hydrophyte have been increasing; 11 per cent of the respondents thought that air quality have been improving, but they also believed that natural resources damage and water pollution have been the main problems remaining in the natural reserve.

Through comparison of advantages and disadvantages on the establishment of natural reserve, 71 per cent of respondents hold a positive attitude. 55 per cent of households surveyed participated in the training sponsored by the management bureau of Poyang natural reserve and 68 per cent are aware of relevant policies for reserve protection. However, their perceptions have been highly affected by economic benefits and income maximization has been the target of local residents. Due to declining income, 58 per cent households surveyed are not willing to convert the rest of their farmland into lake area; 53 per cent are not willing to voluntarily take part in the protection activities; 38 per cent are not willing to move outside the reserve for the sake of nature protection; 40 per cent have no idea for this. According to the estimation by Wucheng township government, if conducting a residential relocation project, nearly 1500 households would have to be moved outside the reserve and about 60,000 RMB would be needed to each household. For this huge amount of money, it would be of great difficulty to the local government.

6.2.2 Establishment of ecological compensation mechanism for farmland conversion into lake area in Poyang natural reserve

6.2.2.1 The stakeholders of eco-compensation

In this case, it is very clear that who should get compensation. For the sake of wetland protection, local residents in Poyang lake natural reserve sacrificed the land use right, so they should get compensation. Who should pay? Who are the beneficiaries? It should be decided on the basis of wetland ecological service

assessment, clarifying who get the benefits and what is the increased value of ecological services.

By reference of "biodiversity value classification standards" compiled by UNEP in 1993, wetland ecological services in Poyang natural reserve can be divided into use value and non-use value. Each category of value also can be classified into several sub-categories. Table 3 listed the specific subcategories and beneficiaries. When beneficiaries are local residents, there is no need to offer eco-compensation because in this situation the providers and consumers of ecological value are the same group of people. It is found that in Poyang natural reserve the local tourism departments, pollution-discharging enterprises and government should be the providers for eco-compensation.

6.2.2.2 Determination of ecological compensation standards

In 1998, 60 per cent of households got ecological compensation in-kind with a standard of 50 to 125 kg rice per *Mu* of farmland converted. Of which, 11 per cent of households got compensation from county government and 43 per cent from the management bureau of Poyang lake natural reserve. The year 1998 is the first year of implementation of land conversion project in the study area and local government gave compensations to those who converted their farmland into lake area. However, the compensation action had not been carried out continuously. For the already-paid compensation, 91 per cent of households believed that the standard is too low.

Normally the standard of ecological compensation depends on two aspects: one is the ecological service value at the price of local residents' loss of land use right. Another is the opportunity cost the local residents lost for the sake of natural reserve protection. As for Poyang Lake natural reserve, the standard of eco-compensation could be based on the opportunity cost of land conversion and farmers' willingness. In the study area, the converted land usually was used for growing rice, with a yield of 450 kg per *mu*. Deducting the costs for fertilizer, pesticide and labor, the net income might be 750 RMB RMB per *mu* and opportunity cost could be 2000 RMB RMB. The farmers' willingness to accept the amount of compensation can be derived from household-base questionnaire survey. For the question of "which compensation means would you like and what is your expected amount?", 99 households among 104 households selected cash compensation and average compensation standard they expected was 3324 RMB per household. 5 households selected the way of compensation in kind. 38 per cent of households surveyed are with an annual income of 4000-5000 RMB, and 34 per cent of surveyed has annual income below 2000 RMB. 63 per cent of households hope to get 2000 RMB compensation per household and 27 per cent expect 1000 RMB compensation per household. About 53 per cent of households surveyed are with an annual income of 1500-1800 RMB and they mainly grow crops for their livelihood. Therefore, these farmers are more easily impacted by land conversion project.

The survey found that most households selected compensation standard based on the possible income impacts in the future. For balancing the income disparity and reducing the possible conflicts between groups aroused from eco-compensation, the average value of farmer's expected amount, e.g., 3324 RMB, can be the principle for identification of compensation standard. For those who grow crops for their livelihood, 750 RMB per mu can be the baseline for compensation. This standard is close to the standard of 3000 RMB per household advocated by Wang Xihong (2004). Therefore, this research advocates that 750 RMB per mu or 3300 RMB per household can be used as references for eco-compensation.

Table 3 Farmers' income and willingness to accept

Income range (RMB)	No of households (percentage)	No of households with compensation willingness (percentage)
≤1000	11(11)	35(33)
1001-2000	24(23)	31(30)*
2500-3000	10(10)	9(9)
4000-5000	39(38)	9(9)
6000-9000	20(19)	10(10)
≥10000	0(0)	10(10)
Total	104(100)	104(100)
remark	Maximum=7000 RMB, Minimum= 220 RMB The average= 4074 RMB	Maximum =10000 RMB, Minimum =300 RMB The average =3324 RMB

* For 5 households expecting for in-kind compensation, the sum was derived from conversion of in-kind compensation (rice).

The receivers of the Poyang lake eco-compensation are local farmers who lost their land use right. Based on calculation, the amount of annual compensation should be 1094 million RMB (including the funds for resident resettlement). It is suggested that some policies such as government subsidy, tax exemption and preferential credit should be given to them for the sake of natural reserve protection.

Field survey showed that 31 households or 39 percent of households converted their farmland into lake with an area of 1-3 *mu;* 10 households or 18 percent of households were with a land conversion of 15-25 *mu;* 7 households or 15 percent of households were with 26-35 *mu* of land conversion; one household's land area converted were more than 40 *mu.* Among four villages surveyed, farmers in Hedong converted their whole farmland into lake area and households converted above 10 *mu* farmland are all in this village. Due to land conversion and lack of techniques and funds, currently the farmers in this village are mainly engaging in fishery with

an annual household income of 6577 RMB, 2000 RMB falling compared with before. Farmers' expected amount of compensation are 7039 RMB with a reluctant attitude towards resettlement. Farmers in Yuyedadui village returned their farmland back in lake area and were engaging in fishery for their livelihood. In 1998, the villagers ever got eco-compensation from government with a standard of 50 kg rice per *mu*, but these villagers' expected amount of eco-compensation were 1000 RMB per household per year. In recent years, the villagers' income declined due to decreasing fish harvest. For these villagers, they have no ideas about whether they should migrate outside the natural reserve. Villagers in Tongxin and Dingshan partially converted their farmland into lake area and they did not get any eco-compensation although their expected compensation amount was 3821 RMB per household per year. About 50 per cent of respondents in this village are willing to move outside lake area for natural reserve protection. Villagers in Dingshan village got eco-compensation in 1998, but they have no idea about whether they should move outside the lake area for the sake of natural reserve protection.

6.2.2.3 The mechanism of ecological compensation in Poyang Lake natural reserve

There are two types of ecological compensation ways in Poyang lake natural reserve. One is users-payment way, that is, to get compensation funds through collecting resources use fees. Another is to give preferential policies such as financial subsidy, tax exemption as well as preferential credits to the residents who lost their land use right. The specific mechanisms for eco-compensation in Poyang lake natural reserve are detailed as follows:

Table 4. Mechanism of eco-compensation in Poyang lake wetland

Items	Activity or impact	Source of funds for compensation	Channel of funds collection	Funds use	Management agency
Environmental quality	Pollutant discharge	Pollutant-discharge enterprises	Fees for pollutant discharge	Waste water treatment	SEPA
Fishery resources	Fishing	Fishing farmers	Fees for fishery resource use	Fishery Resource protection	Management bureau of the natural reserve
	Dropping fishing	Management bureau of the natural reserve		Financial subsidy	Management bureau of the natural reserve
Aquiculture	Aquiculture	Users for water	Fees for water	Fishery	Management

		body	body occupation	resources protection	bureau of the natural reserve
Sands extraction*	Extracting sands	Exploiter	Resource use taxation	Resource protection	Department of land management
Land resources	Land conversion	government		Subsidy	Management bureau of the natural reserve and county government
Tourism resources	Environment pressure	tourists	Increased ticket price	Ecological restoration	Tourism department and Management bureau of the natural reserve
wild animals	hunting	hunter	Fine	Wild animal protection	Forestry bureau

*The survey found that the sands extractors from Jiangxi province and neighbor provinces have been extracting sands in Poyang lake natural reserve every day and it has greatly threatened the wetland environment.

The Table 4 shows that 68 per cent of the households advocate that eco-compensation funds should be managed by the management bureau of Poyang lake natural reserve. It implies that farmers in the study area hold a full trust towards the management bureau. When asked whether they are willing to pay for resources use, most of them reject the idea with the pretext of economic difficulties. About 58 per cent of farmers in the study area perceived that their income have been impacted by the establishment of natural reserve and they should get compensation from government. 26 per cent of households have no idea about the impacts of natural reserve protection on their income. But they think that the establishment of the natural reserve is beneficial to resources management, 16 per cent of farmers hold a reversed opinion.

Correlation analysis shows that the area of farmland conversion in lake area impact farmer's perceptions and willingness. There is a positive correlation between the area of land conversion and decrease of income （r＝0.475**, p<=0.01）and a positive correlation between the area of land conversion and their unwillingness（r＝0.347*, p<=0.05）. they are in favor of funds managed by the management bureau （r＝－0.542**, p<=0.01）because they think that it is convenient to go to the bureau for compensation and communication. Additionally there is a significantly positive correlation between the number of family members and their perceptions（r＝0.311**, p<=0.01）. The households with more family members tend to believe that

the current compensation is not enough to cover their loss. The more family members they have, the more loss they suffer. The young people are more willing to attend the training courses for resource protection than the old people（r＝0.515**, p<=0.01）.

6.3 Case Study 3: Ecological compensation in Xilinguole grassland ecological functional reserve of Inner Mongolia

Box 7 The background of ecosystem functional reserve

The Chinese government attaches high importance to ecology protection, and has adopted a series of measures to ensure ecological security. Construction of nature reserve is one of the measures. Till 2006, 2,349 nature reserves have been established; the total area of nature reserves has reached 1.5 million km^2, approximately 15% of the area of total territory. A nature reserve network with diverse types and rational layout and sound ecological function has been formed primarily. But the speedy expansion of nature reserve leads to the lag of the management due to scarcity of fund input leading to weakening of ecological function of most of the nature reserves. Therefore ecological function area with national, regional and watershed significance is addressed to meet the needs of natural conservation.

Ecology function refers to environmental condition and utility essential for the survival of human beings, which is provided by a ecosystem or formed in an ecological process, including water conservation, soil erosion control, climate regulation, air and water purification, mitigation of floods, winds check and sand control, biodiversity conservation, soil formation etc, of which the major ecology function is the maintenance of the drainage basin, the region ecology security and ecological equilibrium, the promotion of socio-economic.

The ecology function protection areas are the source areas of rivers and streams, the important water conservation area, the soil erosion control area, the rivers and streams flood storage and regulation area, the windproof solid desert region, the important fishery waters, etc, which has the vital role in the maintenance of drainage basin area, equilibrium of the regional ecology, preventing and reducing the natural disaster, guaranteeing national and the local ecological security.

In 2000 the *Ecological Conservation Outlines 2000* passed by the State Council proposed clearly that it is urgent to set up ecosystem functional reserve area to protect important ecological function area and ensure the state ecological security. The *State 10th Five-Year Plan of Environmental Protection* stipulates the assignment of making ecological function regionalization clearly. *Suggestions on the State 11th Five-Year of Economic and Social Development by the Chinese Communist Party Central Committee* stipulates "to strengthen protection and management of nature reserve, important ecological function area and coastal zone". The National Development and Reform Commission has listed the *State Important Ecosystem Functional reserve Area*

Regionalization 2006-2020 in important plans of the *11th Five-Year Plan*.

For scientifically determination of the ecology function of different regions，SEPA has been making《regionalization plan of the state ecological function 》，according to this plan, ecosystem functional reserve area is divided into Water conservation，soil erosion control， winds check and sand control，biodiversity conservation，mitigation of floods，agriculture development and town construction etc. According to the distribution of important and the extremely sensitive area, it is proposed to take the terrestrial ecosystem functional reserve area as the prioritized protection and construction area.

The major measures taken in the construction and management of the ecosystem functional reserve area are as follows: to terminate the exploitative and man-made devastating activities that will result in the degeneration of ecological functions; to terminate the implementation of the projects or programs that will result in serious environmental pollution; to control the population growth strictly and carry out emigration from the over-population areas; to replace the form of extensive production and operation by the way of ecological economic development; to reconstruct and restore devastated but important ecosystems integrating measures of ecological environment construction, so as to check the trend of ecological environment degradation. Firstly, to protect primary regions with good ecological conditions and formal ecological functions by strict protective measures, and keep them from emergent degradation and man-made devastation. In regions with abundant biodiversity and the most typicality and integrality, the construction of nature reserves is favorable. Secondly, to take reasonable management and protective measures, such as maintenance by fences, in regions with devastated ecosystems and degraded ecological functions to promote natural restoration. Thirdly, to carry out ecological restoration and reconstruction by biological and technical measures in devastated ecosystems and regions, so as to make them restore ecological functions.

Source: the framework of ecological functional reserve area plan (primary)

Box 8 Background of Xilinguole grassland ecosystem functional reserve

Xilinguole grassland, an important part in Inner Mongolia steppes and a core area of grasslands in temperate zone in China, forms an ecological barrier in the north of China. Nowadays, about 90% natural grassland in China has been degrading to some extent. Xilinguole grassland, is in serious degradation and desertification condition. With its grassland ecological functions degrading seriously, it is emergent to protect and restore local ecological environment.

1 The particular ecological significance of Xilinguole grassland ecosystem functional reserve

1.1 Grassland types, and rich grassland biodiversity require to be protected immediately

Xilinguole grassland lies in the east of Eurasia grassland area, with 700 kilometers extent in latitudinal direction. Grassland types include meadow steppe, typical steppe, desert steppe, and

sand land vegetation. It completely remains continuous natural grassland vegetations, which make it uniquely precious treasury of grassland biodiversity that maintains abundant gene resources. Thus it is of great value to research either in China or for the whole world.

1.2 Xilinguole grassland is an ecological barrier for Beijing-Tianjin-Tangshan Region of China, in relation to ecological security of North China.

China lies in monsoon zone of East Asia, where warm and damp southeast wind blowing into inland, while cold and dry northwest wind from Siberia blowing into via Mongolia Plateau. Hence Inner Mongolia lies where east monsoon and northwest wind meet, while Xilinguole grassland in a draught of northwest wind in Beijing-Tianjin-Tangshan Region and North China (Fig.2). A large area with grassland and desert vegetation can protect living soil, and can decelerate northwest wind effectively as well. So it forms a natural ecological barrier for Beijing-Tianjin-Tangshan Region, its ecologic regime affects directly ecological security of North China (Fig.3). Its benefits of wind breaking and sand-fixation, conservation of soil and water, the stabilization of regional ecosystem, and ecological barrier on northern frontier, are far more than those of animal husbandry.

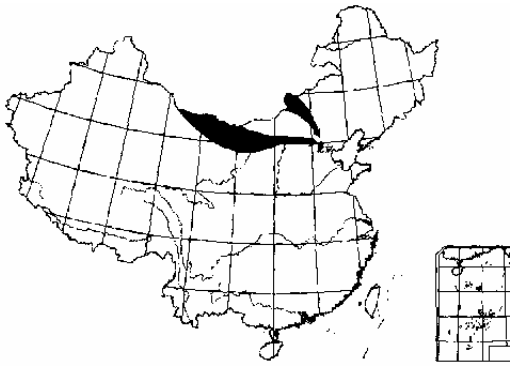

Fig.2 Location of Xilinguole grassland in China Fig.3 Moving routine of sandstorm affecting Beijing-Tianjin-Tangshan Region

1.3 Xilinguole grassland is deteriorating, the protection for this endangered area admits of no delay.

For many years, we only pay attention to economic functions of grassland without being aware of its ecological functions, which leads to excessive use of grassland and consequently, rapid depravation of its ecological environment, coupled continually with a great variety of serious natural disasters in the last few years. Compared the year 2001 with 1984, the average coverage of forage grass has decreased from 35.5% to 23.1%, average height of forage grass lowered from 40.9 centimeters to 22.2 centimeters, and the average yield per Mu, from 33.9 kg to 20.8 kg, and area of degraded and desertificated grassland amounted to 64% of existing grassland. In 2005, the

area of degraded and desertificated grassland is 74% of the total, according to the latest reported provided by Prospective Designing Institute of Inner Mongolia. Large-scale floating dust, blowing dust or sandstorm weather in the whole region have increased from 6 days per year in 1950s to 20 days per year at present. The Inner Mongolia and neighbor provinces suffered huge losses in some huge sandstorms occurring in consecutive years, which brought yellow sand muddy rain weather, and a great deal of ecological refugees. Due to drought in consecutive, frequent plague of locust and disaster of windstorm, Sunite grassland, as a vulnerable ecological environment, desertificated almost completely and merged with Hunsandake sands, which consequently become main source of blowing dust and sandstorm affecting Beijing-Tianjin Region. Almost all of Xilinguole grassland has been or tends to be the region of desertification, which will lead to the conjunction of all deserts in north of China and will threat ecological security of the northern or even whole China.

2 Xilinguole grassland is short of investment for protection and restoration

Although Xilinguole grassland has important ecological significance while its degradation brought comprehensive ecological effect and economic loss，fund for protection and restoration of grassland are very inadequate. The area of Xilinguole grassland is 200 thousand km2, about 1/48 of territory of whole China. But average national investment per year is less than 130 million RMB since establishment of PRC to 1985, and 100 million RMB from 1978 to 1999. In recent years, national investments to grassland are increased to average of 670 million RMB per year from 2000 to 2002, and 500 million RMB per year from 2002 to 2006. Although expenditure on grassland construction has been increased evidently in recent years, it is far less than that of grassland restoration; the latter is processing far more slowly than grassland degradation. Xilinguole consisting of 103 Shumu (towns), has established management station of grassland. The station used to employ 273 persons for management. So there are 567 persons in charge of supervisory management of grassland, only one person per 520 thousand Mu. What's more, equipments of supervisory management of grassland are lag in technology. Besides other natural, social, historical causes for grassland degradation, it should be noted that present investment and effort for construction can not meet the demand of ecological protection for grassland (Supervisory Management Bureau of Xilinguole grassland, 2005).

6.3.1 Analyses of the social-economic impacts of restoration measures on ecological functional reserves

The implementation of polices and measures played an important role In the grassland restoration and protection. But at the same time it has restricted the development of the local herdsmen who make a living by grazing and breeding. Thus, it has led to the decline of the living standards of the herdsmen, the emergency of the "returning to poverty" phenomenon, and the expansion of the poverty range. In 2001, the disposable income per capita of farmers and herdsmen in Xilinguole decreased to 1823 RMB from 2236 RMB in 1999. In rural and pastoral areas, the

poverty population increased from 52,000 people in 1987 when the "helping the poor" program was finished to 242,000 people which accounted for 41.3 percent of the total farming and raising population. Therefore, in rural areas, particularly in pastoral areas, the infrastructure construction lags behind, the self-development capability is inferior and other problems are increasingly severe. In addition, local inhabitants have made great contributions to the improvement of the ecological environments of other regions or even the whole country but have not received the corresponding compensations.

On the basis of investigation of 300 household of herdsmen, most herdsmen supported the seasonal grazing policy, accounting for 73.2 percent of the respondents. 21.6 percent thought that it would increase the input and decrease the output, 3.08 percent thought that the compensation funds were not enough, 16.2 percent thought that it would make their life insecure, 6.6 percent thought that it had a negative effect on the growth of the livestock. Thus, we can see that the main reason why those herdsmen did not support the seasonal grazing policy is that the compensation funds are not adequately enough.

The grassland resources are the basic means of production for the local stockbreeding. So the grassland degradation directly jeopardizes the sustainable development of the stockbreeding. The current measures of the ecological restoration are mainly to accelerate the natural restoration by reducing the scale of the stockbreeding, which has certain effects on the environmental protection and restoration but on the other hand has brought the local stockbreeding losses and directly influenced the amount and the processing of the local livestock products. Processing of the livestock products in Xilinguole started late. Most existing processing enterprises have been set up from 2002 to 2003 when the degradation of the grassland was the most serious. Although the influence on the livestock products exerted by the grassland degradation has come late, the influence on the enterprise production is pretty obvious.

6.3.2 Determination of eco-compensation standard

6.3.2.1 Measures of ecological restoration

Owing to ecological significance of Xilinguole grassland and actuality of degradation and desertification in the area, stall feeding has been adopted so as to reduce grazing pressure on natural grassland and to restore grassland vegetation. The action has been gradually converting traditional production system of livestock husbandry purely dependent on natural pasture into the one that can perform a self-rehabilitative function of natural grassland. Some measures and policies include the follows:

“grass-livestock balance” policy: Grass-livestock balance is a rule that restricts stock-carrying capacity according to type of grassland and yield of grasses per unit area. The rule can avoid heavy grazing so as to protect grassland effectively. It prescribes different maximum capacity of stock-carrying according to different type of grassland, enacts obligation contract, and strictly puts into effect the rules for rewarding and penalizing. Meanwhile, it monitors grassland intensively so as to regulate standards for stock-carrying capacity according to alteration of vegetation.

“Three grazing” policy: “Three grazing” is grazing prohibition, seasonal grazing, and rotational grazing. Grazing-prohibition is to prohibit grazing in some grassland areas with very poor ability of vegetation regeneration, where ecological environment is vulnerable. Closing pastures thoroughly for reservation can let grass grow and propagate so as to recover vegetation naturally. Seasonal–grazing is to feed in stall without grazing for 40 to 60 days every spring when pasture is in bud, so as not to have grass sprout gnawed in the period of turning green, and to increase yield of grasses. According to condition of water source, rotational grazing divides a pasture, usually one with good ecological situation and vegetation condition, into a number of sub-areas which graze in a rotational way, so as to put continuously grazing in control, to bring beneficial cycle to pasture, and consequently to achieve sustainable utilization.

eco-migration policy：The policy originally comes from the project of ecological emigration to support the poor. On the base of herdsmen’s own motion, the project of emigration to support the poor was performed for herdsmen in the few grassland which ecology has deteriorated too severely for them to survive purely depending on grazing.

Local government divided the whole Xilingguole grassland into “four sections, four strips, and twelve rings”. Grazing prohibition, seasonal grazing, and rotational grazing are implemented in “four sections” of land conversion from cropland to grassland and forestry. Green belts with 200 to 1000 meters in width, 1073 kilometers in overall length, were constructed in “four strips” along national highway and province road. Closing to prohibit grazing was performed for grassland in desertification area centered on twelve banner counties, with total area of 1.78 million Mu. With experiment initiating in 2002, this ecological protection and restoration for grassland area came into effect entirely in 2003.

The fund sources of the above policy are from the sand control, eco-migration, prohibit grazing, converting crop to forest, comprehensive agricultural development, drinking project of human and herds. Local government plans to allocate all funds as a whole to relevant banners and counties depending on the overall restoration

designing.

6.3.2.2 Eco-compensation standard determination for seasonal grazing policy

Seasonal grazing policy is the most widely used measure in Xilinguole Steppe. "Seasonal grazing (SG)" policy is to feed the livestock within the stall without grazing for 40 to 60 days every spring when pasture is in bud, so as not to have grass sprout gnawed in period of turning green, and to increase yield of grasses. which is essential for the recovery and protection of entire grassland ecosystem. It has been put into practice from the year 2002. In 2002, SG policy has covered 2,221,200 hm2, which is 11.3% of the total grassland; In 2003, it was increased to 8,658,200 hm2,44%; and 17,372,200hm2 and 88.1% in 2004; In 2005, SG policy has covered an area of 18,234,000hm2,including 98 Sumu(xiang, zhen, chang), 649 villages, 104,503 households, 5790,000 herds in 12 banner(county, town) , which is 92.5% of the grassland. Almost all the grassland has been covered in SG policy. Depending on the continuously investigation conducted by Inner Mongolia Grassland Investigation and Design Institute, after SG policy taking place herbage height has increased by 6.5-25cm, herbage coverage has increased by 8.2-50%, fresh grass yield has increased by 17.8-114.5kg per Chinese *mu*.

Seasonal grazing policy is the main restoration policy in grassland area in Xilinguole steppe, but it has no special fund support. Only a certain fodder and hay compensation accounting for 9.15 RMB/ hm2, far from meeting the losses from this policy. Seasonal grazing policy has strongest impact on local herdsmen. So herdsmen should be considered as the main objective to be compensated, the management organization should be considered as compensation objective in the protection of ecological functional reserve areas.

(1) Compensation standard based on the analysis of herdsman's willingness to accept (WTA) for seasonal-grazing[13]

Using Contingent Valuation Method a function of WTA is constructed by estimation of econometric model according to data from theory and questionnaire. Results showed that herdsman's WTA compensation for seasonal-grazing policy is positively correlated with annual household expenditure. Other factors such as age and educational status have no obvious effects. Using the statistical data of the year 2003 when the SG policy officially come into practice, Then the average herdsmen's WTA in different animal husbandry banners are estimated (Table 5) . The average WTA per household is 1.8555×10^4 RMB.

The Population Per Household in Xilinguole is 3.3233, so average WTA per person is 5581 RMB.

[13] See Yang Guangmei et al. (2006) for further information

The average grassland area per household is 4834.1 mu, so average WTA per mu is 3.83 RMB. In the region of Xilinhaote WTA per person is 6410 RMB, and 3.37 per mu.

Table 5 Herdsman's average willingness to be compensated in the main banner counties of animal husbandry, Xilinguole (unit: RMB)

	Xi city	Ah banner	Dong -shu banner	Xishu banner	Dong -wu banner	Xiwu banner	Xiang -huang banner	Zhengxiang -huang banner	Zheng -lan banner
per household	19680	19648	18078	18383	19759	18348	17700	18786	16612
per person	6410	5918	5413	6047	5566	5013	5584	5658	4815
per Mu	3.37	2.64	1.93	3.38	3.19	7.01	12.17	18.01	14.11

（2）Compensation standard based on the protection cost analysis

In order to determine actual validity and confidence level of theoretical willingness to be compensated, Xilinghaote region in the middle of Xilinguole grassland area, where 280 herdsman's families of Chaokewula, Shengli Sumu, Baiyinxile pasture and Sangendalai Sumu involved, was selected as the case to be analyzed in depth. The expenditure and income per household before and after seasonal grazing policy have been compared. Results show that after taking part in seasonal grazing policy hay expenditure has increased from 9514 RMB to 17937 RMB, with an increment of 8423 RMB per household; fine fodder expenditure has increased from 3188 RMB to 5667 RMB, with an average increment of 2478 RMB per household. Seasonal grazing measure has increased the input of breeding labor, veterinary medicine, shearing, lamb delivery, mowing grass has significantly increased. All these increment amounted to 14,897 RMB per household, and this is the lowest estimation of external cost of seasonal grazing policy.

Grassland's self-rehabilitative functions were utilized by seasonal-grazing measures for grassland restoration to rehabilitation of grassland vegetation, during which the main investment for construction of grassland is used for fencing. In project of withdrawing graze and returning to the grassland returning pasture to grassland, the nation and herdsmen shared the expenses of fencing, whereas in Xilinguole community, herdsmen bear these expenses on their own. The average expenses of fencing amount to 13.6 thousand RMB per household with average 4834 mu grassland per household. Besides the fencing, there are a series of infrastructural construction for grazing-prohibition such as construction of livestock shed, water resource facilities, forage grass base, etc. In terms of 20 thousand RMB of ecological construction cost for seasonal-grazing measures, which was shared by the nation and herdsmen with a ratio of 4: 6, 8000 RMB of compensation should be paid to herdsmen by the State.

Thus it can be seen that seasonal-grazing increases external cost for herdsman by 15 thousand RMB, and increases ecological construction costs, 8000 RMB of which paid by the nation. Consequently, compensation standard for seasonal-grazing is 23 thousand RMB in Xilinhaote region.

Taking into account that aggregate expenditure of herdsman's household is more than the data from statistical yearbook owing to seasonal-grazing, and hence given that the incremental expenditure of the community averages to 30% per household, average aggregate expenditure per household of herdsman in the whole community is 37.552 thousand RMB, and the compensation standard is 19.466 thousand RMB per household. With 64414 households involved in seasonal-grazing in banner counties of animal husbandry in Xilingguole community (based solely on the data of seasonal-grazing in 2005), about 1.25 billion RMB of compensation fund for seasonal-grazing is required each year.

（3）Final compensation standard determination[14]

Using the actual expenditure of the 280 households WTA of herdsmen in Xilinhaote region was calculated by WTA function. It is 22,000 RMB per household, which is close to the standard based on the protection cost. The compensation standard of herdsmen is put forward by consideration of herdsmen's WTA and their protection cost (Table 6). The average compensation standard in Xilinguole is 19,466 RMB per household, 5899 RMB per person and 4.06RMB per mu.

(4)Dynamic eco-compensation standard for herdsmen

Under the present circumstances, the eco-compensation standard for herdsmen in Xilinguole grassland is obtained by calculation according to herdsmen's expenditure under the condition of measures of ecological restoration just at present time. The main characteristic of the calculation is the way of figuring out livestock number of herdsman's household in terms of stock-carrying capacity of grass-livestock balance corresponding to the capacity of herdsman's household just at present time. Because in existing theory of grass-livestock balance, stock-carrying capacity is calculated not according to maximum availability factor of pasture's ecological function, but according to that of its economic one, reasonable stock-carrying capacity obtained by the calculation is a maximum one insuring pasture against degradation. Now that Xilinguole grassland is an important ecosystem functional reserve area, maximum stock-carrying capacity insuring pasture's restoration is to be calculated. According to local experience, there is a gap of 27% between the two capacities calculated above.

[14] All analytical details are in press

Table 6 Herdsman's Compensation standard in the main banner counties of animal husbandry (unit: RMB)

	Xi city	Ah banner	Dong -shu banner	Xishu banner	Dong -wu banner	Xiwu banner	Xiang -huang banner	Zhengxiang -huang banner	Zheng -lan banner
per household	20929	20887	18846	19243	21032	19198	18356	19767	16940
per person	6817	6291	5643	6330	5925	5245	5791	5954	4910
per Mu	3.58	2.81	2.01	3.54	3.40	7.42	12.62	18.96	14.19

Therefore, the period of restoration of ecological function in Xilinguole grassland ecosystem functional reserve area falls into three phases: the phase of inhibiting degradation and slightly restoring, the phase of transition, and the phase of ecological restoration. In the case of 3 to 6 years of restoration term for grassland, it is estimated that 3 years, 5 years, and 10 years are to be allocated respectively for each of the three phrases above. In every phase calculation is to be made according to the method above, with some necessary adjustments, so as to establish dynamic eco-compensation standard.

（5）Dynamic eco-compensation standard for management organizations

Some necessary supervision is needed to implement measures of ecological restoration. According to approximate estimation issued by Supervisory Management Bureau of Xilinguole grassland, each banner county (district)'s expenditure per year for "three grazing" management, grassland monitoring, and investigation of destroying grassland amounts to about 1.104 million RMB, the details are as follows:

- Fuel oil costs ("three grazing" management, grassland monitoring, investigation of destroying grassland, grass-livestock balance and so on) are: average fuel oil for each vehicle per day, i.e., 80 liters × 360 days × 4.8 RMB =138 thousand RMB. Hence 552 thousand RMB for each banner county (district) in the case of 4 vehicles.
- Expense for vehicle repairment: average of 30 thousand RMB for each vehicle per year × 4 vehicle = 120 thousand RMB.
- Travel expense: average of 80 RMB for each person daily (room and board, subsidy for business trip) ×360 days = 28.8 thousand RMB. Hence, each banner county (district) in the case of 15 persons costs 432 thousand RMB in average.

- Three items above amount to 1.104 million RMB. The whole region of Xilinguole grassland, which consists of 9 banner counties of animal husbandry, approximately needs outlays of 10 million RMB for managements per year.

According to management cost at the present stage, the compensation standard of management organization structure is 0.8 percent of that of herdsman. According to the investigation results of 280 households in Xilinhaote, herdsmen generally hold positive attitudes to the grassland restoration and protection as long as they are offered with reasonable compensation, and they therefore are willing to obey grassland management rules and regulations. If this kind of compensation is in cash, at the present stage and the transitional stage, compensation for management may reduce at least by 50%. At the ecology restoration stage, it may be reduced by 70% because of the termination of seasonal grazing policy.

6.3.3 The fund sources of ecological compensation for grassland restoration

(1) Governmental sources

Xilinguole grassland was allocated to herdsmen with contract since 1985. Herdsmen are assigned with usage right, which means use right of the grassland has been changed from public goods to semi-public goods. The grassland ecosystem can provide various services, such as water retentions, maintenance of water and soil, wind ward, sand and carbon stabilization, oxygen production, beautiful landscape and biology diversity protection, which shows typical external economic characteristics and bring benefits to stakeholders and reduce their production cost. This “free rider” makes the grassland management lack of fund. Government should rectify this by public policy to compensate the ecological benefits.

Xilinguole grassland is the main basement of pasturage-production, and the livestock market spreads across the country. The grassland is an important material source of livestock production. For a long time, it is regarded as the renewable resources which can be used freely and endlessly, and the price of livestock doesn’t contain the cost of grassland resource, which induces the overuse of resource and lead to the quality of grassland degraded. In addition, livestock-production industry is the major important source of the country and local revenue. According to the proportion of revenue distribution, the central government is the supreme benefit object, so the central government should take major responsibility for ecological recovery.

Xilinguole grassland wasn’t included in the project of “returning herds to grass”, which plays an important role in the restoration of the grassland. The project of “three-grazing” policy run by Xilinguole community voluntarily began in 2002, and it implementation faced with severe scarcity of fund. Most of the cost for ecological

protection and restoration was taken on by local residents, which made lots of herdsmen returning to poverty. Poverty is the main reason of ecological degradation. So the sustainable development of nature reserve should not solely emphasize on the obligation of protection. The relationship of protection and development of local residents should be moderated by strengthening governmental fiscal transferring.

(2) The beneficial area sources

Xilinguole grassland functions as the ecological barrier for Jingjintang area, and the ecological protection of Xilinguole grassland is directly related to the ecological quality in Jing-Jin-Tang area, so it is necessary to provide compensation for the efforts and opportunity costs involved in the ecological protection and recovery in Xilinguole grassland. It can internalize the external cost for protecting grassland environment by establishing the related policies. In this way, we can make the beneficial owners offer corresponding cost for ecological protection. The amount of money for compensation can be settled by consulting with the areas. Because of stronger economic power in Jing-Jin-Tang area than anywhere else, the figure of compensation fund between these areas varies at least 10%-15% of total amount, or 100 to 200 million RMB of compensation fund annually.

(3) The local beneficial enterprise sources

Grassland is the basic material for animal husbandry, which is directly related to the benefit of the local livestock-product enterprises. By investigating 50 enterprises in Xilinguole area, it can be can realized that most of the enterprises believe those who benefit from grassland should provide fund for the grassland ecological protection and recovery, and the reason why some enterprises are not willing to offer fund lies in the short time operation of the enterprises (approximately 2-4 years) and the lower profits which makes those enterprises incapability to pay. But when asked if they wish to pay if the profits are higher, most of the enterprises show their willingness to offer the fund.

Most companies are willing to pay taxes on ecological protection and restoration of grassland (approximately 79%), and the compensation method is based on annual profits of companies. According to Willingness to Pay (WTP) of typical grassland environmental protection in Xilinguole we know the average fee is RMB 9480 per company. At the end of year 2005 the number of companies which feature meat, milk, wool, feedstuff and other agricultural & livestock goods reached 200. If each company pay RMB 9480 fee for ecological protection, we could raise fund RMB 1.896 million for typical grassland ecological protection in Xilinguole, which is a collection of money if necessary because the size of processing plants is somewhat in less powerful.

(4) Individual sources

We investigated tourists in the region of Xilinhaote and Xiwuqi for their Willingness To Pay for the restoration and protection of the grassland. According to estimation function, the average fee of Maximum WTP is RMB 328 each person which could reflect the real economic condition. We set the traveling people was 1.47 million in 2004, and fundraise could reach RMB 488.1 million for typical ecological protection in Xilinguole. (The formula is 149*327.604=488.1*106)

An ecological protection fund could also be set up to accept all the donation of private individuals as one important supplement source of financing channel.

(5) International sources

Because of the unique geographic location and ecological effect of Xilinguole grassland, the degeneration could not only affect civil regions such as Beijing-Tianjin-Tangshan, but also impair welfare in South Korea, Japan and other neighboring countries. There are many ways for transference to gain common profits:

- Unilateralism payment, which means one-off payment via direct transference to compensate loss of not exploring grassland:
- Compensatory resources to be transferred, which means the victims could make living by other less destructive ways in order not to get environment degenerated. Technology aids and loans in favor of environmental protection are effective methods.

7 Recommendations on eco-compensation policies of nature reserves

7.1 To enact laws for the eco-compensation in nature reserves as soon as possible

The field research indicates that it is imperative to make laws for the eco-compensation, in other words, to determine the establishment and implementation of compensation approaches and standards in the form of law. The legislation mainly has two aspects as follows: The central government should enact the “Law of Nature reserves” as fast as possible and bring the eco-compensation provision into the law. Local governments should also set up corresponding implementation regulations, which aims to uniformly regulate and coordinate the guidelines, policies, systems and measures of the management of nature reserves, the construction of the ecological environment and the input of the eco-compensation funds.

7.2 To set up management institutions with high working efficiency in nature reserves

It is vital to encourage the construction of a cross-departments management institution. For example, the wetland nature reserves should be managed by a management committee composed of a variety of departments, such as water resource, land management, fishery and environment protection. Also, the natural forest nature reserves should be managed by a management committee composed of a variety of departments, such as land resource, water resource, agriculture, forestry and environment protection. However, duties, powers and benefits of different departments should be clearly distinguished. Integrated with the participation of the communities and the coordination of the former management bureaus in nature reserves, such a united management institution is a significant foundation for the biodiversity conversation in nature reserves and the social-economic development in the communities. The cooperation and the coordination between different departments can increase the intensity, the transparency and the fairness of the management

7.3 To improve the ability and the stakeholders' awareness of eco-compensation

Communities are the ultimate targets for the fulfillment of the eco-compensation mechanism. The knowledge, cognition and willingness of the community can directly influence the management of nature reserves. An important way to improve the management of the public resources is to change the current policy of "a clean cut" issued from the superior departments (Cook 2004; Xu *et al* 2006). Therefore, the community's participation should be encouraged for the eco-compensation mechanism and plan formulation, and their capability be improved through the implementation of the project (Waage 2005). In the less developed areas where are short of both talents and money, the capacity building of the government departments and the community organizations should be enhanced by participating in the related international projects so as to better conserve the biodiversity in nature reserves (Chen and Uitto 2003). In addition, the related capacity building should also includes decision makers, planners, managerial personnel and enterprise managers.

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