Managing Water Resources for a Sustainable Future: Law, Policy and Methodology of China

Xi Wang

Xiaobo Zhang

Wenkai Li

Dejin Gu

Yanfang Zhou

Xi Wang, Xiaobo Zhang, Wenkai Li, Dejin Gu & Yanfang Zhou, *Managing Water Resources for a Sustainable Future: Law, Policy and Methodology of China*, *in* ALLOCATING AND MANAGING WATER FOR A SUSTAINABLE FUTURE: LESSONS FROM AROUND THE WORLD (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 2002).

Managing Water Resources for a Sustainable Future: Law, Policy and Methodology of China

Wang Xi[*], Zhang Xiaobo[**], Li Wenkai[***], Gu Dejin[****], Zhou Yanfang[*****]

Notes for a panel presentation
at the conference on

"Allocating and Managing Water for a Sustainable Future:
Lessons from Around the World"

Natural Resources Law Center
University of Colorado School of Law

June 11 – 14, 2002

[*] Ph.D., Professor of Law, Vice Dean, School of Law, Shanghai Jiaotong University; former Vice Director, Research Institute of Environmental Law, Wuhan University, China. Member of Commission on Environmental Law, IUCN-The World Conservation Union. Email: wangxi@public.wuhan.cngb.com.
[**] LLM candidate in environmental law, School of Law, Wuhan University.
[***] LLM candidate in environmental law, School of Law, Wuhan University.
[****] LLM candidate in environmental law, School of Law, Wuhan University.
[*****] LLM candidate in environmental law, School of Law, Wuhan University.

Contents

Tables and Figures

Abstract. Water resources problem is a serious challenge to the sustainable development of China. This paper provides a rather comprehensive analysis on the law, policy and methodology on water resources management in China. Part I of the paper is a brief introduction to the state of water resources in China. In Part II, the authors provide an analysis on the law, policy and methodology in water resources management, including an analysis on the principles on water resources allocation and management, the major existing systems of water resources allocation and management, ownership and the right to use water resources in China, market mechanisms of water resources, prevention and control of water pollution, policies on different forms of water use and their practices, and water resources exploitation and use in minority nationality communities. Part III provides some evaluations to the law, policy and methodology in water resources management in China. Part IV provides some conclusions that based upon the analysis and evaluations of the previous parts.

1. The State of Water Resources in China

China is an agricultural country with large amount of population. The volume of water used in agricultural sector makes up 70 percent of the total amount, which plays a key role in stably providing food for China. Water resource is important for the stability of society. As the country is transforming from an agricultural one into an industrialized one, the volume of water used in industry is increasing. Sufficient supply of water resources is essential to the industrialization of China.

Because of the large scale of population, China is a country in short of water resources. The amount of water resources per capita owned is only 2340 cube meters, only one-fourth of that of the world average and occupies the 109th place out of 149 countries according to the UN statistics of 1997.[i] China has about 600 cities. More than half of those cities have water shortage problem. The shortage of water resources is a bottleneck which limits economic and social development.

Surface runoff is the main form of water resources in China. The natural quality of Chinese rivers is quite good. But most Chinese rivers are facing serious pollution caused by fast industrialization and urbanization. Water pollution is increasingly intensified in almost all surface water bodies. A survey conducted by the Water Resources Ministry in 2000 shown that among the monitored sections of 700 rivers of nine basins, the percentages of first to sixth classes water qualities were 4.9, 24, 29.8, 16.1, 8.1 and 17.1 respectively.[ii]

The total amount of water resources can be used is not very large. The total volume of water supply is 533.1 billion cube meters in 2000. Amount them, the surface

water supply makes up 80.3%, ground water supply makes up 19.3%, other sources of water supply including waste water recycling make up 0.4%. The per capita use of water is 430 cube meters per year.[iii]

The total amount of water consumption is very large. The total volume of water consumption was 301.2 billion tones in 2000, amounts to 55% of the water used. The rates for water consumed by the living of urban residents, the living of rural residents, industries and agriculture are 26%, 86%, 26% and 63%.[iv] Now, the rate of water resources development reaches 20%. Wasting water in water uses is serious. Low efficiency in water use is the main cause of the waste of water. The rate of per 10000 Yuan industrial production used water is 91 cube meters, amounts to 10 times of that industrialized nations. The rate of water recycling is 40%, while industrialized nations reaches 75-85%.[v]

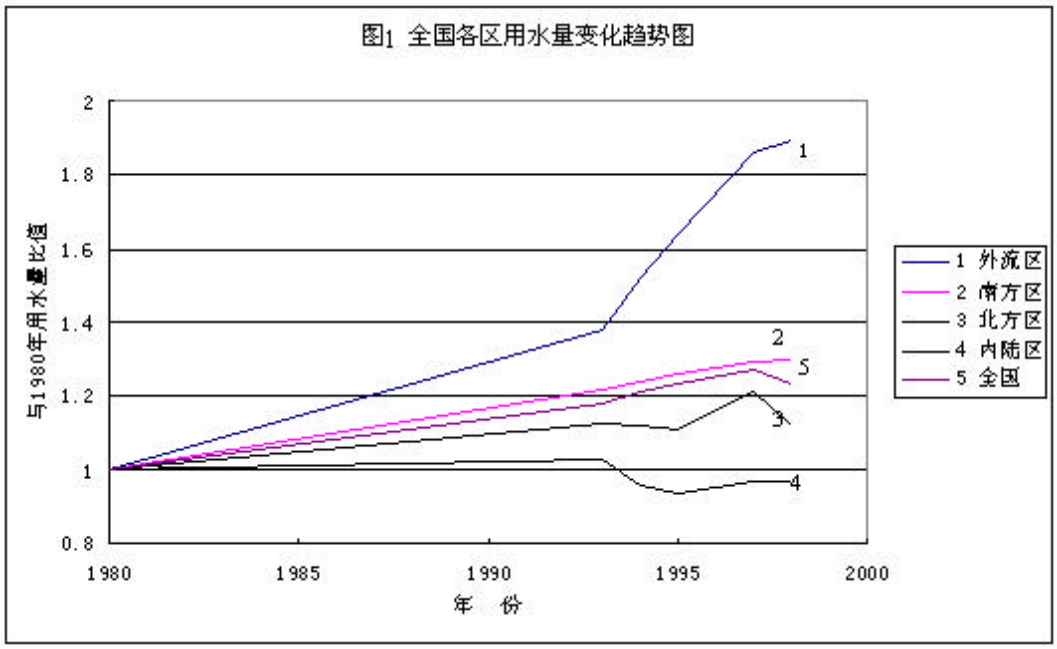
The spatial distribution of water resources in China is not balanced and redistribution of water resources is needed. Since 2000, China has conducted a number of trans-basin water resources allocation projects, including projects diverting water from Yellow River into Hai River Basin, from Yangtze River and Yellow River into Huai River Basin, from Yellow River into Shandong Peninsular, and from Yellow River into inland rivers in Hexi Area of Gansu Province. The largest trans-basin diversion project is the "South Water to North" Project, which will divert a large amount of water from Yangtze River to the north of China. The project is under planning stage at the present. It includes three diverting lines. The three lines are east line, central line and west line. The water diversion projects are mainly for the purposes of promoting economic development and alleviating the difficulties of water shortage suffered by the residents in the northern cities.

In addition, China began to have large scale water diversion projects for the purpose of ecological conservation in 2000. Those water diverting projects include projects of diverting water from Hei river in the northeast of China, diverting water from Talimu River in Xingjiang Vigur Autonomous Region, diverting water from Zhalong Wetland Area and Diverting water from Yangtze River into Tai Lake. Those water diversions are all for restoration of ecological environment of the receiving areas.

As the growth of economy, population and urbanization, the conflict between the demand and supply of water resources may be intensified. The shortage of water resources may cause two problems in addition to other problems. The one is that water used for developing economy may squeeze the water used for ecological environment. The second is that water used for industries and urban areas may squeeze the water used for agriculture and rural areas. The Sustainable Development and Water Resources Strategy Research Team of the China Academy of Engineering predicted that the population of China will increase to 1.6 billion by 2030 and that the per capita amount of water resources will decrease to 1760 cube meters, a quantity lower than the world-wide recognized threshold for water shortage countries.[vi] The study of the team predicted that the water demand would reach the limit of the available water by 2030.

However, the statistics on the growth of GDP and the quantity of water used shows that although the growth of GDP kept an average 9.7% increase rate, the quantity of water used did not dramatically increase from 1980. The annual increase rate of water used from 1978 to 1998 is only 0.1%.[vii] It is predicted that the total amount of demand water is between 720 billion cube meters and 800 cube meters by 2050. The average number is 760 billion cube meters. Considering all the potentials of water supply, such as that of surface water, ground water, trans-basin water allocation, seawater, small water bodies and water recycling and conservation, it is predicted that the total supply capacity can reach 745 billion cube meters by 2050.[viii] Therefore, following the increase of integrated strength of the various allocation and management measures and systems, the exploitation and use of water resources can become sustainable and can ensure the future generations' demands in the course of their development of society and economy.

Table 1 Quantity of Water Used by Four Regions and the Nation as a Whole



Notes:

1 = Region that surface water bodies running outward across boundary

2 = Southern Region

3 = Northern Region

4 = Inland Region

5 = Nation as a whole

Table 2 GDP (1952-2000) and Total Amount of Water Used in China

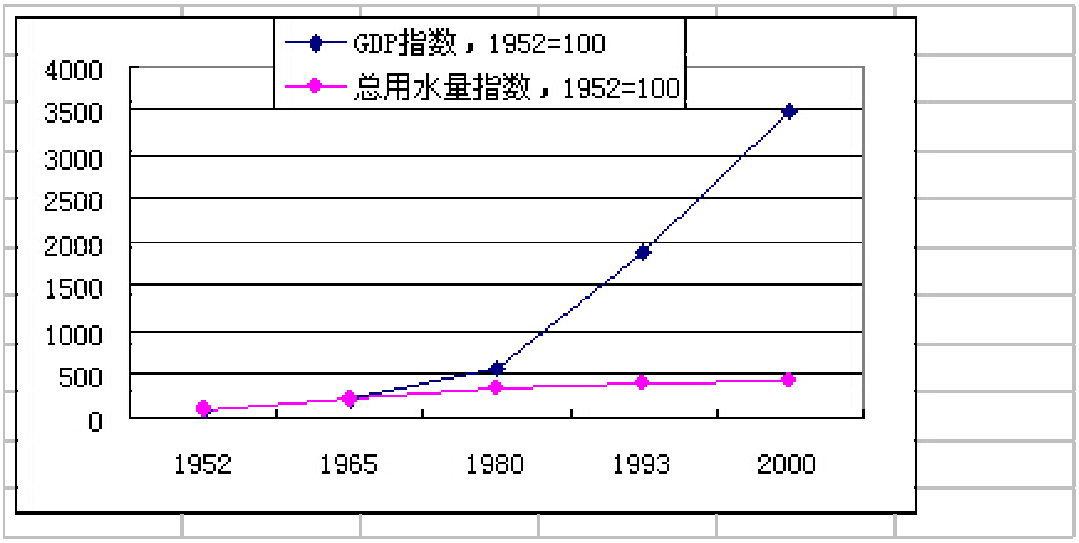


Table 3 Level of Water Resources Development

Basins	Average amount of water resources (100 million cubic meters)	Amount of exploited in 1997			Amount of exploited by 2050		
		Local uses (100 million cubic meters)	Diverted out (100 million cubic meters)	Level of development	Local uses (100 million cubic meters)	Diverted out (100 million cubic meters)	Level of development
The Nation	28 099	5 445	153	0.20	6 900	550	0.27
Songliao River	1 929	620		0.32	800		0.41
Hai River and Luan river	421	377		0.89	373		0.89
Huai River	961	568		0.59	778		0.81
Yellow River	719	403	105	0.71	337	30	0.51
Yangtze River	9 613	1 723	48	0.18	2 545	520	0.32
Pearl River	4 708	834		0.18	1 031		0.22
Rivers in Southeast	2 592	288		0.11	379		0.15
Rivers in Southwest	5 853	86		0.01	109		0.02
Inland rivers	1 304	547		0.42	548		0.42

Source: Wang Weizhong, ed., Analysis for the Trend of Sustainable Development of China, Shangwu Printing House, 1999, p. 2000.

2. Water Resources Management: Law, Policies, and Practices

Since 1980's, Chinese government started to make efforts in regulating and managing rivers and watercourses, and made its first try in water resources legislation. Since then, Water Law (1988), Law on Water and Soil Conservation(1991), Law on Prevention and Control of Water Pollution(1984, revised in 1996) and Law on Flood Control (1997) have been enacted. The state council and its subordinate ministries have issued more than 60 legal rules and regulations of water administration, and the provinces, municipalities and autonomous regions have worked out more than 300 local regulations and rules.

In 1990's, China established sustainable use of water resources as the strategy for the economic and social development. The guiding ideology of water conservancy has been changed from traditional water conservancy to modern sustainable water conservancy. To ensure sustainable development of the society and economy through sustainable use of water resources becomes the main target of management of and legislation on water resources.

2.1. Principles for Water Resources Allocation and Management

Several principles have come into being in water resources management and allocation by Chinese government:

2.1.1 The Principle of Coordinating Water Resources Exploitation and Uses for Economic Development with Social Development and Environmental Protection

Sustainable development is the general guiding ideology of environmental protection, and it is reflected in the field of water resources by coordination between exploitation and use of water resources for economic development with social development and environmental protection. This principle is the fundamental norm of water resources allocation and management. It requires that use and management of water resources be incorporated into the overall planning of national economy, water resources uses be combined with flood prevention and control, and enough attention be given to the social and biological benefits of water resources when seeking their economic benefits. Water saving and protection was put forward as a strategic task in the Proposals of the Central Committee of the CPC on Formulating the Tenth Five-year Plan of National Economy and Social Development, which requires "overall planning, considering all factors when planning, treating the problems by looking into both the root causes and symptoms, and comprehensive controlling, promoting what is beneficial and abolishing what is harmful, paying equal attention to resources exploitation and

consumption reduction, preventing flood and fighting drought at the same time, and sparing no effort to solve the problems of floods, water scarcity and pollution." The Water Resources Ministry also requires that the balance between water supply and demand in both urban and rural areas be achieved through planning of water resources protection, pollutant discharge control and water quality monitoring; frequent floods, water logging and droughts be avoided; water pollution be prevented and controlled; subsistence use, ecological use and production use of water be planned as a whole and be coordinated comprehensively.

2.1.2 The Principle of Rationalism

Rational Exploitation and Use of Water Resources. Rational exploitation and use of water resources requires, first of all, that different types of water resources be exploited according to the objective conditions and reality of water supply and demand. The feasibility of the exploitation should be justified in advance in order to ensure the sustainable use of water resources. Secondly, water function zones should be divided scientifically. Objectives of water quality protection in certain areas should be defined and the activities of exploitation and use in the water area should be regulated. Water function zoning is the scientific and rational division of zones. It is based on river basins and aims at rationally exploiting and effectively protecting water resources that have specific functions. The total quantity of pollutants discharged should be worked out on the basis of water function zoning.

Rational Allocation of Water Resources. Optimized allocation of water resources is the prerequisite of sustainable use of water resources. According to the national development strategies and regional development demand, water resources should be distributed both between different river basins and within river basins. Allocation between different river basins refers to the trans-basin projects, constructed on the basis of adjusting industrial structure and water saving, which divert water resources into the regions where the amount of water resources per capita is low and the water ecology is out of balance.[ix] Allocation within river basins refers to the total amount control of water quantity and quality, with the aid of water resources controlling projects, with a view to enhancing the management of water resources demands and improving water use efficiency. For instance, as to the allocation of stream flow of Hei River, the principle of total annual amount control, the parallel principle and the principle of monthly rolling revision have been established.[x] The auxiliary systems such as compensation mechanism of water resources use and restoration mechanism have to be set up in order to achieve rational allocation on the levels of river basins, administrative regions and cities.

2.1.3 The Principle of Efficiency

Efficient Use of Water Resources. The core of sustainable use of water resources is to improve the efficiency of water use, and due attention should be paid to

the supporting capacity of water resources in urban development and production layout of industry and agriculture. On the one hand, water saving measures are to be promoted, water saving agriculture, industry and service trades are to be developed, and water saving society is to be established. On the other hand, the protection and improvement of water resources is to be strengthened, and special attention should be paid to the ecological use of water, and the prevention of water pollution.

The Effective Management of Water Resources—the Integration of Water Resources Management. The scarcity of water resources in China and the seriousness of the water problems in urban areas put an urgent demand on establishing integrated management system and competent authorities for water affairs. Integration of the competence of national water administration is needed. At present, the Management Office of Water Environment under the State Environmental Protection Administration (called Water Office for short) is in charge of preventing and controlling water pollution, and supervision water pollution control in the key river basins and trans-province water pollution.[xi] Bureaus of Water Affairs have been set up in Shanghai, Shenzhen and Wuhan, etc. Regulations of Guangdong Province on Water Management (for Trial Implementation) expected to be published later in this year provides explicitly that the competent department of water administration be uniformly in charge of the management of water resources, and the other related departments assist the competent department according to their own responsibilities. The establishment of the competent department of water administration provides favorable conditions for implementing the targets and tasks determined by the State in an all-round way. Only on the basis of uniform management and allocation of water resources, can the development scale of a city and the direction of its industrial structure adjustment be properly defined, in accordance with the situation of water resources in the area.

Secondly, the effective management of water resources also requires the integration of water basin management and regional management, specifically, the integrated allocation of water resources over different administrative regions, both between and within river basins. River basins are the basic units of water resources management, and the authorities in charge of river basins are the main bodies of water resources management in the river basins in China. Water Resources Commissions have been set up for the seven major rivers basins like Yangtse River and Yellow River by the Water Resources Ministry, representing the management functions of the Ministry in the river basins. Management based on river basins overcomes the limitations of administrative divisions in trans-boundary water resources management, which is helpful to drawing all the stakeholders into the process of planning and decision-making, and thus to properly allocating water resources. However, owing to the history and the characteristics of the river basins, the role the authorities of river basins play in the management of water resources is less than expected. Therefore, it is necessary to take measures to improve the authority of the basin commissions. Plans for both the inter and intra basins water allocation projects should be drawn up by Water Resource Ministry in consultation with other relevant ministries and departments of the State Council, as well as the governments of the related provinces, autonomous regions and municipalities

directly under the jurisdiction of central government, giving equal consideration to the interests of both the upper reaches and the lower reaches, both the left and the right banks, and of different districts.

Thirdly, the management of water supply and demand should be integrated. The previous model centered on the management of water supply should be replaced by the model which manages the demand, supply and use of water at the same time, and decides on water demand on the basis of water supply. The development scale of cities should be controlled, strict limits should be set on the development of industries and agriculture that require high water consumption and serious pollution is forbidden in the areas in short of water resources.

2.2. The Major Existing Systems of Water Resources Allocation and Management

2.2.1 The System of Comprehensive Planning of Water Resources

The Water Law requires that scientific investigation and assessment be conducted by the competent department of water administration under the State Council in consultation with the other related departments, before the exploitation and use of water resources. On March 15, 2002, the Water Resources Ministry and the State Development and Planning Commission jointly issued a notice, saying that 3 years shall be devoted into the drafting of a comprehensive national plan for water resources. It includes the following basic tasks, 1) assessment of the present situation of water resources exploitation and use; 2) drafting plans for water saving, water resources protection and sewage treatment; 3) analysis of both the potential of water resources exploitation and use and the sustainability of water resources; 4) drafting water resources allocation schemes; 5) working out the arrangements for exploitation, restoration, distribution, saving and protection of water resources as well as the implementation scheme of all the measures; 6) drawing up the countermeasures and methods of water resources management and setting up management systems of water resources suitable for the socialist market economy, etc.[xii] The comprehensive plans of water resources granted by the State Council is legally bounding, and will provide scientific basis and norms with legal effects for the macro-management of water resources in a period of time in the future.

2.2.2 Management Based on Water Function Zoning

After two years' efforts, water function zoning has been completed basically. The China's Water Function Zoning has passed the review of experts on January 22, 2002, and has been put into trial implementation. The zoning includes two levels, namely the first level zoning and the second level zoning. The first level zoning deal with the problem of water resources exploitation and use on a macro scale, mainly coordinate the

relationship between different regions and considering the demand of sustainable development. The second level zoning mainly coordinates the relationship between different water-using departments. Leading functions and the gradation of functions of each water area have been defined. Targets of preventing the functions of water areas from being damaged have been worked out.

2.2.3 Real Time Monitoring Mechanism

Real time monitoring is to monitor in real time the situation of water resources and the operation of engineering facilities and to optimize the allocation of water resources in a river basin or a region, on the basis of modern information technology. It requires that, information of water resources in a river basin or region and other related information be collected, transmitted and processed in time. It requires to build up a communication network connecting the information systems of all levels of the government. It provides favorable conditions for allocation of water resources and immediate response of water pollution accidents. Recently, the Ministry of Water Resources has granted for construction of real time monitoring systems for the water sources areas of Beijing-Tianjing region, the upper reaches of Guanting and Miyun Reservoirs of Beijing. The real time monitoring system for Tai Lake Basin is to be constructed later this year.

2.2.4 The System of Optimized Allocation of Water Resources

Sine water resources becomes increasingly scarce resources, the allocation of water resources is actually allocation of economic and other related benefits. Conflicts between different interests are sharpening up in the process of economic transition. The traditional allocation system of water resources meets neither the demand of optimization of water resources allocation, nor the requirement of coordinating different interests. The so-called optimized allocation refers to the distribution of various forms of water resources over different regions and users, including different river basins as well as that of stream flow over different reaches of a river basin, in a way that take cares all the interests involved. In order to ensure the effective implementation of water allocation schemes, preparatory scheme, allocation norms and legal regulations are to be provided. The optimized allocation of water resources will be the main approach to solve the serious problem of water scarcity in China.

2.2.5 The System of Water Extracting Permit

According to Water Law and The Implementation Provisions of Water Intake Permit System, permitting for water extracting in advance by the competent department of water administration is required, except those of small quantities of water intake determined by the law and those exempted from permit application by the law. The water extracting permit shall firstly guarantee the use of water by the residents for their

living, with due consideration for industrial, agricultural, navigation and ecological protection, in accordance with the comprehensive plans of water resources development, and the national and local plans of water supply.[xiii]

2.2.6 The System of Water Resources Fee

The system of compensated use of water resources has been adopted in China. Article 34 of Water Law provides that water resources fees shall be levied from the one who directly extracts water from urban ground and that for others who extracting water from ground or river or lake, the governments of provinces, autonomous regions and cities directly under the State Council have the discretion to decide if levy a fee or not. The Industrial Policy on Water Conservancy has further provisions on water resources fees. It requires to levy the fee and the fee shall be used as a special fund for water resources conservation.[xiv]

2.2.7 The System of Water Resources Protection

Water resources protection includes protection of surface water and protection of ground water. Water Law forbids reclaiming land from a lake, unless the need is justified by scientific proving. It also forbids reclaiming land from rivers. It puts strict limits on water intake in those areas where the intake exceeds the standards determined by the law, and requires that measures be taken to protect ground water resources and prevent surface subsidence.[xv] Law on Environmental Protection (1989) and Law on Prevention and Control of Water Pollution (1984) also provide for a number of protective systems for the quality of water, such as the system of classification of water resources and quality, the quality standard of water environment and the pollutant discharge standard, the system of pollutant discharge permit, the system of pollutant discharge fee, the system of environmental impact assessment, and the system of "three at the same time" (i.e., the facilities of water pollution prevention and control of a construction project shall be designed, constructed and put into protection at the same time when the main body of the project is designed, constructed and put into use).

2.3 Ownership and the Right to Use Water Resources

2.3.1 Definition of Water Right

Ownership of water resources in China can be categorized into two kinds: one is the state ownership and the other is the collective ownership. Article 9, paragraph 1 of the Constitution of People's Republic of China (1982) provides that natural resources such as minerals, water flows, forests, mountains, grasslands, wastelands and beaches are belong to the State i.e. to the whole people. Article 3, paragraph 1 and 2 of Water Law 1988 provide further that water resources belong to the State and that pools and

water in reservoirs owned by agricultural collectives belong to the collectives. The State Council is the representative of the ownership of water resources in China.[xvi]
The ownership is not an abstract concept, but contains plenty of contents, i.e., it contains a number of subsidiary rights. Article 71 of the General Principles of Civil Law provides that property ownership" means the owner's rights to lawfully possess, utilize, profit from and dispose of his property. The subsidiary rights of the state ownership of water resources is legally transferable, and the state does not have exclusive rights of use. The paragraph 1 and 3, Article 81 of the General Principle of Civil Law provides that "State-owned forests, mountains, grasslands, un-reclaimed land, beaches, water surfaces and other natural resources may be used according to law by units under ownership by the whole people; or they may also be lawfully assigned for use by organizations under collective ownership. The state shall protect the usufruct of those resources, and the usufructuary shall be obliged to manage, protect and properly use them" and that "the right of citizens and collectives to lawfully contract for the management of forests, mountains, grasslands, un-reclaimed land, beaches and water surfaces that are owned by collectives or owned by the state but used by collectives shall be protected by law. The rights and obligations of the two contracting parties shall be stipulated in the contract in accordance with the law". The Article 3 of the Water Law explicitly provides that the State protects the legal rights and interests of the entities and individuals who exploit water resources according to law.

Organizations and individuals have the right of use of China's water resources, apart from the state. The right to use mainly takes the form of a right to extract water, including right to extract water without a permit and right to extract water with a permit. According to the Water Law and the State Council Provisions on Management of Extracting Water, the following water extracting activities do not need permit: 1) extracting water for family living and livestock; 2) extracting small quantity of water for agricultural irrigation; 3) extracting small quantity of water by human force, animal force or other methods; 4) extracting water for resisting drought; 5) extracting water for the safety of mining production and mining construction; and 6) extracting water for preventing or eliminating hazards to public security or public interests.

2.3.2 The System of Marketable Water Rights

The definition and distribution of marketable water rights are the preconditions of the establishment of water rights markets. As what has been mentioned above, the ownership of China's water resources belongs to the state, and it is not marketable. Therefore, the marketable water rights can only be the right of use of water resources. On March 12, 2001, on a Sino-Japanese Symposium on Water Resources, Jing zhengshu, the Vice minister of the Water Resources Ministry, said that Chinese government is actively planning to change the state monopoly over the right to use water resources, and will open up step by step the market for the trade of water rights.[xvii]

There are two forms of water rights trade. First is the allocation of water for public sectors under administrative or judicial intervention, such as large-scale diversion.

The Yellow River Basin was the first basin where the allocation of the rights of water use was conducted. Because of the serious problem of no-stream flow in the lower reaches of Yellow River, which happened nearly every year in the 1990's, the regional ecological environment was increasingly deteriorating. Under the approval of the State Council, in December 1998, the State Planning Commission and the Water Resources Ministry jointly issued a Scheme of Distribution of the Water Supply and Allocation of Mainstream Flow of Yellow River, which empowers the Yellow River Commission to allocate the stream flow of Yellow River. In the drought year of 1999, diversion of water was successful.

The second is trading water for private sectors by means of sale, transfer, lease, etc, namely, the direct transfer between individuals or entities. In November 24, 2000, Dongyang City and Yiwu City of Jinhua Prefecture of Zhejiang Province signed an agreement on compensated transfer of the right to water use. According to the agreement, about 50 million cubic meters of water in the Hengjin Reservoir of Dongyang City will be bought away by Yiwu City after 2003. This is the first case of trans-city water right transfer in China, breaking the state monopoly over the right to use water resources, and becoming the precedence of the reformation in the system of water rights in China.

However, China cannot completely leave the distributable quota and water rights to the market, and it must guarantee the water for ecological uses and the sustainable use of ground water by means of macro-control of the State.

2.4 Market Mechanisms of Water Resources

Market mechanisms are effective approaches of water resources allocation. Under the precondition of explicit definition of water rights, it'll be possible to realize transfer and trade between the owners of water rights through water markets. The water markets can be divided into two levels: the first level market and the second level market. The former refers to the market for the owners of water resources and the explorers or operators of water resources, and the latter refers to the market for the trade of water between the users of water resources.

The symbol of the establishment of water resources market is the levy of water resources fee by the owners on the users or operators in China. Although China has adopted the system of water resources fee, the system has not been implemented in an all-round way. As far as Yellow River Basin is concerned, only three provinces, namely, Shanxi, Shaanxi and Inner Mongol have started the levy of water resources fee. What's more, the levied fee is not turned in to the central government, which indicates that it is in essence an administrative management fee, instead of the compensation for water resources use. Therefore, the first level market has not come into being in China.

A small number of cases exist in the respect of the second level market. The so-called First Case of Chinese water rights trade was the one between Dongyang and Yiwu as above mentioned.[xviii] It is the only case of the second level market for water resources trade in China till now.

Many prerequisites are still wanting for the formation of Chinese water resources market.[xix] First of all, the theory of water rights is to be completed and the related legal systems are to be set up. The formation of water resources market is based on the primary allocation of water rights. However, none of the contents of water rights, or the acquisition methods and compensation, or rules of water rights trading are theoretically sound, neither are they provided for by the law. Secondly, both the effective demand and effective supply are to shape up. This is a key factor of the formation of second level market. Effective demand depends on the proportion between input and benefit. However, most of the areas in want of water are economically backward with serious waste of water resources, and cannot afford to buy water, or it is more economical for them to save water than to buy water. This in turn restrains effective demand. Water resources transfer requires large volume of investment in exploitation and water saving, and it is of high risk without guarantee of stable systems. Therefore, a series of conditions are to shape up before the formation and development of Chinese water resources markets.

2.5 Prevention and Control of Water Pollution

The measures adopted by Chinese government to prevent and control water pollution are enumerated as following:

- To strengthen water pollution control based on river basins. In the recent years, the Chinese government launched a campaign for water pollution control in all the major basins of rivers or lakes and good results have been achieved till now.[xx]
- To strengthen the construction of treatment facilities of urban sewage and to market waste water treatment, as well as to raise the ratio of water pollution treatment. Especially in the cities where the construction speed of water supply facilities has exceeded the increasing rate of water demand, capital should be centralized into the construction of wastewater treatment plant. In 1997, the treatment ratio of Chinese industrial wastewater was 78.9%. 54.5% of the discharged wastewater met the effluent standards. The control of industrial wastewater has been enhanced. For implementation of the Chinese Trans-century Green Project Plan, 99 water pollution control projects have completed, and 325 water pollution prevention projects are under construction.[xxi]
- To set time limits for the dischargers to meet the standards. For the sake of the protection of ecological environment and water pollution prevention and control,

middle-sized and small enterprises with backward techniques, low efficiency and heavy pollution, such as small paper making factories, chemical factories, brewing factories and tanning factories are banned by law since 1997.

- To improve the transparency of water resources information. The Yangtse River Basin is one of the regions with fastest economic development, accounting for 35% of Chinese water resources. In the past, Communique of the Quality of Yangtse River Water Resources, as the monitoring results, has been turned in only to the related department of the government, and kept as internal information, unavailable to ordinary citizens and units. With the development of Pudong District of Shanghai City, the construction of Three Gorges Project and the Project of Diverting Water from the South to the North, water resources of Yangtse River Basin and the problem of ecological environment have become a focus of the social concerns. In order to improve the transparency of water resources management and effective participation of the public, the Bureau of Yangtse River Water Resources Protection decided to publish monthly the Communique of the Quality of Yangtse River Water Resources, releasing information about the water quality of key areas of Yangtse River, water quality of the river within the boundaries of provinces and the water quality of the origin areas in key cities, etc.

2.6 Analysis of Policies on Different Forms of Water Use and Their Practices

Water resources management is based on classification of water resources, i.e., the system of water function zoning in China. Surface water is categorized into five classes according to the purpose of use and protective targets in Quality Standards for Surface Water Environment (1998). The first class water zones are river source areas and national reserves. The second class water zones are centralized drinking water source areas under first class protection. The third class water zones are the centralized drinking water source areas under the second class protection. The fourth class water zones are the general industrial used water areas and non-human body contacted recreational water areas. The fifth class water zones are areas for agricultural used water and general landscape used water areas.

According to the different functions of water resources, uses of water can be divided into economic uses and ecological uses. Economic uses include uses for maintaining human existence uses and uses for industrial, agricultural and other uses for economic purposes. Ecological uses are uses for maintaining stable and balance of ecological systems. Different water uses need different volumes of water. According to the latest communiqué of national water resources published by the Water Resources Ministry, the total volume of water consumption in 2000 in China was 549.8 billion cubic meters, 378.4 billion for agriculture accounting for 68.8%, 113.9 billion cubic meters for industry accounting for 20.7%, and 57.5 billion for subsistence accounting for 10.5%. Compared with the previous year, the total volume of water consumption was 9.3 billion

cubic meters less, 1.2 billion more for subsistence, 2 billion less for industry, and 8.5 billion less for agriculture.[39]

2.6.1 Economic Use

According to National Development Compendium of Agricultural Water Saving 2001, 70% of the total fresh water consumption was for agriculture, 90% of which was for irrigation. Since surface irrigation will still be the main technique of farmland irrigation in China for a long period of time, accounting for 97% of the area of irrigation, the water-saving irrigation techniques should focus on the improvement of surface irrigation. Spraying irrigation and dripping irrigation can be adopted where conditions permit. With the popularization of agricultural water saving, the traditional extensive farming and farming in dry land are being replaced by the modern irrigation farming and modern dry farming, and the efficiency of agricultural use of water is being raised continuously. Cangzhou Prefecture of Henan Province reduced the frequency of wheat irrigation from 5-7 to 2-3 times, through scientific water saving techniques, with larger yield. This can be taken as a guiding experience for certain areas. Besides, dry farming is an important approach to solve the water crisis of Chinese agriculture and to increase the agricultural output. In the foreseeable future of China, the irrigation area is not likely to exceed 50%, and so the water saving high-efficiency agriculture contains two parts, namely, irrigation farming and dry farming. Studies show that, through the construction of water saving high-efficiency agriculture, China is able to meet the demand of 1.6 billion people for agricultural products with present farmland scale and the volume of water used for irrigation. [xxiii]

On the other hand, industry is the largest water consumer in China. It has a great potential of water saving. In the meantime, the ideology of "basing need on supply and basing development on water" has been established, water saving facilities and techniques is being promoted, the efficiency of resources use is being raised in the production process, and pollutant discharge is being reduces. Clean Production ensures environmental benefits and economic benefits at the same time, and it is of strategic significance to the economic development and environmental protection in China.

At present, there are some national standards on water quality for the water bodies that used for industry, agriculture fishery, such as Quality Standard for Farmland Irrigation (1992) and Quality Standard for Fishery (1989) [xxiv]. Besides, Law on Prevention and Control of Water Pollution empowers the people's governments above county level to line out reserves for important fishery water bodies, and to forbid construction of new pollution sources, thus to ensure that the water sources meets the quality standards set for certain purposes.

2.6.2 Subsistence Use

Subsistence use of water accounts for only 1/10 of the total consumption volume. With the population growth, the improvement of living standard and the heightening of

urbanization rate, the subsistence use of water is increasing rapidly. Subsistence use of water includes that for drinking, sanitation and entertainment, and giving priority to subsistence use of water is a principle of water resources management and allocation in China. Law and policies on subsistence use of water contain the quality standards for drinking water and cycling system of urban water use.

Law on Prevention and Control of Water Pollution empowers the government to designate and protect water sources for drinking water and to protect certain water area and land area near the place where water is extracted. Water pollutants are not allowed to be discharged in nature reserves. Construction of new projects or extension of old one which are not related in any way to the water supply facilities and riverhead protection is forbidden in the reserves, and the existing pollutant outlets shall be dismantled within time limits.[xxv] There are some further provisions for implementing the provisions of the Law on Prevention and Control of Water Pollution, Sanitary Standards for Drinking Water (1985) formulated by the sanitation department and Quality Standards for Landscape and Entertainment Use of water (1991) formulated by the State Environmental Protection Bureau are among those provisions.

For saving water for subsistence use, a large number of big cities have started to raise water fees or to fix higher prices for the water uses exceeding the quota. Some cities in lack of water have adopted measures, in dry seasons, to rebuild the networks of urban water supply pipes, and to supply time with time limits and volume limits.

Since 1998 when the Chinese government adopted active financial policies, China has invested and constructed large quantities of urban sewage treatment facilities. The implementation of water treatment projects in Haihe, Liaohe, Huaihe, Dianchi, Taihu and Chaohu Basins greatly expedited the construction of wastewater treatment facilities in these regions. By the end of 2000, China has set up 427 urban sewage treatment plants, 282 among which are second grade biochemical plants with a total treatment volume of 14,750,000 cubic meters per day. The Plan for the Tenth Five-Year Plan of National Economy and Social Development provides that, during the “tenth five-year”, all the major cities should establish wastewater treatment facilities, and by 2005, the centralized treatment rate of urban sewage should reach 45%, and the treatment volume should exceed 40 million cubic meters per day, with the second grade biochemical plants accounting for most of it.

2.6.3 Ecological Use of Water

It is estimated that, the total volume of all forms of ecological use throughout the country adds up to 80 to 100 billion cubic meters (including 5 to 8 billion cubic meters ground water in excess of the standard) in order to achieve remarked improvement of ecological environment by 2030, mainly in Yellow River and Hai River Basins, and inland river basins, with the former accounting for 50 billion cubic meters and the latter 40 billion cubic meters. About 60 billion cubic meters of the above-mentioned ecological use of water is supplied by the surface and underground water that has not been

controlled effectively yet, about 20 billion cubic meters is supplied by the returned water from industrial and agricultural uses and subsistence use, and the gap of the rest 11 billion cubic meters is filled up by the transfer from outside the regions.[xxvi]

Protecting and Restoring the Natural Vegetation and Ecological Environment of Inland Rivers. Protection and management of source areas of rivers should include ecological restoration planning. The forest coverage rate of Yangtse River has dropped from 30% in 1930's to 10%, and the function of the river as "natural reservoir" has weakened. The total amount of soil erosion throughout the basin is about 2.4 billion tons, 71% of which comes from the upper reaches. To solve this problem, the Chinese government and related experts proposed to make researches on the environment alteration in the upper reaches of Yangtse River, the demonstration of ecological restoration and the sustainable development of the river basin.

Guarantee Water Uses for Water and Soil Conservation. Water and soil conservation effectively reduces mud and sand washed into the river. The water used for soil conservation is of small influence in moist areas, and of remarked influence in arid and semi-arid areas. But since this form of water use is positive, it should be ensured. The Outline of Ecological Protection provides explicitly that, schemes of water and soil conservation be formulated for the key projects of all forms of natural resources, or else, the projects should not be allowed to be constructed. Till now, the results of water and soil conservation are evident in middle and small river basins, but not so evident for the main stream of Yangtze River. Long-term experiment and observation are to be conducted.

Maintaining the Basic Ecological Flux in Wetlands and Water Areas. On November 8, 2000, Plan of Chinese Wetland Protection was jointly issued and brought into effect by 17 ministries and commissions under the State Council. It was designed to promote wetland protection activities towards an unified direction. According to the plan, the impacts upon natural wetland induced by human activities are to be checked and the management system of wetland protection and exploitation are to be established.The experiments on wetland restoration were to be conducted in 5 years. From 2006 to 2020, the degraded and lost wetlands are to be restored and the Chinese wetlands and their biodiversity are to be effectively protected. The plan gave priorities to 39 projects, including the protection and exploitation of mangrove, and the restoration and reconstruction of wetland in the middle and lower reaches of Yangtse River.[xxvii] Besides, water conservancy projects such as the ecological water diversion projects in Talimu River and Zhalong wetland and water replacement project in Taihu Lake are all planned and constructed. Those trans-regional allocation water resources are to maintain, raise or improve the ecological use of water in the receiving areas

Refilling Groundwater Bodies in Huanghuai Plain and Other Places. The exploitation rate of shallow groundwater in China's plain area is 100%, and the consumption rate of total water resources reaches 96%. The main means to protect

ground water in the area is to set restrictions on and even forbid the extraction, and to replenish underground water where conditions permit. Jiangsu Province, Suzhou, Wuxi and Changzhou Prefectures in the economically developed eastern China started to forbid extraction of underground water within time limits from 2001. Water level of 40% of the underground water in the forbidden areas has risen again, that of 25% of the underground water has remained stable, and the subsidence rate of part of the area has slowed down.

2.7 Water Resources Exploitation and Use in Minority Nationality Communities

2.7.1 General Situation of Water Resources Exploitation and Uses in Chinese Minority Nationality Communities

China adopts the system of minority nationality autonomy, and establishes autonomous regions in the localities where minority nationalities live. Till the end of 1997, there are 155 autonomous localities, including 5 Autonomous Regions, 30 Autonomous Prefectures and 120 autonomous counties, with a total population of 164.08 million, accounting for 13.6% of the total population of the country, The total area of the autonomous localities is 6,137,000 km^2, accounting for 63.9% of the total area of the country.[xxviii]

Water resources are comparatively scarce in the regions of minority nationalities. The five autonomous regions account for only 28% of the total amount of water resources of the country (figure 4 and 5), but the utilization rate of water resources in these regions is comparatively high, and basically meets the demand of industries and human liveing. For example, Xinjiang Uygur Autonomous Region extracts 46 billion cubic meters surface water a year, which accounts for 50% of surface runoff, 3 billion cubic meters ground water, which accounts for 12% of ground water reserve.

Figure 4 1998 Water Resources Volumes in Administrative Divisions

(Unit: 0.1 billion cubic meters)

Province (Autonomous Regions and Municipalities)	Precipitation	Surface Water	Underground Water	Overlapped Surface and Ground Water	Total Amount of Water Resources
National	67630.7	32725.6	9400.0	8108.5	34017.1
Inner Mongol	4276.8	1010.5	266.0	120.5	1156.0
Guangxi	3960.7	2418.7	658.5	658.5	2418.7
Tibet	7893.4	4945.7	1344.3	1344.3	4945.7
Ningxia	162.1	9.2	30.9	28.9	11.2
Xinjiang	3340.7	914.3	662.6	598.2	978.7

Source: Communique of Chinese Water Resources 1998, issued by Water Resources Ministry

Figure 5 1999 Water Resources Volumes in Administrative Divisions

(unit: 0.1 billion cubic meters)

Province (Autonomous Regions and Municipalities)	Precipitation	Surface Water	Underground Water	Overlapped Surface and Ground Water	Total Amount of Water Resources
National	59702.4	27203.8	8386.7	7394.8	28195.7
Inner Mongol	2585.9	313.5	238.1	114.0	437.6
Guangxi	3796.7	1855.2	296.7	296.7	1855.2
Tibet	7149.2	4548.4	1434.1	1434.1	4548.4
Ningxia	132.1	7.9	28.9	27.6	9.2
Xinjiang	2709.5	934.1	686.0	627.8	992.2

Source Communique of Chinese Water Resources 1999, issued by Water Resources Ministry

Beside the high rates of utilization and exploitation, the per capita volume of water use in minority nationality regions is comparatively high. In 2000, the average volume of comprehensive water use per capita was 430 cubic meters in the country, and those of 8 administrative divisions exceeded 600 cubic meters, including five minority nationality autonomous regions, namely, Xinjiang, Ningxia, Inner Mongol, Guangxi and Xizang, with Xinjiang and Ningxia in great excess of the national per capita volume of comprehensive water use.[xxix] However, except Guangxi, the per capita volumes of water used for living in the other four autonomous regions are less than the national average, which indicated that the utilization rate of water resources in minority nationality regions is quite low (figure 6). This is directly correlated with the backwardness of its economic development.

Figure 6 1999 Major Indexes of Water Use in Administrative Divisions

Province level	GDP/capita(10000 Yuan)	Per capita use (m^3/capita)	Per 10000 yuan GDP use (m^3/10000yuan)	Per mu Irrigation use (m^3/mu)	Per capita Subsistence use L/day		Per 10000 yuan Industrial Production Value Use (m^3/10000yuan)
					urban	rural	
National	0.65	440	680	484	227	89	91
Inner Mongol	0.54	710	1310	445	71	121	68
Guangxi	0.42	590	1400	932	337	149	228
Tibet	0.38	1010	2650	412	94	220	398
Ningxia	0.45	1780	4000	1352	167	32	195
Xinjiang	0.66	2740	4150	814	164	187	193

Source: Communique of Chinese Water Resources 1999, issued by Water Resources Ministry

Chinese government has achieved great success in protecting the water resources benefits of the minority nationality regions. In order to help the minority nationalities exploit and make use of local water resources, Chinese government is strengthening its support continually to the minority nationality regions. For instance, in the Southwest China where many minority nationalities live, there are rivers like Yangtse River, Zhujiang, Lancangjiang, Nujiang and Yaluzangbujiang. The total volume of water resources adds up to 101 billion cubic meters, and the average volume per capita is 5132 cubic meters, both ranking among the largest. However, even in these regions, there are still some mountain areas with serious problems of drinking water, and the water resources have not been used effectively. To change the situation, the central government has made great effort in constructing all forms of water conservancy facilities in those areas. For example, in Tibet, where the natural conditions are most adverse in the country, a key water control project, named Manla Project, was constructed with an investment of more than 4 billion yuan, and has been put into operation. Recently, Tibet is focusing on the development of Yaluzangbujiang River, Lashahe River and Nianchuhe River) for solving the problems of lack of drinking water and electricity.[xxx]

2.7.2 Water Resources Allocation in Western Minority Nationalities Regions

The first problem to be encountered in the implementation of Western Development strategy is the situation of water resources and the ecological and environmental condition which is getting worse increasingly in the western area. Over the past ten years or so, the ground water level in the vast area of northern and eastern Xinjiang Autonomous Region dropped for 5 meters.[xxxi] Talimu River Basin has an area of 1,020,000 square kilometers (996,000 square kilometers within China's boundaries), and is rich in soil, light, heat. It is an important production base of cotton. It is also a place rich in oil reserves and a potential petrochemistry base in China. Talimu River lies in an inland area, with an arid climate and scarce water resources. The mainstream of Talimu River, in the depths of the common boundary of Talakemagan Desert and Kumutage Desert, has a very fragile ecological system. The forests in the lower reaches alone decreased from 810,000 mu in 1950's to 110,000 mu in 1995, and the remnant of it is extremely sparse. On the contrary, the area of desert has increased rapidly by nearly 200,000 mu.

Besides, Talimu River Basin is located in the minority nationality region and border area, with a total population of 8,257,000 in 1998, Uygur nationality accounting for 85% of it. The complexity of the relationship between different interests made the use and protection of Talimu River more than an engineering measure. It involves the influence of economic structure adjustment and the project of returning farmland to forest and grassland, the solidarity of nationalities, the stability of the society and the national security.

Aimed at restoring and maintenance of the vegetation and ecological conditions of the lower reach of the Talimu River, the Water Resources Ministry organized water

diversion to the lower reaches of Talimu River for three times in the recent two years. This first diversion started on May 14, 2000, and ended on July 12, with a total intake amount of 0.17 billion cubic meters from Yangbo Lake. It ensured the diversion of 0.1 billion cubic meters water from Yangbo Lake to Great Xihaizi Reservoir, and the replacement of 0.1 billion cubic meters water from Great Xihaizi Reservoir to the dry watercourse in lower reaches of Talimu River.[xxxii] The second one started on November 3, 2000, and ended on February 5, 2001, lasting for 95 days. 0.22 billion cubic meters water were diverted to the dry watercourse in lower reaches of Talimu River. The third one was from Spring to November, 2001, and 0.4 billion cubic meters water was released from Great Xihaizi Reservoir, reaching the end of Talimu River---Taitema Lake.

The statistics obtained by the Management Bureau of Talimu River Basin shows that, in the reaches of the river where ecological diversion of water has been completed, the ground water level has risen again from the middle of the watercourse to 500 800 meters away on both banks of the river, 4 meters up near the watercourse and 1 meter up off it. Till now, the water level of Talimu River has been restored in an all-round level, with more than 500 square meters of water surface emerging in Taitema Lake, and the ecology of Talimu River has been remarkedly restored. The remarkable achievements of the ecological water diversion project in Talimu River has won precious time for comprehensive control of the river basin and rescue of the endangered "green corridor" in the lower reaches of the river.

But "ecological water diversion" is merely a makeshift. To achieve long-term development and to protect the ecological safety of the "green corridor" of Talimu River, the most practical and effective way is to "return farmland to forest and grassland". Based on the improvement and protection of ecological environment, the Winjiang Water Conservancy Department and the Management Bureau of Talimu River Basin jointly presented Proposals on Short-term Harnassing of Talimu River Basin in 2001, which emphasized that, the target of returning farmland to forest and grassland on the banks of middle and lower reaches of the main stream of Talimu River be accomplished, the competition for water between farmland and forest and grassland be avoided, ecological demand of water be guaranteed, and the sustainable development of the river basin be achieved step by step, with coordination between population, resources, environment, economy and society. The ecology-goes-first principle established in systematic control of Talimu River has pointed the way out for the Western Development.

3. Analysis and Assessment of the Policies on Water Resources Distribution and Management

3.1 Effectiveness of the Existing Systems

The existing water distribution and management system is based upon state ownership of water resources. The state ownership of water resources is suitable for the characteristics of the water resources of China (water resources shortage and un-even distribution in time and space). Therefore, the existing system played a positive role in water resources management and can keep stabilized for a long time. But this system is not suitable for all situations. In the situations of basin-wide and trans-basin water resources allocation and management, the existing system does not work well. The stability of the existing system became a obstacle for the system reform for basin-wide and trans-basin water resources management. Therefore, it is necessary to review and reform the existing system.

3.1.1 The Positive Role of the Existing System in Protecting Ecological Interests

A water resources management system usually have many objectives. The protecting of ecological interests of the society is one of them. Generally, the existing water resources management system in China plays a positive role in protecting ecological interests.

The Water Rights Distribution Paid Attention to Supporting Capacity of Water Resources. The supporting capacity of water resources is a capacity to support the economic and social development in certain area. It is not un-limited. It is pre-conditioned by ensuring ecologically used water and environmentally used water. In China, the water extracting permit, water pollutants discharge permit and pollutants ceiling control system played a positive role in limiting right to use water resources and ensuring the supporting capacity of water resources. For example, the water quota allocated to Ningxia Autonomous Region from Yellow River is pre-conditioned by ensuring ecologically used water and environmentally used water. Water for agricultural, industrial, human living and other purposes is allocated only after the ecologically and environmentally used water is ensured. The waste water discharge permit system is for restricting the discharge within the supporting capacity of water environment. It plays a good role in the campaign again water wollution in Huai River Basin.

The Positive Role of Water Diversion Project for Enhancing Supporting Capacity of Water Environment. One way to alleviate water pollution is to divert clean water to the polluted water bodies. The clean water can dilute the pollution of the polluted water bodies. However, it is only a supplementary measure and cannot be effectively apply in any circumstance, because it is actually a transfer of the supporting capacity of water environment. It may decrease the capacity of the diverting areas for absorbing pollutants. China has successfully diverted water from Talimu River in the west of the Xingjiang Vigur Autonomous Region to the eastern part of the region. That diversion helps greatly the ecological environment of the east. The proposed diversion from Yangtze River to Tai Lake will help the lake to dilute its pollution and change the water.

The Construction of Sewage Treatment Plants. Sewage treatment can reduce the amount of waste water and recycling used water. It indirectly increases he supporting capacity of water resources. Nowadays, many major cities in China are constructing sewage treatment plants. Water recycling is encouraged in industrial enterprises in China.

Water Function Zoning. China has planned its water resources with the preparation of the document entitled The Water Function Zoning of China. The water function zoning is aimed at rational development and effectively protection of water resources nationally. The zoning is based upon national economic and social development plan and national comprehensive plan for the development of water resources. It takes into account the existing situation of regional water resources development and the social needs. The zoning uses basin as the zoning unit and designates the specific water functions for the zones. It establishes different functions and objectives for maintaining the functions for each zones. It sets forth water quality objectives for each zones. The water function zoning provides legal and scientific basis for the future nation-wide water resources management. It has significant and longterm implications for the economic and social development of China.

Water Conservation. Water conservation can reduce non-effective water consumption and alleviate the pressure for water supply as well as reduce sewage. In order to strengthen the work of water conservation, the Water Resources Ministry established a National Water Conservation Office. The Office is responsible for preparation of national water conservation plan and water conservation standards as well as supervision of water conservation work of the governments at various levels.

3.1.2 The Defects of the Existing System

The experience of the past two decades indicated that the water resources management falls behind the development of economic and social development.[xxxiii] Mr. Zhu Rongji, the Premier of the State Council emphases the importance of implementing sustainable development strategy and calls for protecting and rational use of fresh water and land resources in 2001.[xxxiv] The Chinese government has never paid so serious attention to the sustainability of water resources before.[xxxv] The National People's Congress now is amending the Water Law in order to better dealing with the water problems. The major problems related to water problems including the following.

Lack of Coordination Between Water Resources Management Systems. China has adopted many systems for water resources management. But those systems need to be coordinated. For example, there are more than 20 provinces adopted provisions on water resources fees and water prices. But one problem is that the level of the fees and the price of water are very low, so that they cannot effectively depress the demand for water and encourage water pollution control. Another problem is that there are many local governments did not adopt these kinds of system. They still rely on the traditional way of administrative assignment of water resources.

As to the water quality protection, the system conflicts are reflected by the different water quality standards. Currently, China has many kinds of surface water standards, such as Environmental Quality Standards for Surface Waters, Quality Standards for Recreational Waters, Drinking Water Standards, Quality Standards for Farmland Irrigation and Quality Standards for Fishery Waters. There are conflicts and in-coordination among those standards. They sometime caused difficulties for enforcement and compliance.

As to water use management, the right to use water is mainly reflected by the water exacting permit system. But the permit system is not effective in control water exacting activities for agricultural irrigation in rural area. According to the Water Law of PRC and the Implementing Rules on Water Extracting Permit System, extracting small amount of water for agricultural irrigation is legal and there is no need for applying for a permit. However, because China currently applies the family contract system for agriculture production in rural areas, most of agricultural irrigation water can be classified as "small amount of water for agricultural irrigation purposes". Therefore, the agricultural used water is actually under no regulation. Practices that wasting large amount of irrigation water broadly exist. The efficiency of irrigation is very low. Because the agricultural used water amounts to 70% of the total amount of water used, wasting water in agriculture sector greatly intensified the tension between demand and supply of water resources.

In addition, there is an institutional problem. The water resources authorities of the various levels of the government have the power to issue water extracting permits. The environmental protection departments of the governments at various levels are authorized to issuing waste water discharge permits. There is no coordination between the two governmental agencies. This separation of administrative power for regulating water resources and the conflict of departmental interests makes it difficult for the two institutions to coordinate for public interests in water resources matters.

The Role of Basinwide Water Resources Management Authorities Has Not Been Put Into Full Play. The basin-wide water resources authorities and management systems are weak in solving trans-basin or trans-region water resources management. It is not clear about the powers of the basin-wide water resources commissions in law. On the one hand, they are the agency of the Central Government for water resources management in the basins. On the other hand, their power and authorities have not been established by the relevant laws. They have no power of enforcement, for example. There is duplication and conflicts between their power and that of the local governments. The Yellow River Water and Resources Commission is an example of the problem. Yellow River is the second longest river in China. The extracting and use of water from the river are in a open and no order situation for a long time. The provinces in the middle reach of the river competed in constructing various diversion or extracting facilities for a long time. The quantity of water diverted from the river increased 1.5 time from 1950's to 1990's. The instream flow began to stop since 1972. From 70's to 80's, there were four years of stopping flow every five years. From 90's, the stopping of flow took place every year. In order to coordinate the increasing conflicts in water uses between up and middle reaches and the lower reach of the river, the Central Government adopted a Water Quantity Distribution Plan in 1987. The Plan allocated 34.96 billion cube meters water for the eight provinces along the river. However, study shows that the Central Government did not effectively control the lost-control situation of the provinces along the river.[xxxvi] The reasons for the weakness of the intervention of the Central Government include, at one hand, the political will of the Central Government, i.e. the priority was on economic development, and on the other hand, the inadequate power of the Yellow Rive Water Resources Commission, i.e. lack of power to distribute water basin-widely and lack of power of enforcement. Therefore, China needs a new system arrangement in order to solve this problem.

The Problem of Conflicts of Interests in Transbasin Water Resource Distribution Have Not Been Solved. The most economical and reasonable water diversion should be based upon the establishment of water conservation and water pollution control and make full use of local water resources potential of the receiving area. Only this kind of diversion can achieve high effectiveness with lowest costs. But most diversion projects in China are only for the supplement of water for the receiving areas. Environmental and ecological impacts of the projects were not receive enough consideration in the planning process in the past. In addition, the quality of the diverted water is also a consideration. The government of Tianjin City recently refused to accept

and use the diverted water from the eastern line of the water diversion project, because it worry about the water pollution situation in the areas along the eastern line.

Restrictions to System Innovation Caused by System Choice. The Chinese government has been paying more attentions to water pollution control than water shortage problem in the past. It may be because water pollution problems are more serious and imperative. The paragraphs dealing with pollution problems are longer and more specific than the paragraphs dealing with resources problems in the annual report of the Central Government. The Law on Prevention and Control of Water Pollution was amended 12 years after its first promulgation in 1984. But the first case of water rights trading took place nearly 20 years after the first water pollutants discharge rights. The responses of the Chinese government to the dual challenges of water pollution and water shortage are different in time and degree. This difference may explain why China has made some achievements in water pollution control but water resources distribution and management.

There are some reasons for the late of water rights trading experience. Firstly,the first problem caused by the fast economic growth in China was not water shortage but water pollution. Secondly, the technology progress made the operation of water pollutant discharge rights trading earier than that of water rights trading. Environmental monitoring technology, water environmental quality management technology and water pollutants classification and quata distribution technology are all gain fast development in the past two decades. In contrast, water rights trading is more difficult to operate because it often involve with many conflicts of interests such as initial water rights distribution. Lastly, water pollutants discharge rights trading does not involve with state ownership issue. But water rights trading do. Although it is said that the right been transferred is right to use water, it is hard to tell the difference between the two in real life.[xxxvii] Therefore, the ambiguity of water right is a obstacle for the establishment a water resources market. Although the current policy of the government encourages the water rights trading as done between Dongyang City and Yiwu City, it is still un-clear that how far the trading can go.[xxxviii]

3.2 The Equity of the Existing Methodology

Efficiency is a principle for water resources distribution and management. But it is not the only principle. A effective system arrangement for water resources distribution must consider adequately the factor of equity. The factor of equity is not only reflected intra-generation and inter-generation but also reflected between human being and environment.

3.2.1 The Equity of Regional Water Resources Distribution

Although the geographical distribution of water resources is extremely un-even, there is no extremely difference in per capita total water consumption between different geographical regions, except for northwest inland river basin areas (Table 7). The high per capita water consumption in inland river basins can be explained by the high per 10000 Yuan GDP of those areas. If we divide the whole country into east, middle and west parts, we can easily tell that the difference of water consumption is not so big. For example, the per capita total water consumption nationally in the year 2000 is 430 cube meters, while the number for east, middle and west of China are 420, 400 and 500 respectively.[xxxix] So, under the existing water resources distribution and management system, the geographical unevenness of water resources distribution does not cause inequity between different regions. It is because the differences in degree of water resources development and population density.

Table 7 Water Uses in Different Basins in 1999

Basins	GDP per capita (10000 Yuan)	Per capita consumption (m^3/per person)	Water consumption per 10000 Yuan GDP (m^3/10000 Yuan)	Per Mu* irrigation water conumption (m^3/Mu)	Water consumption for living (L/day)		Water consumption per 10000 Yuan Industrial Production (m^3/10000 Yuan)
					Urban life	Rural life	
Songliao River	0.81	530	660	517	165	89	111
Hai River	0.82	340	420	295	223	70	48
Yellow River	0.52	390	730	436	168	55	81
Huai River	0.65	300	460	299	169	65	53
Yangtze River	0.69	410	590	486	260	88	120
including Tai Lake	2.47	790	570	472	392	121	91
Pearl River	0.86	540	630	827	338	141	108
Rivers in East west	1.21	460	380	643	262	108	57
Rivers in South west	0.38	520	1370	614	220	110	158
Inland rivers	0.63	2170	3460	788	153	149	172

Resource: Water Resources Ministry, Communiqué on Water Resources, 1999.

* Mu: Chinese unit for area, 1 Mu =6.6667 Ares

Trans-basin water diversion is an important way for solving the problem of imbalance of geographical water resource distribution. Most of the trans-basin water diversion projects use the diverted water to compensate the water resources systems of the receiving areas. In order to achieve the maximum effectiveness and the balance of interests between diverting areas and receiving areas, it is necessary to conduct a feasibility study on water quantity and water quality of the areas involved. Firstly, it is necessary to determine if the diverting area has enough “surplus” water for diverting.

Secondly, it is necessary to find out if the lack of water in the receiving areas is due to geographical reasons, i.e. the receiving area is a geographically water shortage area. Thirdly, it is necessary to make water conservation as a pre-condition for the receiving area. Fourthly, it is necessary to establish an economic compensation system for the diverting area for the water diverted. Currently, Chinese government pay great attention to the issues of balance of interests and equity between the diverting and receiving areas.

In minority nationality areas, the government respects and takes care of the rights to use water of minority nationalities in water resources management and distribution. Water resources are owned by the State in China. The minority nationality autonomous regions do not own water resources but have the right to use and manage water resources just as same as any other provinces of China. Because they do not own water resources in their regions, their use of water resources may be influenced by the State policy, law and state water management programs. On the other hand, for those minority nationality autonomous regions or areas that made contribution to ecological balance and environment of the nation through their geographical advantages such as richness of water resources, the State will provide compensation for them. The Law Committee of the National People's Congress suggested to make the following amendments to the Law on Minority Nationality Autonomous Regions in 2001:

> "The superior state administrations shall integrate the major comprehensive harness and control projects dealing with ecological balance and environmental issues into state economic and social development plans and planning them uniformly";
>
> "State shall compensate the interests of those minority nationality autonomous regions for their contributions made to the ecological balance and environmental protection of the nation";
>
> "Organizaions or individuals shall take measures to protect and improve local living environment and ecological environment, preventing pollution and other public hazards".

Those suggestions were adopted by the Congress and were reflected in the Article 66 of of the revised Law on Minority Nationality Autonomous Regions 2001. In addition, the new law specifically takes care of the issue of exporting natural resources including water resources from the minority nationality autonomous regions. Paragraph 1 of Article 65 of the new law provides that "State shall take measures to provide certain compensation for the interests of the minority nationality areas that exporting natural resources". Article 66 and Paragraph 1 of Article 65 constitute a interests compensation mechanism of the State for the water resources exporting of the minority nationality autonomous regions and areas.

3.2.2 Equity Between Different Water Uses

Economy-Used Water and Ecology-Used Water. Based upon multi-functions of water resources, water can be divided into human living used water, economy used water and ecology used water. The experience of economic development shows that the development of economy usually squeeze water needed by ecology and causes environmental deterioration. The development of economy by squeezing ecology used water in one place will inevitably cause negative externality to other places and is un-fair to other places. But unfortunately, law and policy ensuring ecology used water are not adequate in China. There is a huge amount of "ecological debts" owned to the dry areas of China. The running out of water of the Yellow River is an example. Now, China has realized that it necessary to integrate the value of resources and environment into gross national production value. So, the state started to pay attention to comprehensive planning the needs for and supply of water resources and to change from traditional method of satisfying all social and economic needs for water by engineering measures to sustainable and optimized water resources distribution among all the competitive water users by comprehensive management measures.

Urban Used Water and Agricultural-Used Water. Under the existing water resources distribution system, water used for living by urban residents is provided by water plants in most cases, while in rural areas water for living is directly extracted from the nature in scattered way with small quantity. There is a remarkable difference between urban living water and rural living water. Table 7 indicates that in most of the urban areas, urban water consumption per capita is almost two to three times of the rural water consumption per capita. Moreover, because of the low water price, the payment for water consumption in urban areas is lower than what they should pay for the water consumed. So, there is an inequity between urban and rural water users in terms of water consumption for living purpose.

In addition, because the quantity of urban and industrial water consumption continuously increase, water resources for rural consumption diminished. Rural residents have to increase investment for water conservation under such circumstances. So, it is necessary to take measures to compensate rural residents.

3.2.3 The Equity of Water Rights Trading

Water resources development is part of economic and social development. Because the diversity between different water users and different places, it is hard to achieve completely free and fair competition in water rights trading. The incompleteness of the Chinese water resources market decides that the price of water resources cannot be

determined by market competition only. However, either the transfer of water resources between different sectors of industries or the distribution of water resources in a basin or between basins requires clearly establishing water rights. In order to avoid conflicts of interests in establishing water rights, the stakeholders shall follow the principles of sustainable use, efficiency, and equity. Moreover, the principle of equity shall be given special and more consideration, because it is a principle that check and balance the principle of efficiency in water resources distribution. The sustainable development of water resources requires such a check and balance. In order to ensure equity in water resources management, expert suggestions include, 1) to establish a just management authority independent from the buyer and seller of water rights and to adopt a dispute settlement mechanism, as well as to adopt a mechanism protecting the interests of third party; 2) as a alternative, to establish an interests distribution mechanism which is based upon water price and under guidance of the concept of water rights trading[xl]

3.3 The Reform and Innovation of Water Resources Distribution System

3.3.1 The Preliminary Introduction of Market Mechanism

The introduction of market mechanism is a new development in water resources management system of China. It is important because it caused the fundament change of the traditional unitary system of governmental managing water resources. The water rights trading agreement between the Dongyang City and Yiwu city, Zhejiang Province, established the precedent for water right trading in China.[xli] There was an incentive for trading between the two parties in that case. The agreement was a response of the two parties to the opportunity of making a profit from the trading. The agreement changed the original water resource management system under which water resources was managed the state only. The trading is a typical induced system change.

In system economics, induced system change is an innovation of system as a response to the opportunity by an individual or a group of individuals. The incurrence of induced system change is based upon an opportunity of profit that people cannot get in the original system. The process of getting the profit opportunity does not exclude the promotion or intervention of government. In fact, government plays a key role in the beginning of the induced system change. The water right trading between Dongyang City and Yiwu City is managed through the governments of the two cities. In China, this kind of governmental promotion or intervention will last for a rather laong time, because water resources is under state ownership. This case tells us that the induced system change is not different in substance from the above-mentioned compulsory system of basin-wide water resources distribution. The difference is that the former is a response to the opportunity of profit, while the latter is an improvement of the original basin-wide water resources distribution system. The former seeks profit, while the latter seeks equity.[xlii]

3.3.2 The Reform of Water Price System

The practice in reforming water price provides examples for the above-mentioned question. For a long time, the Chinese water system is a state welfare water system characterized as over low water price and lacking of incentive for water conservation. For example, the Pingyi county of Shangdong Province constructed 122 rural water supply projects. The water prices of those projects are very low. Some of them are as low as 0.6 yuan per cube meter. Some of them even provide water for free. Therefore, wasting of water are serious in those places.[xliii] According to the estimation of the World Bank, wasting of water in traditional irrigation systems is as high as 60% in Chinese agricultural sector. Most of the industrial enterprises that extract water directly from river or ground water bodies are not recycling and re-use water.[xliv] In addition, water right trading is influenced by price of water resources. Therefore, it is necessary to reform water price system so as to change the irrational water consumption mode.

Water price reform started from Chinese cities and made progress gradually. According to the Circular on Furthering Price Reform in Urban Water Supply issued by State Development and Planning Commission, Financial Ministry, Construction Ministry, Water Resources Ministry and State Environmental Protection Administration, all cities under the direct jurisdiction of provincial governments will apply a ladder-shape water costs accounting system by the end of 2003. All other cities will apply the accounting system by the end of 2005. All cities in China will levy a sewage treatment fee by the end of 2003 and construct and operate capable sewage treatment plants by the end of 2006.[xlv] The Circular requires to establish a water price system that promoting water conservation and to reform operation and management systems of water supply enterprises and sewage treatment plants. It requires improving water conservation measures. Comparing with that of water rights trading, the implication of this system reform is more direct and broader. It is because that the possibility for carrying out water right trading in a large scale is small under the current situation of water resources property arrangement. But the influence of water price reform would cover every Chinese cities. In addition, the influence to people's conducts of consumption by water right trading is indirect. But the rising and adjustment of water price will directly change the expectation of people's water consumption. Lastly, because water price is the basis for water right trading, the fluctuation of water price will influence water right trading. So, it is easier for water price reform to gain a larger achievement than that of water right trading.

4. Conclusions

As a country in short of water, it is a remarkable miracle that the Chinese law, policy and systems on water resources help to satisfy the demands for water by a super-large population and a fast-growth economy. However, China will facing serious water shortage for a long term in the future. It is hoped that as Chinese economy changing from centralized economy to market economy and as the strategy of sustainable development being further implemented, the water resources distribution and management system will be further improved. The improvement can be done through the following reforms. Firstly, China needs to further coordinate and integrate governmental institution in water resources management. The relations among the water resources related departments in the State Council need to be harmonized and integrated. The relation between the central government and local governments regarding water resources management needs to be coordinated too. It is better that the distribution and management of water resources will be under the uniformed management of the central government. Secondly, China needs to establish and improve water price system. The lack of motivation for water conservation in China is largely due to the low price or even free of charge for using water. A comprehensive and economically and ecologically reasonable water price system is badly needed. Thirdly, China needs to establish a second level water resources market and change the existing water distribution system from administrative distribution into market based distribution under governmental regulation. The few cases of water rights trading indicate this trend of development.

In sum, the trend of development in water resources management is to strengthen unformed water resources management and to introduce in market mechanism. The combination of unformed water resources management and water market will provide a guarantee for the equity in water uses and ecologically sustainable development of the economy and society of China.[xlvi] The proposed large-scale water diversion projects and water conservation policies and measures will contribute to the achievement of water security and water equity.

Notes and References:

[i] The Almanac of PRC(1998), The Almanac Press of PRC.p555, p1106;The Almanac of China's Statistics, The Statistics Press of PRC,p5; Wang Weizhong, Analysis of the Trend of Sustainable Development in China, The Business Press(1999), p139.
[ii] The Water Resources Ministry of PRC, The Bulletin of China's Water Resources (2000). The sixth class is also referred as the Fifth minor class.
[iii] The Water Resources Ministry of PRC, The Bulletin of China's Water Resources (2000).
[iv] The Water Resources Ministry of PRC, The Bulletin of China's Water Resources (2000).
[v] The Water Resources Ministry of PRC, The Bulletin of China's Water Resources (2000).
[vi] The world-wide recognized threshold for water shortage countries is 1700 cube meters per capita a year.
[vii] "The Water Problem of China", China Water Conservancy News(2000),Sept.28,p. 2.
[viii] Wang Weizhong, Analysis of the Trend of Sustainable Development in China, The Business Press (1999), p. 197.
[ix] Such trans-basin diversion projects must consider the following factors: changes in global climate, economic and social development of diverting region, the properness of diversion in time and geographical distribution water resources of both the diverting region and receiving region, the engineering and economic feasibilities of the diversion, the bearing capacity for water price in receiving region, operation system of diversion facilities, cost and possibilities of protecting water quality and the volume of the diverted water.
[x] The Water Resources Ministry(2001),No.244: Notice on Issuing and Implementing the Scheme for Diverting Water from the Mainstreams of the Hei River(2000-2001).
[xi] The main responsibilities of the Water Affairs Office include: Drafting the national policies, statutes, regulations and standards for prevention and control of water pollution and supervising the implementation of these documents; supervision and management of prevention and control of water pollution in the key valleys and organizing and drafting programs for prevention and control of water pollution of key valley and the water quality standards for the main trans-provincial rivers and supervising the implementation of those documents; organizing and carrying out the work of national water environment function zoning and protecting the source of potable water; guiding the work of local governments in prevention and control of water pollution and basin-wide water pollution control; carrying out other tasks given by the SEPA. See "The SEPA establishes a Water Affairs Office", China Environmental News, April 13, 2002.
[xii] "Inadequacy of total volume, unreasonable distribution and serious pollution: The three problems perplex China-On how to Utilize water resources". The People's Daily, April 22, 2002.
[xiii] Article 32 of Water Law of PRC; the State Council, The Implementation Measures for the System of Permit of Extracting Water (1993).
[xiv] Article 34 of Water Law of PRC; State Commission of Planning, Article 17 of Industrial Policy on Water Conservancy.
[xv] Article 25 and 27 of Water Law of PRC.
[xvi] Xiao Guoxing, Xiao Qiangang, Natural Resources Law. The law Press (1999), p260.
[xvii] "The first transaction of water right develops the new market". 21st Century Economical News Report, March 29, 2001.
[xviii] The Water Conservancy Department of Zhejiang Province, "The Report on Dongyang City Transferring Part of the Right to Utilize Water of Hengmian Reservior to Yiwu City", Plan and Design of Water Conservancy (2001), Issue 25.
[xix] Su Qing, Shi Guoqing, From the transaction between Dongyang City and Yiwu City See the direction of China's reform of water resources distribution system", Water Development Study, (2001), Issue 6.
[xx] http://svrl-pek.unep.net/soechina/cwater/waterr.htm, visited in April 20, 2002.
[xxi] The Statement of China's Environment, 1997.
[xxii] Water Resources Ministry, The Bulletin of China's Water Resources (2000).
[xxiii] Comprehensive Report on the Study of China's Strategy for Sustainable Development of Water

Resources, http://www.chinawater.net.cn/CWR_Journal/200008/02.html visited in May 14, 2002.
[xxiv] Article 12 and 27 of Law on Prevention and Control of Water Pollution of PRC.
[xxv] Article 20 of Law on Prevention and Control of Water Pollution of PRC.
[xxvi] "China will designate the long-range region for the source of water in the western part to solve the inadequacy of water", China News Press, May 18, 2000.
[xxvii] "China will implement the program for protecting wetlands", China Mining Industry News, Nov. 9, 2000.
[xxviii] The Almanac of PRC (1998), The Almanac Press of PRC, p350.
[xxix] Water Resources Ministry of PRC, The Bulletin of China's Water Resources (2000).
[xxx] Xinhua News Agency, Another major measure to assist the water conservancy of Tibet, http://www.waterinfo.net.cn/.visited it in April 24, 2002.
[xxxi] "The underground water level of Xinjiang declines due to the excessive exploitation", The People's Daily, April 16, 2002.
[xxxii] Talimu River Encounters Spring in the Glorious age. http://www.chinawater.com.cn/ywjd/20010714/200107030024.htm2001/7,visited in April 20, 2000.
[xxxiii] The World Bank, Clean Water and Blue Sky: Prospect of China's Environment in the 21st Century, The Financial and Economic Press of China (1997), p79.
[xxxiv] Zhu Rongji, "Report on the Outline of the 10th Five-year Plan of National Economical and Social Development", The Bulletin of the Standing Committee of National People's Congress (2000),No.3.
[xxxv] For example, the Report on the Work of the State Council (1998) only points out that the relations among economy, population, resource and environment shall be properly handled. But the Report on the Work of the State Council (2000) said that "we should persist in the road of sustainable development". From the changes of those words, we can discover the trend of the development of the water policies of Chinese Government. See Li Peng, "Report on the Work of the State Council", The Bulletin of the Standing Committee of National People's Congress(1998), No.1; Zhu Rongji, "Report on the Work of the State Council", The Bulletin of the Standing Committee of National People's Congress (2000),No.2.
[xxxvi] The local selfish actions haven't been corrected. During 1992-1995, the Inner Mongolia Autonomous Region and Shangdong Province exceed 13% and 11.3% of the quotas assigned. Shangxi Province and Shangxi Province are in short of water in 52% and 75.8% respective in average of recent four years. Hu Angang and Wang Yahua, "The public policies of disposing water resources in the transitional stage: The para-market and political democratic consultation", Soft Science of China (2000), Issue 5.
[xxxvii] Zhubosong, "The theory and pratice of water right (The 1st part)",The Law Review of Taiwan University, Vol.25, Issue 2.
[xxxviii] Cao Dong, China's Economics of Industrial Pollution. The Environmental Science Press of China (1999),p234.
[xxxix] Water Resources Ministry of PRC, The Bulletin of China's Water resources (2000).
[xl] Jiang Wenlai, "The characteristics and the definition of water right", Water Conservancy News, Nov. 2, 2000.
[xli] See Section 2.4 Market mechanism of water resources.
[xlii] Of course, there are still some ambiguous parts in the classification of the transformations of these two systems.
[xliii] Zhaoliang and Zhang Decheng, "Analysis of the composition of the price for supplied water in rural areas, China's Water Conservancy in Rurual Areas (2001), Issue 3.
[xliv] The World Bank, Clean Water and Blue Sky: Prospect of China's Environment in the 21st Century, The Financial and Economic Press of China (1997), p81.
[xlv] Promoting the Reform of the Price for Supplied Water in Urban Areas, China's Water Conservancy News, April 16, 2002.