Title of the Project: **Valuing Groundwater's Supporting Services to Ecosystems in Heihe River Basin**

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ABSTRACT

Zhangye City in Heihe River Basin is suffering from the declining groundwater. In 2002 a water use right system with tradable water quotas has been established to achieve the sustainable use of water. But most of the groundwater users use far more groundwater than their quotas. And lower levels of government have no incentive to monitor the groundwater use and restrain local farmers from over-using water due to the highly external diseconomies for the groundwater use. The policy-makers have to find out some sustainable financed incentives for groundwater conservation. Taking account of the economic value of conserving groundwater provides a possible way for finding out these incentives. The general objectives of the proposed study are to estimate the economic value of the groundwater's supporting services to ecosystems and try to find out sustainable financed policy incentives for conserving the groundwater in Zhangye City. Specifically, the study aims to: identify and analyze the ecosystem services supported by the groundwater, including types, scales, locations and changes of the services; estimate the economic value of the ecosystem services supported by the groundwater; find out sustainable groundwater-conserving policy incentives financed by the econimic value of conserving the groundwater; analyze the influential factors of the value and incentives of conserving the groundwater; and finally, make policy recommendations for conserving groundwater. The proposed study will adopt Contingent Valuation Method and both primary and secondary data. Primary data will be gathered through in-person interviews and questionnaire field survey with 800 samples from urban and rural households. The findings of the study will be expected to provide information about the value of the groundwater's supporting services to ecosystems and policy stimulus for conserving groundwater in Zhangye City in Heihe River Basin.

Valuing Groundwater's Supporting Services to Ecosystems in Heihe River Basin

Zhang Junlian

1 INTRODUCTION

1.1 Background and Statement of the Problem

Groundwater has important value to terrestrial ecosystems, especially in desert area. Many oasis ecosystems are mainly supported by groundwater in desert area. When the groundwater declines to some degree, the oasis ecosystems will disappear.

Locate in the middle reaches of Heihe River, in arid and desert area in northwest China, Zhangye City consists of many oasis ecosystems watered by Heihe River. Some artificial ecosystems such as farmland ecosystems, village and urban ecosystems are originated from the oasis ecosystems in desert area. As the population growing and the plantation expanding, water resources become more and more scarcity. According to the historical records, the population in the midstream of Heihe River was 80 thousand in Han Dynasty (about 2000 years ago), and the irrigation area was about 70,000 mu (4,667ha). But the population increased to 550 thousand and irrigation area was 1 million mu (68,667 ha) in 1950s. By the year of 2002, the population swelled to 1.12 million, and the irrigation area expanded to almost 4 million mu (266,666 ha). Huge demand on water consumption in Zhangye City makes Ejina Oasis at the downstream of Heihe River shrink from 6940 km^2 to 3328 km^2 in recent 4 decades, and the desert area increase 460 km^2. In 1961 and 1992, the West Juyanhai Lake and East Juyanhai Lake dried up respectively. Now Ejina Oasis has become a main source of sandstorm in northwest China.

In order to make Zhanye City save water for recovering the ecosystem in Ejina Oasis, in early 2002, the Ministry of Water Resources (MWR) of China initiated an experimental project – Building Water-saving Society in Zhangye City – this project was the first of its kind in China. The pilot project was set to save water in three ways: (1) the Government invested extensive capital to build a water-saving irrigation system

because local farmers could not afford it; (2) the Government invested and installed meters for water users (including irrigators), and tried to discourage farmers from wasting water by accurately metering and charging for irrigation water; and finally (3) a water use right system with tradable water quotas was established, which tried to reallocate water more reasonably and efficiently and raise water use efficiency through water quotas trading.

Now in Zhangye City, every water user gets a water quota according to the water use right system. For a water user, the water quota contains a surface water quota or a groundwater quota or both of them. Anyway, for most of water users, the water quota is less than the average amount of water use in the years before the project carried out. The results of the experiment project shows that the groundwater quotas are almost totally ignored and only surface water quotas are faithfully adhered to by irrigators. Most groundwater users use groundwater water more than their groundwater quotas. It leads that the groundwater use increases rapidly and the aquifer declines rapidly (Zhang 2005a). One major reason for this result is that lower levels of government have no incentive to monitor the groundwater use and restrain local farmers from over-using water due to the highly external diseconomies for the groundwater use (Zhang 2005b).

The groundwater would continue to decline if there is nothing to do to the groundwater quota system. It is necessary to set up some sustainable incentives to encourage local communities to enforce and obey the groundwater quota system (Zhang 2005a 2005b). Up to date, most incentives of the pilot project are financed by Central Government. Obviously, the fiscal support of Central government is not enough to enforce long-term market-oriented instruments for water savings (Zhang 2005a). What is more, the finance support for the pilot project is temporary. It will be over when the pilot project is finished in 2007. Taking account of the economic value of conserving natural resources provides a possibility to finance the sustainable incentives to conserve natural resources (Emerton et al 2006). So, in Zhangye City, the problem is how to establish sustainable financed incentives for conserving groundwater through taking account of the economic value of conserving groundwater.

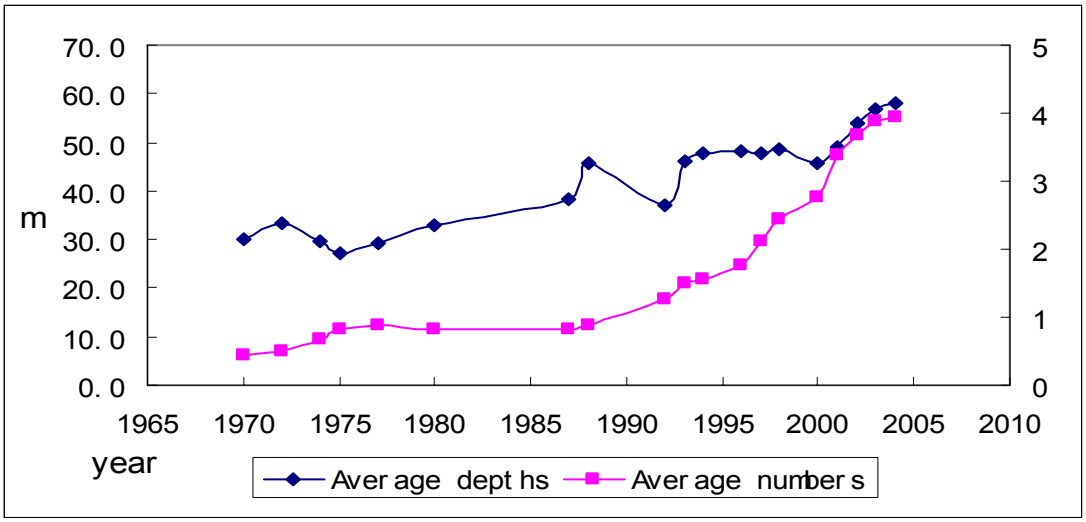
1.2 Literature Review and Significance of the Study

1.2.1 Studies on groundwater and its ecosystem services

Chen et al (2003) found that the groundwater level showed evidently decreasing tendency in the last 20 years, especially in recent years in Zhangye city. Zhang (2005a) found that the increase in the number and depth of irrigation wells in Zhangye City

over the last few decades, especially Since 2000 (see Figure 1). Ding et al (2002) studied the changing features of groundwater resources in recent 50 years in Heihe River Basin. The result shows the recharges of groundwater are decreasing successively because of the continuous growing industry, agriculture and irrigation system since the 1950s even if the annual surface water resources from mountains are relative stable. As a result, a series of hydrological and geological problems, such as constant decline of regional groundwater level, substantial reduce of spring water, yearly enlargement both in scale and amount of groundwater extraction, continuous decrease of surface water entering into the lower reaches, water quality worsening and so on.

Fig 1. The average number and average depth of irrigation wells in the sample villages (1970–2004)



According to the ecological appropriate theory and the random sampling investigation of several major plants in the Tarim basin, Zhang et al (2004) built the logarithm normal distribution relation model between the growth of plants and the depth of ground water. Based on the model, the fittest depth and suitable range of groundwater of these plants and their tolerance towards ground water are gained. Most kinds of plants would die when the groundwater is below 2-4 meters. Ma et al (2003) studied the ecological and environmental problems caused by the excessive exploitation and utilization of groundwater resources in Mingqin Basin (nearby Zhangye City). The results show that the ecology and environment in the basin are extremely vulnerable due to the shortage of water resources. The regional groundwater level occurs from 1-9 meters the 1970s down to 21-28 meters depth now. Many kinds of vegetation, including some specially growing in desert area, died and forests degraded. A lot of land became desertification. The desertification is making a lot of farmland damaged

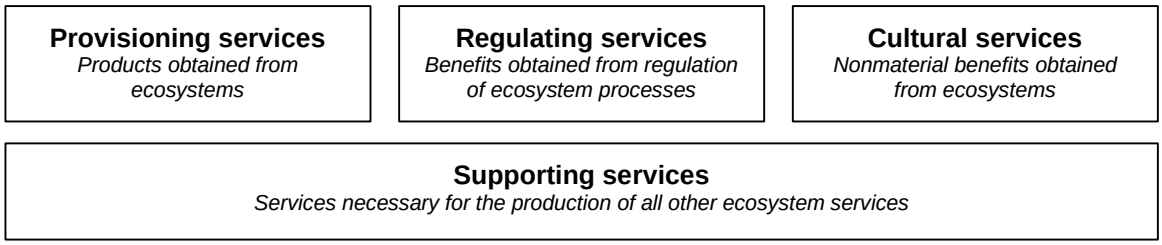
and many local farmers homeless.

According to the above studies, we could conclude that the groundwater is rapidly declining and most kinds of plants even many oasis ecosystems that are supported by groundwater would disappear if the groundwater decline to a certain level in Zhangye City.

1.2.2 Studies on valuing ecosystem services

The Millennium Ecosystem Assessment (2003) defines ecosystems as dynamic complexes of plant, animal, and microorganism communities and the non-living environment, interacting as functional units. And the services that ecosystems can provide are classified into four broad categories: provisioning services, regulating services, cultural services, and supporting services (Figure 2). They illustrate the diverse ways in which ecosystems contribute to human welfare.

Figure 2 Typologies of ecosystem services



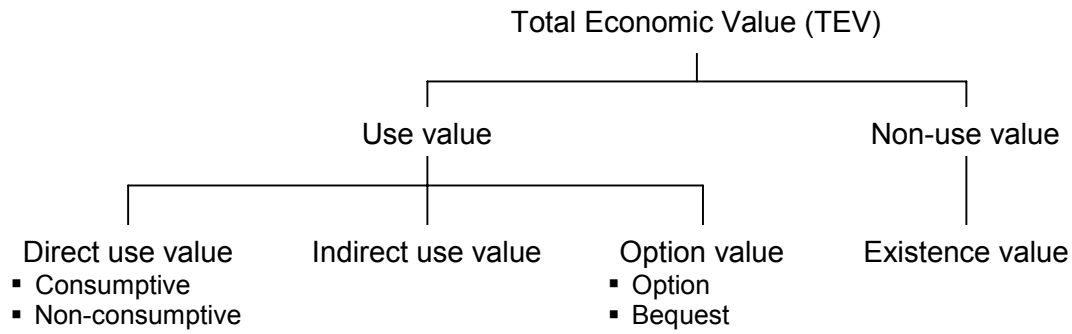
Source: Millennium Ecosystem Assessment, 2003.

Economic valuation offers a way to compare the diverse benefits and costs associated with ecosystems, by attempting to measure them and expressing them in a common denominator—typically a monetary unit. Generally, the Total Economic Value (TEV) includes (i) direct use value; (ii) indirect use value; (iii) option value; and (iv) non-use value (See figure 3, Pearce and Warford, 1993).

Pagiola et al (2004) presented how valuation should be used to examine four distinct aspects of the value of ecosystems. (1) Determining the value of the total flow of benefits from ecosystems. (2) Determining the net benefits of interventions that alter ecosystem conditions. This question typically arises in a project or policy context: Would the benefits of a given conservation investment, regulation, or incentive justify its costs? It differs fundamentally from the previous question in that it asks about

changes in flows of costs and benefits, rather than the sum total value of flows. (3) Examining how the costs and benefits of ecosystems are distributed. And finally (4) identifying potential financing sources for conservation.

Figure 3 Typologies of ecosystem services



Many methods for measuring the utilitarian values of ecosystem services are found in the resource and environmental economics literature (Hanneman 1992; Pearce 2002). Table 1 summarizes the main economic valuation techniques. Some are broadly applicable, some are applicable to specific issues, and some are tailored to particular data sources. A common feature of all methods of economic valuation of ecosystem services is that they are founded in the theoretical axioms and principles of welfare economics. Most valuation methods measure the demand for a good or service in monetary terms, that is, consumers' willingness to pay (WTP) for a particular benefit, or their willingness to accept (WTA) compensation for its loss (Hanneman, 1991; Shogren and Hayes, 1997).

These valuation techniques have been used extensively in recent years, and a growing literature exists on their application (Johansson, 1994; Willis and Corkindale, 1995; Garrod and Willis, 1999; Freeman, 2003). These techniques can and have been applied to a very wide range of issues, including efforts to estimate the benefits of entire ecosystems such as forests (Bishop, 1999), wetlands (Heimlich at el, 1998), coastal ecosystem (Seenprachawong, 2002), and watersheds (Aylward, 2004; Kaiser and Roumasset, 2002). Other studies have focused on the value of particular ecosystem goods and services such as water (Young and Haveman, 1985), carbon storage (Fankhauser, 1995), landscape (Garrod and Willis, 1992; Powe at el, 1995), biodiversity (Pearce and Moran, 1994; Barbier at el, 1995; Pearce at el, 2002; Subade, 2005). Many valuation studies are cataloged in the Environmental Valuation Reference Inventory (EVRI) website, maintained by Environment Canada (EVRI, 2004).

Table 1: Main economic valuation techniques

Methodology	*Approach*	*Applications*	*Data requirements*
Revealed preference methods			
Production function (also known as 'change in productivity')	Trace impact of change in ecosystem services on produced goods	Any impact that affects produced goods	Change in service; impact on production; net value of produced goods
Cost of illness, human capital	Trace impact of change in ecosystem services on morbidity and mortality	Any impact that affects health (e.g. air or water pollution)	Change in service; impact on health (dose-response functions); cost of illness or value of life
Replacement cost (and variants, such as relocation cost)	Use cost of replacing the lost good or service	Any loss of goods or services	Extent of loss of goods or services, cost of replacing them
Travel cost (TCM)	Derive demand curve from data on actual travel costs	Recreation	Survey to collect monetary and time costs of travel to destination, distance traveled
Hedonic pricing	Extract effect of environmental factors on price of goods that include those factors	Air quality, scenic beauty, cultural benefits	Prices and characteristics of goods
Stated preference methods			
Contingent valuation method (CVM)	Ask respondents directly their WTP for a specified service	Any service	Survey that presents scenario and elicits WTP for specified service
Choice modeling	Ask respondents to choose their preferred option from a set of alternatives with particular attributes	Any service	Survey of respondents
Other methods			
Benefits transfer	Use results obtained in one context in a different context	Any for which suitable comparison studies are available	Valuation exercises at another, similar site

Source: adapted from Pagiola et al (2004).

1.2.3 Studies on policy incentives for water resources conservation

It takes huge costs or money to conserve natural resources, including groundwater. But many conservation efforts have traditionally paid little attention to economic values of natural resources, as a result it has often been hard to justify or sustain ecosystem management in economic terms (Emerton, 2005). Fortunately, more and more researchers have developed many incentives that are based on economic value and pay attention to increase awareness and capacity among planners, policy-makers and managers to identify and use economic measures for natural resources conservation.

Emerton et al (2006) reviewed the incentives for sustainable financing of protected areas in some related study cases. Fiscal instruments, benefit and revenue sharing, cost-sharing, and investment, credit and enterprise funds are all important means of funding protected areas. Tourism charges and resource use fees are an important existing source of funding for many protected areas. Payments for ecosystem services are rapidly emerging as a significant new funding source. More generally, they are also key tools for strengthening private incentives to conserve biodiversity. Their main role in protected area finance is to ensure that financial resources flow to consumers, producers, groups and individuals whose actions affect biodiversity. These incentives should be helpful for conserving groundwater.

In the same report, Emerton et al (2006) analyzed the significance of financial resources to manage protected areas and the global finance sources in recent years. The finance sources include: domestic government budgets and foreign assistance; private voluntary donations; and environmental funds and debt-for-nature swaps. This global trend masks significant variation at national and local levels.

Up to date, most of the finance sources for conserving water resources in Zhangye City come from fiscal budget of government, especially from Central Government. Local levels of government and communities make little contribution to it. Obviously, the fiscal support of Central government is not enough to establish market-oriented instruments for water savings (Zhang 2005a). In Zhangye City the tradable water use rights system has been established and is poor enforced, especially for groundwater. Besides the fiscal barriers, Zhang (2005a 2005b) found that there are many other barriers led to the bad implementation and enforcement of the system. (1) Local officials and water managers could not benefit from conserving groundwater even could benefit from farmers' overusing the groundwater. (2) Self-monitoring mechanism, which plays a very important role for the well implementation for surface water, doesn't exist for groundwater. (3) Simple enforcements could lead to social conflicts and disturbances because the poor farmers, who have not social secure system, are hard to bear the loss caused by water shortages. (4) There are no incentives to promote some effective water-saving technologies.

Accordingly, Zhang (2005a) recommended some policy activities: (1) to reform the

water management system and make local officials and water managers be able to benefit from conserving groundwater; (2) to establish a self-monitoring mechanism among the groundwater users, for example, let farmers from different regions to monitor the groundwater use in other regions; (3) to reduce the farmers' poverty caused by water shortages; (4) to promote water-saving technologies, such as to help farmers shifting their high water-intensive crops to low water-intensives crops; (5) to buy groundwater quotas from farmers and "retire" the water for environment.

But it needs more money to take these activities. For example, Wang (2005) found that the monetary incentives for local water managers could lead to water savings. Water managers have incentives to conserve water when they could increase their incomes by conserving water. Obviously it takes money to establish the monetary incentives. So, policy makers not only need to find out effective activities but also need to finance them.

1.2.4 Significance of the Study

Sometimes the reason for our failure to conserve natural ecosystems is that we don't know what kinds of loss and damage will occur. But more times, the reason is that we do not realize how valuable they are even if we have known what kinds of loss and damage will occur. Zhangye City is suffering the loss and damage from the declining groundwater, but we still do not know how much the loss is. In this case, the Government and local residents seems no incentives to conserve the groundwater. This study will tell what is the value of the groundwater's supporting services to ecosystem and will provide very helpful information for policy-makers to make a decision on how to conserve the groundwater.

There are some studies on valuing the ecosystem services in northwest China (Zhang 2002; Xu 2003). But they measured the value of the total flow of benefits from ecosystems. Pagiola et al (2004) argued that measures of the current total flows of benefits provided by ecosystems provide useful and interesting information on how things stand, but they are not generally directly policy-relevant. In Zhangye City it is not enough to know the total value of ecosystems for making a policy on conserving groundwater. We should exactly know how much the groundwater water value or what would happen if we do not conserve groundwater. This study will answer it. Actually, there is still no study to be reported to value the ecosystem services supported by groundwater even through many regions in the world are suffering from the declining groundwater.

1.3 Research Objectives

The general objectives of this study are to estimate the economic value of the groundwater's supporting services to ecosystems and try to find out sustainable financed policy incentives for conserving the groundwater in Zhangye City, Heihe River Basin, northwest China. The specific objectives are as follows:

(1) to identify and analyze the ecosystem services supported by the groundwater, including types, scales, locations and changes of the services;

(2) to estimate the economic value of the ecosystem services supported by the groundwater according to the WTP through using CVM;

(3) to find out sustainable groundwater-conserving policy incentives financed by the econimic value of conserving the groundwater;

(4) to analyze the influential factors of the economic value and incentives for the groundwater conservation, including sicoal, economic and geographical factors;

(5) to make policy recommendations for conserving groundwater.

1.4 Study Area and Scope of the Study

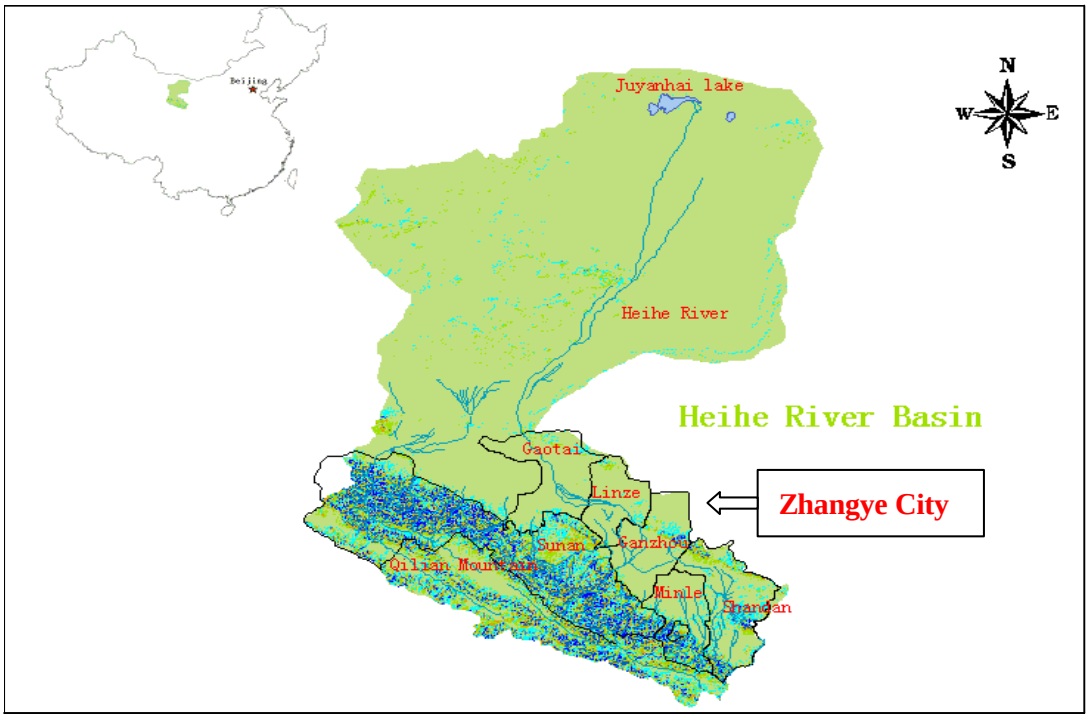
1.4.1 Study area

The Heihe River, the second longest inland river in China, originates from the Qilianshan Mountain which lies mainly in the Qinhai province and ends in Juyanhai Lake in Inner Mongolia. The study area is Zhangye City in Gansu province, which is located in the midstream of the Heihe River. According to the Statistics Bureau of Zhangye City (SBZC 2003), the city is 42,000 km^2 in size and governs six counties, Ganzhou, Shandan, Minle, Gaotai, Linze and Sunan (Figure 4). The city currently has a population of 1.264 million, including a rural population of 911,000 and an urban population of 353,000. The area of farmland is 260,000 ha.

Located in one of the driest zones in the world, Zhangye City consists of many oases in desert mainly watered by the Heihe River. The precipitation in the city is 89-283 mm per year, while the evaporation is 1,700 mm per year. The water sources of the Heihe river basin are mainly the snow-melted water from the Qilianshan Mountain which is perpetually covered by snow. There are 26 rivers in the basin. All the rivers originate from the north side of the Qilianshan Mountain. The total water volume is 2.65 billion m^3, including 2.475 billion m^3 of surface water and 0.175 billion m^3 of groundwater. So far, there are 43 small and middle-sized reservoirs, and 35 pool embankments with

a total water capacity of 202 million m^3. There are 814 main canals and branch canals, and 4,489 irrigation wells. There are 24 irrigation areas which are larger than 10,000 *mu* (667 ha). The total available irrigation area is 257,000 ha, including 212,000 ha of farmland and 41,000 ha of forestland and grassland. Since 2002, the irrigation areas are not permitted to enlarge due to the lack of water resources. All irrigation areas are located in the 5 counties of Ganzhou, Shandan, Minle, Gaotai and Linze. There is no irrigation area in Sunan county, which locates in the north side of the Qilianshan Mountain with higher altitude and very deep groundwater. (All data from SBZC 2003)

Figure 4 The study area: Zhangye City



1.4.2 Scope of the study

The study will focus on the terrestrial ecosystems which are mainly or partially supported by the groundwater in Zhangye City. Actually, the geographical scope will be the 5 counties of Ganzhou, Shandan, Minle, Gaotai and Linze. Sunan county with deep groundwater will not be considered.

The study will only consider the services of the ecosystems which are directly supported by groundwater. In Zhangye City, there are two dominant kinds of ecosystems, oasis ecosystems and desert ecosystems. The desert ecosystems are showed in Figure 5. The desert ecosystems are just supported by rainwater. There are very few plants in the desert due to strong evaporation and extremely less precipitation

in Zhangye City. The oasis ecosystems are showed in Figure 6 and 7. The oasis ecosystems should be supported by other kinds of water sources except few rainwater, such as river water, groundwater or/and irrigated water. The oasis ecosystems could also be classified as 4 types, oasis ecosystem supported by surface water (such as river and lake water), oasis ecosystem supported by irrigated water, oasis ecosystem supported by groundwater, and oasis ecosystem supported by source-mixed water. In Zhangye City, the first type and the last type are very few. And the other 2 types are large. Most of oasis ecosystems supported by irrigated are artifical ecosystems, such as farmland ecosystem. Most of oasis ecosystems supported by groundwater are natural ecosystem. In this study, we will focus on the oasis ecosystems supported by groundwater. Specially, the ecosystems which are irrigated by groundwater will also be looked as not being directly supported by groundwater. By contrast, some wetland ecosystems will be looked as being directly supported by groundwater if the water sources are directly come from groundwater, such as spring water. For example, the ecosystems in Figure 6 and 7 are supported by spring water. There will be looked as belonging to the type of oasis ecosystems supported by groundwater.

In this case, the study must identify the types of ecosystems. It is not difficult to do it in Zhangye City. Due to strong evaporation and extremely less precipitation in Zhangye City, rainwater is very few. The water sources of most ecosystems are homogeneous and easily identified.

The study will mainly assess the indirect value, option value and non-use value except the direct use value. For example, to a grassland ecosystem supported by groundwater, the direct output of grass or breeding animals will not be considered.

2 METHODOLOGY

Urban households and rural non-groundwater users will benefit from the groundwater conservation. Their WTP to conserve groundwater is the economic value of the groundwater's supporting services to ecosystems in Zhangye City. This study will apply the Contingent Valuation Method (CVM) to value it. Local water officials and rural groundwater users will take some activities to conserve groundwater. Some activities and incentives to conserve groundwater, that are supposed to be financed by the economic value of conserving groundwater, will be identified mainly by analyzing the preferences of local water officials and rural groundwater users.

2.1 The Contingent Valuation Method

2.1.1 Identifying the WTP

In Zhangye City, the Government has set up the groundwater quota system according to the total amount of the annual available groundwater. The groundwater would not decline if all the groundwater users obey the system. But most of the users violate the system and their actual groundwater use is far more than their quotas (Zhang 2005a). The oasis ecosystems supported by groundwater will disappear if no measures or activities will be taken to stop the groundwater users violate the system and the groundwater continues to decline and can no longer support the ecosystems.

In order to enforce the groundwater quota system, a groundwater conservation fund will be set up. The fund will be used to support necessary activities to enforce the system and guarantee every user obey the system. The fund will finance from the WTP to conserve groundwater of its beneficiaries (including urban households and rural non-groundwater users). The way to manage the fund and the necessary activities will be determined according the willingness of the fund contributors, local water officials and groundwater users. The WTP is the economic value of the groundwater's supporting services to ecosystems in Zhangye City.

2.1.2 The WTP models and estimation techniques

In this study, the dichotomous and referendum CVM model will be used to estimate the WTP. Based on the model developed by Hanemann (1984), the WTP/WTA could be calculated according to the following equations (Subade 2005):

$$\ln\left[\frac{\Pr(Yes)}{1-\Pr(Yes)}\right] = \alpha_0 + \alpha_1 P + \sum \beta_i X_i \qquad (1)$$

$$W = \frac{1}{\alpha_1}\left[\ln\left(1+e^{\alpha_0+\sum \beta_i X_i}\right)\right] \qquad (2)$$

where Pr(yes) is the probability of the respondents say yes to the bid price P, α_0 is a constant, α_1 is the coefficient of P, X denotes a vector of the characteristics of the respondents, $\beta$is the vector of the coefficients of X.

2.1.3 Biases-reducing techniques

Mitchell and Carson (1989) discussed several biases that can be encountered in the use

of CVM, such as strategic bias, embedding bias, and survey mode bias.

Strategic bias or strategic behavior can be minimized by carefully framing the CVM questions, in an incentive-compatible way such that this type of behavior/bias is not induced (Pearce and Moran 1994). Moreover, the dichotomous choice (take-it-or-leave-it) elicitation format in CVM has been found to be incentive-compatible in that it is in the respondent's strategic interest to say yes if his/her WTP is greater than or equal to the price asked, and to say no otherwise (Hoehn and Randall, 1987). Also, by removing the outliers (observations with extreme values) from the data set gathered, the effect of strategic bias can be reduced.

To minimize the embedding bias, Mitchell and Carson (1989) suggest that the survey instrument include a description of the larger and smaller commodities, and then asking respondents to focus their attention on the smaller commodity. Inclusion of graphic aids such as maps and photographs is also proposed (Boyle et al., 1994). Spash et al. (2000) pointed out that the embedding problem can be remedied by careful survey design.

This study will try our best to use some of the above techniques to reduce the biases. For example, we will use graphic aids such as maps, satellite images and photographs to show the effects of the declining groundwater, and use pre-survey to improve the designs of the survey and its questionnaires.

2.2 Incentives to conserve groundwater

The incentives to conserve groundwater mainly refer to the way to manage the groundwater conservation fund and the necessary activities supported by the fund. There are 2 possible ways to manage the fund. One is to be managed by local government; another is to set up a non-government agency to manage it. Which of them will be adopted will be determined through field survey.

In the literature review, some incentives or activities to conserve groundwater has been given. In this study, we preliminarily plan to choice the following possible activities: (1) to reform the water management system and make local officials and water managers be able to benefit from conserving groundwater, for example, reward a prize to the local officials and water managers if they could make the local water users obey the water quotas; (2) to establish a self-monitoring mechanism among the groundwater users, for example, let farmers from different regions to monitor the groundwater use

in other regions; (3) to reduce the farmers' poverty caused by water shortages, for example, provide donations and helps to poor families; (4) to promote water-saving technologies, such as to help farmers shifting their high water-intensive crops to low water-intensives crops; (5) to buy water quotas from farmers and "retire" the water for environment. These preliminarily chosen incentives to be supported by the fund will be revised through a pre-survey.

Whether and why these possible incentives are actually necessary or acceptable for conserving groundwater in Zhangye city will be further tested and analyzed through the field survey. The field survey mainly adopts 5-point Likert scale to prove whether these possible incentives are actually necessary. The 5-point Likert scale responses the opinion of respondents (including local water officials and groundwater users) to the possible incentives. The response choices are: 1 = "Strongly agree that the possible incentives are actually necessary and acceptable," 2 = "Agree," 3 = "Neither agree nor disagree," 4 = "Disagree," and finally 5 = "Strongly disagree." By analyzing the opinion of different respondents to the possible incentives, we could judge whether these possible incentives are actually necessary.

2.3 Data gathering

Both primary and secondary data are used to achieve the study's objectives. Primary data will be gathered through field survey based on well-designed questionnaires. Secondary data will be gathered through the pre-survey.

2.2.1 Pre-survey

Most of the secondary data will be gathered in the pre-survey, including the data of social-economic statistics, water use, land use, climate, geography, topology, hydrology and the graphic data of land use maps, satellite images and landscape photographs. By using these data and geographical information system (GIS), the oasis ecosystems supported groundwater could be spatially identified in a map.

In the pre-survey, the ecological and environmental effects of the declining groundwater will be identified through in-depth, in-person interviews. The interviewees, both in local study areas and at national level, included local farmers, experts, and officials of various levels in the government. Based on this, a survey booklet with maps (such as the locations of different kinds of ecosystems), which will

be used in the main survey, will be made to depict how and why the ecosystem services would change when the groundwater decline.

In the pre-survey, the main survey design and its questionnaire will be pre-tested and improved. Especially, the price bid ladders for WTP and the possible incentives to support by the fund will be determined.

2.2.2 Field survey

The field survey will base on the well-designed questionnaire and in-person interviews. By using the stratified random sampling methods, the respondents will be chosen from households in the 5 counties of Ganzhou, Shandan, Minle, Gaotai and Linze in Zhangye City. In the 5 counties, there are 353,000 households, including 83,000 urban households and 270,000 rural households. Of 270,000 rural households, about 43% are groundwater-using households (some of them use surface water simultaneously), and about 57% are non-groundwater-using households (they just use surface water for agriculture). The rural households come from about 25 main irrigation areas. There are about 15,000 local officials and water managers. The field survey consists of two kinds of survey, WTP survey and incentives survey.

For WTP survey, the samples will be 600 households that come from 250 urban households and 350 rural non-groundwater-using households. For sampling the rural households, 2 irrigation areas will be randomly selected in every county of the 5 counties. 70 villages and 350 households will be randomly selected in every irrigation area of the 10 selected irrigation areas.

For incentives survey, the samples will be 200 households or local officials that consists of 140 rural groundwater-using households and 60 local officials. For sampling the rural households, 2 irrigation areas will be randomly selected in every county of 2 selected counties. 28 villages and 140 households will be randomly selected in every irrigation area of the 4 selected irrigation areas.

The total number of samples will be 800 (see Table 2).

Table 2 The samples for the proposed study

Survey type	WTP survey	Incentives survey

Stratum and samples	Urban households	Rural non-groundwater-using households	Rural groundwater-using household	Local officials
	250	5 counties 10 irrigation areas 70 villages 350 households	2 counties 4 irrigation areas 28 villages 140 households	60
Sub-total	600		200	
Total	800			

2.2.3 Questionnaire Design

The questionnaire in the final survey contains 4 sections as shown in Annex 1. Section 1 describes the characteristics of the irrigation areas and respondent households, such as the water quotas, actual water uses, farmland areas, crops, income, education, and labor of households. Section 2 combines single- and multiple-response questions and open-ended questions to elicit the opinions of respondents on the ecological issues, conserving groundwater, water quota system and local water management. Section 3 will be the WTP questions. Section 4 will the incentives questions.

2.3 Data Analysis

The parameters in Equation (1) will be estimated parametrically using logistic regression which can be done with the use of some econometric software, such as EVIEWS. Then WTP could be estimated according to the Equation (2). At the same time, we could analyze the influential factors of WTP according to the parameters.

Based on the 5-point Likert scale survey, the mean values of respondents' choices from 1 to 5 will be used to examine whether the possible incentives are supported by data obtained from the large survey of farmers and other respondents. A possible incentive will be considered to be necessary and acceptable for conserving groundwater if it takes a rank mean value of less than 3. The level of significance will be tested at probability levels of 5% and 1% using the t-test of statistical significance. The differences in the responses of farmers and officials will be assessed using the Mann-Whitney *U*-test and Kolmogorov-Smirnov test. The above analyses will be taken by using some statistic analysis software. At the same time, we could analyze the influential factors of the incentive choices according to the characteristics of the respondents by using regression analysis.

3 EXPECTED RESULTS AND DISSEMINATION

The study is expected to provide information about the value of the groundwater's supporting services to ecosystems and policy stimulus for conserving groundwater in Zhangye City in Heihe River Basin. This information can be used to develop a policy regarding to incentive farmers and lower levels of the Government to conserve groundwater. The results and the methodology used in this study would be helpful to the study on valuing the groundwater.

The study project's findings will be disseminated in seminars to be attended by officials of the governments and private agencies involved in the basin land and water management and distribution. Many Medias, such as China Central TV, Xinhua News Agency, have been paying great attention on natural resources management and protection in northwest China. They must be interested in our study project.

We will try to write at least one academic paper to be published in international journals.

4 INSTITUTION AND PERSONEL

The implementing institution will be the College of Resource and Environment (CRE), China Agricultural University (CAU). CRE owns the National-level Key Laboratory in Soil Science and Water, the China Water Resources Strategy Research Center, and Land Resources Research Center, which are supported by the Central Government. CRE offers a sub-professional course, a baccalaureate degree, a diploma course, five master's degrees, and four doctoral degrees. It has made many important contributions to the advancement of land and water resources economics.

The research team will be composed of:

Study Leader:
Dr. Zhang Junlian, associate professor, CRE, CAU, nature resources economist

Team members:
Dr. Zhou Xuejun, associate professor, College of Humanities and Development, CAU, rural development specialist and nature resources economist
Dr. Zhang Liqin, associate professor, College of Agricultural Economics, CAU, agricultural economist and econometrician
Ms Liu Chang, assistant professor, CRE, CAU, ecologic economist

The curriculum vitae of the research team are provided in Annex 2.

5 TIME TABLE

The project will have duration of 12 months, which will be broken down as Table 3.

Table 3 The project schedule

MONTH	ACTIVITY
1-2	Coordination with the concerned government and private agencies Gathering fundamental and secondary data, such as maps, statistic data Conduct of research team discussions Preparation of interviews
3-4	Coordination with local government units where the survey will be administered Conduct pre-survey Preparation of field surveys questionnaires Test the questionnaires Revision of questionnaires
5-7	Train the investigators Conduct the field survey
8-9	Data analysis
10-11	Report and papers writing
12	Dissemination of results

6 BUDGET

The proposed budget of the study is given in Table 4.

Table 4 The proposed budget of the study

ITEM	AMOUNT (CNY)
a. Research Expenses	
Research assistant (1 x CNY1,600/mo x 10 mos)	16,000
Computer assistants (3 x CNY1,600/mo x 3 mos)	14,400
Trips between Beijing and Zhangye city (5persons/trip x 2trips x CNY750)	7,500
Local transport & living expenses (5persons/trip x 2 trips x 16days x CNY200/day)	32,000
Pre-test survey(CNY120 x 30 questionnaires)	3,600
Main survey(CNY100 x 800 questionnaires)	80,000
Data entry(CNY9,000 x 2 mos)	18,000
Data processing(CNY15,000 x 2 mos)	30,000
b. Dissemination	
Training for enumerators(2 day, cost of venue, food, material)	6,000
Seminar(2 day seminar, cost of venue, food, material)	6,600
c. Support services	

Office supplies	14,000
Equipment (rent computers and printers for data processing; rent scanners and LCD projectors for the seminar and other possible meetings)	5,000
Communication and postage	5,000
Photocopying and Printing	5,700
TOTAL	**243,800**

Budget requested from EEPSEA: CNY243,800 or CAD34,829

Conversion rate: CAD1: CNY7

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Annex 1

Section A Questionnaire for Irrigation Area Level

(For rural respondents)

Irrigation Area:_____ County**: _____**
Name of the respondent□_____ Sex:_____ Age:_____
Position: _____ Education level:_____

1. Basic statistic data of the irrigation area

Item		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	unit
Number of households												
Households of Migrating to urban												
Population												person
Labor force	Total number											person
	Farm labors											person
	Off-farm labors											person
Farmland	Total area											ha
	Cereal area											ha
	Cash area											ha
Forestland												ha
Grassland												ha
Farmland transfers	Number of transfers											
	Total area of transfers											ha
Water use	Water quotas											m^3
	Actual use											m^3
Water	Number of transfers											

transfers	Total amount of transfers											m^3

2. Land and water information of the irrigation area

Item		2005	Unit
Farmland	Total area		ha
	Irrigation area		ha
	Non-irrigation area		ha
Crops Area	Wheat		ha
	Corn		ha
	Fruits		ha
	Vegetables		ha
	Alfalfa		ha
	others		ha
			ha
			ha
Water quotas	Total amount		m^3
	Surface water		m^3
	Ground water		m^3
Actually water use	Total amount		m^3
	Surface water		m^3
	Ground water		m^3
Water price	Surface water		CNY/m^3
	Ground water		CNY/m^3
Total water fee			CNY
Irrigation technologies	Flood irrigation		ha
	Furrow irrigation		ha
	Sprinkler irrigation		ha
	Drip irrigation		ha

Section B-1 Questionnaire for Household Level

(For rural respondents)

Irrigation Area:_____

County**:** _____

Name of the respondent□_____

Name of the householder: _____ Sex□_____

Age: _____ Education level:_____

Time interview started: _____
Time interview ended: _____

1. Family members

Members	Age	Sex	Education level	At school or not	Months working in agriculture	Months working in non-agriculture	Who decide production□draw√□
Member1							
Menber2							
Member3							
Member4							
Member5							
Member6							

2. Farmland resources

Item		Irrigated	No-irrigated	Subtotal
Land contracted from village collective	Area (mu)			
	Parcel number			
Land contracted from other farmers	Area (mu)			
	Parcel number			
Land subcontracted to others	Area (mu)			
	Parcel number			
Land transfer 1	Area (ha)			
	Number of Plots			
	Type of transfer**			
	Price□CNY□			
Land transfer 2	Area (ha)			
	Number of Plots			
	Type of transfer**			
	Price□CNY□			
Land transfer 3	Area (ha)			
	Number of Plots			
	Type of transfer**			
	Price□CNY□			

Note: * Parcel number means the number of disjoined farmland parcels of one household.

** The types of transfer could be buy, sale, exchange, rent in or out, and etc.

3. Crop structure in 2005

Crops*	Farmland area			Irrigation water □m^3□	Total production □*jin*□	For sale □*jin*□	Price for sale □CNY/*jin*□	Earn money □CNY□
	□mu□	Irrigated	No-irrigated					
1.								
2.								
3.								
4.								
5.								
6.								

Note: * crops type including wheat, barley, maize, rice, vegetable (such as paper), fruits (such as apple and grape), pasture (such as alfalfa), herbal medicine. Vegetable as one type, but should clarify what kind of vegetable is; so does the herbal medicine.

4.Family livelihood

(1) Cash income in 2005 (CNY)

Total income	Grain income	Fruits and vegetable income	Others crops income	Livestock income	Non-agricultural income	Others income

(2) Cash expense in 2005 (CNY)

Total expend	Taxes and other fees	Production expense	Housing expense	Living consumption	Education fee for children	Others (Clarify□ □

5. Information of water resources

Item		2005	unit
Farmland area	Total area		ha
	Irrigable area		ha
Water quota	Total amount		m^3
	Surface water		m^3
	Groundwater		m^3

Water quotas	Total amount					m^3
	Surface water					m^3
	Groundwater					m^3
Actually water use	Total amount					CNY/m^3
	Surface water					CNY/m^3
Irrigation technologies	Flood irrigation					ha
	Furrow irrigation					ha
	Sprinkler irrigation					ha
	Drip irrigation					ha
Water use rights trade	Type* of buy					
	Amount of buy					m^3
	Price					CNY/m^3
	Type* of sale					
	Amount of sale					m^3
	Price					CNY/m^3

Note: * Type could be (A) long-term trade with land, Or (B) short-term trade.

6. Attitudes on conserving groundwater and related matters

(1) Do you think it is necessary to conserve the groundwater?

____Yes. Because:

____It is helpful to raise my income;

____It can benefit eco-environment.

____Others, please specify_____

____No. Because:

____It doesn't matter my income;

____It can't benefit eco-environment;

____I think it is impossible to conserve the groundwater;

____Others, please specify_____

(2) Do you approve of the water quotas system? Why?

____Yes. Because:

____It increases my income;

____It is helpful to decrease water conflicts;

____It can encourage people to save water;

____It can lead equity and fairness in water use;

____It can benefit eco-environment.

____Others, please specify_____

____No. Because:

____It decreases my income;

____It forces me to change my customs and makes me feel uncomfortable;

____It leads more water conflicts;

___It can't encourage people to save water;
___It leads more inequity and unfairness in water use;
___It can't benefit eco-environment;
___I just don't trust government;
___Others, please specify_____

(3) Do you think whether the eco-environment is becoming better or worse? Why?
___Better. Because:
___The air is becoming fresher;
___ There are more plants;
___ There are more wild animals;
___ The water is becoming cleaner;
___Others, please specify_____
___Worse. Because:
___The air is becoming worse;
___There are more sandstorms;
___There are fewer plants;
___ There are fewer wild animals;
___ The water is becoming worse;
___Others, please specify_____
(4) Who should be responsible to protect the eco-environment?
__The Government.
__NGOs.
__Local residents.
__Others, please specify_____

Section B-2 Questionnaire for Household Level

(For urban respondents)

Town or city: _____
County**:** _____
Name of the respondent□_____
Name of the householder: _____ Sex□_____
Age: _____ Education level:_____
Time interview started: _____
Time interview ended: _____

1. Family members

Members	Age	Sex	Education level	At school or not	Occupation
Member1					
Menber2					

Member3					
Member4					
Member5					
Member6					

2. Family livelihood

(1) Cash income in 2005 (CNY)

Total income	Salary	Others income

(2) Cash expense in 2005 (CNY)

Total expend	Taxes and other fees	Housing expense	Living consumption	Education fee for children	Others

3. Information of water resources

Item		2005	unit
Water quota	Total amount		m^3
	Surface water		m^3
	Groundwater		m^3
Actual Water use	Total amount		m^3
	Surface water		m^3
	Groundwater		m^3
Water use fee	Total amount		CNY/m^3
	Surface water		CNY/m^3

4. Attitudes on conserving groundwater and related matters

(1) Do you think it is necessary to conserve the groundwater?

____Yes. Because:

____It is helpful to raise my income;

____It can benefit eco-environment.

____Others, please specify_____

____No. Because:

____It doesn't matter my income;

____It can't benefit eco-environment;

____I think it is impossible to conserve the groundwater;

____Others, please specify_____

(2) Do you approve of the water quotas system? Why?

____Yes. Because:

____It increases my income;

____It is helpful to decrease water conflicts;

____It can encourage people to save water;

____It can lead equity and fairness in water use;

____It can benefit eco-environment.

____Others, please specify_____

____No. Because:

____It decreases my income;

____It forces me to change my customs and makes me feel uncomfortable;

____It leads more water conflicts;

____It can't encourage people to save water;

____It leads more inequity and unfairness in water use;

____It can't benefit eco-environment;

____I just don't trust government;

____Others, please specify_____

(3) Do you think whether the eco-environment is becoming better or worse? Why?

____Better. Because:

____The air is becoming fresher;

____ There are more plants;

____ There are more wild animals;

____ The water is becoming cleaner;

____Others, please specify_____

____Worse. Because:

____The air is becoming worse;

____There are more sandstorms;

____There are fewer plants;

____ There are fewer wild animals;

____ The water is becoming worse;

____Others, please specify_____

(4) Who should be responsible to conserve the eco-environment?

__The Government.

__NGOs.

__Local residents.

__Others, please specify_____

Section C Questions on WTP

(For urban households and rural non-groundwater-using households)

Please keep in mind when answering the following questions: (1) The issues discussed here are only a few among many other environmental problems; (2) This interview is on conserving the groundwater in Zhangye city and not on other regions; (3) Your own personal income is limited and has important alternative uses; (4) There is no right or wrong answers and you should answer for yourself. (5) The following is only a hypothetical situation (that means suppose it happens as such).

1 WTP question

Suppose that a groundwater conservation fund will be set up. The fund will be used solely to support necessary activities to enforce the groundwater quota system and guarantee every user obey the system and avoid the oasis ecosystems to disappear by overpumping groundwater.

Would you be willing to pay _____ (figure randomly selected from the bid price ladder[1]) CNY as your yearly contribution to the fund for the next five years, in order to conserve and conserve the groundwater? Please keep in mind your present income and financial commitments.

2 Which way to manage the fund do you prefer?

_____Managed by local government

_____To set up a non-government agency to manage it

3 To respondents who refuse to bid, why did you refuse to bid?

____I have no money to support it;
____I think no need to conserve groundwater;
____I think I could not benefit from conserving groundwater;
____I think it should not be my duty to conserve groundwater;
____I think the fund has no help to conserve groundwater;
____Others, please specify_____

4 To respondents who have bid, which ways will you prefer to contribute to the fund?

____Donate money;
____Pay more taxes;
____Pay more water fees;
____Spend time to participate in water use monitoring;
____Invest money to adopt water-saving technologies and give up some water quotas;
____Others, please specify_____

[1] The bid price ladder would be: 1; 2; 5; 10; 15; 20; 25; 30; 40; 50; 70; 80; 100; 140; 180; 250; 300; 350; 400; 500; 600 (CNY)□And it will be finally determined through the pre-survey.

Section D Questions on incentives to conserve groundwater

(For rural groundwater-using households and local water officials)

Please keep in mind when answering the following questions: (1) The issues discussed here are only a few among many other environmental problems; (2) This interview is on conserving the groundwater in Zhangye city and not on other regions; (3) There is no right or wrong answers and you should answer for yourself. (4) The following is only a hypothetical situation (that means suppose it happens as such).

Suppose that a groundwater conservation fund will be set up. The fund will be used solely to support necessary activities to enforce the groundwater quota system and guarantee every user obey the system and avoid the oasis ecosystems to disappear by overpumping groundwater.

1 Which way to manage the fund do you prefer?

_____Managed by local government

_____To set up a non-government agency to manage it

2 Do you believe that the fund could work effectively?

_____Yes

_____No

3 To the respondents who say yes to the above question, please give your opinions if the fund is used to support the following activities to conserve the groundwater.

(1) To reform the water management system and make local officials and water managers be able to benefit from conserving groundwater;

Your opinion:

1 = "Strongly agree that the fund should be used to support this activity"

2 = "Agree"

3 = "Neither agree nor disagree"

4 = "Disagree"

5 = "Strongly disagree"

(2) To establish a self-monitoring mechanism among the groundwater users, for example, let farmers from different regions to monitor the groundwater use in other regions;

Your opinion:

1 = "Strongly agree that the fund should be used to support this activity"

2 = "Agree"

3 = "Neither agree nor disagree"

4 = "Disagree"

5 = "Strongly disagree"

(3) To reduce the farmers' poverty caused by water shortages;

Your opinion:

1 = "Strongly agree that the fund should be used to support this activity"

2 = "Agree"

3 = "Neither agree nor disagree"

4 = "Disagree"

5 = "Strongly disagree"

(4) To promote water-saving technologies, such as to help farmers shifting their high water-intensive crops to low water-intensives crops;

Your opinion:

1 = "Strongly agree that the fund should be used to support this activity"

2 = "Agree"

3 = "Neither agree nor disagree"

4 = "Disagree"

5 = "Strongly disagree"

(5) To buy water quotas from farmers and "retire" the water for environment.

Your opinion:

1 = "Strongly agree that the fund should be used to support this activity"

2 = "Agree"

3 = "Neither agree nor disagree"

4 = "Disagree"

5 = "Strongly disagree"

4 To the respondents who say no to the Question 2, what are your opinions on conserving groundwater?

___I think no one would obey the groundwater quota system whatever will be done.

___I have better ideas to conserve groundwater. They are_____.

ANNEX 2 CURRICULUM VITAE OF RESEARCH TEAM

ZHANG JUNLIAN; Chinese; male; born on March 4, 1967 in Hubei Province, Central China; Married; currently residing at Apt. 14-506, No.3, Yuanmingyuan West Road, Beijing City.

CURRENT POSITION

Associate Professor, the College of Resource and Environment (CRE), China Agricultural University (CAU).

EDUCATION

Ph.D Nature Resources Economics (Land Sustainable Use and Management/Optimization Modeling of Land and Water Resources Uses), CAU, 1997;
M.S. Land Science (Land Evaluation/Land Resources Management), CAU, 1992;
B.S. Soil Science and Agriculture Chemistry, CAU, 1989.

OTHER TRAININGS

Training Program on Eco-management Strategies and Polices, sponsored by Italian Ministry for the Environment and Territory, in Beijing and Italy, 2004-2005;
Training Course on Physical Science of Pollution Control, sponsored by EEPSEA in Thailand, 2004;
Training Course in Natural Resource Economics, EEPSEA/CCAP, 2003;
Training Course in Water Resource Sustainable Use and Management, the Ministry of Water Resources of China, 1996;
Training Course in Land Population Supporting Capacity, FAO, 1992.

WORK EXPERIENCE

Associate Professor, CRE, CAU, 2001 to date;
Assistant Professor and Lecturer, CRE, CAU, 1992 to 2000.

Main Teachings:
Teaches courses in Land Law (for undergraduate students), Land and water Policy (for graduate students and masters of public administration); Conducts research and advises graduate students in Resources Economics.

Main Researches:
Study leader, Study on the Barriers and Transaction Costs of Water Markets in Heihe River Basin in Northwest China, sponsored by EEPSEA, 2004-2005.

Study Leader, Study on Promotion System for Regional Eco-agricultural Technologies, the Ministry of Science and Technology of China, 2002-2004;

Study Leader, Study on Land Consolidation, the Ministry of Land and Resources, 2002-2004;

Main research participant, Study on Farmland Protection and Food Security, the Ministry of Land and Resources, 2003;

Study Leader, Study on Land and Water Use Policy in West China, the Ministry of Land and Resources, 2002-2003.

MAIN PUBLICATIONS

Academic Papers

Zhang Junlian, Zhou Linxia, 2003. Study on models and policies for matching land and water resources in West China. Chinese Journal of Eco-agriculture, in press.

Zhang Junlian, Wu wenliang, Liu Chang, 2003. The exploration on National Green Budget. Chinese Journal of Eco-agriculture. Vol.11, No.2, 165-167.

Zhang Junlian, Li Xianwen, Liu Qin, Zhou Linxia, 2003. Study on the models of foreign urban readjustment. China Land Science. Vol.17, No.1, 46-51.

Zhang Junlian, Lu Shilei, 2002. Suggestion and economics analysis on competition policy in return cultivated to forests. Forestry Economics. 7, 45-46

Zhang Junlian, 2001. Study on Farmland use rights system. Territorial Economy. 4, 44-45

Zhang Junlian, 2001. Changes in property ownership thoughts and developing trend of Chinese land property law. Journal of China Agricultural University. 3, 64-67

Zhang Junlian, 2001. Study on Chinese land property rights system. Law Science Magazine. 3, 40-41

Books

Yao Changtian, **Zhang Junlian**, et al, 2003. Mountains, Inhabitants & Treasure in China. Kaiming Press;

Zhang Junlian, 2001. Land Law. China Agricultural University Press.

Liu Liming, **Zhang Junlian**, 2001. The Discipline of Land Resources. China Agricultural University Press.

Chen Huanwei, **Zhang junlian**, 1997. Survey in Soil Resource. China Agricultural University Press.

Liu Liming, **Zhang Junlian**, 1994. Survey and Evaluation in Land Resources. Science and Technology Documental Press.

ZHOU XUEJUN; Chinese; male; born on August 10, 1965 in Hubei Province, Central China; Married; currently residing at No.3, Yuanmingyuan West Road, Beijing City.

CURRENT POSITION

Associate professor, trainer, researcher & consultant, the College of Humanities and Development (CRE), China Agricultural University (CAU).

EDUCATION

2003-present	PhD candidate in the University of Vienna.
1995-1997	DEA (= Master + 1 year), ESSOR (Espaces, Sociétés Rurales et Logiques Economiques)*(Development Sociology and Economics)*. Toulouse University--le Mirail, Toulouse of France.
1988 - 1991	M. Sc., Agricultural Resource and Environment. China Agricultural University, Beijing.
1981 - 1985	B. Sc., Agronomy. Huazhong Agricultural University, Wuhan, Hubei Province.

OTHER TRAININGS

2000	Dialogue on best practices in local-level partnerships for rural poverty alleviation in Asia (March 12-19, Philippines)
1994	Local counterpart of an ICRA[2] field study on rural sustainable development. Main contents: -Farming system research; -Agricultural knowledge and information system (AKIS) research; -Agricultural and rural sustainable development; -Agricultural diversification; -Introduction of ICRA approaches especially RRA (Rapid Rural Appraisal) and PRA (Participatory Rural Appraisal).
1994	International training workshop on Organic Farming in Nanjing, with key trainer Mr. Thomas Harding, the president of the Federation of Organic Farming Movements International. Main contents: -Introduction and definition of organic farming; -Monitoring and certification of the production, proceeding and marketing of the organic food; -Potential analysis of organic farming development in China.
1990	Participant of a two week training on poverty alleviation project management in Inner Mongolia.

[2] ICRA-International Centre for development oriented Research in Agriculture (Wageningen, The Netherlands).

1986 Participant of an one month training on farm management in Wuhan, Hubei Province.

WORK EXPERIENCE

Since 1993	Associate professor, trainer, researcher & consultant at CIAD (Center for Integrated Agricultural Development) / CORD (College Of Humanitiesand Development), China Agricultural University.(GO)
1993	General manager of Shandong Shinelong Industry and Commerce (Agricultural Development) Co., Ltd.(PB)
1988-1992	Assistant professor / Lecturer / Researcher at College of Resource and Environment Management, China Agricultural University.(GO)
1985-1988	Extensionist and official at Hanyang County, Wuhan Municipality. Vice manager of Shihu State Farm in Hanyang County, Wuhan.(GO)

Main Teachings:

Participatory Development—*theory-methods-tools*
Poverty Reduction and Development—*theory and practice*
Gender and Development—*theory-tools for analysis and planning*

Main Researches:

National Technical Adviser (long-term assignment). German KfW "Sino-German Poverty Alleviation Project Shanxi (SG-PAPS)" in Luliang Prefecture, Shanxi Province. Nov.-Dec. 2003.

Senior researcher. EU project "SUCCESS (Sustainable Users Concepts for China Engaging Scientific Scenario)". Sep.-Nov. 2003

National Technical Adviser (long-term assignment). German KfW "Sino-German Poverty Alleviation Project Shanxi (PAPS)" in Shanxi. Nov.-Dec. 2002

Senior researcher. EU project "SUCCESS (Sustainable Users Concepts for China Engaging Scientific Scenario)". Sep.-Oct. 2002

Senior Consultant. AusAID/WFP Mid-term Beneficiary Survey for "Wuling Mountains Rural Development Project—WFP/AusAID 6166--Guizhou". June 2002

MAIN PUBLICATIONS

2003	Participatory Impact Assessment of the Women Migration on the Migrant Women (ZHOU Xuejun, the World Bank Southwest and Qingba Mountains Poverty Alleviation Project. June 2003) (73 pages in English)
2002	Mid-term Beneficiary Survey Report (ZHOU Xuejun, Wuling Mountains Rural Development Project WFP/AusAID 6166—Guizhou. July 2002) (86 pages in English)
2002	Institutional Innovation to Sustain Participatory Development—On the Principles and Significance of Farmers' Self-help Organization Development <-*Experience from and a case study on the Sino-German cooperation project "Contribution to Sustainable Development of Mountainous Areas of Jiangxi Province" in Longgou Township, Chongyi County, Jiangxi Province*> (ZHOU Xuejun, SMD-JP/GTZ, Jan. 2002) (10 pages in Chinese)
2001	Design of the project "Processing of Organic Agricultural Products by Poor Women in Shanxi Province". (ZHOU Xuejun, ASIAN DEVELOPMENT BANK (ADB) RSC No. C10245 PRC/Efficient Utilization of Agricultural Waste. Project work report. Dec. 2001) *(in English)* (80 pages)
2001	Voice of the urban poor—*a participatory case study on urban poverty in Beijing* (ZHOU Xuejun, June 2001. ADB work report) (43 pages in English)
2001	Training materials on Farmer's Self-help Organization Development (ZHOU Xuejun, SMD-JP, Jan. 2001) *(in Chinese)*(26 pages)

ZHANG LIQIN; Chinese; female; born on June 23rd, 1973 in ShanXi Province, North China; currently residing at No.3, Yuanmingyuan West Road, Beijing City.

CURRENT POSITION

Associate Professor, the College of Economics & Management, China Agricultural University (CAU).

EDUCATION

Ph.D Agricultural Economics, China Agricultural University, Beijing, 2001;
M.S. Agricultural Economics, China Agricultural University, Beijing, 1998;
B.S. Economics, Beijing Agricultural University, 1995.

OTHER TRAININGS

Chinese Women Economists Training, gender focus, sponsored by Ford Funds, held in China Center of Economic Research of Peking University in May, 2002;
Computer, Secondary Major, from March 1993 to Dec. 1995

WORK EXPERIENCE

Research fellow, Associate Professor, College of Economics & Management, CAU, 2001 to date

Main Teachings:
Teaches courses in Land Economics (for graduate students and masters of public administration); Conducts research and advises graduate students in Agricultural Economics.

Main Researches:
Main Writer and Project participant, Study on Structural Adjustment of Agricultural and Rural Economy: How to Reform Domestic Support Policies? Sponsored by Ministry of Agriculture (MOA), Apr. 2002 – Aug. 2002;

Main Writer and project participant, Study on Agriculture Domestic Support Policies of China after WTO Accession, MOA, Sep. 2001 – Mar. 2002;

Project participant, Study on International Experience on Farmer Income Support Policy, sponsored by Soft-science Funds of MOA, 2001 – 2002;

Main project participant, Study on Projection on China Agricultural Investment Demand and Structure by 2010, sponsored by Soft-science Funds of MOA, April 1998 – Feb. 1999;

Project participant, Study on Performance of “Harvest Plan” Projects of MOA, sponsored by State Harvest Plan Office, Feb.2001 – Dec. 2001;

Project participant, Study on Economic Behaviour of Rural Resident in Beijing, sponsored by National Agricultural Population-survey Projects of National Statistic Bureau, 1998 – 1999;

Project participant, Study on Rational Distribution of Feedstuff China, sponsored by MOA, 1996 – 1998;

Writer and Project main participant, Study on Measurement of Land Use Coefficient in levelling on Agricultural Land, sponsored by Ministry of Land Resources of China**,** 2002 – 2003;

Financial and economic analyzer, Study on World Band Husbandry Integrated Development Project in Xinjiang and Gansu Province, 2001 – 2002;

Financial analyzer, Study on Husbandry Integrated Development Project for Mancuo Lake Area, Tibet, 2000;

Financial analyzer, Study on High Science and Technology Agricultural Project of Huhehaote city (Inner Mongolia Autonomous Region), 2000.

MAIN PUBLICATIONS

Academic Papers

Zhang Liqin, Effective Assistance on Agricultural Products of Agricultural Policy in China, Ph. D degree paper, Economics & Management College of China Agricultural University, 2001.

Zhang Liqin, Weiming Tian and Zhangyue Zhou, China's PSEs: Are the Chinese farmers subsidized? paper presented to 46th Annual Conference of Australian Agricultural and Resource Economics Society, February 12-15, 2002, Canberra, Australia.

Weiming Tian, **Zhang Liqin** and Zhangyue Zhou, Experiences and issues in measuring the level of support in China□Paper presented to the Workshop "Agricultural policies in China after WTO accession" held jointly by Ministry of Agriculture and OECD on May 30-31, 2002, Beijing. The paper is published in Agricultural policies in China after WTO accession, p284-300, OECD, Paris.

Zhang Liqin, The Status of Women and Backyard Hogs Production in Jilin and Henan, Paper presented to the 2nd China Economics Annual Conference held in Xi’an on Oct.14-17, 2002.

Zhang Liqin, Wanlong Lin and Yi Xin, Challenge and Reform of China’s Domestic Agricultural Support Policy, Journal of China Agricultural Economics, 2003.4□

Fu Qin, **Zhang Liqin**, Building system of China domestic agricultural support policy, Journal of Scientific Decision-making, p19-24, 2003.1.

Yi Xin, Wanlong Lin, **Zhang Liqin**, International competitive of China labor-intensive

agricultural products, Journal of China State Farms Economy, p25-28, 2002.11.

Zhang Liqin. Measurement of agricultural support level in China, Journal of Rural Sociology and Economics, p8-22, Vol.53, 2001.

Zhang Liqin, Challenges faced by China agriculture after WTO accession, Journal of China State Farms Economy, p39-40, Vol.355, 2001.3.

Books

Fu Qin, Wanlong Lin, **Zhang Liqin**, 2002. Investment Project Evaluation, published by China Science & Technology Press;

Fu Qin, Xiuqing Wang, Xian Xin, Xiurong He, **Zhang Liqin**, et al, 2003. Foreign Agricultural Support Policy, China Agriculture Press.

LIU CHANG; Chinese; female; born on Jan. 23rd, 1970 in Beijing, China; currently residing at No.3, Yuanmingyuan West Road, Beijing City.

CURRENT POSITION

Assistant Professor and Master degree student, the College of Resource and Environment(CRE), China Agricultural University(CAU).

EDUCATION

Master degree student in ecology (ecological economics), CRE, CAU, 2002-2004;
B.S. in Economics, Peking University, 2000.

OTHER TRAININGS

Training Course in Accounting, LCCI, 1996.

WORK EXPERIENCE

Assistant Professor, CRE, CAU, 2000 to date;
Accountant and officer, Finance Section, CAU, 1992-2000.

Main Researches:

Main project participant, Study on Farmland Protection and Food Security, the Ministry of Land and Resources, 2003;

Project participant, Study on Promotion System for Regional Eco-agricultural Technologies, the Ministry of Science and Technology of China, 2002-2004.

Project participant, Study on Land and Water Use Policy in West China, the Ministry of Land and Resources, 2002-2003.

Main project participant, Study on The Key Technique of High Effective Organism & Agronomy, the National Program of High Technology Development, 2001-2004.

MAIN PUBLICATIONS

Zhang Junlian, Wu Wenliang, **Liu Chang**, 2003. The exploration on National Green Budget. Chinese Journal of Eco-agriculture. Vol.11, No.2, 165-167.