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Diversity of Agricultural Water Management

― An Analysis of the Policies in the People's Republic of China ―

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Contents

I Introduction

1 Trends in Agricultural Water Policies of the World

Tackling water shortages will become one of the biggest international agendas by the middle of the 21st century. How to manage water resources is affected by international politics, because these resources are connected to worldwide population growth, lack of natural resources and damage to the environment caused by economic growth and inconsiderate use of water.

Discussions on water management sometimes cause confusion and misunderstandings among people because the background of each person is different. There are many reasons for these differences. Some articles mentioned differences of water management in dry areas and wet areas (Fukui, 1987).

The Organization for Economic Cooperation and Development (OECD) hypothesizes that water should be treated as a product in the marketplace and discusses water pricing. Moreover, the OECD has addressed the idea that irrigation water is consumed unproductively and inefficiently.

Although European countries and the United States of America (USA) have argued this issue for a long time, it is essential to discuss this issue for Asian countries, the main operators of irrigation systems in the world. Asian countries should also join the discussion to better understand the issues as an international dilemma.

Irrigation systems have an important role in the management of water quality. However, market-oriented dialogue sometimes denies or discounts this importance. In this paper we focus on management systems of irrigation as well as water pricing, we review various arguments for setting up water pricing, carry out case studies in Japan and discuss the necessities of integrated irrigation management before applying water pricing to the Asian humid tropics.

I studied water pricing mechanisms in developing countries for many years, especially in Asian Humid Tropics. Results of the previous studies, shown in Fujimoto et al. (2003c), are summarized as follows:

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a Water Pricing

Some international organizations have tried to solve problems of water shortage by saving and reallocating water resources based on water rights. The World Bank (WB) and the OECD, therefore, have discussed these issues in seminars and have published research papers associated with water pricing (WP). According to Johansson (2000), 348 papers related to WP have been published.

(1) Classification of WP

(i) Classification by the OECD

The aim of applying WP mechanisms is to set a price for reallocation and transfer of water easily and to determine how users should pay water charges to recover costs. There are various WP systems related to water charge, water trade and the water market. The OECD has classified the types of WP mechanisms for member countries (**Table 1**). The OECD (1999b) focuses on discussion of full-cost recovery (full-cost pricing) and monitors how member countries have dealt with WP and analyzes the conditions (**Table 2**).

On the other hand, WP addresses the water market. For example, according to Chang and Griffin (1992), central-western areas in the USA, Chile and Mexico have traded water rights for many years. For example, water trade started in Texas in the 1960s when the urban areas needed more water for city use while the rural areas had surplus water.

(ii) Classification by Fujimoto et al.

Table has caused confusion in Japan because some papers indicate that area charge in Japan is classified as area pricing (Fujimoto 2001). However, some consider that the charging measures in Japan should not be included as part of WP. In order to avoid confusion in this paper, the author has distinguished between water charge and WP, and the measures applied in Japan are classified as part of water charges to recover costs of operation and maintenance (O&M).

There are three aspects associated with WP (Fujimoto et al. 2001). Categorized by purpose and performance of WP, the three aspects are volumetric pricing, full-cost recovery and water market. The main purpose of volumetric pricing is to save water resources for special functions. The concept of full-cost recovery is to set up an appropriate water price. When people set up a price, they should consider the entire expense, including construction costs, operation costs and maintenance costs related to water distribution. The idea of the water market is to boost reallocation of

Table 1 Water Pricing Mechanism OECD Countries.

Types of Water Pricing Mechanisms	Descriptions
Area pricing	Charges for water used per unit of irrigated area. Sometimes area-pricing is discriminated based on the crops that are irrigated, on irrigation technologies, or on the season of the year.
Volumetric Pricing	Based on actual records of consumed volumes, or on measurement of time use of a known flow.
Two-part tariff pricing	Makes farmers pay a volumetric charge for each unit of water used, as well as a fixed annual charge (usually based on the fixed cost component to recoup provision of irrigation water).
Tiered pricing	Different prices for the volumes of water expected to be used in different ways
Betterment Levy pricing	Charges irrigated land based on the increased value of the land, due to the provision of irrigation water
Volumetric Pricing with a Bonus	Farmers are required to pay for any water that exceeds a certain volume, and are financially rewarded if their consumption is below another threshold.
Passive Trading	The district offers a price ― presumably the one which equates aggregate water supply and demand ― and farmers make use of whatever amount of water they want. Farmers' consolidated rights to water are then charged at the average price, but those whose consumption is higher have to pay the offered price, and those consuming below their rights receive a payment for their thrift.
Water Market	Public agencies can elicit farmers' "willingness-to-pay" for marginal units of water, and set prices accordingly.

Source: OECD (1999a).

Table 2 Application of Water Pricing for Irrigation among OCED Countries.

Performance	Member countries	Strong Inter-sactor water competition
Good	Australia, Belgium, Netherlands, New Zealand	Australia
Fair	France, Japan, Mexico, British, United States	Japan (during droughts), Mexico, United States
Poor	Canada, German, Greek, Italy, Portuguese, Spain, Turkey	Greek, Southern Italy, Spain

Source: OECD (1999b).

water for different purposes.

(iii) Classification by Perry

Perry (2002) explained, “There are a number of reasons, each with different purposes, for recommending water charges.” Some reasons are: (a) to recover the cost of providing the service (either the full cost, including capital expenses, or the ongoing O&M cost, or some intermediate level); (b) to provide an incentive for the efficient use of scarce water resources; and (c) as a benefit tax on individuals receiving water services to provide potential resources as further investment for the benefit of others in the society.

(2) Policy of WP

Considering the two classifications by Fujimoto et al. (2001) and Perry (2002), I illustrate the relations between water charge, water transfer and WP in **Fig. 1**. As the illustration shows, WP is not a purpose but a measure to carry out some policies. As Fujimoto (2000) pointed out, water transfer, one important purpose for applying a WP policy, should only be done when three conditions are met: (a) there should be tradable water rights; (b) there should be non-returning water flow in the district, or if there already is, it should be easy to measure the volume of water flow; and (c) the quality of the water should not change in the district.

b Possibility of Applying WP to the Asian Humid Tropics

WP is based on the hypothesis that the price of water is stable, or fluctuation in the price is not very large. In the area where this hypothesis is correct, a policy based on a WP mechanism may bear some political fruit. However, in the Asian humid tropics (AHT), where fluctuations in precipitation during the irrigation season are large, people must carefully consider whether WP is applicable. Here we investigate geographical and climatic characteristics of the AHT and discuss the problems of applying WP.

(1) Characteristics of the AHT

(i) Seasonal differences in precipitation

We can point out the characteristics of the AHT as fluctuations in precipitation during the different seasons. In **Fig. 2**, seven cities in Japan, Sendai, Tokyo, Kanazawa, Nagoya, Kyoto, Okayama and Kumamoto and four cities in Euro-America, London, Paris, Rome and New York are illustrated. The average precipitation of Japan and Euro-America was plotted following the rule that the least monthly precipitation of each city is calculated in month “1,” and the precipitation of the following calendar month is calculated in month “2” and this is continued to month “12.”

As we can easily understand, precipitation in both areas in the first month, the least precipitation month, is almost equal, but precipitation of both areas in the following month is quite different. In cities in the AHT, fluctuations in precipitation during a year are very large, as shown in **Fig. 2**. In addition, large fluctuations in precipitation occur over several days. Therefore, many social systems have been designed for the purpose of avoiding conflicts induced by unstable water supply or unpredictable climatic changes during drought seasons.

(ii) Reuse of irrigation water

We must also consider reuse of water resources in the AHT. In Japan, the amount of irrigation water is calculated as shown in **Fig. 3** when projects are

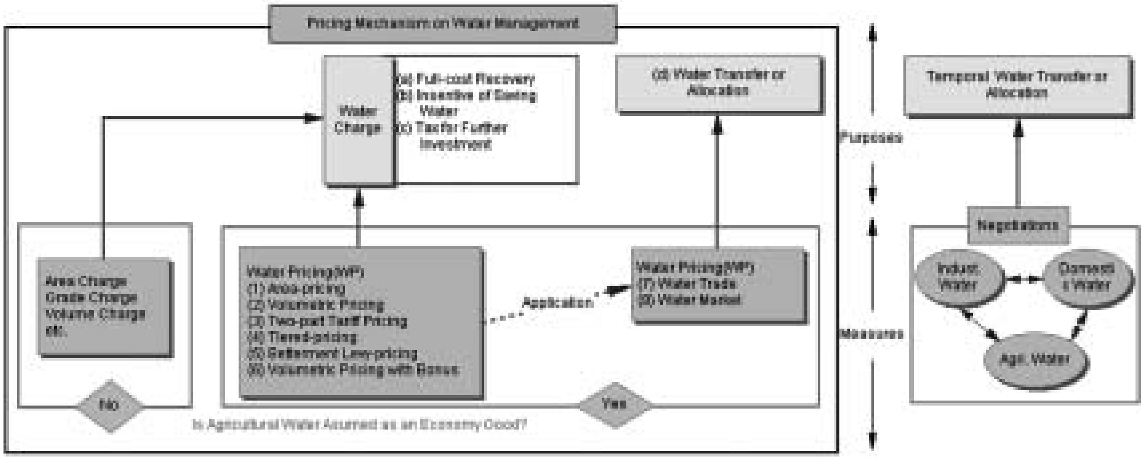

Fig. 1 Relationship between water Charge, Water Transfer (Allocation) and Water Pricing.

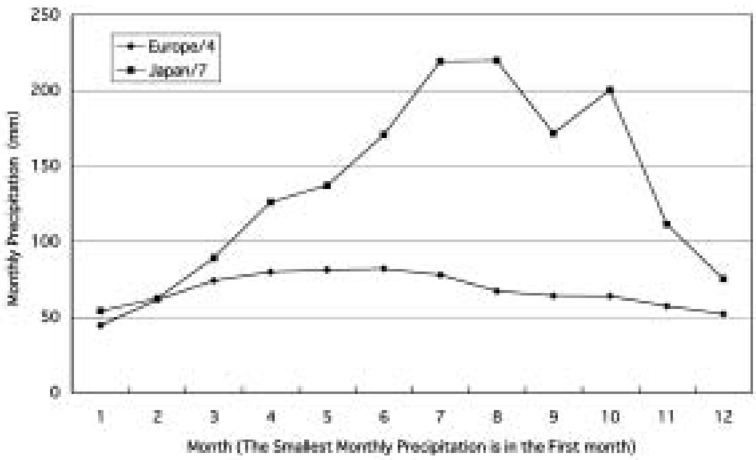

Fig. 2 Fluctuation in Precipitation.

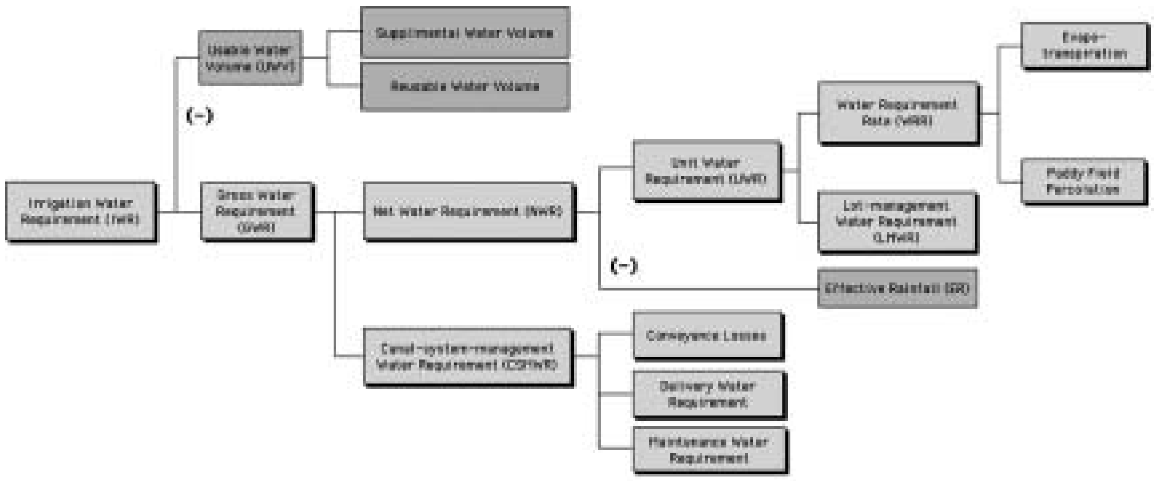

Fig. 3 Aggregation of Water Requirement on Project Planning.

planned (MAFF 1993). Here, only evaporation and transpiration really consume water, while a small amount of water remains in the plants. The rest of the water delivered to farming plots is effectively reused by farmland downstream after it returns to canals and rivers with some water infiltrating into the aquifer.

Irrigation water for paddy farming contains paddy field percolation, management water requirement (MWR) (Eq. 1) and losses, so little of the water delivered to farming plots is consumed, and a part of the reusable water is counted as reusable water volume (RWV) (Eq. 2). On the other hand, irrigation water for upland fields simply contains water consumed by plants and losses.

$$MWR=LMWR+DWR+MnWR \tag{1}$$

$$RWV=sigma(LWR+PFP)rA \tag{2}$$

where MWR is management water requirement; LMWR is lot-management water requirement; DWR is delivery water requirement; MnWR is maintenance water requirement; RWV is reusable water volume; PFP is paddy field percolation; r is return flow ratio; and A is paddy area.

The volume of water actually reused is difficult to determine, so there are not many theses on reused water, except for Mitsuno (2002). He carried out a simulation study using a connected-tanks model analysis in the Yasugawa River Basin, Japan. According to Mitsuno, multi-use water rates, the proportion of multi-used water to the entire water taken from the river, were more than 50% (45-75%) in almost all years from 1985 to 1997.

(iii) Communities

In the AHT, farmers have traditionally farmed their paddies and operated and maintained their irrigation facilities by co-operative community activity to allow for the use of the climatic conditions. Sato (2000) illustrated this fact by saying that “control and management of water for rice cultivation has been an important issue since ancient times," and "over a long period of time, water user groups made up of farming households have been organized in each region, and established a mechanism of water management for the entire region."

Piper (1993) also stated that "as ways of controlling water were developed, societies changed further, investing ever more in the land for terracing, transplanting rice, and eradicating pests," and "the great kingdoms of South-East Asia have usually been based on irrigated rice production." People in the AHT have often stated that water is a blessing from heaven, but, in fact, water distribution has been achieved by the co-operative activity of the people. For a long time, intensive societies of Asian style have been formed through these activities (Mase 2001).

(2) Difficulty of Pricing

(i) Shadow price

We can easily set the balance point between demand and supply of annual water distribution when the water supply in the irrigation season is automatically decided only by snow-fall depth during the winter in a reservoir area, such as the San Joaquin River basin in California, USA, where there is almost no rainfall during the summer irrigation season (Japanese Institute of Irrigation and Drainage 2002). In this case, the water price can easily be decided.

However, in the case of the AHT where irrigation is needed mainly during the rainy season and daily fluctuations are large, the water price may vary daily according to how much rainfall can be utilized and how much water is needed depending on farming stages. Therefore, it is difficult to manage long-term distribution plans and long-range plans based on WP as carried out in California.

(ii) Organizations to collect water charges

In addition to the above-mentioned problems, the difficulty of collecting charges from farmers must be mentioned. In Japan, it is not a problem because the Land Improvement District (LID) office can officially collect charges from member farmers. However, it is a big problem in developing countries where there is no such organization. It is difficult to collect charges from farmers where there is no concept of paying money for water used. For example, according to Kirpich et al. (1999), the government of Egypt cannot collect water charges from farmers because this is against Islamic precepts. Although the Korean government has collected water fees from farmers, the government discontinued this policy from 2000 (Kim 2001). If there is no organization to collect charges, WP is practically impossible to apply. So, we must at first consider how to form farmer organizations that insist on the concept of participatory irrigation management (PIM) (Fujimoto et al. 2001).

In the Netherlands, officially established water boards tally water surcharges for citizens according to the volume of water used and the water table (Teramura 1998). If there is no organization to collect the water charge, establishing a tax system may be an alternative method. In fact, officers have considered establishing a tax system to collect water charges in Zhejiang Province, China (Fujimoto et al. 2003).

(3) Discussions on the AHT

At the Asian workshop of the International Commission on Irrigation and Drainage (ICID) held in 2000, there were discussions on the sustainable development of irrigation systems for paddy fields. According to the ICID (Japanese National Committee of ICID 2000), "it is important to monitor people who are not involved with paddy planting or agriculture." "The application of open market or free competition at the global level should be reflected in local and regional level differences." "It is essential to look at differences in facilities, economic levels and cultural and social adaptation of many countries" and "you should not consider only cost performance."

In addition, participants of the PIM seminars held by the Asian Productivity Organization (APO) in 2000 stated that "ensuring water rights is appropriate rather than applying WP in the next 10 years because some countries are pre-mature to accept it", and "all the members in a discussion group agreed on the need for tradable water rights in the future, even though the argument on water market was not conclusive" (Asian Productivity Organization 2000).

Tanji (2002) stated that WP is difficult to apply in Japan because many technical difficulties need to be solved beforehand, and part-time farmers usually possess more water to ensure flexibility in agricultural use even if it requires paying more money. Therefore, applying WP in Japan will result in no water savings.

(4) Results

When assessing WP from three viewpoints; effectiveness, equality and sustainability, it is not effective to apply

WP to the AHT where shadow prices of water surge. It is not easy to obtain consensus on equality in the AHT where thousands of years of history exist on irrigation system. Furthermore, it is not easy to transfer water-use and land-use that have been continuously passed down by ancestors.

On the other hand, a concept of agricultural water possesses not only functions for agricultural production but also functions for environmental protection. However, the value of environmental protection does not have a market value (Loomis 1998), so protecting the ecosystem can be difficult. The three pillars of agricultural water sustainability are efficiency, equity and ecosystem protection (Postel 1992).

c How to Decide the Water Charges

(1) Several Measures Active in the AHT

Japan has mainly employed an area charge system and the fee has been used for O&M of irrigation facilities. According to research carried out by the Nationwide Federation of LIDs (1999), 5,108 out of 5,279 districts (96.8%) applied area charges for management-cost recovery and 5,857 out of 6,232 districts (94.0%) applied area charges as O&M-cost recovery. Other measures including volumetric charges are not common in Japan (**Table 3**).

Generally speaking, area charges are accused of leading to a waste of water because farmers have no incentive to save. On the contrary, volumetric charges easily provide farmers with an incentive to save water. However, volumetric charges require an extra expenditure to install water gauges. For example, the price of installing a gauge for each small plot will cost a great deal in the AHT, where small farming is dominant.

Underground-water irrigation is irrigation where water is pumped from aquifers and provided to farm lands. Since pumping facilities are easy to equip with water gauges, volumetric charges are easy to apply. Also, underground water is a type of personal property and is freely pumped, sold and lent by owners, so market-oriented transfer is easy to apply (Okamoto 2002). In fact, people run irrigation businesses in underground-water irrigation areas of Bangladesh (Fujita 1999).

In upland irrigation areas, such as northwest China and India, a volumetric charge system is active.

(2) Case Study in Japan

According to research conducted by the Ministry of Agriculture, Forestry and Fisheries (MAFF) in 2000, 27 districts had employed volumetric charges. From January to May 2001, together with the regional agriculture offices, we visited six districts in five prefectures and investigated the volumetric charge system they employed.

(i) Case study in the Tokai region, central Japan

The “A” project area covers three cities and seven townships with 7,300 ha of upland and paddy fields providing supplementary irrigation water by pipe lines. In this area, volumetric pricing has been applied since 1986 as a normal charge including maintenance and management fees. The tallying system is a combination of leveled tally up to 300 m^3/0.1 ha and volumetric pricing over the margin (**Fig. 4**). This system has been in effect since 1998. There are 42 irrigation blocks (IBs) in which the farmers receive agricultural water at

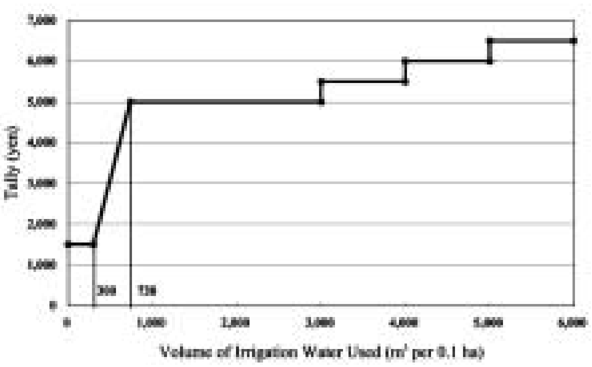

Fig. 4 Tallying System in “A” Project Area.

Table 3 Water Charge for Cost Recovery by LIDs.

Charge Based on	Management Cost (LIDs)	Management Cost (%)	O&M Cost (LIDs)	O&M Cost (%)
Farmland Area	5,108	96.8	5,857	94.0
Grade	52	1.0	108	1.7
Water Volume	16	0.3	81	1.3
Project Cost	17	0.3	41	0.7
Land Elevation	2	0.0	12	0.2
Others	84	1.6	133	2.1
Total	5,279	100.0	6,232	100.0

Source: Nation-wide Federation of LIDs (1999) the same time, and 22 IBs used more than the marginal 300 m^3/0.1 ha in 2000. The actual water gauge is read every day during the irrigation season at all turnouts. However, the total amount of water charged is collected biannually. In July, 1,000 yen is charged to all users and the rest is charged in December. Farmers using water at less than 300 m^3 pay 1,000 yen in July and 500 yen in December. Inside an IB, the LID official does not know the details, but he believes it is area priced. An official in the LID commented as follows: (1) the reason why farmers accepted volumetric pricing was that they were familiar with water volume as they formerly used pumping machines to supply irrigation water from other origins; (2) IBs are expected to save water because farmers in the IBs can watch the gauge; and (3) the project is a kind of insurance for irrigation water since users pay a minimum 1,500 yen even if they never use any water.

(ii) Case study in the Chugoku-Shikoku region, Western Japan

The "B" project area covers two cities and seven townships with 7,200 ha of upland fields providing supplementary irrigation water by pipe lines. The typical agricultural product is mandarin oranges and the project area is divided into 9 LIDs, and under a LID there are 17 users unions. In this area, a combination tally system of area pricing and volumetric pricing has been employed since 1987. A management fee is levied by area at 1,000 yen/0.1 ha. The costs of supplying water, such as base charges for electric provision, maintenance charges, etc., are area-priced and power supply charges are tallied based on volumetric consumption. Calculations are done by a comprehensive LID (CLID). After each IB receives bills for power supply, officers in the CLID divide the bills into three types of charges proportionally: (1) base charge is divided by land area, (2) power supply charge is divided by volume of water used and (3) entrust maintenance fee is divided by land area (**Tables 4, Table 5**).

The total charge is disclosed monthly and levied biannually. Under IBs, each users union charges farmers by land area, because there is no gauging facilities inside the IBs. However, an official in a users union said that nobody claimed area pricing in each IB, because many duties associated with farming are carried out by a team. In addition, an official in LID said, "the reason they introduced volumetric pricing was that a huge imbalance in water consumption among IBs existed and farmers gained an incentive to save water because of the volumetric charge."

(iii) Conclusion and future prospect of volumetric charge

The IBs were the smallest elements in which farmers were charged volumetric water fees. Each farmer, however, had a duty to pay water charges according to the area of land he/she owned. Specifically, the individual farmers charge was calculated by the proportion of land inside an IB. Therefore, methods effective in these areas are a combination of volumetric charge and area charge. Different IBs or districts used different calculation/collection methods. In fact, three districts out of six charged monthly. Alternatively, two districts charged annually at an annual meeting. Thus, good organization of the LID was significant in collecting

Table 4 Area and Water Volume Used of User's Union in November, 2000.

Users' union (initial)	"K"	"M"	"S"	"J"	Total
Project area (ha)	259.0	299.1	108.3	35.7	702.1
(a) area ratio (%)	36.9	42.6	15.4	5.1	100.0
Water volume used (m^3)	3,268	8,394	1,752	463	14,057
(v) volumetric ratio (%)	23.2	59.7	12.5	4.6	100.0

Table 5 Electricity Charge per Union calculated in November, 2000.

Users' union (initial)	"K"	"M"	"S"	"J"	Total
Base charge (yen)	377,814	436,309	157,981	52,077	1,024,181
ratio (%) = (a)	36.9	42.6	15.4	5.1	100.0
Power supply charge (yen)	27,473	70,566	14,729	5,406	118,174
ratio (%) = (v)	23.2	59.7	12.5	4.6	100.0
Maintenance fee (yen)	23,240	26,839	9,718	3,203	63,000
ratio (%) = (a)	36.9	42.6	15.4	5.1	100.0
Charge per union (yen)	428,527	533,714	182,428	60,686	1,205,355

the fees in order to run the systems.

Concerning saving water, officers in the LIDs pointed out that farmers tended to save water in IBs because they used water competitively against other IBs, not against other farmers. This fact shows us that farmers in the same IB use water at the same time for farming. On the other hand, the officers said that if individual farmers tried to measure water volume to save water, they would face contradiction because the counting facilities are expensive.

Hence, innovation is needed to lower measuring costs, if volumetric charge is applied to the whole of Japan.

(3) Reason for Applying Area Charge

It is difficult for farmers to have an incentive to save water if they do not possess a title to the land or license for water usage. However, water usage and land ownership are controversial issues in developing countries. Therefore, the relationship between an area charge system and land ownership in Japan was pointed out. According to Tomosho et al. (2001), there are other reasons for paddy field farmers in Japan to accept area charges: (a) exchange of farm plot on a reclamation project can be easily managed because an area-based water fee will never be changed after the project; (b) farmers feel free to choose cropping programs or culturing methods using un-metered water supply; and (c) no claim can be made even if surrounding fields have been affected by the water requirement rate (WRR), consisting of evapotranspiration and paddy field percolation, because of a farmers land-use change to upland fields or other farming techniques.

(4) Results

If WP mechanisms are introduced to the AHT where farmland is divided into small plots, it will require a large trade cost to collect charges and read gauges, and investments in facilitating pipe-line irrigation systems or metering gauges. On the other hand, collecting water charges by a co-operative water management organization reduces trade costs. As WP in irrigation is efficient for saving and reusing important water resources, many countries try to use it in various situations and seek more acceptable ways of applying it. However, the characteristics of farming or geographical conditions in each country should not be neglected. Different methods of WP should be used in different situations. For example, cannot easily apply a method effective in dry lands to wetlands where agricultural water is traditionally reused (Fujimoto et al. 2001).

d Water Transfer

In the following section, I introduce examples of water transfer without WP mechanisms. Although, we are not convinced that the examples are all applicable to the AHT as a whole, we believe they will provide good references for discussion.

(1) Temporal Water Transfer in the Drought Season

Kumasaka et al. (2002) discussed sharing of benefits between citizens and farmers by temporarily lifting drinking-water charges when drought hits. They use an example of the drought during 1997 to 1998 in the Angat River basin in the Philippines. In Japan, temporal transfer between users, ‘yuzu’ in Japanese, is done by voluntary negotiation between the users (Kataoka 1995). Yuzu is a transfer of water without water use right transfer. For example, according to the Ministry of Agriculture, Forestry and Fisheries (MAFF) in Japan (MAFF 1998), 41 coordinating organizations of river basins carried out the voluntary activity of saving water in 1994, and agricultural areas saved more water than cities in 31 basins. Also, yuzu from agriculture to cities amounted to 12.183×10^6 m^3 in 1994, while counter-activity of yuzu was only 1.354×10^6 m^3.

In the Tone River basin in Japan, temporal water transfer has normally been done by even reduction of distribution of water resources such as reduction of 10, 20 or 30% regardless of whether (1) the water use rights are old or new, (2) diversion is from natural river flow or dams, (3) water users are farmers, citizens or industry, and (4) water use rights are permitted, conventional or temporal. In the Yahagi River basin in Japan, temporal transfer has been done by uneven reduction between users, such that citizens are first and agriculture and industry are next. It can be said that new unofficial rules have been formulated during the Showa and Heisei Eras, and can be changed as needed (Okamoto 2002).

(2) Water Right Transfer between Users in Japan

According to Minegishi and Teranishi (2002), current states of Agricultural Water Re-allocation Projects in Saitama Prefecture are described below: after distributing facilities were renewed in the projects, agricultural water of 12.321 m^3/s was transferred to the metropolitan area of Saitama and Tokyo. In Saitama, water use rights of 25.541 m^3/s were transferred to cities as of the fiscal year 2003, in which 7.951 m^3/s (about 30%) was from agriculture. In the fiscal year 2003, the Midstream-Tone Agricultural Water Re-allocation Project finished and transferred rights from agriculture of 10.913 m^3/s.

This was about 38% of the total amount transferred in Saitama and provided drinking water for 2.6 million citizens.

(3) Results

As explained previously, water saving or water transfer has been carried out without using the WP mechanism, but by using a co-operative management mechanism which was developed historically for paddy farming in the AHT (**Fig. 1**). Co-operative management mechanisms enable mutual understanding between water users through discussions and negotiations. When an adjustment in water-use is set for some user groups, users in each group carefully check the new allocation.

2 Aim of this Study

In China, many discussions on water resources and water management including water rights, water pricing have been made on the web-site associated with the Ministry of Water Resources (MWR).

In this thesis, I don't analyze the differences in land use, water law etc. among several countries, but focus on precipitation and population as key factors to distinguish a typical style of management. In this regard, China is the best country for analyzing these differences, because large diversity of natural conditions exist and they are governed by the same policy for land use and water resources.

Chinese government limits access to web-site data abroad from the states and publication of articles in English is limited, so it is very difficult for foreigners to understand the real situation in China. On the other hand, information technology (IT) is now growing day by day in China, so articles written in Chinese are also increasing rapidly. In fact, Fujimoto (2003) pointed out the progress of IT, and said analyzing web-site data maybe the only way to check the real situation in China.

Therefore, I started checking the web-site data and firstly categorized the tendency of the articles of web-site data.

3 Basic Information on China

a Natural Conditions in China

According to Xu (2001), China has a territory of 9.6 $\times 10^6$ km^2, accounting for 1/15 of the total land area in the world. Climate, topography and agricultural production are very different from region to region. Generally speaking, China slopes from an elevation of more than 4,000 m at the Tibetan Plateau in the West to an elevation less than 50 m in the Eastern coastal region (**Fig. 5**).

Fig. 5 Geographical map of China.

Most of China belongs to temperate and subtropical zones and is affected by monsoons with abundant rainfall in summer. However, the rainfall is unevenly distributed in China. The average annual precipitation is approximately inverce to the land elevation, decreasing from about 1,600 mm in the South-east coastal area to less than 200 mm in the North-west deserts (**Fig. 6**).

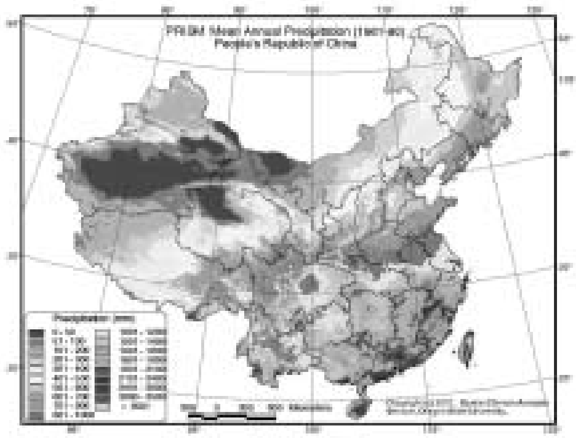

Fig. 6 Mean annual Precipitation in China.

According to Zhou et al. (2002), China is a country with a variety of crops thanks to the different climatic conditions. China is also a country with the most rotation and repeat cropping in the world with a national average rotation index over 1.6. The crops have very distinctive regional characteristics. Corn and bean are concentrated in the northeast where the non-frost period is short and there is usually one harvest a year. North China is the main production base for such dry-land crops as wheat, corn, edible oil and cotton and there are two harvests a year or three harvests in two years. Rice in the main crop in the middle and downstream area of the Yangtze River and regions further south with two or three harvests a year. Since the northwest is dry and lacks rain, the main crops are spring wheat, corn and cereal and there is usually one harvest a year.

b Social Conditions of China Related to Agricultural Water Management

The political situation of China is very different from the West, but I indicate only information indispensable to understand the policies on water management.

All land and water resources belong to the nation.

People in rural areas are registered as rural population, Chinese script indicates "farmers" are strictly required to stay in rural area. Also, along with the Single-Child Policy, it is not difficult to officially prospect the future population of each province. Therefore, there is a potential surge of immigration from poor rural areas in the west to large cities in the south-east (**Fig. 7**).

Along with recent economic development in coastal areas, there is a serious imbalance of income between the rich cities and poor rural areas. All levels of government try to diminish this income gap and emphasize development of the western poor parts of China.

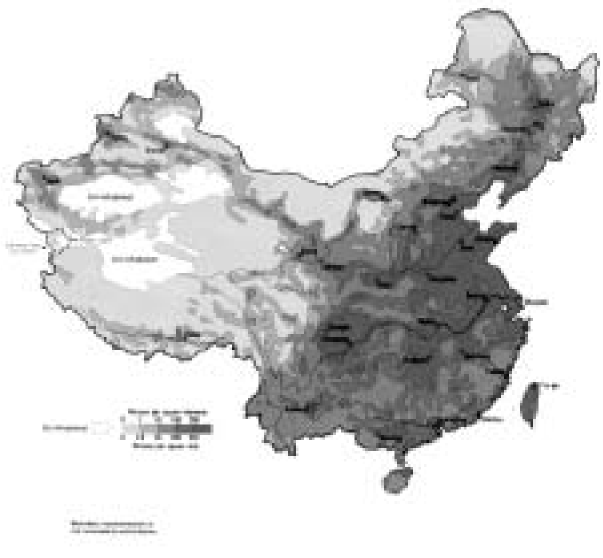

Fig. 7 Population in China.

II Agricultural Water and Organizations Concerned in China

1 Organizations Concerned with Agricultural Water

Water policy is governed by the central government, the Ministry of Water Resources (MWR), and provincial bureaus of water resources (PBWRs) have jurisdiction on all water related issues and legal suites. Provincial governments can issue particular ordinances to execute laws which the central government have proclaimed, and PBWRs can impose practical regulations such as water fee, water intake license etc. (**Fig. 8**) that are mentioned later. Therefore, to understand the practical policies on water management in China, activity of provinces or political emphasis for provinces must be evaluated.

According to Zhou et al. (2002), MWR has been restructured and reorganized according to the government-restructuring requirements. The essence is to further transform the government function, enhance macro control function of the government in the market economy, emphasize policy formulation and planning of water resources management and development, and supervise the implementation of water laws and regulations.

River basin management can be strengthened and the function and authority of current river basin commissions can be improved. In the near future, some river basins will be selected to test river basin management reform. During this testing real river basin commissions will be set up with representatives from MWR, provinces and municipalities within the river basin.

In irrigation district management, some irrigation districts can adopt the model of self-reliance. In fact, China has already carried out reform in some irrigation districts. In particular, a model of economically independent irrigation districts has been tried and water

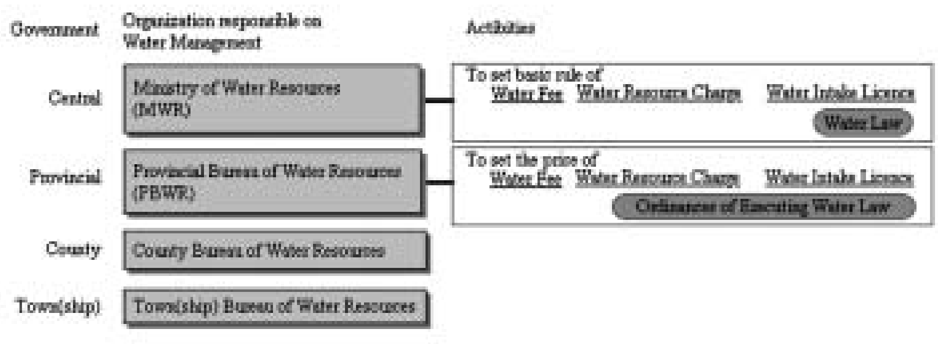

Fig. 8 Organization Concerned with Agricultural Water in China.

supply companies and agricultural users- association have been set up, which have established as a buy-sell relationship between the two, in the World Bank financed Yangtze River Water Resources Development Project and Irrigated Agriculture Project (second phase). The water supply company is responsible for the operation and maintenance of main canals and branches. The users-association is responsible for the operation and maintenance within its own system and paying the water fees to the company. The experiences gained can be extended to other irrigation districts, which is in the same direction as the reform of the water sector. But at present, there are difficulties in adopting such a model in irrigation districts in China on a large scale.

2 Agricultural Water in China

a Current State and Characteristics of Water Resources in China

According to FAO (1999), the MAP in China is 648 mm. The average annual river runoff generated throughout the country is 2,711.5 km^3, corresponding to a depth of 284 mm. In total, there are more than 50,000 rivers with a basin area of over 100 km^2 with 1,500 of these rivers having a basin exceeding 1,000 km^2. There are approximately 2,300 lakes (excluding seasonal ones) with a total storage of 708.8 km^3, of which the freshwater portion is 31.9 % (226.1 km^3). The main large rivers in China are Heilong Jiang, Liao He, Hai-and-Luan He, Yellow River, Huai He, Yangtze River and Pearl River (**Table 6**).

Characteristics of water resources in China are as follows:

(a) Total volume of water resources isn't very high: average water resources per capita in China are 2,700 m^3, which is about 1/4 of the world average.

(b) Monthly fluctuations in precipitation are quite large: according to the National Astronomical Observatory (1994), more than 60% of rain falls from June to September.

(c) Eighty percent of the population lives in 1/3 of the total land. Land resources as well as water resources are concentrated in particular areas. For example, aggregate areas of the Liao River Basin, Hailuan River Basin and Huai River Basin include 1/3 of the total land areas, while people enjoy only 5.8% of the water resource provision.

b Water Resources Development and Issues

The number of dams constructed are 86,000 and the total capacity of these dams is 4.13×10^{11} m^3 (**Table 7**). There are also 6.4 million ponds or small reservoirs whose capacity is less than 1.0×10^5 m^3. The number of irrigation districts whose area is larger than 667 ha are some 5,200. Overall irrigated area is 4.66×10^7 ha.

Existing storage facilities provide water resources of 4.66×10^{11} m^3. This is 17% of the water resources in use. Water resources taken from rivers are 4.2×10^{11} m^3 and are 15.9% of the average total run-off. Ground water currently used is 4.58×10^{10} m^3 and is 24.3% of the overall usable shallow ground water.

According to Ke (1998), current issues include:

(a) Water resources development ratio is still at low levels and the guaranteed ratio for supplying water resources is low. In fact, comparing the

Table 6 Main Rivers in China.

River	Length (km)	Drainage Area (km^2)	Average Annual Run-off (km^3)
Yangtze River	6,300	1,808,500	951.3
Yellow River	5,464	752,443	66.1
Heilong Jiang (Amur)*	3,420	**896,756	117.0
Songhua River (Sungari)	2,308	557,180	76.2
Pearl River*	2,210	442,100	333.8
Yarlung Zangbo	2,057	240,480	165.0
Tarim	2,046	194,210	35.0
Hai-and Luan He	1,967	307,731	34.8
Lancan Jiang*	1,826	167,486	74.0
Nu Jiang*	1,659	137,818	69.0
Liao He	1,390	228,960	14.8
Huai he	1,000	269,283	62.2
Ertix (Irtysh)	633	57,290	10.0
Min Jiang	541	60,992	58.6
Total		6,121,229	2,067.8

* Length and drainage area within China
** Including the Songhua River basin
Source: FAO (1999)

Table 7 Dams Constructed in China as of 1980.

Types of Dams	Numbers	Total Capacity of Dams		Irrigation Districts	
		109m^3	%	1,000 ha	%
Big Dam	326	297.54	72.0	6,254.9	39.1
Middle Dam	2,298	60.52	14.7	4,212.5	26.4
Small (I)-Type Dam*	14,108	36.58	8.9	3,278.9	20.5
Small (II)-Type Dam**	70,120	18.42	4.4	2,242.8	14.0
Total	86,852	413.06	100.0	15,989.2	100.0

* Total capacity of the small (I)-type dam is from $1.0 \times 106m^3$ to $1.0 \times 107m^3$.
** Total capacity of the small (II)-type dam is from $1.0 \times 105m^3$ to $1.0 \times 106m^3$.
Source: Ke Li-dan (1998)

total capacity of dams with overall run-off, China utilizes 15% of its scarce water resources. Meanwhile, the supplying capacity of dams is at low level of 54%.

(b) Scarcity of water resources in Northern China and cities along the seashore-belt is often pointed out. Industrial water demand was some 7.0×10^{11} m^3 in 2000, and total water shortage was 6.0×10^{10} m^3. Also targeting the 40 million farmers in rural areas is a big problem. Providing drinking water at secure volumes as well as maintaining water quality is also difficult.

(c) Wastewater from industry and residences amounts to 3.0×10^{10} m^3, 15% of which is treated by sewerage systems. Water pollution in the big cities is a serious problem. Meanwhile, recycled ratios for water resources are in a preliminary stage between 20% and 30%. Coefficient of agricultural water usage (amount of agricultural water at the farm plots divided by amount at the intake) is between 40% and 50%. Indispensable water resources are currently not effectively used.

3 Water Law and Related Regulation in China

a Water Rights

No definition for water rights exists in any of China's laws. Article 3 of the Water Law (WL) of China, effective on July 1, 1988, basically mentions, "the water resource belongs to the nation." Another expression, "water flow belongs to the nation" is in article 9 of the Constitution of China. Due to the lack of a clear definition, People's Daily on April 2, 2001 emphasized the concept that water rights contained right of ownership and right of usage.

There is no definition of water rights in China. However, arguments on water rights are currently encouraged by the MWR. In fact, I retrieved a large number of documents on related web sites. According to Hu et al. (2001), one of the documents listed on the web site, the right of ownership in China can be divided into three parts, i.e., rights of usage, rights of getting benefits and rights of trading. Characteristics of water rights in irrigation districts are as follows: (a) rights of water usage and rights of getting benefits from water belongs to farmers in irrigation districts. (b) Two rights stated here are usually restricted to applications besides irrigation, and (c) rights of trading water don't belong to farmers. There is no perfect right of ownership of water, so Hu et al. (2001) called the situation "uncertainty of water rights."

To complement uncertain situations, people in China need guidance from the upper government because the upper government possesses certain power to manage the situations. However, due to the decentralization of governance in China, MWR is now reducing the number of staff, so I think it will not be easy to control all the controversial issues related to water rights. Of course, it maybe said there is much flexibility of public action in China, but I think the time has come to issue concrete definitions of water rights in the laws.

b Water Resource Charge (WRC)

Concerning the water resources charge (WRC), article 34 of WL states, "The nation can levy WRC to organizations that directly intake ground water in the cities. Provinces or metropolitan cities can levy WRC to organizations that directly intake ground water or intake water from rivers, lakes or ponds." WRC is not a tax, but a charge submitted to some levels of governments. A provincial government may set a procedural regulation for WRC.

According to article 46 of the Zhejiang Ordinance for Executing WL (ZOEWL), effective on March 1, 1991, "Zhejiang can levy WRC to an organization that directly intakes ground water or intakes water from rivers, lakes or ponds."

However, in the latter part of the same article, Zhejiang indicated not to levy WRC when water was being used for irrigation, individual homes, livestock cultures or fisheries. Officers in Zhejiang explained that the rate of WRC was decided between 0.01 yuan/m^3 to 0.02 yuan/m^3.

According to article 17 of the Policy of Industrial Usage of Water Resources, enacted in 1997, WRC is (1) stored both in the provincial and local governments separately after submitted; (2) managed independently and (3) used to evaluate, observe, protect and manage water resources. Therefore WRC is a kind of appropriation fund for water resources.

c Price of Water

According to Iijima (2001), Chinese policies on the water fees have been studied and arranged from the 1980s for the purpose of saving water, ensuring management cost of facilities and avoiding burden to the state of a large budget for a water resources project.

The current system of water fees is basically illustrated as follows (Iijima, 2001):

(a) All projects for water resources must provide water charging a water fee, and all beneficiaries must pay a water fee to the managing organization of the facilities for water resources.

(b) A water fee is generally set based on aggregate cost to recover all construction and management expenditures, but the water fee for agricultural water is specially set at a lower level than for other purposes.

(c) The Managing Organization of facilities for water resources calculates and collects the water fee.

(d) The water fee is calculated based on volumetric supply of water (volumetric charge). However, agricultural water is calculated based on the area of agricultural land that users own (area charge) or a combination of area charge and volumetric charge.

The water fees should be used for O&M and stored in the organization for future rehabilitation or reconstruction.

Concerning water saving, which each level of the Chinese government encourages recently, some provinces have increased the water fee for irrigation in order to encourage farmers to save water. This is usually reported in western provinces like Gansu, Ninxia and Inner Mongolia. One of the biggest problems associated with a water fee in China is how to collect the water fee from every farmer. Every province is tackling this issue.

According to Zhou et al. (2002), present water pricing administration and procedures for determining water fees[*1] are as follows.

Generally, the Chinese Central government, i.e. State Council, issues water pricing methods and principles, and specific tariff standards are issued by relevant administrative authorities.

(a) As for large water projects bordering several provinces, the water fee is proposed through consultation among the provinces, and subject to approval by the State Development Planning Commission (SDPC). If the project is directly under the administration of the Ministry of Water Resources (MWR), water fees are proposed by the relevant river basin commission, and subject to MWR's review and SDPC's approval.

(b) As for the projects under the administration of the Province, the project management agency proposes the water fee plan, which is subject to review and approval by the Provincial Water Department and Pricing Department.

(c) As for other projects rather than above, water fees are proposed by the project management agency and subject to review and approval by the Water Resources Department and Pricing Department at the same level as the projects.

After issuing of the Water Fee Method by the State Council in 1985, provincial governments have determined implementation regulations for the Water Fee Method in line with local situations. The implementation regulations generally stipulate the water fee, collection method and management requirements of different water uses for various types of water projects, such as reservoir, irrigation district and pumping stations in certain regions. At present the water fee is based on administrative regions and different water uses or a unified water fee for each water use is applied in the same administrative regions if the project scale, water resource conditions and economic situation are similar. The irrigation water fee is similarly administered. Some provinces started to specify the water fee based on calculations of a single project in the 1990s. Pricing principles for different water uses can be seen in **Table 8**.

Although several reforms of water pricing have been made and irrigation water fees commonly have increased since 1985, irrigation water fees are still far below the supply cost in most areas. According to

[*1] Zhou mentioned "water tariffs" instead of "water fees" in this context, but I think the "water fees" is more appropriate than "water tariffs", because "water fees" is not only the word by word translation from Chinese "shui fei" but also "water tariff" may miss-lead us to understand that it is a kind of tax.

Table 8 Principles for Different Water-uses.

Water uses		Pricing Principle
Agriculture	Grain crops	Water supply cost
	Cash crops	Slightly higher than supply cost
Industry		Supply cost plus 4 to 6% profit
Domestic		Supply cost plus mini-small profit

Source: Water Tariff Method, State Council, 1985

statistics, the average national irrigation water fee was 0.026 yuan/m^3 in 1997, while the average water supply cost was 0.0718 yuan/m^3, the water fee accounts for only 36% of the supply cost. Water fees in the north are normally higher than in the south of China because there is much more rainfall in the south than in the north (**Table 9**). Development of water resources and water supply cost have great differences.

Dalian City has the highest irrigation water fee, 0.155 yuan/m^3, which meets the water supply cost. The irrigation water fee in Shanxi province comes second, 0.14 yuan/m^3, which is about 50 to 60% of the water supply cost. The water fees in several large scale irrigation schemes of Shaanxi province is 0.116 yuan/m^3, 45% of the supply cost. The water fees in Hebei province is 0.075 yuan/m^3, only 25% of the cost. **Table 10** shows the water fees and supply costs in several provinces and cities.

d Water Intake License (WIL)

According to article 32 of the WL, "The nation undertakes a water intake license (WIL) system when organizations directly intake ground water, or intake water from river, lake or pond water." In article 9 of the WL, it also states, "Government at all levels should be responsible for related water resource management." Therefore, it is impossible for local governments to trade water without permission from the upper governments.

e Future Prospect of Water Pricing Reform

According to Zhou et al. (2002), a future water pricing reform is expected: (1) to promote high efficiency of water use and to realize water saving and proper allocation of water resource, and (2) to guarantee steady and sustainable development of water supply projects. Specific measures are as follows.

(a) Strict execution of principles for determination

Table 9 Average water Supply Cost in South and North China. (yuan/m^3)

Area	Agriculture	Industry	Domestic
North part	0.045	0.15	0.10
South part	0.012	0.04	0.03

Source: Wang & Huang, Water Project Pricing and Cost Recovery, China Water Resources, 1999

Table 10 Irrigation Water Tariff and Supply Cost in some Provinces and Cities.

Region	Agricultural Water Tariff		Water Supply Cost
	Grain crops (yuan/m^3)	Cash crops (yuan/m^3)	(yuan/m^3)
Beijing Minuciparity	0.020	0.040	
Liaonin Province	0.040		0.079
Shanxi Province	0.140	0.140	0.230-0.280
Jilin Province	0.030		0.053
Jiangxi Province	0.020	0.020	0.070
Shandong Province	0.050	0.050	0.130
Henan Province	0.040	0.040	0.120
Hubei Province	0.033	0.033	0.045
Guangdong Province	0.020	0.020	0.060
Hainan Province	0.036	0.120	0.100
Yunnan Province	0.025	0.040	0.080
Gansu Province	0.068	0.100	0.110
Chongqin Minuciparity	0.020	0.030	0.130
Dalian City	0.155		0.159

Source: Department of Eccconomic Regulation, MWR (2002) of water fees, i.e. pricing according to supply cost for grain crops and supply cost plus minor profit for cash crops, thus ensuring financing of operation, maintenance and rehabilitation of irrigation projects.

(b) Adopt basic pricing and water volume pricing. Basic price is to ensure normal operation and maintenance under any operation conditions. Water volume pricing is to set tariffs based on the water supplied, which aims to cover depreciation and overhaul costs.

(c) Set water quota and supply water according to this quota, higher pricing for any water use exceeding the quota.

(d) Adopt different tariff systems for different seasons or change pricing based on relationship of supply and demands. Higher pricing is set when supply is smaller than the demand, lower pricing is set when supply is larger than demands.

(e) Properly decentralize pricing approval authority. Pricing authority stipulated in Water Fee Method is too concentrated and adjustment procedure is too complicated. The Power for water pricing and adjustment should be decentralized to County or Pricing Department over the jurisdiction of projects.

Water pricing reform requires the covering of total cost, which is an advantage for cost recovery of irrigation projects, ensuring timely and adequate maintenance of projects and facilities. In the mean time, irrigation project management agencies can have and sustain further development and provide better service to farmers. Increases in the water fee will also reduce government subsidies and burden.

Chinese government expects the water pricing reform will promote water saving and better use of water resources, and encourage farmers to adopt new water-saving irrigation techniques (Zhou et al., 2002). However, it may require increased initial input to adopt new water saving techniques.

III Analysis of Web-site Articles

1 Hypothesis

I hypothesize as “several policies on agricultural water in China possess keen relations to population or precipitation of the region.”

Theme #1: Development and management of water resources are related to population.

Theme #2: Land and water conservation has focused on application in areas where the land is scarcely covered by grass because of small amounts of precipitation.

Theme #3: Better management of agricultural water is propelled throughout China, but has been related to population.

Theme #4: Saving water-usage or reducing water leakage is focused for application in dry areas.

Theme #5: Issues of water rights, water price and water market are discussed and several measures have been undertaken throughout China.

Theme #6: How to collect water fee is a big concern throughout China, and is discussed in the context of introducing mechanisms of water pricing.

Theme #7: Avoiding contamination of agricultural water will be a big problem in the future in areas near big cities, but hasn’t yet been considered a serious problem.

2 Measures of Analysis

Using web-site data, I analyzed particular policies on agricultural water in the Peoples' Republic of China (China) regarding population and precipitation of particular provinces or particular zones divided by precipitation. I also used field data that I previously collected to explain the results.

a Data used

Precipitation data was chosen because agricultural production is highly affected by natural conditions, such as precipitation and temperature. At the same time, I chose population to analyze policies of agricultural water management because experience in Japan shows that the management of agricultural water has different problems in rural and sub-urban areas where population is different in each area. Also, as I indicated in 2-3-2, “Social Conditions of China Related to Agricultural Water Management”, population is the key political issue for all levels of government in China. Political massage of all level of governments to execute the policies associated with the population can be observed in this analysis. Descriptions of the data are as follows:

(1) Precipitation data

Precipitation data in China is from the Rika Nempyo 2002 and the Atlas China issued in 1989. Data of official mean annual precipitation (MAP) of the 12 cities cited in the Rika Nempyo (**Table 11**) were

Table 11 Precipitation and Population of each province in China.

Provinces	Average Precipitation			Capital City		Precipitation	Population	Area	Density
	Mini.	Max.	Ave.	English	Japanese	(mm)	(million)	(km²)	(person/km²)
Beijing Municipality			600	Beijing	北京	575.2	13.82	16,800	823
Tianjin Municipality	550	650	600	Tianjin	天津		10.01	11,300	886
Hebei	400	800	600	Shijiazhuang	石家荘		67.44	187,700	359
Shanxi	350	700	525	Taiyuan	太原		32.97	156,300	211
Inner Mongolia AR	50	450	250	Hohhot	呼和浩特		23.76	1,183,000	20
Liaoning	400	1,200	800	Shenyang	瀋陽	694.9	42.38	145,900	290
Jilin	350	1,000	675	Changchun	長春		27.28	187,400	146
Heilongjiang	250	700	475	Harbin	哈爾浜	525.3	36.89	454,600	81
Shandong	560	1,170	865	Jinan	済南		90.79	156,700	579
Shanghai Municipality			1,000	Shanghai	上海	1,155.1	16.74	6,300	2,657
Jiangsu	800	1,200	1,000	Nanjing	南京		74.38	102,600	725
Anhui	700	800	750	Hefei	合肥		59.86	139,600	429
Zhejiang	1,200	2,200	1,700	Hangzhou	杭州		46.77	101,800	459
Jiangxi	1,200	1,900	1,550	Nanchang	南昌		41.40	166,900	248
Fujian	800	1,900	1,350	Fuzhou	福州		34.71	121,400	286
Henan	500	900	700	Zhengzhou	鄭州		92.56	167,000	554
Hubei	750	1,500	1,125	Wuhan	武漢	1,234.1	60.28	185,900	324
Hunan	1,250	1,750	1,500	Changsha	長沙		64.40	211,800	304
Guangdong			1,500	Guangzhou	広州		86.42	177,900	486
Hainan			1,500	Haikou	海口		7.87	33,900	232
Guangxi	1,200	1,800	1,500	Nanning	南寧		44.89	236,000	190
Shaanxi	400	1,000	700	Xi'an	西安	555.8	36.05	205,600	175
Ningxia Hui AR	190	700	445	Yinchuan	銀川		5.62	51,800	108
Gansu	30	860	445	Lanzhou	蘭州	317.0	25.62	454,000	56
Qinghai	50	700	375	Xining	西寧		5.18	721,200	7
Xinjiang Uygur AR			150	Urumqi	烏魯木斉	269.8	19.25	1,650,000	12
Sichuan	500	1,200	850	Chengdu	成都	883.4	83.29	485,000	172
Chongqing Municipality			850	Chongqing	重慶		30.90	82,400	375
Guizhou	900	1,500	1,200	Guiyang	貴陽		35.25	176,000	200
Yunnan	600	2,300	1,450	Kunming	昆明	1,017.2	42.88	394,000	109
Tibet AR	60	1,000	530	Lhasa	拉薩	409.1	2.62	1,228,400	2
Total							1,284.69	9,635.200	133

Source: Atlas China (1989), Zhejiang Province (1999), China Statistic Databook (2002) and Rika Nempyo (2003)

calculated with data of 30 consecutive year from 1971 to 2000. Sources of precipitation data of provinces cited in the Atlas China are unknown, and the data ranged between maximum and minimum precipitation for the province. Therefore I took a mean of the maximum and minimum for MAP. MAP of the capital city of a province was used to represent the MAP of the province.

(2) Cereal production data

Cereal production and cropped area in 1994 were obtained from the World Bank of 1997.

(3) Population data

Population data (**Table 11**) and area of provinces were from the China Information Handbook (2003) and Sekai Kokusei Zue (2003/2004).

(4) Articles

Concerning articles retrieved from the web-site, I chose the Water Information Network (WIN), URL of which is shown below, from several web-sites on water resources in China.

http://www.waterinfo.com.cn/

The reason I chose this website was because WIN arranged a lot of information on water related policies into the 10 categories of government policies shown below:

1. Water Resources
2. Saving Water
3. Integrated Basin Management
4. Water Right, Water Price & Water Market
5. Water Management
6. Water & Land Conservation

7. Water Conveyance from South to North
8. Development of Western China
9. Overlook of Economy
10. Management of State Asset

WIN is managed by the Development Research Center of the Ministry of Water Resources (MWR) in China, so we can obtain the current water related policies in China, but I omitted data in category 7 to 10 because they didn't contain any articles for a particular province.

List of articles include (a) the title and (b) the date, and can be retrieved by clicking the title, two other pieces of information such as (c) an URL of the article and (d) a summary of the article which contains some 180 characters. When you click the URL, you can see (e) the body of the article. All data excluding dates or URLs are written in Simplified Chinese.

I used a software program to analyze data and counted the points for each province to produce graphs mainly to clarify the relations between population, precipitation and policies indicated by points in the graphs. I calculated the number of articles in each particular category shown below that matched the keywords in Chinese. If more articles which anybody can access match a particular keyword or policy, the policy is considered more important by the Chinese government.

Theme #1: use a data set of (a) a title and (d) a summary from category 1.
Theme #2: use a data set of (a) a title and (d) a summary from category 6.
Theme #3: use a data set of (a) a title and (d) a summary from category 5.
Theme #4: use a data set of (a) a title and (d) a summary from category 2.
Theme #5: use a data set of (a) a title and (d) a document body from category 4.
Theme #6: use (e) a document body from category 4.
Theme #7: use 6 data sets of (a) a title and (d) a summary from category 1 to 6.

(5) Official Documents and Field Data

Previous results of studies, etc. are used in the discussion to clarify the importance and problems of water policies according to precipitation and population.

b Data Arranging Steps

Data arrangement was done by 7 steps as shown in **Fig. 9**.

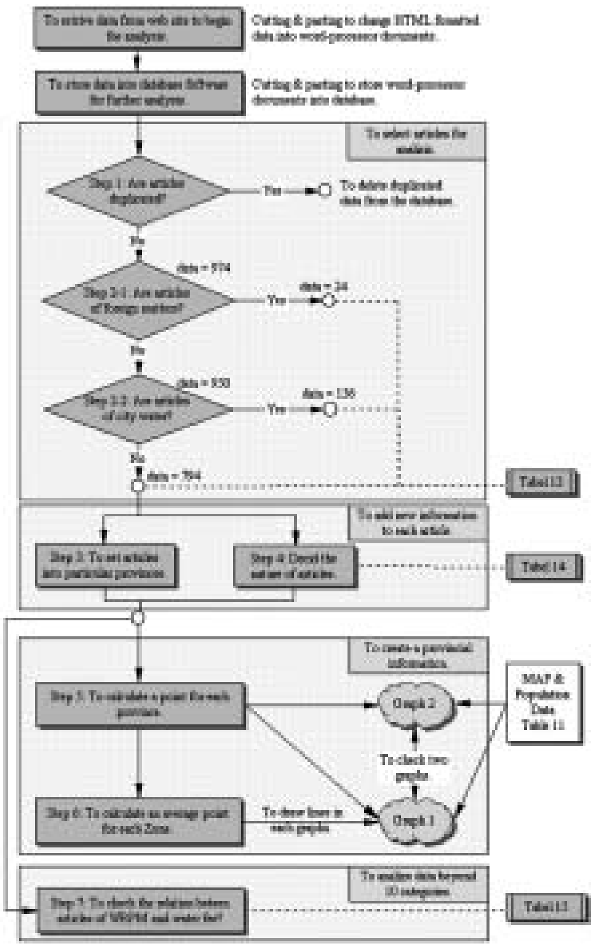

Fig. 9 Data Arranging Steps.

(1) Step 1

Data for each category provided by the web-site as of November 30, 2003 are shown in **Table 12**, after deleting duplication. There was no data for Hainan Province.

(2) Step 2

Omitting both data citing foreign affairs (24) and data citing city water (156) out of the 974 articles, the total number of data on agricultural water are 794 (**Table 13**).

(3) Step 3

Articles were set into a particular province. In this process, a check-mark indicating the particular province was made, so all provinces can be checked when an article is cited throughout China.

Practically, I put check marks for several areas or river basins and show some examples:

Example 1: If the document indicated the upper stream of the Yangtze River, I named 3 provinces and a city, (1) Yunnan Province, (2) Guizhou

Table 12 Articles and Duration.

Categories	Articles	Oldest date (yy-mm-dd)
WIN	974	
1. Water Resource	288	03-07-15
2. Saving Water	117	02-12-31
3. Integrated Management	74	02-11-01
4. Water Right, Price & Market (WRPM)	122	01-04-23
5. Water Management	84	02-12-25
6. Water & Land Conservation	289	02-03-22

Table 13 Articles about Foreign Matters, Water for City or Agriculture.

	(1) Foreign Matter	(2) City Water	(3) Agric. Water	Total
WIN	24	156	794	974
1. Water Resource	9	61	218	288
2. Saving Water	3	26	88	117
3. Integrated Management	4	28	42	74
4. WRPM	4	14	104	122
5. Water Management	0	9	75	84
6. Water & Land Conservation	4	18	267	289

Province, (3) Sichuan Province and (4) Congjing City. In the case of the middle stream of the Yangtze River, I named 4 provinces, (5) Hubei Province, (6) Hunan Province and (7) Jiangxi Province. In case of the downstream of the Yangtze River, I named 2 provinces and a city, (8) Anhui Province, (9) Jiangsu Province and (10) Shanghai City.

Example 2: If the area indicated the Haihe River, I named 4 provinces, (1) Hebei Province, (2) Shandong Province an (3) Beijing City and (4) Tianjing City.

Example 3: If the area indicated the Waihe River, I named 3 provinces, (1) Henan Province, (2) Anhui Province and (3) Jinagsu Province

Example 4: If the document indicated the upper stream of the Yellow River, I named 2 provinces, (1) Qinghai Province and (2) Gansu Province. In the case of the middle stream of the Yellow River, I named 4 provinces, (3) Ningxia Hui Autonomous Region, (4) Inner Mongolia Autonomous Region, (5) Sha'anxi Province and (6) Shangxi Province. Also, in the case of the down stream of the Yellow River, I named 3 provinces, (7) Hebei Province, (8) Henan Province and (9) Shandong Province.

Example 5: If the document indicated the Loess Plateau, I named 7 provinces, (1) Qinghai Province, (2) Gansu Province, (3) Ningxia Hui Autonomous Region, (4) Inner Mongolia Autonomous Region, (5) Sha'anxi Province, (6) Shanxi Province and (7) Hennan Province.

The number of articles for each area or basin is shown in **Table 14**.

Table 14 Area and Number of Provinces Included in Articles.

Name of Area/Basin	Provinces	Articles Cited	Sum
The Northen China	8	1	8
Four Provinces	4	1	4
The Northwest China	4	2	8
The Southwest Three Provinces	3	1	3
The Western Dry area	4	1	4
The Huan-wai-he Plane	5	1	5
The Liao River Basin	4	1	4
The Haihe River Basin	4	5	20
The Black River Basin	3	1	3
The Yellow River Basin	9	33	297
Up & middle stream	6	1	6
Middle stream	4	2	8
Middle & down stream	7	1	7
Down stream	3	1	3
The Waihe River Basin	3	13	39
The Zhang River Basin (Upper Stream)	2	2	4
The Yangtze River Basin	10	4	40
Up & middle stream	7	6	42
Middle & down stream	6	1	6
Limestone Area	3	1	3
The Taihu Lake Basin	2	3	6
The Zhu River basin	7	1	7
The Loess Plateau	7	26	182
The Black Soil Preservation Area	2	4	8
Total		113	717

(4) Step 4

Consulting a title and a summary of 794 selected articles, I divided, using keywords, the articles into 5 natures, such as an article on a success story, problems raised, encouragement, current state and other.

When I categorized articles, some coordination was done to avoid duplication of counting. I used the 6 rules shown below:

Rule 4-1: When an article included a success story and problem raised, the one with more keywords was selected.

Rule 4-2: When an article included a success story and problem raised with the same number of keywords, a selection should be done by consulting the complete summary.

Rule 4-3: When there wasn't a problem raised but there was a success story the success was selected.

Rule 4-4: When there wasn't a success story but there was a problem raised the problem raised was selected.

Rule 4-5: When there was encouragement and current state, encouragement was selected.

Rule 4-6: When there wasn't a keyword, then other was selected.

The number of articles for each nature selected is shown in **Table 15**.

(5) Step 5

Data selected through the previous 3 steps have been referred to as 4 different regions, single province, multi-provinces, basin (area), and all of China. I gave 4 different ranking points for each region to sum the points for each province. I considered that every article should be treated as equally important since regional diversity was analyzed in this thesis. If C_1 to C_4 in equation 3 are 1.0, a particular province cited specifically in an article will reduce its importance and multi-cited provinces or all of China will be exaggerated. Therefore, I multiplied each article with a co-efficient for C_1 to C_4 that indicated the cited ratio for each province.

(a) If an article referred to only one province, 1.0 point was given to the province per article.

(b) If an article referred to several provinces, 0.35 point was given to each province per article. Totally, 48 aggregate provinces were referred to in 17 articles.

(c) If an article referred to basin or area, 0.16 point was given to each province per article. Totally, 717 aggregate provinces were referred to in 113 articles (**Table 14**).

(d) If an article referred to all China, 0.03 point was given to all provinces per article. Totally, 361 articles referred to all of China.

$$P_t = C_1{*}P_1 + C_2{*}P_2 + C_3{*}P_3 + C_4{*}P_4 \quad (3)$$

$$C_1 = 1 / 1 = 1.00$$
$$C_2 = 17 / 48 = 0.35416.. = 0.35$$
$$C_3 = 113 / 717 = 0.15760.. = 0.16$$
$$C_4 = 1/ 31 = 0.03225.. = 0.03$$

Where

P_t is total points

P_1 is number of articles referring to only a province

P_2 is number of articles referring to several provinces

P_3 is number of articles referring to a particular river basin or area

P_4 is number of articles referring to all China

C_1 is co-efficiency of article referring to only a province

C_2 is co-efficiency of article referring to several provinces

C_3 is co-efficiency of article referring to a particular river basin or area

C_4 is co-efficiency of article referring to all China

(6) Step 6

I retrieved 104 articles on WRPM, and select

Table 15 Keywords to Categorize Nature of Articles.

Nature of Articles	Keywords (English Equivalent)	Articles
success story in titles	betterment (4), documentary (1)	57
in articles	benefit (42), to fulfill (20)	
encouragement in titles	to Ensure (5)	61
in articles	to Propel (31), full-fledged (21), basics (20)	
current state in titles	–	33
in articles	current state (21), to point out (36)	
raising problems in titles	serious (13)	126
in articles	serious (99), dangerous (23)	
Other		523

keywords for further analysis to determine the relationship between water rights, water price and water market as well as water fee. Keywords in Japanese characters and English equivalents are shown in **Table 16**.

(7) Step 7

In order to easily understand the relationship between figures, I tried to divide the articles by precipitation zones. Analyses made so far are re-arranged into several precipitation zones. All articles are summed for each precipitation zone and divided by the number of provinces contained in each zone if average points were needed.

3 Results

a Number of Articles

Articles cited in the web-site are shown below, there were 303 articles cited for a single province, 17 articles for multi-provinces, 113 for basins and 361 for all over China (**Table 17**).

"Water Resources" and WRPM are much discussed throughout China, but "Saving Water" and "Water & Land Conservation" are much discussed in provinces. Gausu Province (26 articles), Hebei Province (5 articles), and Xinjiang Uygur Autonomous Region (AR) (5 articles) are included in "Saving Water" and Inner Mongolia AR (26 articles), Xinjiang Uygur AR (17 articles), and Ninxia Hui AR (15 articles) are included in "Water & Land Conservation."

b Division by Precipitation

(1) Division by Precipitation and Drought Index

According to Zhou Yaozhou et al. (2003), 5 precipitation zones are set for China (**Table 18**). In this thesis, the division caused an uneven number of provinces, such that no capital cities of provinces were selected for arid zones where MAP is less than 200 mm, 4 provinces for semi-arid areas, 12 provinces for semi-humid areas, 14 provinces for humid areas, and 2 provinces for abundant rainfall areas (ARA). However, only Zhejiang Province belonged to ARA.

(2) Division by Cropping Patterns and Precipitation

When considering cropping patterns of wheat or rice production, we can divide China into 3 portions by precipitations of 400 mm and 1,300 mm. In every province with a MAP less than 400 mm, people cultivate wheat as the main crop, and in every province

Table 16 Keywords to determine relationship between "Water Saving" and WRPM.

Theme	Keywords	Keyword (English Equivalent)
(i) Water right	水権	Water right (s).
(ii) Water price	水価	Price of water, water pricing.
(iii) Water market	交易，転譲，跨流，水市場	Water trade, tentative water trade, beyond the basin transfer.
(iv) Water fee	水費，水資源費	Water fee, water resource charge.

Table 17 Articles & Multi-provincial Articles.

	(1) Single	(2) Multi.	(3) Basin	(4) Overall	Total
WIN	303	17	113	361	794
Number of provinces cited	303	48	717	–	–
1. Water Resource	50	0	42	126	218
2. Saving Water	50	1	3	34	88
3. Integrated Management	16	1	6	19	42
4. WRPM	32	1	4	67	104
5. Water Management	32	1	5	37	75
6. Water & Land Conservation	123	13	53	78	267

Table 18 Distribution of Precipitation in China.

Precipitation Zone	Annual Precipitation (mm)	Drought Index (annual evaporation/annual precipitation)
Arid	<200	>7.0
Semi-arid	200 – 400	3.0 – 7.0
Semi-humid	400 – 800	1.0 – 3.0
Humid	800 – 1,600	0.5 – 1.0
Abundant rainfall	>1,600	<0.5

with a MAP more than 1,300 mm, people cultivate rice as the main crop.

I used 800 mm by Zhou et al. (2002) as an additional division.

Incidentally, I can divide China into 4 portions (zones) with MAP of 400 mm, 800 mm and 1,300 mm. Namely, Zone I where MAP is less than 400 mm; Zone II where MAP is equal and more than 400 mm, but less than 800 mm; Zone III where MAP is equal and more than 800 mm, but less than 1,300 mm; Zone IV where MAP is more than 1,300 mm.

Finally, provinces were divided into 4 divisions of which the provinces were 4, 12, 8, and 7, respectively (**Table 19**), to explain the tendency of policies in China if related to precipitation.

c Water Policy, Precipitation and Population

(1) Development and Management of Water Resources

Although water is an important factor for any country to develop, precipitation is one valuable but not indispensable resource of industrialization. Relationship between precipitation and population or relationship between precipitation and GDP per capita in China is not clear (**Fig. 10**). However, the relationship between precipitation and wheat cultivation is very clear with correlation coefficient (CC) of −0.78 (**Fig. 11**), and relationship between precipitation and rice cultivation is also very clear with CC of 0.93 (**Fig. 12**).

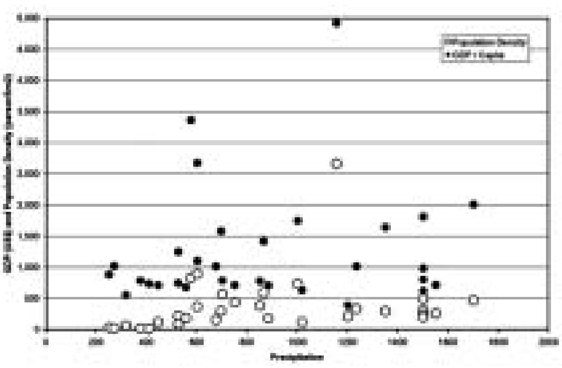

Fig. 10 Precipitation, GDP/Capita & Population Density.

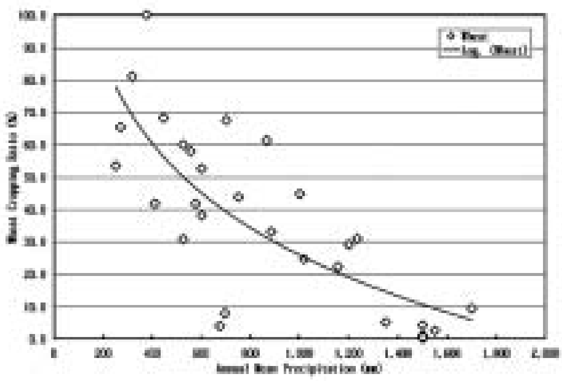

Fig. 11 Relationship between Precipitation and Wheat Cropping Ratio in China.

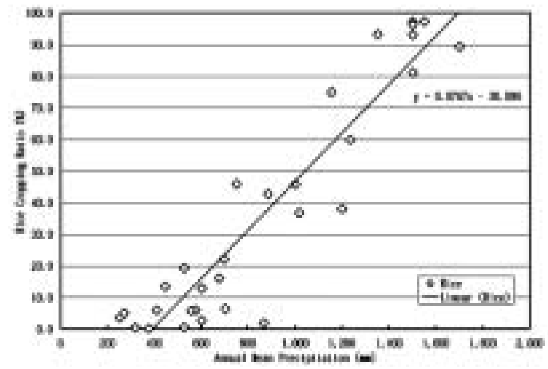

Fig. 12 Relationship between Precipitation and Rice Cropping Ratio in China.

Table 19 Relationship between Precipitation and Crop Production.

MAP (mm)	Planting Wheat (more than 50%)	Intermediate	Planting Rice (more than 50 %)
0 mm - 399 mm Zone I	Inner Mongolia (250), Xinjiang (270), Gansu (317), Qinghai (375)		
400 mm - 799 mm Zone II	Ningxia (445), Shanxi (525), Shaanxi (556), Hebei (600), Henan (700)	Tibet (409), Heilongjiang (525), Beijing (575), Tianjin (600), Jilin (675), Liaoning (695), Anhui (750)	
800 mm - 1,299 mm Zone III	Shandong (865)	Sichuan (883), Chongqing (883), Jiangsu (1,000), Yunnan (1,017), Guizhou (1,200)	Shanghai (1,155), Hubei (1,234)
1,300 mm & more Zone IV			Fujian (1,350), Hunan (1,500), Guangxi (1,500), Jiangxi (1,550), Zhejiang (1,700), Guangdong (1.500), Hainan (1,500)

Source: The World Bank (1997), Zhejinag Province (1999) and Rika Nempyo (2003)

Therefore, I thought there must be a keen relationship between policies on water resources (218 articles) and precipitation, but this isn't clear (**Fig. 13**). It is rather clearer that a relationship between population and articles with CC of 0.52 (**Fig. 14**), and the nature of the articles, such as articles on problem raised are more than those on success stories (**Fig. 15**).

Based on the results mentioned above, issues on water resources don't have strong relationship to precipitation, but have a relationship to population.

(2) Land and Water Conservation

Concerning the relationship between the number of articles on land and water conservation (267 articles) and precipitation, the number of articles increases with decreasing precipitation with CC of −0.64 (**Fig. 16**). We can see a tendency in importance of land and water conservation in less populated areas, but a relationship between articles and precipitation is not clear (**Fig. 17**).

Observation on the nature of articles, articles on problems raised are dominant (**Fig. 18**). Although, the policy of land and water conservation is highlighted in areas with less water, but the policy is difficult to achieve.

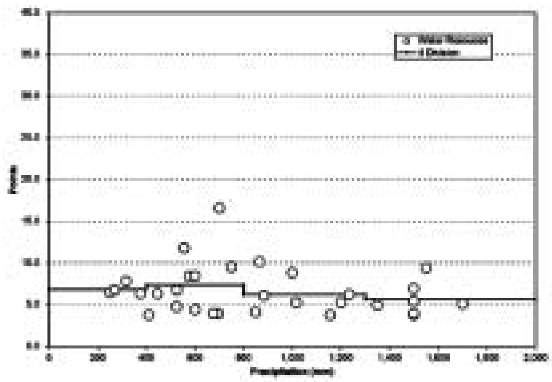

Fig. 13 Precipitation & Articles Cited on "Water Resources".

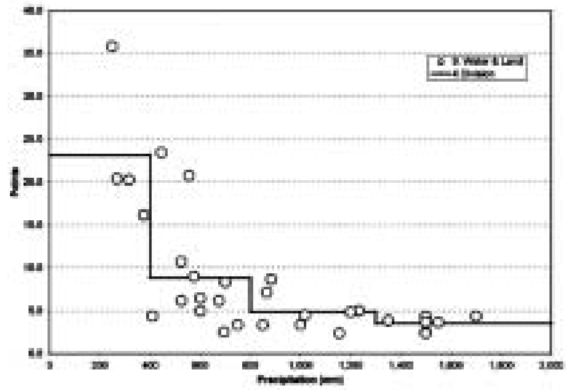

Fig. 16 Precipitation & Articles Cited on "Water & Land Conservation".

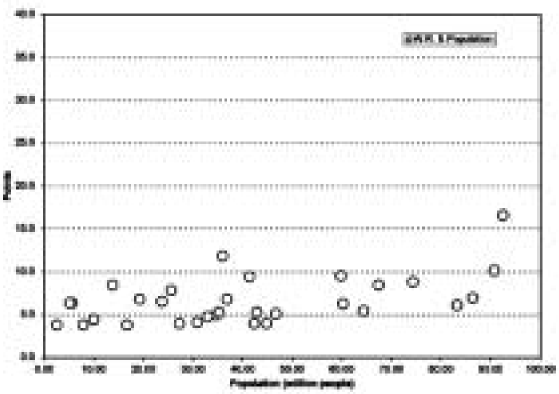

Fig. 14 Population & Articles Cited on "Water Resources".

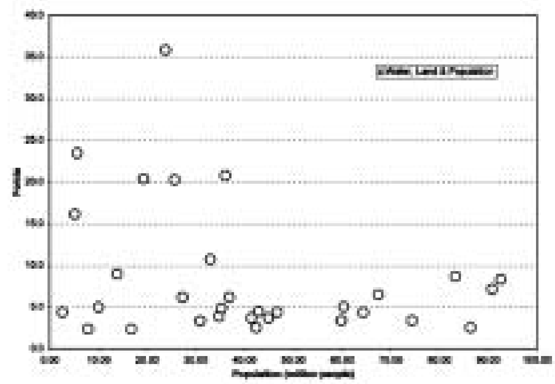

Fig. 17 Population & Articles Cited on "Water & Land Conservation".

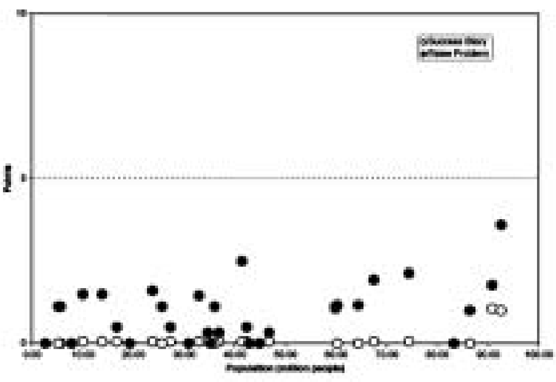

Fig. 15 Population & Articles (Success Story, Raise Problem) Cited on "Water Resources".

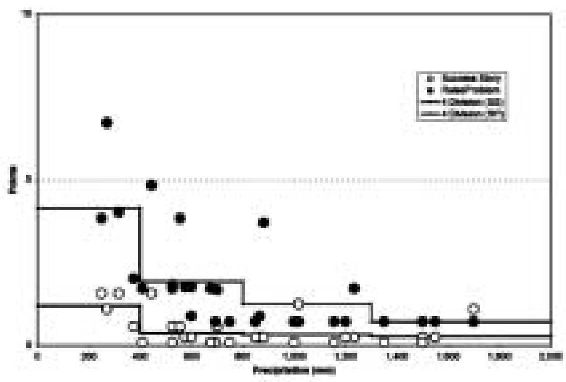

Fig. 18 Precipitation & Articles (Success Story, Raise Problem) Cited on "Water & Land Conservation".

(3) Better Management of Agricultural Water

The policy on agricultural water management (75 articles) focused in areas where MAP was between 500 mm to 1,300 mm (**Fig. 19**). This means the relationship to population is higher (**Fig. 20**) than precipitation. Since articles on success stories are dominant (**Fig. 21**), we can say that a lot of effort was done for water management. Therefore, people can achieve fruitful results on the policies for betterment of water management.

(4) Saving Water-usage or Reducing Water Leakage

The policy on saving water and reducing leakage (88 articles) is focused in areas with less precipitation (**Fig. 22**). Observing the nature of articles, number of articles of both success story and PP are almost equal (**Fig. 23**). Contrarily, the relationship relation between articles and populations isn't clear (**Fig. 24**).

(5) Water Rights, Water Price, and Water Market (WRPM)

We can see the policy on water rights, water price

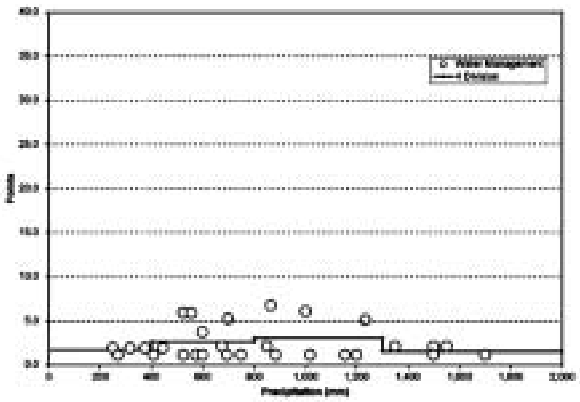

Fig. 19 Precipitation & Articles Cited on “Water Management”.

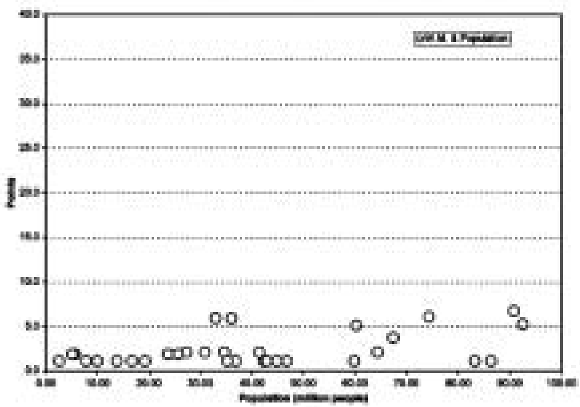

Fig. 20 Population & Articles Cited on “Water Management”.

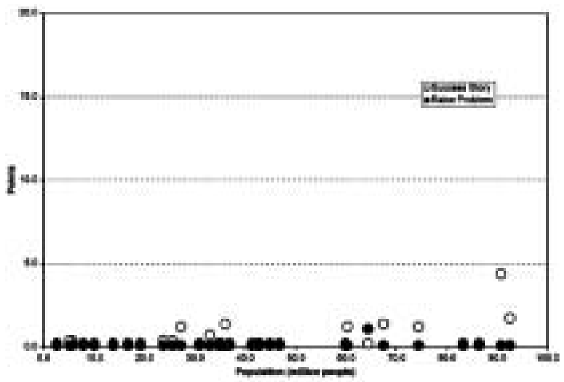

Fig. 21 Population & Articles (Success Story, Raise Problem) Cited on “Water Management”.

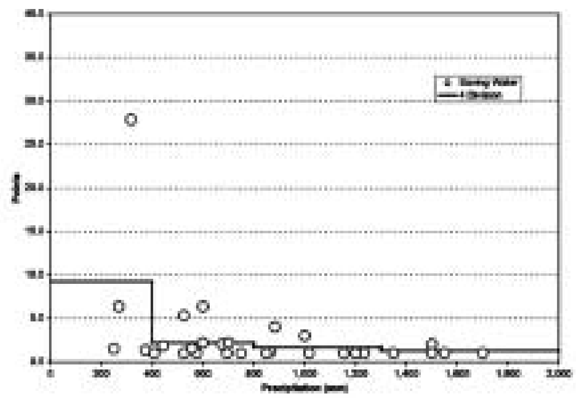

Fig. 22 Precipitation & Articles Cited on “Saving Water”.

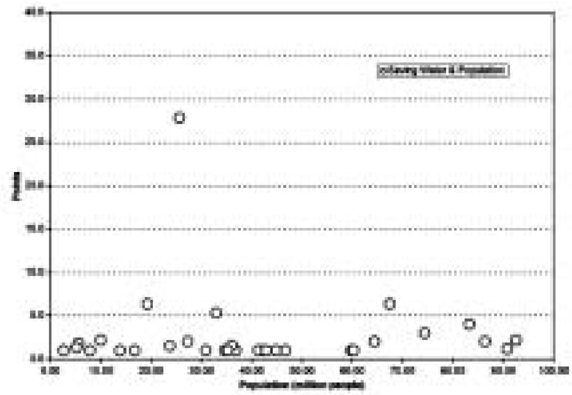

Fig. 23 Population & Articles Cited on “Saving Water”.

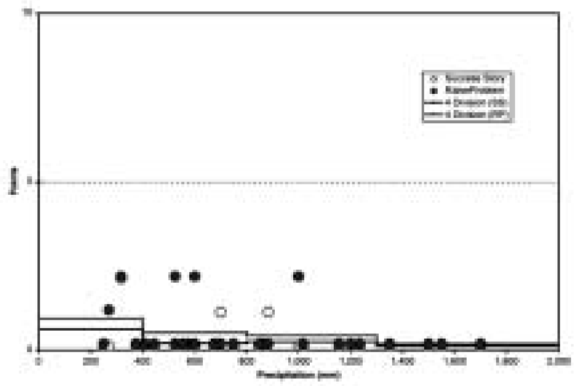

Fig. 24 Precipitation & Articles (Success Story, Raise Problem) Cited on “Saving water”.

and water market (WRPM), which are cited in104 articles, where focused in the area with less precipitation (**Fig. 25**), but a relationship between articles and population was also observed (**Fig. 26**). Observation on the nature of articles, the number of articles of both success story and PP are almost equal (**Fig. 27**).

Concerning the relationship between the number of articles (**Table 20**) and precipitation, the following results were observed.

(a) With decreasing precipitation, the number of articles on water rights (totally 54 articles) increases (**Fig. 28**) in contrast to the relationship between articles and population (**Fig. 29**).

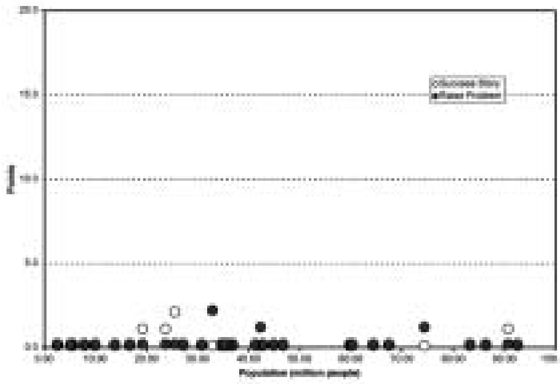

Fig. 27 Population & Articles (Success Story, Raise Problem) Cited on "Water Right, Water Price & Water Market".

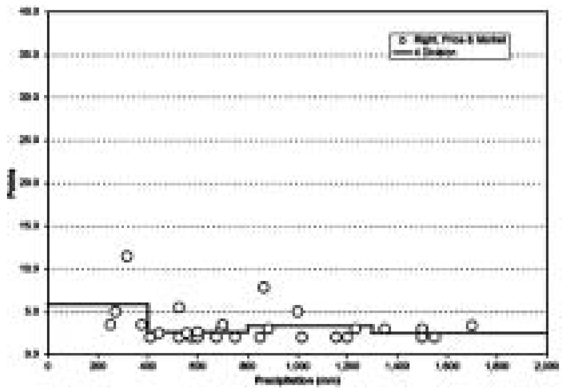

Fig. 25 Precipitation & Articles Cited on "Water Right, Water Price & Water Market".

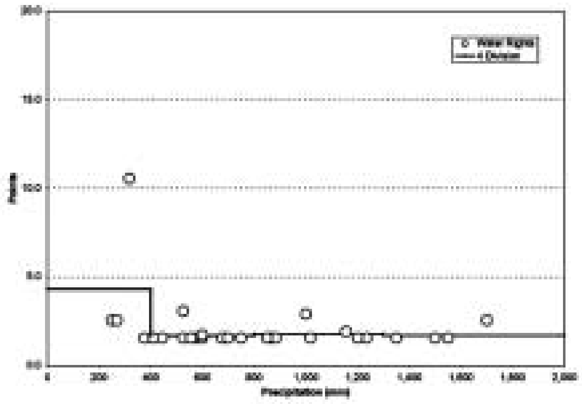

Fig. 28 Precipitation & Articles Cited on "Water Right"

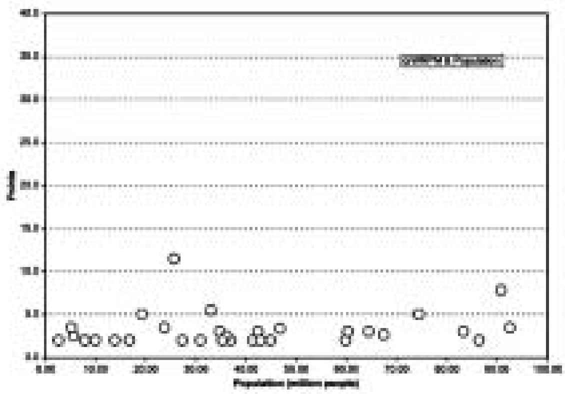

Fig. 26 Population & Articles Cited on "Water Right, Water Price & Water Market".

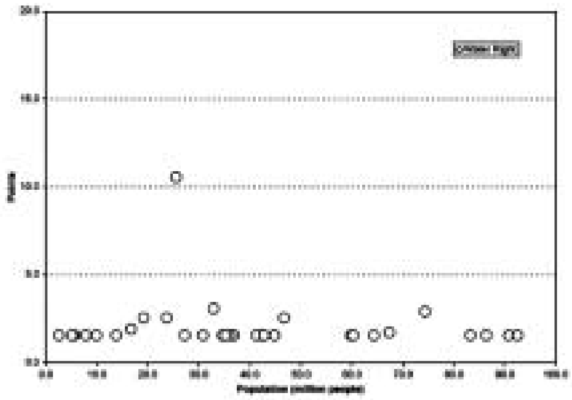

Fig. 29 Population & Articles Cited "Water Right".

Table 20 Keywords to find relationship between "Water Saving" and "Water Rights, Water Price and Water Market".

Theme	Keywords (English Equivalent)	Articles
(i) Water right	Water right (s).	54
(ii) Water price	Price of water, water pricing.	80
(iii) Water market	Water trade, tentative water trade, beyond the basin transfer.	45
(iv) Water fee	Water fee, water resource charge.	59

(b) There is no clear relationship between the number of articles (totally 80 articles) on water price and precipitation (**Fig. 30**), rather we can see a clear relationship between articles and population (**Fig. 31**).

(c) There is no clear relationship between the number of articles on water market (totally 45 articles) and precipitation (**Fig. 32**), nor a relationship between articles and population (**Fig. 33**).

Based on the results mentioned above, the policies of water rights, water price and water market on the whole is propelled throughout China, but only the issues on water rights are focused especially in the areas with less precipitation.

(6) How to Collect Water Fees

There is no clear relationship between the number of articles on water fees (totally 59 articles) and precipitation (**Fig. 34**). Therefore, the policies on water fees are focused in areas where the population is higher (**Fig. 35**).

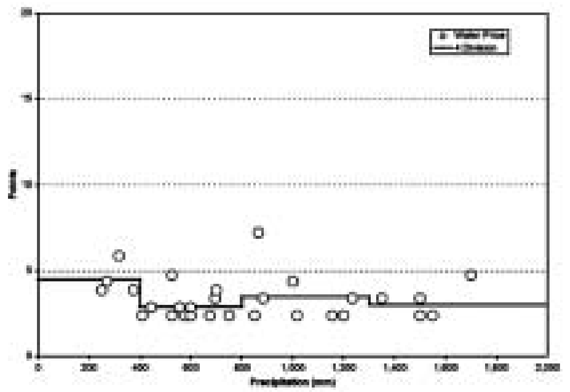

Fig. 30 Precipitation & Articles Cited on "Water Price".

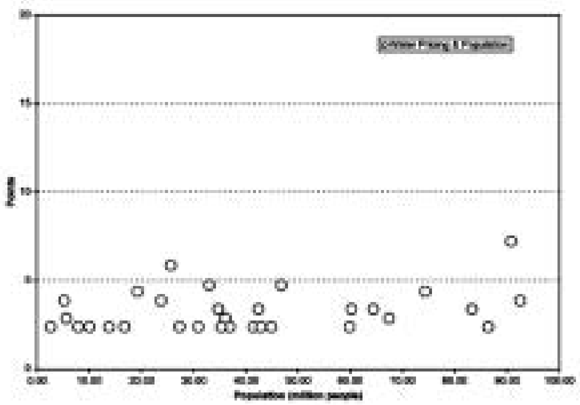

Fig. 31 Population & Articles Cited on "Water Price".

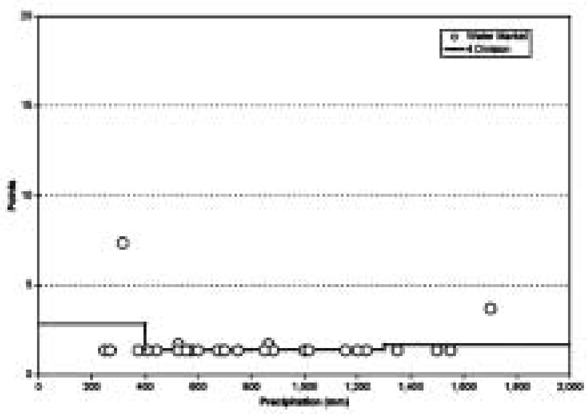

Fig. 32 Precipitation & Articles Cited on "Water Market".

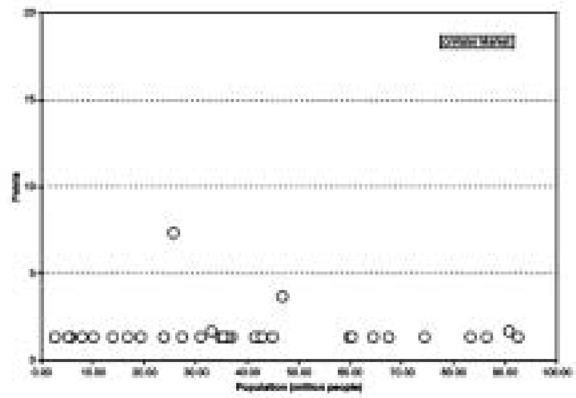

Fig. 33 Population & Articles Cited on "Water Market".

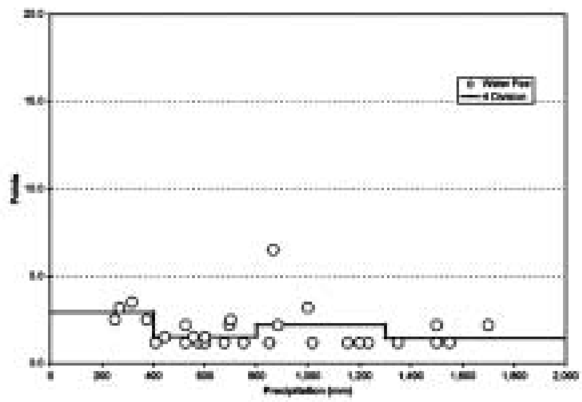

Fig. 34 Precipitation & Articles Cited on "Water Fee".

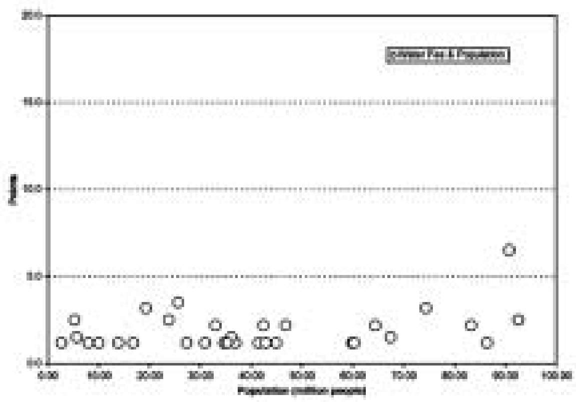

Fig. 35 Population & Articles Cited on "Water Fee".

The issues on water rights, water price and water market are referred in the articles on water fees. Almost all articles mentioned water price, but only one third of the articles referred to water rights or water market (**Fig. 36**).

Water fees in China are decided to recover a part of the initial costs that the government spent, so the relationship between water price and water fee is keen. **Fig. 30** and **Fig. 34** similarly explain a keen relationship between the number of articles and the precipitation.

(7) Avoiding Contamination of Agricultural Water

I selected articles on contamination of agricultural water from category 1 to 6 (794 articles). There was no clear relationship between the number of articles (36 articles, in which 9 are cited for a single province, 2 multi-provinces, 8 basin and 17 all of China) and precipitation (**Fig. 37**). However, relationship between articles and population is clearer (**Fig. 38**). Observation on the nature of articles showed that articles on problem raised are dominant (**Fig. 39**). Although a policy for avoiding contamination of agricultural water is propelled throughout China, especially in populated areas, it will take much time to pave the way to fulfill the policy.

d Comparison among Themes

The research dividing precipitation zones is shown in **Table 21**.

Division by precipitation can help to easily understand the points we saw in the previous results. According to the research for theme 3 and 4, the relationship policy and the precipitation are as follows:

(a) The policy for saving water is the most important in area I.
(b) The policy for saving water as well as betterment of agricultural water management are important in area II.
(c) Importance of betterment of water management doesn't decrease, but importance of saving water is lowered in area III.
(d) Although importance of betterment of agricultural water management (1.5 points) is decreased only by 12% from that in I area (1.7 points), the importance of saving water (1.3 points) is decreased 86% from that in I area (9.3 points) for area IV.

Concerning theme 5, the policy of water rights, water price and water market is focused in area I (5.9

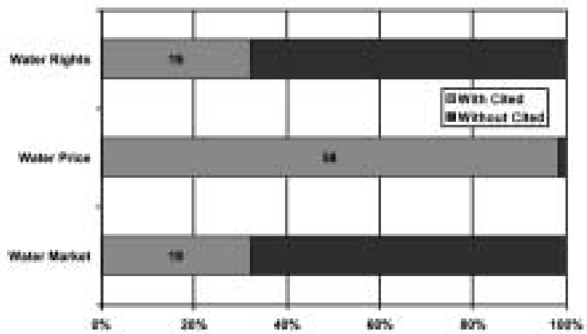

Fig. 36 Keywords Cited in 59 "Water Fee" Related Articles.

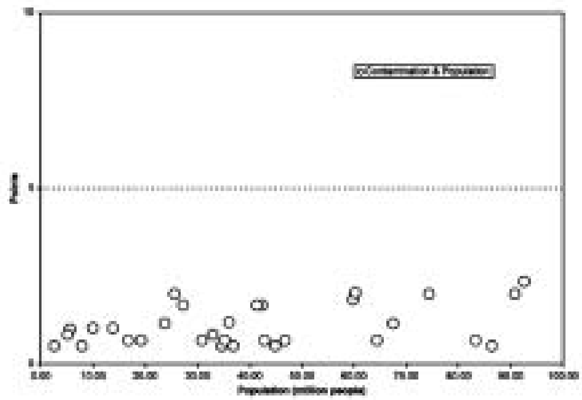

Fig. 38 Population & Articles Cited on "Water Contamination".

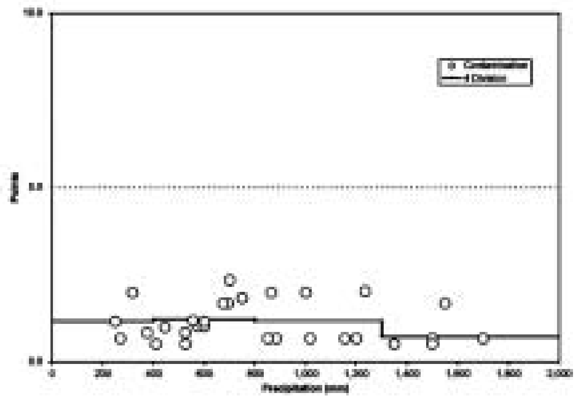

Fig. 37 Precipitation & Articles Cited on "Water Contamination".

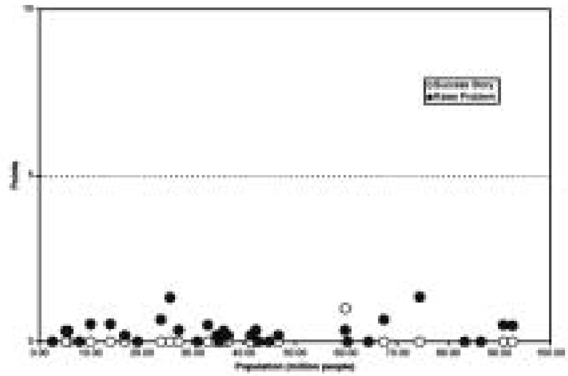

Fig. 39 Population & Articles (Success Story, Raise Problem) Cited on "Water Contamination".

Table 21 Division by MAP.

Theme		unit	I	II	III	IV	Tendency
	MAP minimum	mm		400	800	1,300	
	MAP maximum	mm	399	799	1,299		
	Provinces divided		4	12	8	8	
	Wheat cultivation rate	%	67.3	45.5	40.4	3.4	
	Rice cultivation rate	%	2.7	14.8	35.1	91.8	
	Population/Province	million	18.5	35.6	54.3	43.6	
1	Water Resource		6.9	7.4	6.2	5.6	/\\
2	Water & Land Conservation		23.2	8.9	4.9	3.6	\\\
3	Water Management		1.7	2.6	3.1	1.5	//\
4	Saving Water		9.3	2.2	1.7	1.3	\\\
5	WRPM		5.9	2.6	3.4	2.5	\/\
5-1	Water Right		4.3	1.7	1.8	1.7	\/\
5-2	Water Price		4.5	2.9	3.5	3.0	\/\
5-3	Water Market		2.9	1.38	1.39	1.7	\//
6	Water Fee		2.9	1.6	2.2	1.5	\/\
7	Water Contamination		1.16	1.23	1.17	0.7	/\\

Source: The World Bank (1997), Atlas China (1989), China Statistic Data Book (2001), Rika Nempyo (2002), and Sekai Kokusei Zue (2003).

points), followed by area III (3.4 points). Articles on water market cited in area IV (1.7 points) are more than those in area II (1.4 points) and area III (1.4 points).

e Comprehensive Analysis

Policy for saving water is focused on in areas with less precipitation. The Chinese government has enhanced water saving technology throughout China, but techniques are applied differently from area to area.

Consulting official documents related to water saving policy in which Inner Mongolia (MAP is 250 mm, Zone I), Gansu Province (317 mm, Zone I), Shaanxi Province (556 mm, Zone II), Shandong Province (865 mm, Zone III), and Hunan Province (1,500 mm, Zone IV) are referred (**Table 22**), we can see clear characteristics of four divisions. Although saving water is mentioned in every province, increasing water fees (theme 6) is mentioned only for provinces in Zone I. Water transfer to cities and ecological betterment, which reflect lower interests in water contamination (theme 7), are mentioned only in Zone IV. This shows us that people in Zone I think about market mechanisms to decide water price and charge farmers for the purpose of effective water use. We can understand why Inner Mongolia AR and Gansu Province mentioned increasing water fees in their official documents (**Table 22**).

IV Case Studies

I undertook several field surveys in China from 1995 to 2001. Several of these projects were supervised by the World Bank Loan during 1995 to 1997 and 2 projects Gansu Province and Xingjiang Uygur AR are referred to in IV-1, and 2 projects Shandong Province and Jiangsu Province are referred to in IV-2. The last case study of Zhejiang Province was conducted in 2001 under permission from MWR.

1 Policy for Saving Water-usage or Reducing Water Leakage

In this section, field visits to Gansu Province in 1995 and Xinjiang Uygur AR in 1996 are reported.

Table 22 Achievement Mentioned for Executing Water Saving Policy.

	Inner Mongolia	Gansu	Shaanxi	Shandong	Hunan
Precipitation Zone	I	I	II	III	IV
Overall Saving Water	Yes	Yes	Yes	Yes	Yes
Increasing Water Fee	Yes	Yes			
Water Transfer to Cities					Yes
Applying Advanced Irrigation Method	Yes	Yes	Yes	Yes	
Changing farming Method	Yes				
Ecological Betterment					Yes
Recovering Underground Water				Yes	Yes
Dissemination		Yes	Yes		Yes

Source: Water Saving Irrigation (Network) of China, 2001

a WB Project in Gansu Province

(1) General information about Gansu Province

According to Atlas China, the basic information about Gansu Province is as follows:

Population: 20.7 million

Urban population: 8.1 million

Nationalities: Han, Hui, Tibetan, Dougxiang, Yugur, Baonan, Mongolian, Kazak, Tu, Slar, and Manchu

Area: 390,000 square kilometers

Altitude: mostly above 1,000 meters

Climatic features: subtropical, humid climate in the east changes to a temperate, dry climate in the west; cold, humid, highland climate in the Qilian Mountains; temperatures shift greatly from day to night as well as from season to season in the central and western parts of the province.

Average temperature: from -14 to 3 degrees in January, from 11 to 27 degrees in July

Annual average rainfall: from 30 to 860 mm; precipitation decreases sharply north of the 37th parallel north latitude; from 50% to 70% of the rain falls during the summer

Physical features: the Qinghai-Tibet, Loess, and Inner Mongolia Plateaus adjoin the province; where the plateaus meet is a narrow, 1,000 km passage, the Hexi or Gansu Corridor, which was part of the ancient Silk Road leading to the Western Regions, present day Xinjiang and areas further to the west.

Mountains: Qilian Range along the central part of the Gansu-Qinghai border; Beishan mountains in the north; Diashan-Minshan Mountains in the southwest

Rivers: the Yellow River and tributaries, the Weihe River and the Taohe Rivers; the Bailong River in the south; the Heihe River, the Shule River and other inland rivers in the Hexi Corridor

Products: wheat, highland barley, millet, broomcorn millet, potatoes, corn, sorghum, rice, rape, soybeans, sugar beet, cotton, sun-cured tobacco, muskmelons, wool, leather, sausage casing, coal, petroleum, nickel, copper, sulphur, zinc

(2) Canal Efficiency

In this project, water usage is very high to maintain water control, because of the scarce water resources. Efficiency of water usage through canals was calculated based on (1) regulations of SDJ217-84 in China and (2) PMO's experiences in/near Gansu province such as the Jing-dian II Project, the In-da-re-qing Project and the Nei-mong-he Project (**Table 23**).

The problem was how they managed to assure this high-level of water control.

(3) Lining for Canals

The sites of this project are typically divided into two areas, i.e. the Gobi (gravel desert) area and lower land (**Fig. 40**). The structure of the canals is different

Table 23 Canal Length and Effectiveness in nearby Project.

Name and area of the project		Unit	Length and Canal Efficiency				
			Main	Sub-main	3rd.-main	Branch	Sub-branch
Chang-ma		km	75.48	110.31	140.04	652.98	
	56,867 ha	E(*1)	0.90	0.90	0.95	0.96	0.84
Jing-dian II		km	100.57	14.76	-	326.00	
	34,667 ha	E	0.91	0.98	-	0.90	0.80
In-da-re-qing		km	86.94	122.41	-	687.48	
	57,333 ha	E	0.94	0.946-0.956	-	0.655-0.988	
Nei-mong-he		km	-	96.10	93.19	210.00	
	36,667 ha	E	-	0.88	0.90	0.90	0.88

*1 : efficiency

Total efficiencies are calculated as below.

Chang-ma 0.62 (= 0.90*0.90*0.95*0.96*0.84)

Jing-dian II 0.64 (= 0.91*0.98*0.90*0.80)

Nei-mong-he 0.59 (= 0.88*0.90*0.90*0.83)

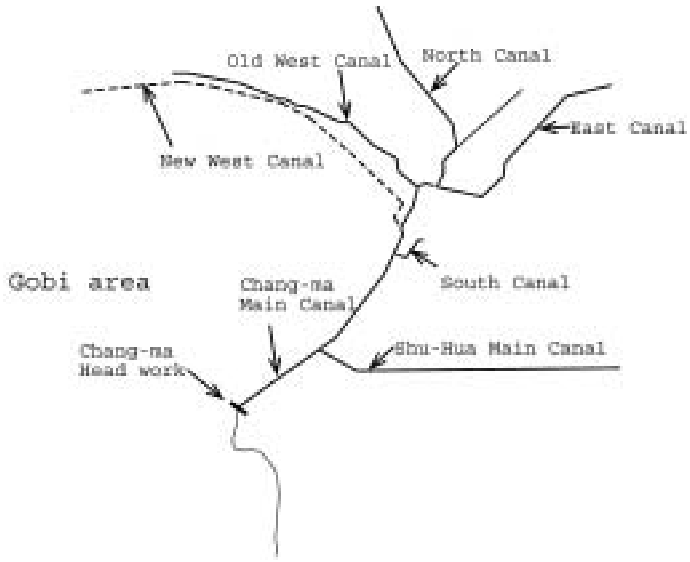

Fig. 40 Basic Layout of Changma Irrigation Project.

for each area.

The main reason for the lining of the canals is in this area because many portions of the canals may collapse from freezing and swelling (**Fig. 41**). This phenomenon is said to happen when (1) the underground water table is higher than the bottom of the canal and (2) there is a thick soil layer holding seepage of water from the canal.

Essential ideas for the canal structure are to preferentially use raw materials such as sand and large size gravel, when a large quantity is easily available. But in the freezing and swelling areas, canals are designed to avoid freezing and swelling by the design of the following.

In the Gobi area, no special construction method is needed, because the Gobi usually has the toughest basement for a canal and the ground water table is usually very low. Swelling phenomenon never occurs in this area. The use of casting concrete and/or concrete panels are planned (**Fig. 42**).

If the soil layer is thick, PMO plans to use concrete (plate) and mason on the surface of the canal and

Fig. 41 Canal Seriously Damaged by Freezing in Gansu Province. (October, 1995)

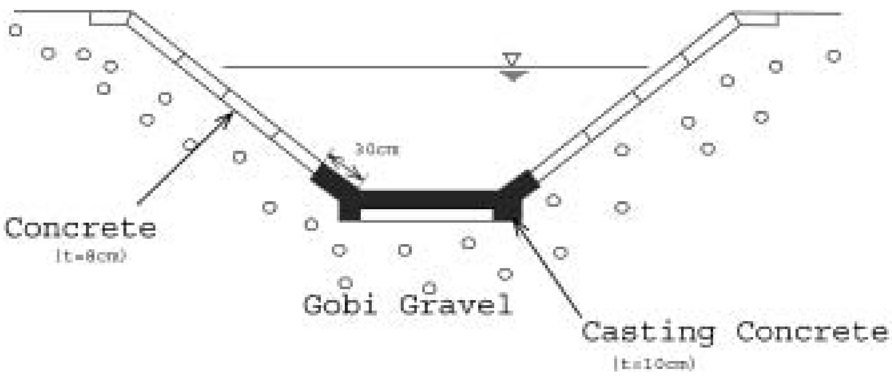

Fig. 42 A Cross Section of the Changma Main Canal in Gobi Area

between the lining and the soil basement, the gravel layer should also be replaced (**Fig. 43**).

If the soil layer is thick and underground water table is high, PMO plans to use plastic film (t=0.18 mm) which has been investigated and designed particularly for this area by the Shu-lu River Management Station. A protecting layer consisting of sand or fine sand is needed for the plastic film (**Fig. 44**, **Fig. 45**).

Additionally, if the longitude slope is steep, PMO uses mason on the surface of the canal to avoid wearing (**Fig. 46**, **Fig. 47**).

(4) Underground Water

Underground water is also an important water resource in this area even though it causes freezing at some portions of the project,

There are four water resources in this area: (a) the Chang-ma Reservoir, (b) the Shuang-ta Reservoir, (c) the Chi-jin Reservoir and (4) Underground water (*2) with 1.014×10^9 m^3, 3.11×10^8 m^3, 4.9×10^7 m^3 and 9.5×10^7 m^3 (P=50%), respectively. In this plan, underground water is stored in the Shuang-ta Reservoir as (natural) spring water that came from the edge of the Gobi area (**Fig. 48**).

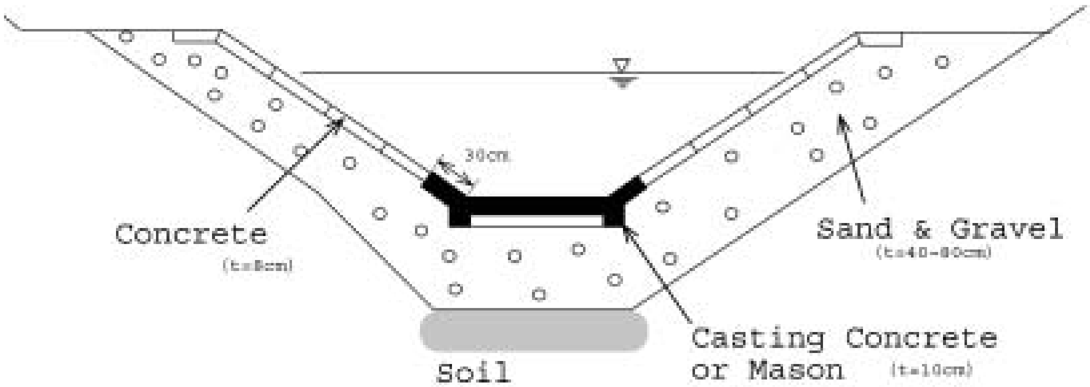

Fig. 43 A Cross Section of the Changma Main Canal on the Soil Baseent (1)

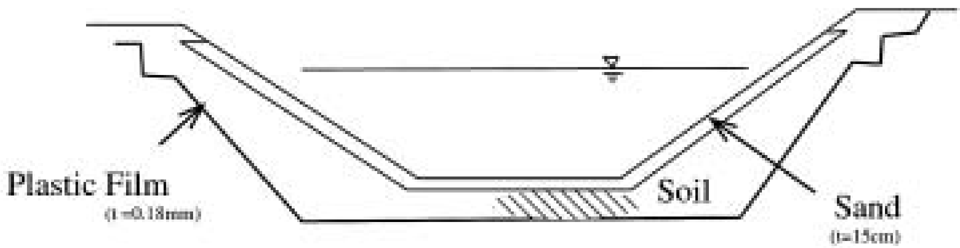

Fig. 44 A Cross Section of the Changma Main Canal on the Soil Baseent (2)

Fig. 45 A Canal Lining in Gansu Province - Consisting of Plastic Film, Sand and Grass. (October, 1995)

Fig. 46 A Lining of the Changma Old Main Canal at an area with a steep-slope in Gansu Province. (September, 1995)

Besides spring water, underground water is used as a supplement at the end of the canals (**Fig. 49**), where small pumping stations supply good quality water.

Underground water is not only used for irrigation, but also used for the city, because underground water is the only resource.

(5) Leaching Water

This project includes land reclamation. New land requires additional water that is used for land leaching.

The demand for leaching water is calculated by the degree of salinity, (a) normal area, (b) slightly salty area, (c) little salty area, (d) middle salty area, (e) heavy salty area and (f) extremely salty area.

A large area of heavy salty land was provided for this project. Especially, more than 30% of Shuang-ta area is heavy salty or extremely salty and require water quantity of which 4 times to 6 times more than normal land.

(6) Water Efficiency at the fields

Although water efficiency of canal is enough

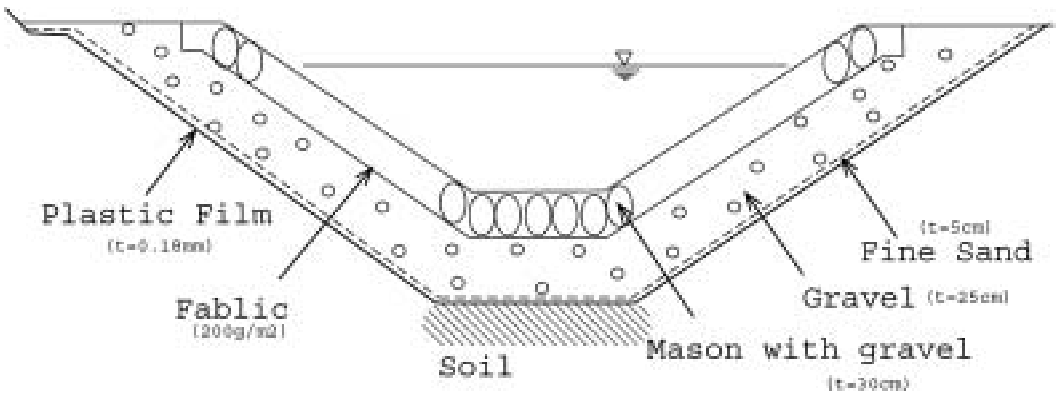

Fig. 47 A Cross Section of the Changma Main Canal at Steep-Slope Area

Fig. 48 Supplementary used underground water. (October, 1995)

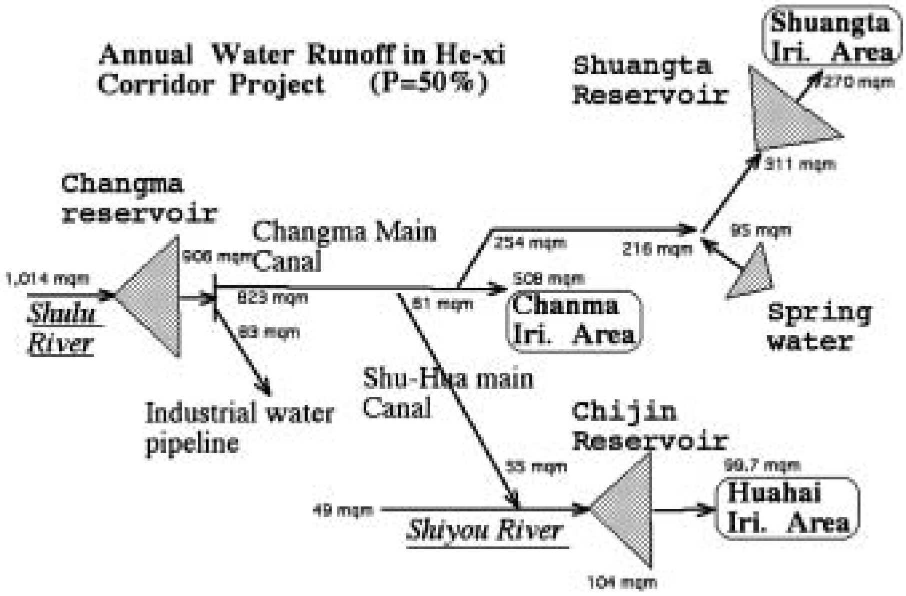

Fig. 49 Annual Water Runoff in Hexi Corridor Project.

considered to minimize water leakage from the canal, water efficiency at the field level isn't enough. Usually, basin irrigation with pond water at a small farming plot divided by a levee is used at the field (**Fig. 50**).

Fig. 50 A Temporally-used Intake to Farmland in Huang-Hua State Farm. (September, 1995)

b WB Project in Xingjiang Uygur AR

(1) General information about Xingjiang Uygur AR

According to Atlas China, the basic information about Xinjiang Uygur AR is as follows:

Population: 13.8 million

Urban population: 6 million

Nationalities: Uygur, Han, Kazak, Hui, Mongolian, Xibe, Kirgiz, Ozbek, Tajik, Russian, Manchu, Daur, and Tatar

Area: 1.6×10^6 km^2

Altitude: 8,611 m at the Qogir peak; 155 m below sea level at the bottom of the Turpan Depression, the lowest point on the China continent

Climatic feature: temperate, continental climate; warmer in the south; extreme temperature changes; little precipitation; frequent gales in spring and autumn

Average temperature: in January, from −20 to −15 degrees in the north; only 10 mm around Qarqan and Qarkillik

Physical feature: three major mountain ranges separate the lowlands into various-sized basins and valley lands; conspicuous differences in land elevation

Mountains: Tianshan Range in the central area; Altay Range in the north; Karakorum, Kunlun, and Altun Mountains in the south

Deserts: Taklimakan Desert in the Tarim Basin; Gurbantunggut Desert in the Junggar Basin; Gamtay Desert in the east

Basins: Junggar Basin between the Tianshan and Altay Ranges; Tarrrrrrim Basin between the Tianshan and Kunlun Ranges, over 500,000 km^2 in area; Turpan Depression between the Bogda and Qoltag Mountains; east of the Turpan is the Hami Basin.

Rivers: the 2,137 km Tarim River, China's longest inland river; the Ili River and the Ertix River

Lakes: Lop Nur, a famous salt lake; Bosten Lake, the largest fresh water lake of the region; Aydingkol Lake in the Turpan Depression with the lowest altitude in China

Products : wheat, rice, corn, sorghum, millet, potatoes, rape, sesame, sugar beet, peanuts, peaches, grapes, cotton, silk cocoons, iron, coal, petroleum, gold, copper, salt, jade, sulphur

Specialties: Turpan grapes, Hami melons

Xinjiang Autonomous Region, covering 1.65×10^6 km^2, is a place with a vast territory, making up 1/6 of China. The Tarim River Basin, situated in the south west of Xinjiang, is one of the largest inner river basins in China. There are many rivers in this basin, but most of the rivers seasonally disappears downstream (**Fig. 51**).

The average annual temperature is from 3.2 to 11.3 degrees in the Tarim River Basin, while the highest temperature is from 32 to 33 degrees and the lowest is from −29 to −39 degrees. The average annual precipitation and evaporation is from 50 mm to 80 mm and from 2,000 mm to 2,900 mm, respectively. The annual sunshine hours are 2,839 hours and the frost-free days are 210 to 221 days from March to October. The maximum depth of frozen earth is from 1.31 m to 1.75 m and the relative air humidity is from 40% to 52%.

(2) Project

The proposed Tarim Basin II Project is located north west of the Tarim River Basin. The purposes of the project are (1) expansion of the irrigated area to 130,000 ha and improvement of an irrigated area of 204,667 ha, (2) increases in water of 8.77×10^8 m^3 per year and water savings of 1.043×10^9 m^3/year, (3) land reclamation and land improvement of 130,000 ha, (4) increases in cotton production to 381,000 tons and grain production to 60,000 tons and (5) increases of water supply for ecological use for the Tarim River to 1.50×10^8 m^3/year.

(3) Water Resources

In the Bayangol Sub-project, the annual runoff of the Kaidu River is 3.006×10^9 m^3 (P = 75%). Including the water resources coming from four other rivers (3.5×10^8 m^3), the total surface water resources in this area are 3.356×10^9 m^3. As 1.258×10^9 m^3 of water is used for irrigation, factories and cities up stream, water flowing in the Bosten Lake2 amounts to 2.098×10^9 m^3. Addition of precipitation (9.5×10^7 m^3), drainage water (2.45×10^8 m^3) and ground water (1.2×10^8 m^3) with deduction of evaporation (1.345×10^9 m^3), the total water resources usable from the Bosten Lake at present are 1.213×10^9 m^3 (**Fig. 52**).

Water resources in the Tarim River Basin are decreasing rapidly. For example, at Alaer, the origin of the Tarim River, the water resources in the 1950s was estimated to be 5.600×10^9 m^3, but in the 1990s it decreases to 4.000×10^9 m^3. At Kala, from where the Tarim River Management Bureau (TRMB) named the Tarim River as down stream area, water resources were 1.500×10^9 m^3 in the 1950s and 0.250×10^9 m^3 in the

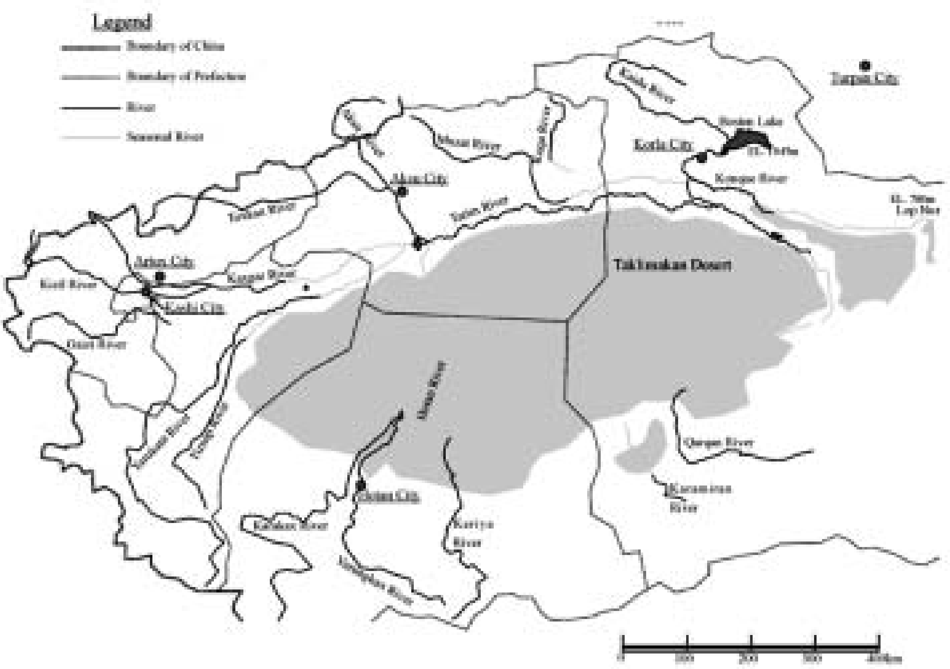

Fig. 51 Main Rivers in the Tarim Basin

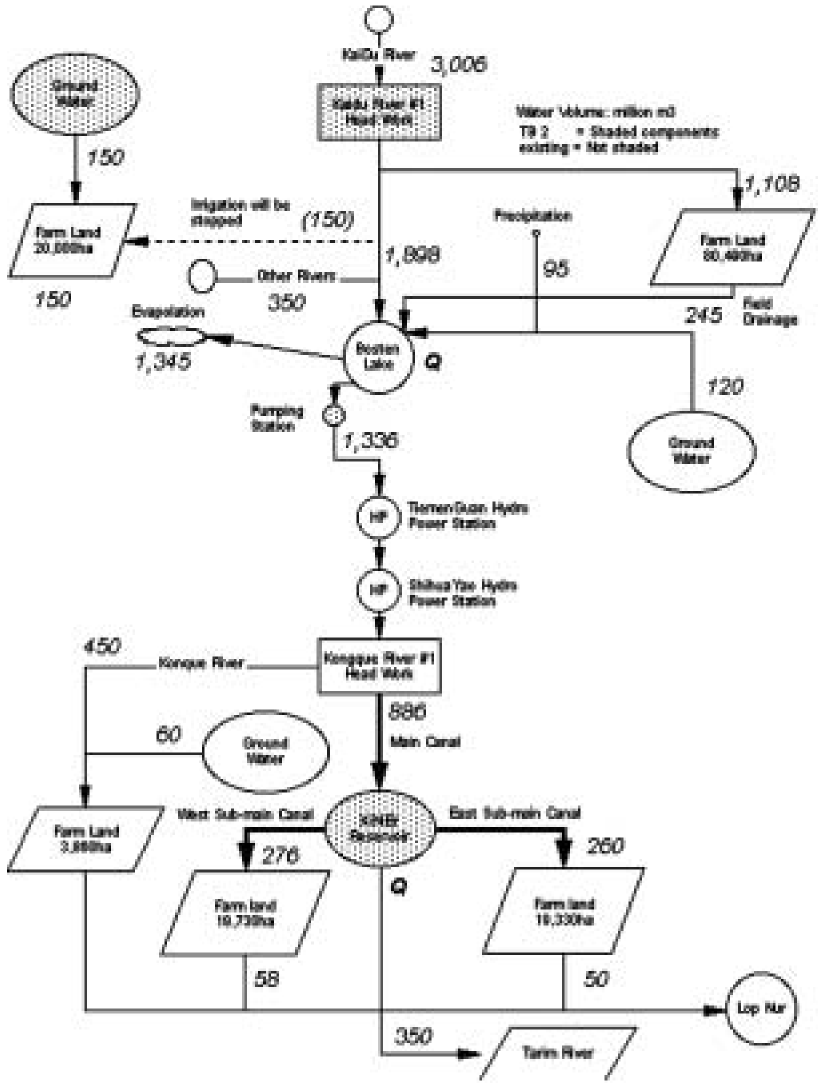

Fig. 52 Schematic Drawing of Bayangol Sub-project.

1990s. The underground water table also became lower at 2.0 m to 10.0 m from the ground surface. The reasons the water resource decreased so quickly are because the city uses of water increased in the west part of the Tarim River Basin and losses from the canals and rivers also increased. Water balance in the Tarim River Basin should be analyzed as pointed out in the mission meeting. However, TRMB could not begin immediately because of a lack of hydrologic data.

2 Policy for Better Management of Agricultural Water

In this section, field visits to Shandong Province in 1996 and Jiangsu Province in 1997 are reported.

a WB Project in Shandong Province

According to Atlas China, the basic information of Shandong Province is as follows:

Population: 77.8 million
Urban population: 44.5 million
Nationalities: Han, Hui, and Manchu
Area: 150,000 square kilometers
Coastline: 3,000 kilometers long
Climatic features: warm-temperate, semi-humid, monsoonal climate; influenced by the ocean, it is warmer and more humid than inland province; rainy summers; dry winters
Average temperature: from -5 to -1 degree in January, from 24 to 28 degree in July
MAP: from 560 to 1,170 mm; precipitation decreases from the southeast to the northwest; from 60% to 70% of the rain falls during the summer
Physical features: situated in the lower Yellow River Valley; hills in the central region and on the eastern peninsula; plains, in the north, west, and, central east; narrow

lowland in the south and along the southeastern coast; faces the Bohai Gulf in the north and the Yellow Sea in the east.

Products: wheat, corn, sorghum, millet, potatoes, sweat-potatoes, rice, soybeans, peanuts, tea, sesame, cotton, tussah, ambary hemp, flue-cured tobacco, peaches, walnuts, chestnuts, persimmons, sea products, coal, petroleum, salt

Specialties: Yantai apples, Leling jujubes, Laiyang pears, Pingdu grapes, Dezhou watermelons

I visited the WB project in Shandong province in 1996. The project area is shown in **Fig. 53**. Tai'an City is in Laiwu County of Shandong Province, population 90.79 million, and has an interesting “IC card operating system” working under the township government. The IC cards are a pre-paid card and provide eligiblility at a particular tube-well station in the project area. By this system, farmers can easily know how much water they are using and how much money is left on their individual cards by reading an indicator installed inside a tube-well station. Therefore, the local officials believe this system is effective not only for saving water resources but also for collecting water fees.

In the operation manual of the tube well issued by a county in Shandong Province, the county level government suggests (1) let the organization of lower level issue a detail manual, (2) the operators must receive technical training, (3) water fees should be charged according to the amount of irrigated area, amount of electricity or volume of water. Almost all organizations in the county obey these suggestions.

b WB Project in Jiangsu Province

(1) Basic information about Jiangsu Province

According to Atlas China, the basic information about Jiangsu Province

Population:	62.7 million
Urban population:	20.6 million
Nationalities:	Han, Hui, Manchu
Area:	100,000 km^2
Altitude:	less than 50 m for most of the province
Coastline:	1,000 km long
Climatic features:	spans the warm-temperate/semi-humid and subtropical/humid zones; clear-cut seasonal changes; frequent, plum rains-between spring and summer; typhoons with rain-storm in late summer and early autumn; occasional frost, dry and hot winds, and hailstorm

The average population of provinces in China is 40.7 million (31 provinces and 1,262 million people). The

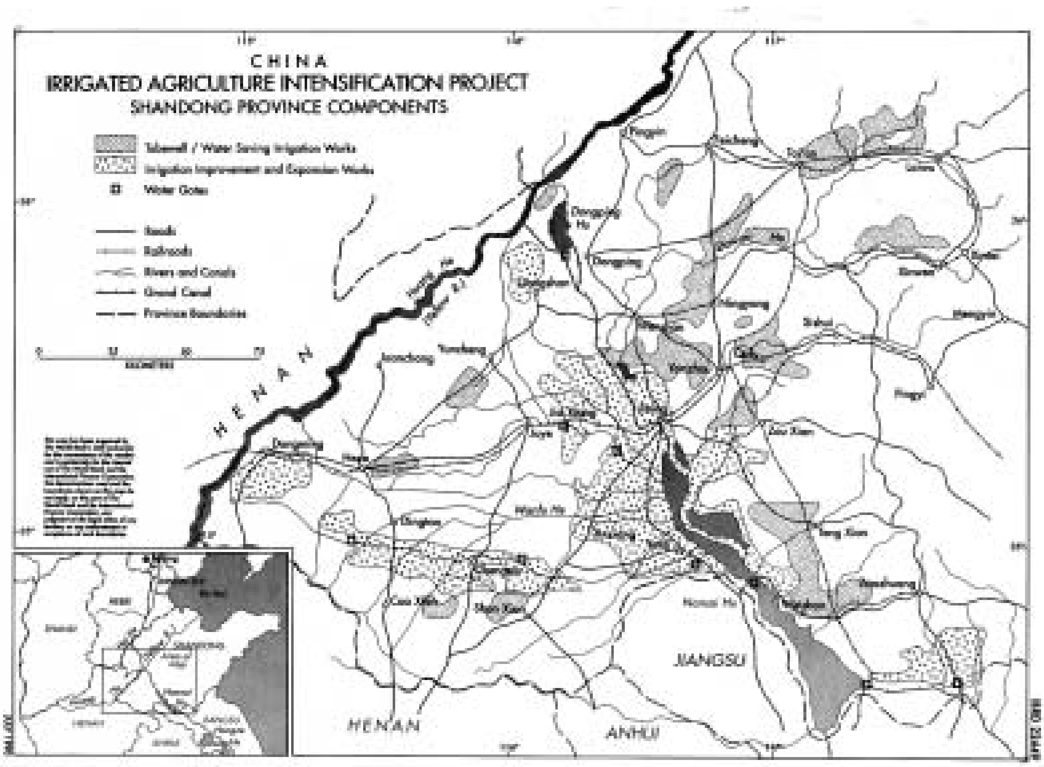

Fig. 53 The Irrigation Agriculture Intensification Project (Shandong Province Component)

policies for management of agricultural water are focused in the populated provinces. Because water management is challenging in an area with many users, success stories are cited more than articles of problems raised.

(2) Project Component

The project area is shown in **Fig. 54**. I visited Huai'an, Siyang and Liulaojiang pumping stations. I was satisfied with the construction quality of the completed pumping stations, however, there were some things requiring safer working circumstances. All pumping stations will be completed in the time PPMO planned, and will be managed as well as other stations by the non-World-Bank project, such as Huai'an No. 2 pumping station and Jiangdu pumping station.

I also emphasize a need to prepare plans for O&M of the completed facilities and preparation and issue of regulations and guidelines for O&M.

(3) Other Projects

The Tai Zhou Ying Jiang He Project began in 1996 in the southeast Jiangsu Province to increase water use from the Yangtze River (max. 600 m^3/sec) through new diversions (rout C - D of Project Layout below) into the Grand Canal (rout A - B of Project Layout) to increase the irrigated area by about 1.65×10^7 mu (1.1×10^6 ha) and improve navigation. I visited the project site in Taizhou City and saw soil excavation had been carried out by water power.

Tong Yu He Project (rout E - F of Project Layout) was aided by the Japanese government. The project improved the existing canal of 245 km to provide irrigation water to northeast Jiangsu at a total cost of US$ 226.1 million, of which US$ 105.8 million (JAN Yen 11,535 million) was from Japanese aide. The construction of this project was 55.3% finished by the end of January, 1996.

As an Eastern Route for South Water Transfer to the North Project (SWTNP) a total of 1,000 m^3/sec water were provided from three parts of water supply, (a) 400 m^3/s taken from the Gaoyou Lake, (b) 200 m^3/s carried from the eastern part of Jiangsu Province, and (c) 400 m^3/s already provided through the Jiangdu Pumping Station. Only after the two projects mentioned above have been completed will 200 m^3/s be provided to SNTP (**Fig. 55**).

3 Water Trade in Zhejiang Province

In this section, a field visit to Zhejiang Province in 2001 is reported.

According to Atlas China, the basic information about Zhejiang Provinc is as follows:

Population: 40.7 million

Urban population: 17.8 million

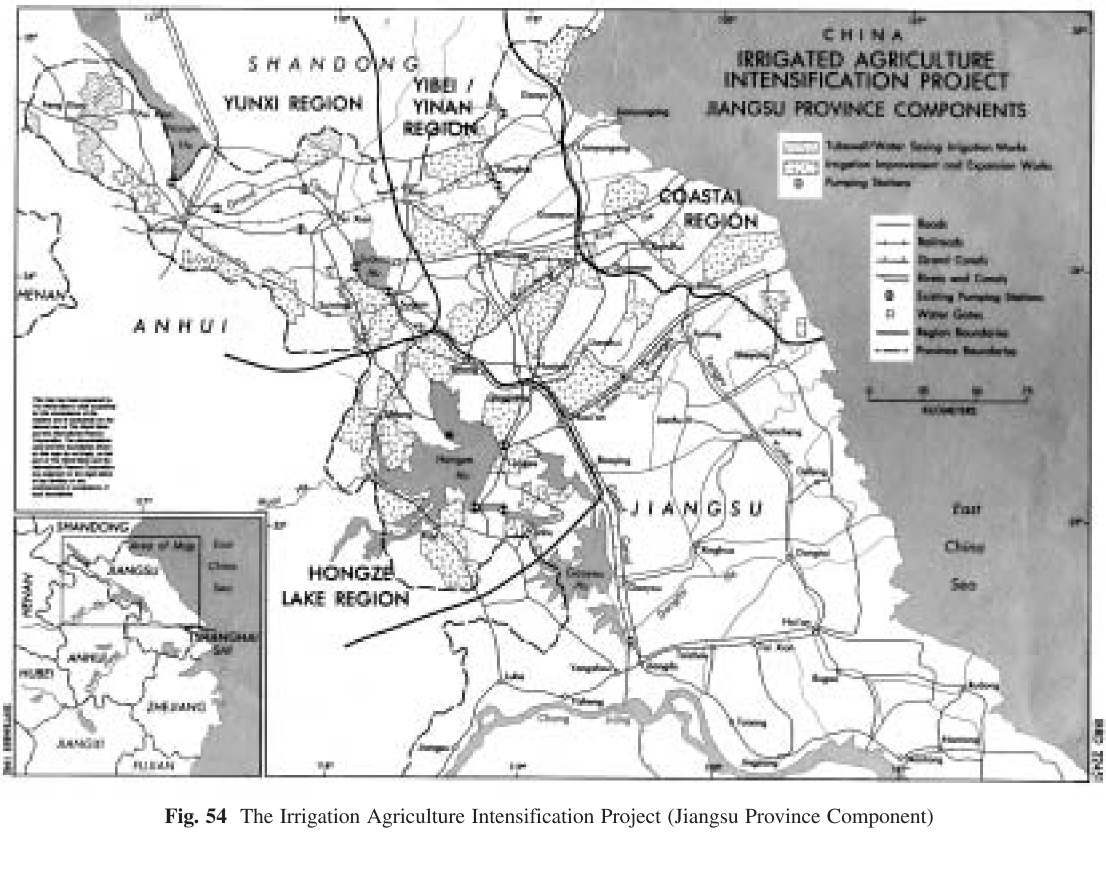

Fig. 54 The Irrigation Agriculture Intensification Project (Jiangsu Province Component)

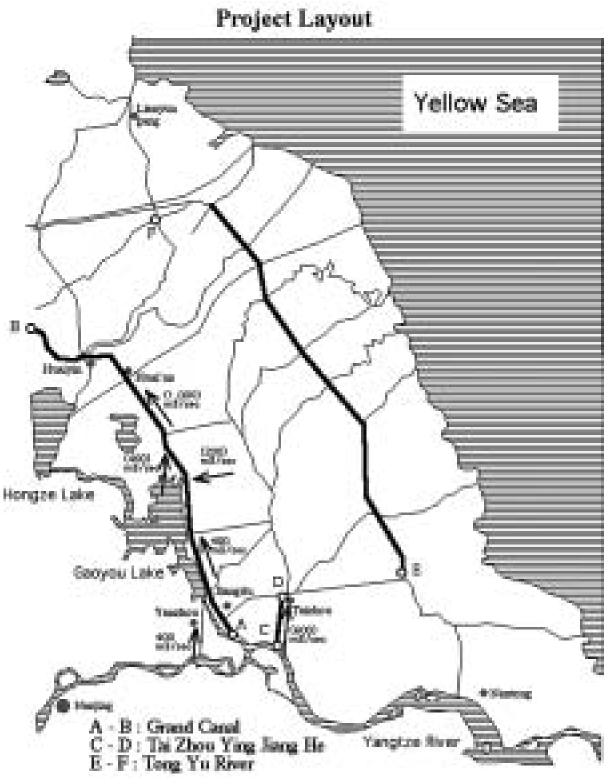

Fig. 55 Related Project for South-Water-Covey-North Project.

Nationalities: Han, She, Hui, Manchu, and Miao

Area: 100,000 square kilometers

Coastline: 2,200 km

Climatic features: subtropical, monsoonal climate; clear-cut seasons; plum rains from early June to early July; drought in July and August; typhoons from late August to late September

Average temperature: from 2 to 8 degree in January, from 27 to 33 degree in July; high temperatures in the central basin

MAP: from 850 mm to 1,700 mm; low precipitation in the north

Physical features: lowlands in the northeast and mountains in the southwest; 70 % mountains and hills; faces the East China Sea; the Hangzhou Gulf at the mouth of the Qiantang River is closed in by the Zhoushan islands in the east.

Rivers: the Qiantang River in the north; the Oujian River in the south

Products: rice, wheat, corn, potatoes sugar cane, rape, sesame, peanuts, soybeans, tea, ramie, jute, silk, cocoons cotton, bamboo, tea-oil tree, Chinese tallow tree, oranges, red bayberries, walnuts, Chinese torreya, loquats, peaches, persimmons, gingko, mushrooms, dried bamboo shoots; sea products including yellow croaker, hairtail, cuttlefish, laver, kelp; alum, fluorite, salt

Specialties: Fuchunjiang shad, Jinhua ham, Longjing tea, Huyang sheep

In 2001, the transfer of water from Dongyang County to Yiwu County, Zhejiang Province was cited many times in a web-site and the success story of water saving activity in Zhangyi City, Gansu Province has been referred to many times recently (**Fig. 56**).

a Agreement

People's Daily (2001) published the spearheading water trade signed on November 24, 2000. The trade

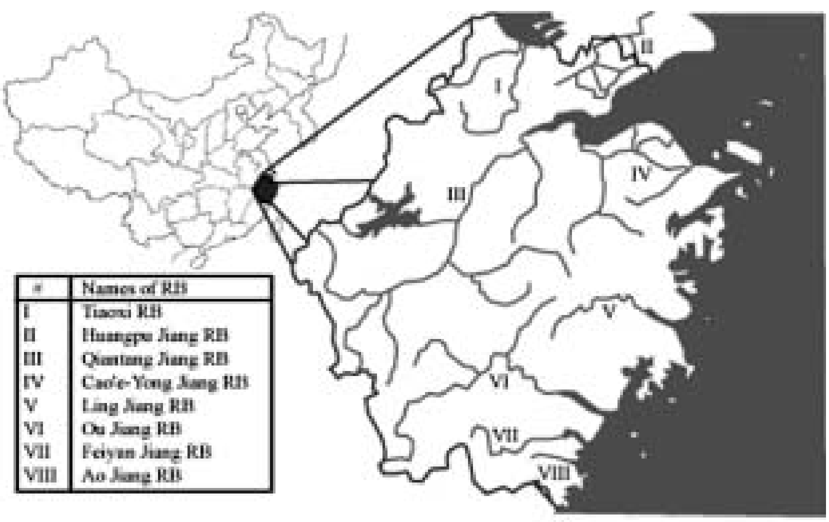

Fig. 56 Water Trading and Diversion in Zhejiang Province.

was made between Yiwu County and Dongyang County. Agreements of water trade signed between Yiwu County and Dongyang County are listed below (**Fig. 57**):

(1) Yiwu County will pay 200 million yuan annually to Dongyang County to purchase 5.0×10^7 m^3 of water resources out of the Hengjin Reservoir situated in Dongyang County.

(2) Even after the trade, property rights of the dam will not be changed. Responsibilities of management and O&M will be retained by Dongyang County. However, Yiwu County must pay Dongyang County a comprehensive management charge of 0.1 yuan/m^3 including a WRC of 0.017 yuan/m^3.

(3) Pipelines to convey the water from Dongyang County to Yiwu County must be designed and planned by Yiwu County. All procedures and construction will be implemented by Dongyang County, while Yiwu County will bare all the costs. Meanwhile, in Yiwu County, water-supplying facilities with a treating capacity of 1.5×10^5 m^3/day have been planned. The cost of construction is estimated to be about 150 million yuan. Including the construction cost of diversion-pipelines of 35 km, the overall cost of construction will be 500 million yuan and will require 17 months for completion.

b Dispute

On the other hand, China Youth (2001) has commented that Shengzhou County, contiguous to the southern boundary of Dongyang County, was upset about this trade because Dongyang County planned to intake water resources from the Zi Xi (Zi River), one of the tributaries of Changle Jiang. Changle Jiang is in a different river basin, Cao'e Jiang Basin, than Qiantang Jiang Basin, so Hengjin Reservoir will garner water resources beyond the watershed.

China Youth (2001) stated on behalf of Shengzhou County that water resources belonged to the nation and execution of possession to obtain benefits and trading of water were to be done by the nation and if water in Zi Xi was diverted, water resources in Changle Jiang would decrease in the future. Consequently, this could reduce the effectiveness of some national projects, and seriously affect irrigation projects and urban water in Shengzhou County as well as the environmental balance downstream of Cao'e Jiang river basin.

Considering the opposition made by Shengzhou County, Shaoxing City submitted a report entitled "The Project of Dongyang County Diverting Water of the Zi Xi Basin will Affect Our City," and stated, "water is a common resource for both upstream and downstream users, when planning water resource development, (a) everyone should carefully consider economic needs, social needs and needs for sustainable development." Also stated, "(b) scientific rationality, negotiations between upstream and downstream users and decision making applying the laws are indispensable and (c) no one can divert water beyond their border of administration" (China Youth, 2001).

China Water Resources (2001) pointed out the report was drafted based on the misunderstanding by Shenzhou County and stated that managing water resources practically belongs to the government or division of water resources in the area. The project was approved by the government of the upper level based

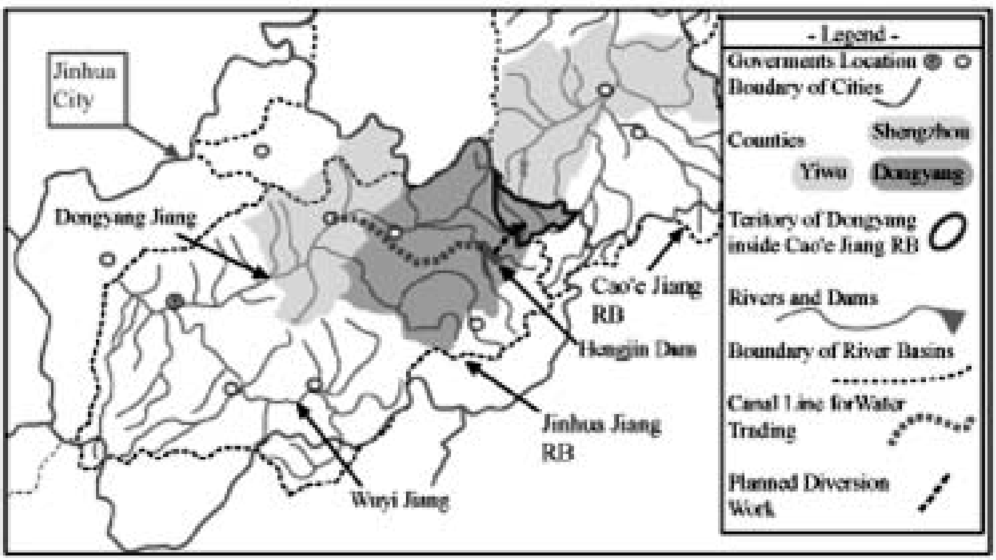

Fig. 57 Water Trading and Diversion in Zhejiang Province.

on long-term water resource management of Zi Xi and betterment of water resource allocation through a water market mechanism. After the article, no serious argument on water trade occurred.

c Standpoint of MWR

Originally, WRC was not the driving organization of the Hengjin Dam (**Fig. 58**, **Fig. 59**). However, the purposes changed or increased after finishing the project associated with water trade. Yiwu County, therefore, must pay WRC to (a) Dongyang County, (b) Jinhua City and (c) Zhejiang following article 46 of ZOEWL. At 3 levels of government, WRC will be used for evaluation, observation, protection and management of water resources.

Including the dispute mentioned above, a web site of the Water Information Network managed by MWR enlisted a number of water trade documents. As of November 6, 2001, there were 176 articles on the site and 17 were directly related to this water trade, 112 with other aspects of water trade in China and the rest introduced water laws from all over the world including China.

d Issues of water trade in China

As Fujimoto (2000) pointed out there should be water rights and they should be tradable when establishing water pricing or water market mechanisms exist. China has not yet the right conditions to start water trading. However, People's Daily (2001) cited the case between Yiwu County and Dongyang County as the first water trade in China. I believe traded water rights are re-tradable to other users. However, officers of both MWR and Zhejiang denied this idea and said that Yiwu County would not be allowed to sell water to other cities even after Yiwu County obtained the water. I believe that Zhejiang will check this water diversion periodically, and give strong suggestions to both counties for the time being. Therefore this is "water lending" rather than "water trading" (**Fig. 60**). Officers

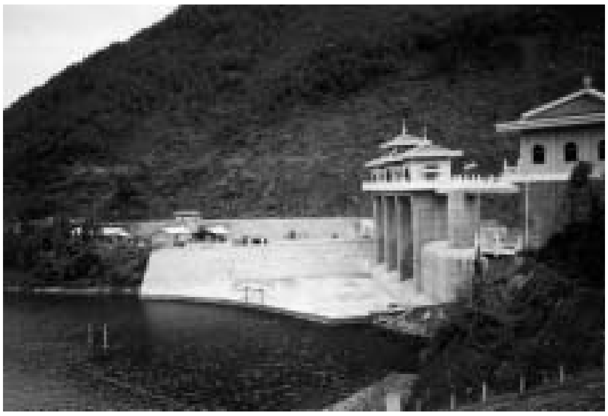

Fig. 58 The Spillway of the Hongjin Dam in Zhejiang Province Rehabilitated in 2001. (September, 2001)

Fig. 59 Three Gates and the Spillway of the Hongjin Dam Rehabilitated in 2001. (September, 2001)

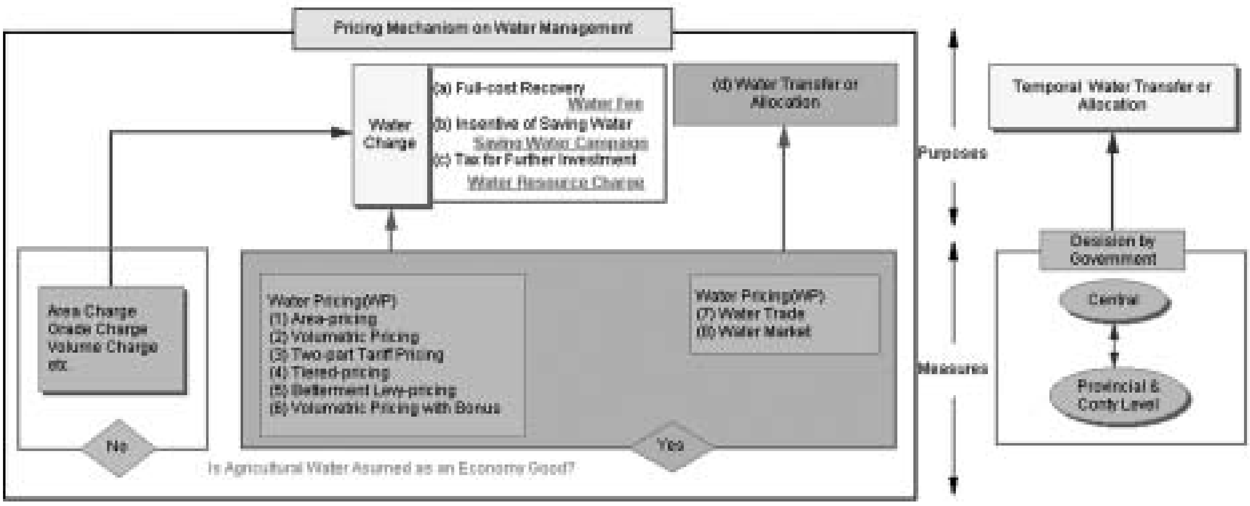

Fig. 60 Relationship between water Charge, Water Transfer (Allocation) and Water Pricing in China.

also commented that the case in Zhejiang is a test case of water trading in China and regulations, rules or even laws should be developed.

Lastly, although surplus-water is produced from rehabilitation by uplifting irrigation efficiency, mainly by reducing leakage, farmers could lose their chance to obtain sufficient water to modernize farming and increase cropping patterns.

Every question hasn't been solved yet. However, each level of the government has tried hard to lead this case to a successful goal. I think it is an effective choice of the Chinese government at a higher level to impose a new tax system ensuring the collection of PW and WRC.

I realize that MWR and the provincial department of water resources still possess power to control water trade throughout China with legal authorization by WL especially the WIL. I think Zhejiang and MWR should keep the authority to control water trade, especially in the case of water resource diversion beyond the river basin.

Also, I expect governments at a higher level to determine sustainable development both in urban and rural areas and to rapidly fine tune the regulations for water pricing mechanisms including water trade and water markets.

4 Results

(a) According to the field survey in Gansu Province situated in Zone I with a MAP of 317 mm, not only is avoiding water leakage from canals the most important policy, but also the salinity and effectiveness of water used at the field level are difficult issues to validate the results of the literature survey **III, 3, c, (4) "Saving Water-usage or Reducing Water Leakage."**

(b) Also, according to the field survey in Xingjiang Uygur AR situated in Zone I with a MAP of 270 mm, water savings as the most important policy validates the results of the literature survey **III, 3, c, (4) "Saving Water-usage or Reducing Water Leakage."**

(c) According to the field survey in Shandong Province with a population of 91 million, effective water management undertaken by using cutting-edge technology such as pre-paid IC card system validates the results of the literature survey **III, 3, c (3) "Better Management of Agricultural Water."** Also, in Jiangsu Province with a population of 74 million, complicated water management needed to ensure stable water delivery through the Water Conveyance from South to North Project validates the same results.

(d) The water transfer practiced only in Zhejiang Province, where there is a MAP of 1,700 mm and population of 47 million, was rather mentioned as tentative water lending instead of as a water trade through market mechanisms.

(e) Since water rights, water price and water market are different policies handled by other countries, the category of WRPM is mixed with different policies. On the contrast, water savings is currently the key issue to understand the policy of water related issues in China. In fact, more than 50% of the articles cited on water rights, water price, water market and water fees contained issues of water savings (**Fig. 60**).

V Conclusions

Crop production in China was clearly classified by MAP. Wheat is produced in drier areas, rice is produced in wetter areas and approximately 1,000 mm is the border for wheat and rice production. I can categorize Chinese water policy into 3 groups, (a) policies that relate to MAP, (b) policies that relate to population and (c) policies that cover all of China. However, I cannot confirm how the particular policies of each province are affected by MAP and population because of a lack of data.

Water policies in China are practically focused on several provinces according to the content of each policy, such as:

(a) The policy of land and water conservation is highlighted in areas with less water, but it can be assumed that the policy is difficult to achieve because articles on problems raised are dominant. The policy on saving water and reducing leakage is also focused in areas with less precipitation, but it isn't easy to ensure whether the policy is successful or not.

(b) It is clearer that there is a relationship between population and the policy for development and management of water resources, but it can be assumed that the policy is difficult to achieve since articles on problems raised are dominant. Although the policy on better management of agricultural water is focused in the area where MAP in between 500 mm to 1,300 mm, the policy is related more closely to population. It can be said that many effort was done on better management of agricultural water and people can obtain a fruitful result on the policy because articles on success stories are dominant. It can also be said that the policy of water fees is focused in the areas where population is higher. Since water fees in China are decided to recover a part of the initial cost of irrigation facilities that the government has already borne, the relationship between water price and water fee is keen.

(c) Concerning the relationship between the policy of WRPM, MAP and population, the following results on the policy are observed: (a) the number of articles on water rights increased with decreasing MAP; (b) there is a relationship between population and policy on water prices; and (c) there is no clear relationship between the policy on water market and MAP, nor a relationship between the policy and population. Therefore, the policy of WRPM appears to be propelled throughout China, but only the issue of water rights is focused in areas with less precipitation. It isn't easy to ensure that the policy of WRPM is successful or not. The policy of WRPM is still developing as a lot of arguments are gathering in the same arena. It can be said that the policy for avoiding contamination of agricultural water is focused in the populated areas. It can be assumed that the policy for avoiding contamination of agricultural water is difficult to achieve since articles on problems raised are dominant. I hope the policy for water contamination of agricultural water will be focused on in populated areas of China in the future.

References

1) Asian Productivity Organization (APO) (2000): Organizational change for participatory irrigation management. *Proc. APO Seminar on Organizational Change for Participatory Irrigation Management*, SEM-32-00, Manila, the Philippines, 13-15.

2) Foreign Language Press (1989): Atlas China, Beijing, China.

3) So-so Sha (2003): China Information Handbook (in Japanese), So-so Sha, Tokyo, Japan.

4) Chang C. and Griffin R.C. (1992): Water marketing as a re-allocative institution in Texas. *Water Resource Res*. 28(3), 879-890.

5) The Food and Agriculture Organization (FAO) (1999):

6) Fujimoto N. (2000): Water pricing as a method of water resources reallocation (in Japanese). *Proc. 51st Symposium of Kanto Branch of the Japanese Society of Irrigation, Drainage and Reclamation Engineering (JSIDRE)*, Takasaki, Japan, 44-46.

7) Fujimoto N. (2001): Meaning of water pricing in South-east Asia -toward an effective water use- (in Japanese). *Proc. 22nd Symposium on Global Issues*, JSIDRE, Tokyo, Japan, 51-61.

8) Fujimoto N. (2002): Multifunctional roles of agricultural water in Japan. *Proc. of Irrigation Water Policies -Micro and Macro Considerations-*, vol. 3. Committee of Irrigation Water Policies, Agadir, Morocco, 1203-1212.

9) Fujimoto N. and Kadota M. (2003a): Bypass canals for irrigation in the Yabe River basin. *Proc. 1st International Conference on Hydrology and Water Resources in Asia Pacific Region (APHW2003)*, 509-513.

10) Fujimoto N. and Tomosho T. (2003b): Water trade in Zhejiang Province, the People's Republic of China -a literature survey and field survey-. *J. of Soc. Hydrology and Water Resources (SHWR)*, 16 (3), 215-224.

11) Fujimoto N. and Tomosho T. (2003c): A viewpoint to apply water pricing to the Asian humid tropics, *Paddy and Water Environment*, 1(2), 75-83.

12) Fujimoto N., Tomosho T. and Yoshimura A. (2001): Importance of integrated irrigation management for applying water pricing mechanism in monsoon Asia (in Japanese). *J. of JSIDRE*, 69(8), 855-858.

13) Fujimoto N. and Yoshimura A. (2002): Current states of water trade in Victoria State (in Japanese). *Proc. 6th Symposium on Water Resources*, 4-4.

14) Fukui H. (1987): Ecology and technology -application style- (in Japanese), Asian History of Rice, 2nd Issue in 1997, Sho-gaku-kan, Tokyo, Japan, 277-331.

15) Hu H. and Wang Y. (2001): Issue of water right on reforming irrigation districts (in Chinese), China Water Resource News (biweekly) 18th October, 2001, Water Information Network, Beijing, China.

16) Iijima T. (2001): Price of water in China and its current situation (in Japanese), Report of the Res. No. 22, the Japanese Inst. of Irrigation and Drainage (JIID), 63-75.

17) Johansson R.C. (2000): Pricing irrigation water -a literature survey-. World Bank, Washington, DC, 46-64.

18) Kataoka N. (1995): River and water-use. Society and Law, Approach to Juridical Sociology (in Japanese). Law Culture Publication, Kyoto, Japan, 97-108.

19) Ke L. (1998): Water law and water management in China (in Chinese), Water Resource and Hydropower Publishing Company, Beijing, China, 113-116.

20) Kim J. (2001): Development of rural engineering in Korea. *J. of JSIDRE*, 69(4), 341-347.

21) Kirpich P.Z., Haman D.Z. and Styles S.W. (1999): Problems of irrigation in developing countries. *J. of Irrigation and Drainage Engineering, American Soc. of Civil Engineering*, 125(1), 1-6.

22) Loomis J.B. (1998): Estimating the public's values for in-stream flow -economic techniques and dollar values-. *J. of American Water Resources Association*, 34(5), 1007-1014.

23) Ministry of Agriculture, Forestry and Fisheries (MAFF) (1993): Planning and designing standard for land improvement project. Planning of agric. water -paddy field- (in Japanese). MAFF, Tokyo, Japan, 31-61.

24) MAFF (1998): Blessing from the heaven: water and the land for ever (in Japanese). Ko-kyo-Jjgyo Tsu-shin-sha, Tokyo, Japan, 254-255.

25) Mase T. (2001): Differences of background on paddy field farming and upland farming (in Japanese). *Proc. of 22nd Symposium on Global Issues*, JSIDRE, Tokyo, Japan, 39-50.

26) Minegishi M. and Teranishi S. (2002): Current states and assessment on agricultural water rationalization project in Saitama Prefecture (in Japanese). *Proc. 6th Symposium on Water Resources*, Tokyo, Japan, 299-304.

27) Mitsuno T. (2002): Water recycle and river flow formed by paddy irrigation in the Yasu River basin (in Japanese). *Proc. 6th Symposium on Water Resources*, 19-24.

28) Nationwide Federation of Land Improvement Districts (1999): Special report for management of LIDs (in Japanese). NFLID, Tokyo, Japan, 95-97.

29) OECD (1999a): Agricultural water pricing in OECD countries. Working party on economic and environmental policy integration. OECD, Paris, France, 15-16.

30) OECD (1999b): The price of water-trends in OECD countries. OECD, Paris, France, 69-70.

31) Okamoto M. (2002): Issues on global standards -issues on agricultural water and river management- (No. 5) (in Japanese). *J. of Japan Association of Agricultural Engineering Enterprise*, Tokyo, Japan, No.64, 16-23.

32) Perry C.J. (2002): Charging for irrigation water: the issues and options with a case study from Iran. *Proc. of Irrigation Water Policies -Micro and Macro Considerations-*, vol. 3. Committee of Irrigation Water Policies, Agadir, Morocco, 1244-1269.

33) Piper J.M. (1993): Rice in south-east Asia -cultures and landscapes-. Oxford University Press, Kuala Lumpur, Malaysia, 16-17.

34) Postel S. (1992): Last oasis -facing water scarcity-. WW Norton, New York, USA, 28-29.

35) Sato H. (2000): The current state of paddy agriculture in Japan. *Keynote speech on sustainable development of irrigation and drainage for rice paddy fields*, Japanese National Committee of ICID, Tokyo, Japan.

36) Yanotsuneta-kinenkai (2003/2004): Sekai Kokusei Zue (in Japanese), Tokyo, Japan.

37) Teramura S. (1998): Budget and current states of water boards in the Netherlands (in Japanese). *J. of JSIDRE* 66(10), 75-81.

38) Tomosho T., Fujimoto N. and Yoshimura A. (2001): Possibility of volumetric pricing on irrigation-a study of land utilities in paddy field agriculture (in Japanese). *Proc. 52nd Symposium in Kanto Branch of JSIDRE*, Tsukuba, Japan, 25-27.

39) The World Bank (WB) (1996): From vision to action in the rural sector, the World Bank, Washington DC, USA.

40) Zhou Y. and Wei B. (2002): Pricing of irrigation water in China. *Proc. of Irrigation Water Policies -Micro and Macro Considerations-*, vol. 1. Committee of Irrigation Water Policies, Agadir, Morocco, 269-293.

農業用水管理の多様性

ー中国における施策の分析ー

藤本直也

摘　要

最適な農業生産は，その地域の水資源のみで決定されるのではなく，土地・価格等の経済的要因，水利権・土地所有等の社会制度等の諸要因によって決定されているため，各国の農業用水管理は多様なものとなっている。そこで，一国の中に小麦・米等の穀物生産地域が並存し降水量の地域差が著しい中華人民共和国を例にとり，主に自然条件の違いによる水管理の多様性を分析した。

インターネットから得られた中国語情報の分析により，省政府段階での農業水利政策が以下のとおり明らかとなった。降水量 1,000 mm 程度を境に，少雨地域では小麦が，多雨地域ではコメが選択生産されていること，表土流出防止対策や節水対策は解決が容易でないこと，複雑な利害関係の中で農業用水管理が成果を収めていること，水質汚染防止対策は問題点の提起に止まっていること，水利権・水価格・水市場に関する政策は未だ発展途上であること。

現地調査からは，文献分析と整合する以下のような結果が得られた。少雨地域では水路の漏水防止等による節水対策が最重要課題であること，人口密集地域では複雑な用水管理が必要であること，現在行われている水取引は水の融通と言うべきものであること。

キーワード：中国，降水量，節水，用水管理，水価格