PROBLEM IDENTIFICATION AND NEEDS ASSESSMENT OF AGRICULTURAL WATER RESOURCE MANAGEMENT IN CHINA

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Abstract
This paper addresses agricultural water resource management in China by examining the present status of agriculture water use followed by some suggestions and key measures. China is the most populated nation in the world, therefore needs more food. It is also a nation of water shortages, in which agriculture uses the largest part of water resources. However, agricultural water use efficiency in China is amongst the lowest in the world. In this regard, the efficiency of agriculture water use is the neck to support the head of whole China. A comprehensive understanding of the status quo of water resources for agriculture is presented and the results discussed. The lack of flood prevention and safety measures, water shortages combined with extravagant use of water resources, damage to the ecosystem as a result of over-exploitation of water and land and deterioration of water bodies and worsening water pollution were found to be key problems existing in China. Networking of water use monitoring system, improving legislation system, increasing public awareness and participation, enhancing pricing mechanism, maintaining of irrigation systems and implementing water saving technologies were put forward for central government's reference in future decision making.

Additional Keywords: water shortage; water pollution; water use efficiency; water use monitoring; pricing mechanism; uneven distribution

Introduction
China is the most populated nation in the world and, therefore, needs more food to feed. The total population of the world outnumbered 6 billion in 2000 and will exceed 8 billion in 2030. The main growth of population will go to developing countries and nations in transition, i.e. 2 billion net increase from 2000 to 2030 (World Bank, 2003). The population in China amount to 1.271 billion in 2001 (World Bank 2003), about one fifth of the world total. It is estimated to outnumber 1.6 billion in 2030 and the total consumption of food will reach 700 billion kg (Research Group of China Engineering Academy, 2000).

China is also a nation of water shortage on the whole in which agriculture uses the largest part of water resources (Zhou, 2000). Although the amount of water resources is about 2,800 km^3, the sixth largest in the world, the fresh water per capita is around 2200 m^3, one fourth of the world on average and ranked 121 (Chen, 2000). Nonetheless, it unevenly distributes across vast mainland China. The average precipitation of rainfall is 648 mm with the total annual amount at 619 million m^3. But most of it falls in the southeast along the coastal areas and in parts of the southwest where an annual precipitation of above 2000 mm is common (Qian, 2001). That of the northwest inland areas, however, has less than 200 mm annually. Between these two extremes the rainfall is from 800 mm to 1600 mm annually (Wang and Luo, 2001). Furthermore, the big problem lies in the fact that there are even 55 million hm^2 of arid land without irrigation. There are 93 million hm^2 pastures facing desertification and 80 million persons and 60 million livestock having no enough water to drink, on one hand. Up to 20 million hm^2 out of the total 133 million hm^2 arable land threatened by drought on the other (Zhang, 2000). The annual water shortage for the even year is estimated totally at 35.8 km^3, among which 30 km^3 is in agriculture that causes food decreasing by 35 to 40 billion kg annually (Zhou, 2000). Even worse to the situation is the fast spreading water pollution. Half of the rivers in mainland China are polluted, among them, 40 percent are undrinkable, 33 percent even not suitable for fish and 10 percent seriously polluted (Zhang, 2000). It needs more efforts to curb the worsening trends.

However, agricultural water use efficiency in China is considerably low compared to the world average, let alone to that of the industrialized. The irrigation water use co-efficient is around 0.45 in China whilst that of developed country at 0.8 (Shi Y.L. and Lu L.S., 2001). The efficiency of agriculture water use is deemed the neck to support the head of whole China. United Nations Convention to Combat Desertification (UNCCD) has set up four thematic programme networks (TPNs) since its fostering of cooperation between countries. Some of the work here drew from the preparation materials for the TPN4, in which national needs from the network on agriculture water resources is requested to identify.

Materials and Methods

In order for collecting opinions and overall mastering the situation of agricultural water resources in China, literature, questionnaires, expert interviews, symposia and field trip investigations were used for data gathering and analysis. The questionnaires were sent by mail, fax and e-mail to some national agencies and ask them to fill out or tick appropriate one and return to us in due course. Some of them did these by organizing small meetings of experts relevant. All the questionnaires were summarized by a small group consist of postgraduates and staffs in the Beijing Forestry University and exposed to the symposium for discussion we hosted on December 18, 2001 in Beijing. After that, some distinguished experts from different stakeholders were interviewed for insights arranged by six groups made of our postgraduate students. Based on these, two following symposia sponsored to discuss the problems and specify further needs on agricultural water use and management in the future. Field trip investigations arranged spontaneously to county level samples, one in Dengkou County of Inner Mongolia Autonomous Region and another in Ji County in Shanxi Province, where water use condition and resources management were documented. Analysis of the data and materials in this paper is primarily and just in the way of qualitative method.

Problems Identified

Lots of work had been done on water resources management for agriculture as in legislation, administration, assessment and monitoring. However, some problems still exist across China generated from technology, personnel competence, and daily management as well.

Management inefficiency

A dilemma can be good expression of water condition in mainland China. The serious water shortage sprawls combined with substantial wastage of water resources in agriculture. The efficiency of water use in irrigation, the main user of agricultural water resources, is only about 45 percent, i.e. more than half of the water is wasted (Peng, 1997). The cause is the inefficient running of the water resource management system for agriculture. At the central level, no flood prevention measures have been added to the former hydraulic engineering measures. Well, the local level agencies are often frustrated by the big gap between money demand and the money available to improve water use efficiency. There are no detailed clauses to implement national laws and regulations due to either irresponsibility or geographic differences across China lead to no action activated (Ou, 2001). Nonetheless, water pricing for agriculture is somewhat difficult when faced with low-income farmers making up a vast portion of the population. The local irrigation providers have to cover half the cost in other ways than selling water to farmers. This has led to a vicious circle of the problems.

Investment inefficiency

Another dilemma lies between investment deficiency and capital waste in vary projects. Statistics show that irrigation systems in 220 zones need repairing and 111 large reservoirs are running at risk. Most of the buildings at the very beginning of irrigation systems are deteriorating. For example, among the 373 investigated buildings, 70 percent were too old to use and 16 percent were useless, 10 percent had been completely destroyed, only 4 percent worked normally (Jiang, 2001). However, 10.9 percent of the destruction is attributed to improper management or deliberate destruction. Much money has gone to new giant projects that prevailing in China while channel leakage attached to old system was ignored totally rendering about one third of the water is lost during transportation (Xiao, 2000). Capital channeled through the ministry goes enthusiastically to engineering project rather than research projects and personnel competence, which are strengthening capability of water use efficiency.

Water pollution

The average amount of wastewater discharged in mainland China is 36 billion m^3 annually, and the content of discharging harmful matter such as BOD, heavy metal etc. is increasing. There are totally 95,000 km rivers in mainland China, of which 19,000 km are polluted, including 5,000 km that are seriously polluted (Wan, 1999). Furthermore, the water body in lakes is polluted and leads to reduction in fishing, on one hand. Through the food chain, the public's health is endangered by eating polluted fish and other food, the other.

Over exploitation

Over-exploitation of underground water is deteriorating the ecosystem. In the underground water irrigation area, besides lowering the water table, empty funnels are witnessed repeatedly. There are 56 funnel areas that cover 82,000 km^2, which leads to land subsidence and even infiltration of seawater into the water table. There are now 700 subsiding zones in China, for example, 32.4 km^2 has been infiltrated by seawater in Qinhuangdao City along the Bohai Bay in north China. Breaks of water flow as well as drops of underground water table at the lower reaches of the Yellow River in central China occurred in recent years due to the over use of water at the upper reaches (Shi, 2001).

Conclusion & Suggestions

In order to meet the food needs of 1.6 billion people in 2030 and keep agriculture sustainable, reform of the water resources management system and strengthening of agricultural water resources management are seen as essential although lots have done as mentioned above. There are some key points in balancing water use at national level:

Improve legislation system

Compartmentalization is often seen leading to the abuse of or depletion of water resources in a certain area. Clearly identified or integrated legislation is, therefore, proposed as a necessity in planning water use integrally and rationally. Such a system will watch departments of water resources management, urban flood-control, water supply, sewerage, drainage, the waste water treatment and reuse of treated water function well through legislative channels. With the market economy employed into water use operation, supervision of smart water use as well as the pricing of water and its service through public hearing is urgently needed in legislative system. Coordinative arrangements are need between related Acts as such on water and soil conservation, environment protection, water pollution control and flood prevention.

Enhancing personnel competence

The staff and professionals need to be trained to fulfill their duty. The newly highlighted integrative development theory from the top leaders of the nation need to comprehend thoroughly based on professional knowledge and compound ecosystem philosophy. Obviously an interdisciplinary training should carry out as soon as possible to officials as well as the think tank of them. Multidisciplinary research should also advocate in academics relating to water resources management.

Water right recognition

Defining and recognizing of water rights is the basis of water trading in accordance with the WRA, which was revised by the China National People's Congress recently. This includes adopting regulations on water trading rights as well as defining and clarifying water rights. The water use permit system is a precondition of trading and therefore will be enhanced as expected. Water use allocation is also made upon water use permit system. This made the water allocation among stakeholders more practical and has been of use reference to other rivers that go through different administrative regions that all claims to have water rights. This is of instant help for the allocation draft of all south water diverting river project.

Improve monitoring system

Water use monitoring is essential to realize the water use rights or water trading rights. Although monitoring devices have been installed within a restricted area, some of them are now in need of repair and some inaccurate. The above mentioned communiqué based on fragile recording system. As a whole, China has the urgent need to set up the monitoring system as soon as possible and network them by installing or improving monitoring devices so as to reallocate water resources and reduce water wastage. As the nation often hit by drought and flood simultaneously due to geographic difference and climate extremes, this system is of high value to the overall state benefits.

Regulating water prices

Setting price of water resources at a certain level will be an efficient way to reduce water consumption. As water is essential to daily life and difficult to store, a modest price should be set under the direction of the local government to ensure easy access for all. Subsidies should be arranged for low income farmer for daily use. As for the agriculture production, a pricing system should be introduced in light with practical condition. Subsidies to low income should directly go to farmers themselves avoiding possible corruption at all levels. Public hearing should be the right way towards reconcile, fair and concord in water use practice.

Implementing water saving technologies

China used to use flood irrigation in the past without realizing there are other more efficient methods of irrigation. With the most serious water shortage and water pollution problems witnessed across China, water saving technologies need to be introduced instantly to update the way we thought and practiced. Otherwise, we would suffer from water shortage and food scarcity soon.

Maintaining irrigation systems

Obsolete equipment and irrigation channels leak during transporting water from one place to another lead to substantial waste of water across mainland China. Repairing and upgrading existing facilities, lining canals, and piping water could result in dramatic improvements. With the rising budget of hydraulic engineering across China, certain amount of money should go to repairing or replacing the existing irrigation systems, furthermore, integrate them into a system that can be well monitored and nursed.

Combining water conservation with vegetation
In the upper reaches of Yangtze and Yellow Rivers, there are already programs to convert arable land into forest and to ban the cutting down of natural forest, as well as small watershed management projects. A nationwide forestation campaign, like 'baby-forest' in Waitakere, New Zealand (Richard, 2002), need to be initiated as soon as possible to raise the total forest coverage and therefore nurse water resources and improve the Eco-environment. Eco-agriculture measures such as using organic fertilizers and increasing water efficiency should be emphasized in preparing land for farming.

Reconcile food production with pollution
In agricultural practice, the use of pesticide and fertilizers should be wisely and strictly controlled so as to increase the efficiency and lessen the discharge of pollutants into the environment. The reuse of disposed wastewater in agriculture irrigation should be promoted but under strict monitoring.

User awareness and participation
The public awareness of water saving and its importance to living environments should be addressed intensively via different media. To ensure that they are widely known and strictly enforced will be the foci in following stages of water resources management. A series of activities to promote the Acts and obtain support from the public should be arranged from now on. It is difficult to carry out water saving and effective water resources management without the participation of the public. Therefore, it is necessary to set up demonstration projects, in which people representing different stakeholders are actively involved. A system recommended by the World Bank is under experiment in Jiangsu, Shandong, Anhui, He'nan and Hebei provinces, in which public participation is the core has seen obvious benefits.

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