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Water Resources and Social-Economical Development in China

Zhang Wei, Liu Lin and Chen Yinghui

Information and Electrical College, China Agri. Univ No.17, Qinghua East Road, Beijing 100083, China

Problems with water resources and water supplies are found in nearly every country of the world. China is one of 13 countries that face very serious conditions in water resource shortages. Water resources must be saved, conserved and well managed, then water supplies will be sustainable. Hydro-engineering and ecosystem interactions must be considered when constructing systems for water resources. Cooperation, experiences and funds are basic aspects for water resources management.

Key words: water resources, water supply, hydro-engineering, management

1. Background of Water Resource Problems in China

In 2006, there were some very important events about "water" in Chinese social and economical development. A fearful drought took place in Chongqing City, the most important city in Southwest China, from July to September of this year. The disaster began in early July, and became more serious in late August. The city with a population of 32 million faced difficulties: shortages of water supply for more than 2/3 of the towns and villages, and more than half of the population temporarily lacking access to enough drinking water. The direct expenses of the disaster reached nearly US $800 million in two months. Chongqing is only one typical example of the drought appearing in the headlines of the media this summer. In fact, approximately 400 of 670 cities in the whole country faced more or less similar problems with water supplies (Wang, 2006). According to statistics, the nation losses are approximately US$25 billion for industries due to shortage of water supply each year. This is approximately 1.2% of the GDP for 2004.

The 5th World Water Conference held in Beijing on the 10th of September 2006 was organized by the International Water Association (IWA) and the Chinese Government. This was the first time for China, even for Asia, to organize a World Water "summit". During the conference, the Chinese super leaders expressed: great important to construct a society with characters for saving natural resources and friendly relationships with the environment. Water resources must be saved, conserved and well managed for water supplies to be sustainable. This shows us that problems with water resources management and water supplies are very critical for developing countries like China.

Problems with water resources and water supplies do not only occur in China, but also throughout the whole world. According to the World Water Resources Report published by the United Nations (UN) on March 13th of 2006, the quantity of water consumed increased 6 times in the 20th century, but during the same time period the population only doubled. At present nearly 1/5 of the world population (1.2 billion) has a secure water supply for drinking. In 2002 more than 3 million people in the world died from unclean water. Approximately 90% were children younger than 5 years of age. The report predicted that more than 2/3 of the world population will live in cities by 2030. Compared with that of 2007 with a rate of less than HALF, indicates the water demands in the cities will greatly increase. A critical problem is that the capacity of the water supplies will not be able to meet the needs for water because of limita-

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Corresponding Author: Zhang Wei, E-mail: Zhwei888@263.net

tions such as financial support. This report indicates that the key link is effective management of the water resources.

2. Basic Conditions of Water Resources in China

Generally speaking, water resources are very scarce in China when compared to other countries with vast lands and huge populations. Freshwater in China is only about 7% of the world, but must support the entire Chinese population, which is nearly 1/5 of the world population. Spatio-temporally the water resources in China are inconsequence. The following comparisons make this very clear. We chose 10 countries from 190 that have populations over 100 million, and compared several aspects of each country such as water resources and GDP. From Table 1 we see that even though the total water resources of China are $2810\times10^9\,m^3$, the third highest of the 10 countries, the water resources per person in China are only $2200\,m^3$, just 1/3 of the average level for the world. This is the 121st for the 190 countries of the world. China is one of 13 countries that face the most serious conditions in water resource shortages (Table 1) (Ren, 2006).

Another problem is that the spread of water resources is disproportionate in space. Statistics show that the north part of China has 62.2% of the land area, 41.7% of the population and 41.44% of the GDP for the whole nation every year, but only 20.11% of the water resources. Whereas, the south part of the country has 80% of the water resources, but only 37.8% of the land area, 58.3% of the population, and 58.56% of the GDP. This is especially true for the Huabei plain, which is the main political and economical district of China, with Beijing the capital of the country located in the north of the plain. Beijing has only 8.05% of the water resources, but 39.7% of the agricultural land of the whole country (Table 2) (Ma, 2006). Depending on the year and the season, large variations in rainfall and snowfall occur, so water resources are available at different times throughout the country. Monsoon weather is the main reason for these variations and source of most of the water during dry years, wet years, dry seasons and wet seasons. In the south part of China, approximately 60% of the rainfall occurs in summer from April to July. However in the north, nearly 80% to 90% of the rain is concentrated in the hot season from July to September. Large amounts of rain fall in a short time and 2/3 of the rain often forms a "flow" or causes flooding. This is a disaster for the water resources.

Table 1. Comparison of water resources in 10 countries (Ren, 2006)

Country	Population (10^8)	W-R ($10^9\,m^3$/year)	W-R (m^3/pers)
China	12.76	2800	2194
Pakistan	1.41	429.4	3045
Bengal	1.29	1357	10519
Japan	1.27	547	4307
India	1.28	2085	2044
Indonesia	1.29	2530	12048
Nigeria	1.2	280	2333
Russia	1.44	4498	31236
Brazil	1.7	6950	40882
US	2.83	2478	8756
Total	36.2	23954.4	6617

(Note: population data based on a survey of 2004)

3. Problems in Water Resources Management

During the past 30 years, the average rate of increase in the GDP has been $>8\%$ in China. It is clear that industrialization and urbanization strongly impact the social and economic development of the country and the demands for water increase very rapidly. Water consumption has increased from 103 billion m^3 in 1949 to 443.7 billion m^3 in 1980 and 554.8 billion m^3 in 2004. It is necessary to tap the underground water to irrigate farms. Agricultural production still decreases 35 million tons each year because of water shortages. Furthermore, there are more than 300 million people in the countryside that do not have enough fresh and clean water (Wang, 2006). The underground water levels are lower than before in many areas because of over pumping of water. According to some reports, the underground water is 30 m lower in Beijing than it was 40 years before. This may lead to new disasters (Fig. 1).

Water quality is also a serious problem. One reason for water pollution is the use of chemical

Table 2. Distribution of water resources, arable lands and GDP in different regions of China (Song, 2005).*

District		WR (10^{12} m^3)	Population (10^8)	WR-pp (m^3 pers^{-1})	Agri-land (10^7 hm^3)	GDP-US$ (10^{11})
whole country		2.81	12.85	2189.4	13.00	10.48
N-part	NE	0.15	1.07	1427.0	2.15	1.16
	N-1	0.17	3.35	502.5	3.63	3.19
	NW	0.22	0.93	2410.3	1.61	0.55
S-part	SE	1.28	2.50	5092.8	2.09	1.29
	SW	0.93	4.90	1891.3	3.08	5.62

(* reference 12)

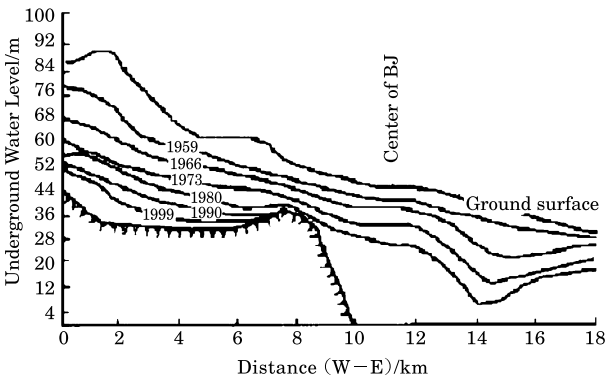

Fig. 1. Changes in underground water levels (1959～1999) (Wang, 2005).

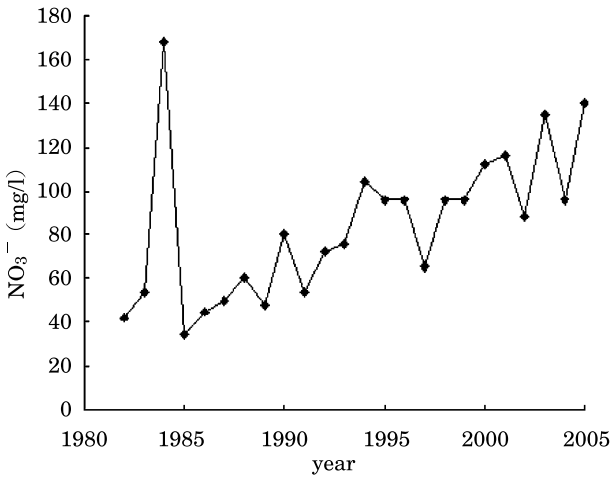

Fig. 2. NO_3^- Changes in the underground water

fertilizers in agricultural production. Chemicals such as N are often used as fertilizers and nearly half of the amount used flows into the soil with the rain water and pollutes the underground water. According to a survey of a test well in the Huabei plain, the content of NO_3^- in the underground water increased greatly and reached 233.33% during the past 25 years from 42 mg/l in 1982 to 140 mg/l in 2005. Although agricultural lands are less than before the year 2000, water pollution continues for unknown reasons (Fig. 2) (Chen, 2006).

4. Water Resource Management and Development Strategies

Water resource management is a core concern for the life of the Chinese people and development of China. Droughts and flooding have deeply impacted for a long time and Chinese people have gained abundant experiences in dealing with "water". According to historical reports, the Chinese have been fighting flooding since before the establishment of the first dynasty, "Xia", approximately 5000 years ago. During the Qin dynasty approximately 200 BC, "Du Jiangyan" Hydro-Engineering was constructed and has become well known in world history as the Great Magic Hydro-Engineering. It was evaluated as engineering that has continued for the longest time and the only irrigation engineering without a dam in world history (24th World Heritage Conference, UNESCO, Nov., 30, 2000). This system is still irrigating more than 1 million hectares of agricultural land every year in China.

"The Great Canal" is the longest manmade river in world history. The 1782 km long canal from Hangzhou to Beijing, the east part of China, is about 22 times longer than the "Panama Canal". Construction of the dam began in 486 BC, and was

finished in 1293 A.C., requiring approximately 1800 years for completion. This canal played a very important role in Chinese history as a food transfer channel from south to north. Even at the present time, "The Great Canal" is still used not only as a waterway, but also as a tourist site.

With the long history of these practices, the Chinese have achieved a lot and formed mature concepts and strategies for water resources management. The main achievements include dragging the rivers to withstand flooding; dealing with the spatio-temporal disproportionate spread of water resources through hydro-engineering, with dams and reservoirs; and forming a very important idea of "water supply sustainable" in modern times by resolving water pollution and saving water through social and economical development. Since the 1950 s, China has constructed 85 thousands reservoirs with total capacities for water supplies of approximately 500 billion m^3. In addition, more than 1 million hydro-engineering sites have been constructed. China now has water supply capacities of 580 billion m^3 per year. In the next 15 years, the country will complete some big hydro-engineering projects that may the government obtain enough water resources to serve the social and economical development of the country.

5. Discussion

1) In developing countries like China, hydro-engineering receives more attention because of fast and clear benefits. However, hydro-engineering of dams, reservoirs, water transfer buildings, etc., have a limited life span because of sand deposition and other reasons. Many hydro-engineering projects were constructed in a short time, so we must think about potential problems such as ecosystem interactions.

2) Compared with engineering for water resources management, e new concepts and experiences are more important. A "sustainable water supply" is the key link for water management through resolving water pollution and water savings. Exchange of ideas and sharing experiences do not only benefit the developing countries, but also developed countries. "Thinking first, then actions" is an important idea to remember.

3) Problems of water resources and water supplies are not only important for every country of the world, but also make all countries related with each other because rivers flow through different countries and "we only have one globe". Cooperation, experiences and funds are the basic aspects of water resources management.

4) Policies may be one of the most important factors for water resources management. Government and non-government institutions have the same responsibilities in this area because the driving power will push water resources management forward, and POLICIES will organize the people, both officials and common people earnest to resolve the problems in water resources management.

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