WATER DIVERSIONS AND CHINA'S WATER SHORTAGE CRISIS

chansheng HE

Department of Geography, Western Michigan University, Kalamazoo, Mi 49008, U.S.A.

Abstract

China's water shortage crisis has affected the daily lives of more than 39 million urban residents in over 300 of 617 large cities and caused annual financial losses of $20 billion in recent years. The Yellow River, the cradle of the Chinese civilization and the second longest river in China, has been experiencing seasonal desiccation of up to 226 days annually in its lower reaches since 1990. The Hai River basin, which contains the Cities of Beijing and Tianjin, faces a water deficit of 20 billion m^3 per year. To alleviate the water shortage crisis, China has approved the South Water Northward Diversion Projects to deliver about 50 billion m^3 of water from the Yangtze River to the water thirst north. This paper assesses the impacts of the water crisis to China's economy and environment, and discusses the feasibility of the South Water Northward Diversion Projects in alleviating China's water shortage problems. The paper suggests that China develop institutional strategies such as conservation, water pricing, and reclamation to manage the increasing water demands. Construction of large water works such as the South Water Northward Diversion Projects should be considered as the last resort in dealing with China's water shortage problems.

Key words: *water shortage, water diversion, the Yellow River, and environmental impact.*

1 CHINA'S WATER SHORTAGE CRISIS

Freshwater is a scarce resource. Worldwide more than 2 billion people use less than 50 liters per person per day (the basic water requirements defined by multiple international organizations) for drinking and sanitation services, and nearly 3 billion people lack access to adequate sanitation systems (Gleick 2000). With the increasing population and multiple demands for freshwater resources, it is estimated that by 2025 over 3.5 billion people will have water shortages (World Commission on Dams 2000).

China, the world's most populated country, is facing a water shortage crisis. Over 300 of China's 617 largest cities are facing water shortages at a rate of about 6 billion m^3 per year , affecting about 39 million urban residents daily lives (Liu and He 1996). While China ranks the 4th place in the world with respect to the total annual renewable water resources (just behind Brazil, Russia, and Canada), China's available water resources per capita (2,292 m^3/capita) is only one-third of the world average (7,176 m^3), far less than Canada's 98,462 m^3/capita and the U.S. 9,413 m^3/capita (World Resources Institute 1996). Even within China, there is the water thirsty North and the water rich South. The North of China, while supplying more than 60 percent of the nation's farmland, shares only approximately 20 percent of the nation's total water resources (Liu and He 1996), averaging only 750 m^3 per capita compared to the South's 3,400 m^3 /capita of water resources. In the North China Plain (which produces China's 40 percent of grain), overdrafting of groundwater has caused the declining of water table at a rate of more than 1.5 m per year during the past few years and the cone of depression has extended to over 23,000 km^2 (Liu and He 1996). Several large cities such as Tianjin have sunk over 1.5 m at some locations. The Hai River basin (the fourth longest river in the country), which contains the Cities of Beijing and Tianjin with a combined population of 92 million, now faces an annual water deficit of 20 billion m^3 (see Fig.1). The Huai River, located between the Yellow and Yangtze, went dry in 1997, and groundwater levels have dropped 100-300 meters in the region. The Yellow River, the cradle of Chinese civilization and the second longest river in China with a population of over 100 million people (including 7 large cities of more than 500,000 people each) has gone dry in the lower reaches 22 out of the last 28 years (Liu and Wang 2000). In 1997, desiccation occurred in the 700 km lower reaches of the Yellow River for 226 days -- the longest record in the history of the River (NEPA 1997). Along the coastline, overpumping of the groundwater has led to sea water intrusion in cities such as Dalian, Qingdao, and Yantai and several thousand of wells had to be closed (Liu and He 1996).

China's water shortages, estimated at 40 billion m^3/year, have caused the country annual financial losses of $20 billion ($24 billion in 1997), which is an equivalent of about 3 percent of China's GDP (Liu and He 1996; China Environment Series 2000). In the Yellow River basin, for example, the two downstream Provinces of Henan and Shandong suffered annual economic losses of more than $380 million for the period of 1991to 1996, and over $ 870 million (over 7 billion Yuan) in 1997 due to the desiccation of the Yellow River (NEPA 1997).

Water shortages have reduced China's grain production by 70-80 million metric tons per year (The Chinese Academy of Sciences 1997). Nationally, irrigated farmland produces more than 65 percent of China's grain and has a much higher productivity (60 to 110 percent higher) than the rainfed farmland on a per-unit basis. However, in recent years, water is diverted away from agriculture to large cities to meet the increasing municipal and industrial demands. For example, the Miyun Reservoir, located in the suburb of Beijing, used to provide 0.9 billion m^3 of water for agricultural irrigation annually, now mainly supplies water to Beijing's municipal uses, leaving only 0.1 billion m^3 of water for agriculture (Liu and He 1996). As economic returns of agricultural water uses are only a fraction of those of industries, diverting water from agriculture to municipal uses will continue. Consequently, it is uncertain if China will be able to sustain her self-sufficient food policy. If China has to import a large amount of food from the international market to meet her food demand, global food security might be impacted (Brown and Halweil 1998).

Water shortages have damaged China's environment and ecosystems. Desertification has expanded from 137, 000 to 176, 000 km^2, an increase of 28 percent since the 1950's (Liu and He 1996). The areas of freshwater lakes, rivers, and reservoirs have dropped by 18,600 km^2, and over 500 lakes have disappeared, and freshwater storage has declined by 34 billion m^3 (Li and He 1996). In the Yellow River, the seasonal desiccation has endangered 180 types of birds, 10 fish species and more than 100 wild animal species (NEPA 1997).

Water pollution has further intensified China's water scarcity situation. Most municipal wastewater in China is discharged, without treatment, to rivers and lakes. In 1993 about 10 billion m^3 of municipal wastewaters and 25 billion m^3 of industrial effluents were discharged to the rivers, lakes, and coastal waters, and less than 13 percent of those municipal wastewaters received some types of treatment (Liu and He 1996; China Environment Series 2000). In Beijing, less than 5 percent of its 1.1 billion m^3 of municipal wastewaters were treated in 1990 (Liu and He 1996). In Shanghai, about 4.5 million metric tons of raw wastewaters are discharged into coastal waters daily. Those untreated wastewaters have severely polluted the receiving waters. A 1995 survey reports that more than one-third of all rivers and over 90 percent of rivers surrounding urban areas and half of the groundwater in China were polluted (Liu and He 1996; China Environment Series 2000). Nationwide, only about 32 percent of the rivers meet Grades I and II (suitable for drinking) of the water quality standard. In the South, water pollution has cost Guangdong Province economic losses of more than $3 billion (26 billion yuan) each year, and made 86 percent of the province's water sources undrinkable in 1999 (CND 2001). In the Yellow River, the increased effluent discharge and reduced river flow have resulted in frequent violations of drinking water quality standard in municipal water supply systems such as those of Xinxiang and Zhengzhou Cities of Henan Province and caused fish kills in several main tributaries such as Wei, Fen, and Huangshui Rivers, etc (NEPA 1997).

2 WATER DIVERSION PROJECTS

Traditionally, Chinese have relied on development of large water works to meet the increasing water demands and built some of the world's largest water diversion projects. For example, the well-known Grand Canal, a 1,783 km canal linking Beijing and Hangzhou for transportation, was started in 456 B.C. and completed in 1239 A.D. The famous Dujiang Dam, built in 256 B.C. for diverting water from the Mian River, a tributary of the Yangtze River to irrigate 0.2 million ha farmland in Sichuan, is still functioning well today. Since the 1950s, over 300 major dams have been built in China. In recent years, seven major diversion projects have been completed to supply water to municipal and industrial uses. For example, the Lian River Diversion Project, diverting about 2 billion m^3 of water from the Lian River, via 286 km of pipelines and channels, to the Cities of Beijing, Tianjin, and Tangshan; the Yellow River to Tianjin Diversion Project, delivering 1 billion m^3 of water over a 580 km open channel to Tianjin; and the Yellow River to Qingdao Diversion Project, transferring about 0.7 billion m^3 of water 262 km to the City of Qingdao in Shandong (Liu and He 1996; People's Daily 2000). Currently, 10 major diversion projects are being planned in the North China Plain, Northwest, Northeast, Southeast, and Southwest to address the chronic water shortage problems in China. The largest of the 10 diversion projects is the recently approved South Water Northward Diversion Projects, transferring water from the Yangtze River to the North China Plain and the Yellow River via three routes: East Route, Central Route, and West Route (Fig.1). Each of the three Routes is briefly described below.

2.1 The East Route.

This diversion project proposes to withdrawal about 9 billion m^3 of water from the lower reaches of the Yangtze River, and pump the water to 65 m high and deliver it 1,150 km northward by artificial channels to the North China Plain (6 billion m^3 of water) and further to the City of Tianjin (nearly 3 billion m^3 of water). As it will utilize the existing Grand Canal for water delivery, its overall construction costs are relatively low. But the low elevation of the delivery

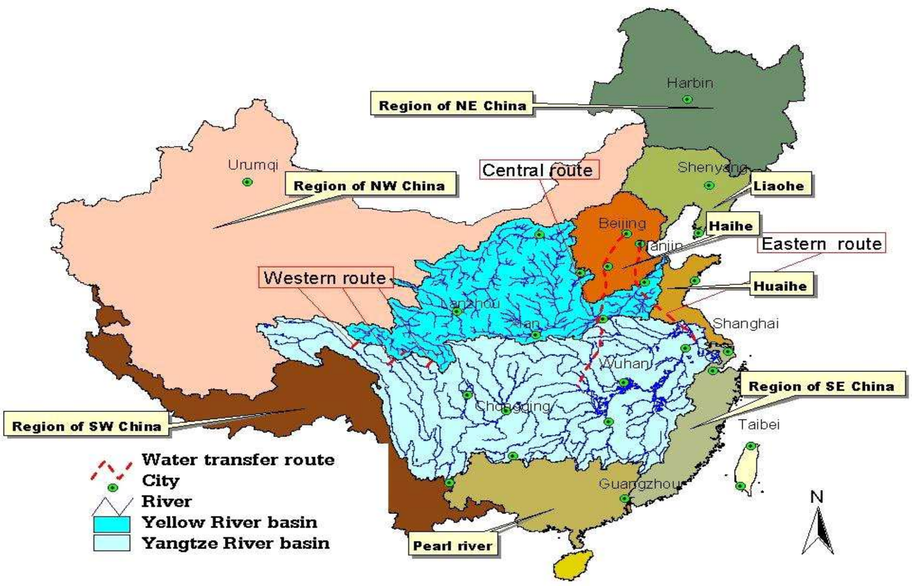

Figure 1. Major river basins of China

channels subjects the water transfer to industrial and agricultural pollution, particularly nonpoint source pollution along the route. If maintained improperly, this project might be delivering polluted water northward (Liu and He 1996).

2.2 The Central Route.

This project will divert 23 billion m^3 of water annually from the Three Gorges Dam of the Yangtze River to the North China Plain and further northward to the Cities of Beijing and Tianjin. The first phase of the project is to divert 15 billion m^3 of water annually from the Han River, a tributary of the Yangtze River, to Beijing over 1,240 km of underground pipelines. It is less vulnerable to pollution and its maintenance cost is relatively low. But its construction costs are high as large pipelines have to be constructed along the transfer route (Liu and He 1996).

2.3 The West Route.

This project will build about 400 km channels to divert 20 billion m^3 of water annually from the sources of the Yangtze River to the sources of the Yellow River. It requires construction of dams of up to 200 m high and 200 km channels in high elevation of Qinghai-Tibet Plateau under the extreme climate and will have to overcome many engineering and technical difficulties. But the length of the whole delivery system is much shorter. The proposed project will also promote the economic development of the western China (Liu and He 1996; He 1998).

The Ministry of Water Resources has started preparation for the planning and design of the South Water Northward Diversion Projects. The proposed projects, once implemented, are estimated to provide about 40-50 billion $m^3$of water annually to the water-thirst north, alleviating the water shortage problems in 16 large cities including Beijing and Tianjin. The economic benefit from the diversion is projected to be around $40 billion annually. In addition, the projects will stimulate the economic development in 12 adjacent provinces. The overdrafting of groundwater in the North China Plain will be gradually controlled and the water shortage in the lower reaches of the Yellow River can also be alleviated (Liu and He 1996).

However, the projects cross four major river basins (the Yangtze River, Yellow River, Hui River, and Hai River), divert water from the Yangtze River up to 1,200 km away, involve jurisdictions of 12 provinces, and will certainly encounter many technical, institutional and economic challenges. The three projects are designed to deliver about 50 billion m^3 of water via the three routes to the North. Considering the delivery and evaporation losses, the storage capacity of the dams will have to be much larger than the delivery requirements of 50 billion m^3. With the magnitude similar to the Three Gorges Project (designed storage capacity: 40 billion m^3), the projects will have major impacts on China's environment and ecosystems. Such impacts include loss of primary farmland, displacement of residents, depletion of habitat, alteration of river basin hydrology, and modification of ecosystems, etc. These issues have yet to be investigated. Moreover,. will the estimated 50 billion m^3 of water to be transferred annually be adequate to meet the increasing demands of the thirsty North? The answer is probably no. In the Hai River basin alone, annual water deficit is reported to be 20 billion m^3. In the Yellow River basin, agricultural irrigation withdraws more than 30-40 billion m^3 of water every year. With the call for development of the western China, more and more industries and businesses are likely to develop in the upper and middle reaches of the Yellow River, thus generating a greater demand for water and leaving less water for the lower reaches. In addition, the project, particularly the East and Central Routes, will have to supply local water demands along the way and the amount of water reaching the North China Plain and the Yellow River is likely to be much less than the expected 50 billion m^3 annually. In addition, the financial costs of the projects will be huge, and it is uncertain if China is able to carry out such projects before the completion of the Three Gorges Project in 2009.

In the international arena, the era of construction of large water development works for water supply is long gone. Many countries now focus on nonstructural approaches such as water pricing, conservation and effective use of water resources to meet the increasing water demands. A few countries such as France and the U.S. have started to remove some most damaging dams to restore pathways and habitat for fisheries and wildlife (Gleick 2001). In the U.S. alone, approximately 500 unsafe or environmentally damaging dams have been removed in recent years (Gleick 2001). China needs to consider all options, particularly nonstructural ones such as water pricing and conservation, water valuation, and land use planning to address her water shortage problems as there is still large room for improvement in China's water resource management . For example, China's current water price ($0.001-0.01/m^3) and the water use efficiency are very low (Liu and He 1996; NEPA 1997). China uses 23 to 56 m^3 of water to produce a ton of steel while the U.S. only needs less than 6 m^3 of water (Brown and Halweil 1998). Currently, China's water re-use rate is less than 50 percent. If water re-use rate is increased from the current 50 to 75 percent, China's industry alone can save 13.5 billion m^3 of water annually (Liu and He 1996). In the agricultural sector, adoption of water conservation technology such as irrigation scheduling, drip irrigation, and lining irrigation canal can save about 100 billion m^3 of water per year (Liu and He 1996). Alternatively, importing 20 million tons of grain would save 20 billion m^3 of water for China (China Environment Series 1998). Therefore, China should develop institutional strategies to focus on demand management and water conservation in addressing her water shortage crisis. Dependence on construction of large water works for water supply such as the South Water Northward Diversion Projects should be considered as the last resort for water supply as such projects are expensive, capital-intensive, long construction cycle, and environmentally risky.

3 REFERENCES

Brown, L.R. and B. Halweil. 1998. China's Water Shortage Could Shake World Food Security. World Watch, Vol.11 (4):10-21.

China Environment Series. 1998. An Overview of Chinese Water Issues. Issue 2. The Woodrow Wilson Center, Washington, DC. pp.46-57.

2000. Conservation and Pollution of Water Resources in China. Issue 3. The Woodrow Wilson Center, Washington, DC. pp.58-60.

The Chinese Academy of Sciences. 1997. Long term food supply capability in China- issues and countermeasures. Institute of Geography, Beijing, China.

China News Digest. 2001. [CND, 02/04/01] Pollution Puts Guangdong in Water Crisis. Feb. 4. http://www.cnd.org.

Gleick, P.H. 2001. Making every drop count. Scientific American Feb.2001, p.41-45.

Gleick, P.H. 2000. The World's Water 2000-2001. The Biennial Report on Freshwater Resources. Island Press, Washington D.C. p.1-13.

He, Guang-Hua. 1998. Water Transfer from the Yangtze River to the Yellow River. People's Daily (Overseas Edition), May 15, p.10.

Liu, Changming and Xiqin Wang, 2000. A Remarkable Event of Human Impacts on the Ecosystems: The Lower Yellow River Drained Dry. Symposia Proc. Of Human Impacts on Ecosystems and Natural Impacts on Human Systems, 29th International Geographical Congress, Seoul, Korea, Aug.14-18 .

Liu, Changming and Xiwu He. 1996. China's water resources issues in the 21st century. Science and Technology Press, Beijing. 199 pp.

National Environmental Protection Administration. 1997. Streamflow Depletion and the Sustainable Development of the Yellow River. Proc. of the Symposium of the Ecological Impacts of the Streamflow Depletion and Management of the Yellow River. China Environmental Science Publishing House, Beijing. 264 pp.

People's Daily (Overseas Edition). 2000. The Yellow River to Tianjin Diversion Project Started Delivering Water. Oct. 16. p.1.

World Commission on Dams. 2000. Dams and Development. Earthscan Publications Ltd., London. p.1-10.

World Resources Institute. 1996. World Resources 1996-97. Oxford University Press, New York, p 306-309.