

SOUTH-TO-NORTH WATER DIVERSION PROJECT IN CHINA

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The South-to-North Water Diversion Project in China is the largest water project of its kind ever undertaken in the world. It was proposed in 1952 and the main construction was started in 2002 after 50 years of baseline inventorying and study. The project is expected to be completed in 2050 with a total investment of approximately 486 billion yuans (1 dollar = 8 yuans in 2002). The South-to-North Water Diversion Project will not only relieve the severe water shortage in northern China, but, more importantly, it will efficiently manage water resources by establishing a strategic water distribution and security network for the Yangtze River, Yellow River, Huai River, and Hai River. The project consists of three routes - the Western Route, the Middle Route, and the Eastern Route - diverting water from upstream, mid-stream, and downstream of the Yangtze River, respectively. The total water to be transferred in the project is expected to be nearly 44.8 billion m³ annually by 2050, with 17.0 billion m³, 13.0 billion m³, and 14.8 billion m³ of water transferred by the Western Route, the Middle Route, and the Eastern Route, respectively.

This paper on the South-to-North Project consists of a background explanation of why China needs this water project; a section on how the Three Route Project will be constructed; the expected social, economical, and ecology benefits; and existing and potential future impacts of the project on ecology and the environment.

BACKGROUND

The large population in China (about 1.3 billion people in 2002) is unevenly distributed, with a high density of people in eastern China and a low density in western China. The spatial distribution of water resource is also uneven, with higher resources in the south and east than in the north and west. The current distribution of water resources is not

compatible with the distribution of the population and agricultural, industrial, and social development. The level of water shortage in China in 2000, representing the water resource, social and economical development, water supply, water demand, water shortage and water quality, indicates sufficient water resources in southern China but a deficiency of water resources in northern China (Figure 1). The shortage of water resources in northern China will only get worse with the anticipated social and economical development. The South to North Water Diversion Project is expected to relieve this problem.

THREE ROUTE PROJECT

Since beginning to consider the feasibility of implementing the South-to-North Water Diversion Project in early 1950s, more than 150 alternative layouts for the project had been proposed, with the Three Route Project ultimately chosen for implementation. The Three Route Project (Figure 2), including the Western Route Project, the Middle Route Project, and the Eastern Route Project, will divert water from upstream, mid-stream, and downstream of the Yangtze River, respectively, to connect the four major rivers - the Yangtze River, Yellow River, Huai River, and Hai River - into a national water resource network.

Eastern Route Project

Construction of the Eastern Route Project started in December 2002 and is planned for completion in 2016, with a total investment of 65 billion yuans. The Eastern Route Project will divert water from a downstream branch of the Yangtze River to the eastern Huang-Huai-Hai Plain, with the termination in the Tianjin Municipality via the existing Beijing-Hangzhou Grand Canal, which is the oldest and longest canal in the world. The Eastern Route Project is expected to relieve water shortages in the Tianjin Municipality, the Heilonggang Yundong regions in the Hebei

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Figure 1. Distribution of the water shortage index in China in 2000. (Source: <http://sdinfo.chinawater.net.cn/waterresources/ww007.jpg>)

province, and the north and southwest part of Jiaodong Peninsula of Shandong Province. As already stated, it will divert water from the Yangtze River, which normally has mean annual water flow of 960 billion m^3 entering the Eastern Sea and more than 760 billion m^3 of water flow in extremely dry years. The length of the completed water-course will be about 1,560 km from the Yangtze River to the Tianjin Municipality. The Eastern Route Project involves establishing 13 pumping stations south of the Yellow River where the water will then flow to the Tianjin Municipality by gravity. The Eastern Route Project also involves the construction of a nearly 9 km tunnel beneath Yellow River. When completed, the Eastern Route Project is expected to divert approximately 14.8 billion m^3 of water per year.

Middle Route Project

The Middle Route Project was started in December 2003 and its completion is expected in 2050, with a total investment of 117 billion yuans. The Middle Route Project will divert water from the Danjiangkou Reservoir on Han River to the Beijing Municipality in the short-run. In the long-run, the Middle Route Project will divert water from the Three Gorges Reservoir or downstream of the dam on the main branch of the Yangtze River to the Beijing Municipality, the Tianjing Municipality, and the provinces of Hebei, Henan, and Hubei. The main advantage of this project is that water will flow by the forces of gravity. Two key components of the construction effort for this project are heightening the Danjiangkou Reservoir dam from 97 to 170 m and building two tunnels of 8.5 m in internal



Figure 2. Layout of the Three Route Project of South-to-North Water Diversion. (Source: http://www.water-technology.net/projects/south_north/south_north1.html)

diameter and about 7 km long with a planned flow capacity of 500 m³/s. After the completion of the Danjiangkou Reservoir, the mean annually transferred water will be increased from 12.0 to 14.0 billion m³ in normal years and 6.2 billion m³ in dry years. Another benefit of Danjiangkou Dam Extension Project is that it will increase the level of flood control in the middle and lower Han River and enhance the safety of Wuhan City and the plain to the north of the Han River. The diversion route of the Middle Route Project will be about 1,274 km in length, starting at the head of the Taocha canal and terminating at the Yuyuan Pool in Beijing. The Middle Route Project will supply water to Beijing for the 2008 Olympic Games. The transferred water is temporarily from reservoirs in the Hebei province, with an annual flow rate of 0.4 billion m³.

Western Route Project

The Western Route Project is expected to start in 2010, with the investment of 300 billion yuans, an amount accounting for 60% of total investment for the South-to-North Water Diversion Project. The Western Route Project is expected to relieve the water shortage in the north and northwest of China.

It will divert water from the upper reach of the Yangtze River to Yellow River. The Western Route Project is planned to transfer 20 billion m³ of water annually from three tributaries of the Yangtze River, including 10 billion m³ from the Tongtong River in the upper reach of Yangtze River, 5 billion m³ from the Yalong River, and 5 billion m³ from the Dadu River. Two main parts of the construction effort for the West Route Project are building a dam with a height more than 200 m and digging a tunnel through the Bayangela Mountain with the length of more than 100 km. This project will necessitate overcoming major engineering and climatic challenges because it is situated on the Qinghai-Tibet Plateau where the elevation is between 3,000 and 5,000 m and is characterized by complicated geological structures, extremely low temperatures, and frequent and severe earthquakes up to 8 to 9 degrees on Richter scale in some areas.

BENEFITS

The South-to-North Water Diversion Project will eventually divert about 38 to 48 billion m³ of water per year. It is expected to have important social, economic and environmental benefits for the

Huang-Huai-Hai District by alleviating the existing water shortage, promoting socio-economic development, and improving living conditions for the nearly 300 million residents of urban and rural areas. Some of these benefits are discussed below.

Social Benefits

The South-to-North Water Diversion Project will have social benefits to the water district. For example, Beijing, the capital of China, is the nation's center of political, cultural, financial and diplomatic activities. Tianjin is the largest industrial base in northern China and, additionally, an important trade port. The western and northwest region is the country's base of energy resources, raw materials, and heavy chemical industries. The South-to-North Project will ease the competition for water between geographic regions and between the agricultural and industrial sectors. It will also reduce or relieve regional health problems such as fluoride bone and thyroid problems due to drinking contaminated deep groundwater.

Economical Benefits

It is planned that 40% of 17 billion m³ of water transferred by the Eastern Route Project will be allocated to urban and industrial uses and 60% to rural and agricultural uses. About 65% of 13 billion m³ of water transferred by the Middle Route Project will help to satisfy urban and industrial needs and 35% will be made available to rural and agricultural uses. One-half of the 14.8 billion m³ of water to be transferred by the Western Route Project will go to urban and industrial uses and 50% to the rural and agricultural sectors. Based on recognized criteria for agricultural and industrial outputs and the current price level, the average annual economic benefit from the South-to-North Diversion Project will be approximately 60 to 80 billion yuans. Importantly, it is also expected that the financial inputs and outputs for this project will come into balance in less than 10 years.

Ecological and Environmental Benefits

The transferred water will increase the supply of water to people and the industrial sector, improve sanitation, and enhance the vegetative cover in urban

areas. The project will also increase the water supply to agriculture and livestock purposes, adjust the agricultural crop components to improve efficiency, and increase the overall level of agricultural production. The diverted clean water will replace sewage water for agricultural irrigation purposes and, in doing so, reduce pollution of agricultural lands and improve the quality of agricultural production. The increasing availability of clean water will also reduce excessive extraction of groundwater and, as a consequence, alleviate the problem of declining aquifers. By reasonable water distribution, it will be possible to recharge dry wetlands, creeks, and streams, which will likely increase the ability of self-dilution and self-cleaning of water resources and promote the development of aquatic biological resources.

ECOLOGICAL AND ENVIRONMENTAL IMPACTS

As the largest water project in the world, the South-to-North Water Diversion Project certainly has existing problems and could have problems in the future such as financial, technical, and mechanical problems and, as discussed here, ecological and environmental problems. Poor water quality for the Eastern Route Project, severe soil erosion for the Middle Route Project, and feasibility and reliability for Western Route Project are among the most crucial of these possible problems.

Eastern Route Transfer Project

The main problem with the Eastern Route Project is the poor quality in the water output district. The project uses the Beijing-Hangzhou Grand Canal and other natural rivers and lakes as its watercourse. Main sources of pollution at this time are the point-discharges of sewage pollution from living and industry; surface discharges of water containing chemical fertilizers and pesticides that are applied widely on agricultural lands around the Huai River, the Yellow River, and the Hai River; the high sediment concentrations resulting from the movement of large sediment deposits within the transferred water; and pollution resulting from the heavy traffic of shipping that takes place on the Beijing-Hangzhou Grand Canal. Water pollution

control and its treatment will be the first step to insuring that the diverted water meets established quality standards. Planned pollution control projects include building urban sewage treatment system, industrial sewer diversion, adjustment of the industrial structure, and comprehensive management of industrial and watershed treatment.

Middle Route Project

The major problem for this project is that the ecological environment is deteriorating. The mountain areas with steep slopes and a high level of ecosystem fragmentation are prone to severe soil erosion. Another concern for the Middle Route Project is that the quality of water is getting progressively worse due to the increasing discharges of living and industrial wastewater into the Han River and Dan River. Treatment of soil erosion and wastewater, therefore, will be the highest priority in diverting clear water to the north.

Western Route Project

The Western Route Project will divert water from the upstream of the Yangtze River to the Yellow River. It is located on the eastern Qinghai-Tibet Plateau, with elevations of 3,000 to 5,000 m. There is inherently a high diversity of geomorphology and rich natural resources in the project area. Fortunately, the change of water flow should not have significantly adverse impacts on the biological stock of the region that relies mainly on precipitation inputs for survival. Although construction on the project will begin in 2010, its feasibility and reliability is still debated, since it is both an inter-basin water transfer project and a large-scale ecological and environmental project. Current arguments are centered around the main issues that building the high dam could trigger the

occurrence of higher degrees of earthquakes in this area; constructing a tunnel of a 100 km length and a dam with a height of 200 m is a technical and mechanical challenge considering the geomorphology characteristics in this mountain area; and a recognition that the natural ecological system is fragile, and, as a consequence, the ability of the ecosystem to sustain itself is unknown after the massive of grassland and agricultural lands are destroyed. And finally, the Tibetans living in this area of the project worship at highly regarded temples; the high mountains of the region have special meaning to the people; and the natural waters of the area have a great value. Of particular note, relocation and rebuilding of the temples is another large problem.

CONCLUDING COMMENT

Taking 50 years from conception to commencement, the South-to-North Water Diversion Project is expected to require another 50 years to complete its construction. After it is completed in 2050, at a total investment of 486 billion yuans, this large project will eventually transfer 44.8 billion m³ of critically needed water per year to benefit the growing population centers of the drier regions of northern China. It is indeed at unique undertaking.

REFERENCES

- Information for this paper was obtained from the following Chinese government Web sites:
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