China Is Completing the Greatest Water Project in World History

by Mary Burdman

China, the world's most populous nation, is rapidly completing the first two man-made rivers of what will be the greatest water project ever built by mankind—the South-North Water Diversion project (SNWD). With 1.35 billion people, China has about 21% of the world's population, but just 6% of the freshwater and only 9% of its arable land—meaning that water available per person is just above 25% of the world average. This disparity shows what a huge challenge China faces, as it stays committed to feeding itself, while rapidly expanding energy supply and industrial production as it shifts from being a rural to an urbanized country. Nothing like this has been done before in China's 5,000 years of history—or in the history of the world.

The government-funded SNWD project will transfer water along three waterways from the water-rich Yangtze River basin to the Yellow River basin in the north. This continent-size nation has large, but very unevenly distributed water resources. The great North China Plain is the national grain belt; the huge cities here, including the capital of Beijing with its 20 million people, are expanding rapidly, and the area is also an industrial center. But there is not enough water. As one of the world's leading water scientists, Prof. Xia Jun, emphasized at the Stockholm World Water Week in August, "The ability to move water around is essential, to distribute the water more evenly." Lack of water is putting serious constraints on China's economic growth, and the SNWD project will end that, at least for immediate period.

Such projects are essential on other continents, and other nations or groups of nations have proposed great projects that would divert essential water supplies across watersheds on a national or continental scale, but China is the only nation actually building one which will affect its national water supply.

• In Russia, the Siberian-Aral Canal, to divert some 7% of the waters of the Siberian Ob and Irtysh rivers south and west to the arid nations of Central Asia and to revive the almost-destroyed Aral Sea, had first been proposed over a century ago, and was fully researched and designed by the Soviet Union in the 1970s and 1980s. Preparations were well underway when the project was halted in August 1986; the reasons cited were cost and environmental concerns.

• In the United States, the North America Water and Power Alliance, a project which would bring a small portion of the vast water resources of Alaska and Northwestern Canada south, to the fertile but relatively dry Prairie Provinces, the dry southwestern states, and even as far as northern Mexico, was issued by Parsons Engineering in 1964, but it was never implemented. The LaRouche Political Action Committee is leading a campaign to build NAWAPA XXI, to greatly expand agricultural production and create millions of jobs.

• And in Africa, the TransAqua project has been on the drawing boards since the 1970s. It is a plan to divert waters of the mighty Congo River northward to the parched Chad basin and the central Sahel Desert. More vital today than ever before, it is not being built.

But China is addressing its water crisis on the massive scale required.

Redrawing the Map of a Nation

At the beginning of 2012, as Beijing put construction of the SNWD's Central Route waterway into high gear, Cheng Xiaotao, deputy chief engineer at the China Institute of Water Resources and Hydropower Research, stated succinctly why the project has such priority: "China's population has increased by 700 or 800 million in the past few decades, and people have also been flowing into the cities with unprecedented speed. Urban industry is also rapidly expanding. This is something no other country has experienced. The water those people need just isn't available locally."

China has a very complex water situation. The great North China Plain—the largest in Asia, created by the silt from the Yellow River—and the Yangtze River valley have been densely populated and cultivated for over 3,000 years. China's population has grown by 2.5 times in the past 60 years, while the nation has main-

FIGURE 1
Watering the North

Sources: Chinese Ministry of Water Resources; futuretimeline.net; Will Fox

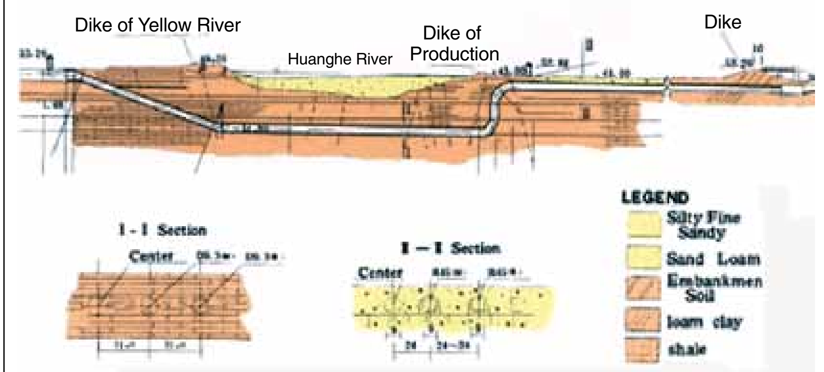
tained its commitment to food self-sufficiency, requiring a constant increase in agricultural production, but remaining dependent on imports. The population of the two river basins is about 800 million—over two and a half times that of the entire United States.

Building the SNWD project is an even greater challenge than the now-completed construction of the Three Gorges Dam. After some four decades of discussion and study about whether and how to build this project, which was first proposed by Mao Zedong in 1958, it will start delivering water in the coming two years. Two new, man-designed rivers will bring water from the Changjiang (Yangtze) River—the third longest river in the world, after the Amazon and Congo—to northern China. After severe drought at the end of the 1990s and depletion of the waters of the Huang He (Yellow) River, the SNWD project was finally put on the front burner in 2001. It is one of four national projects designed to redraw China's economic division map, by strategically restructuring national water resources. Construction began in late 2002; by 2009, the government began to really step up investment.

Agriculture uses 75% of China's water, close to the world average; usage has increased more than fivefold since 1949. Rapid industrial growth is increasing demand for water, especially for energy generation; and urbanization and rising living standards mean increased domestic use of water. Beyond all this, insufficiently advanced technologies, industries, and infrastructure, have all caused both inefficient use of water supplies and severe pollution of China's waterways, especially in the East.

The SNWD project will use three routes (see *boxes*) to divert 5-7% of the water from the Yangtze River basin—which has a mean annual flow of 1,050 billion cubic meters (m^3), and more than 600 billion m^3 even in extremely dry years—to the arid North China plain. When finished, the SNWD will carry some 44.8 billion

The Eastern Route (ERP), when completed, will transport 14.8 billion m^3 of water some 1,467 km north to Shandong and Hebei provinces and the northeast port city of Tianjin. Water will be taken from the lower Yangtze River at two sites, pumped by the Jiangdu pumping station, using the ancient Beijing-Hangzhou Grand Canal—which was built starting 2,500 years ago—as the trunk route to connect regional rivers. The water will be pumped up some 65 meters, to the level of the Huanghe (Yellow) River, in about 15 stages.



Sketch map showing the Huanghe River-Crossing tunnel of ERP

http://www.nsbd.gov.cn/zx/english/english.htm

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In January this year, engineers completed a huge double tunnel beneath the Yellow River (see photo). In its lowest reaches, the Yellow River flows between high dikes, at least 10 meters above ground level. The tunnels, called the "throat" of the Eastern Route, are 585 m long, 9 m in diameter and up to 70 m deep.

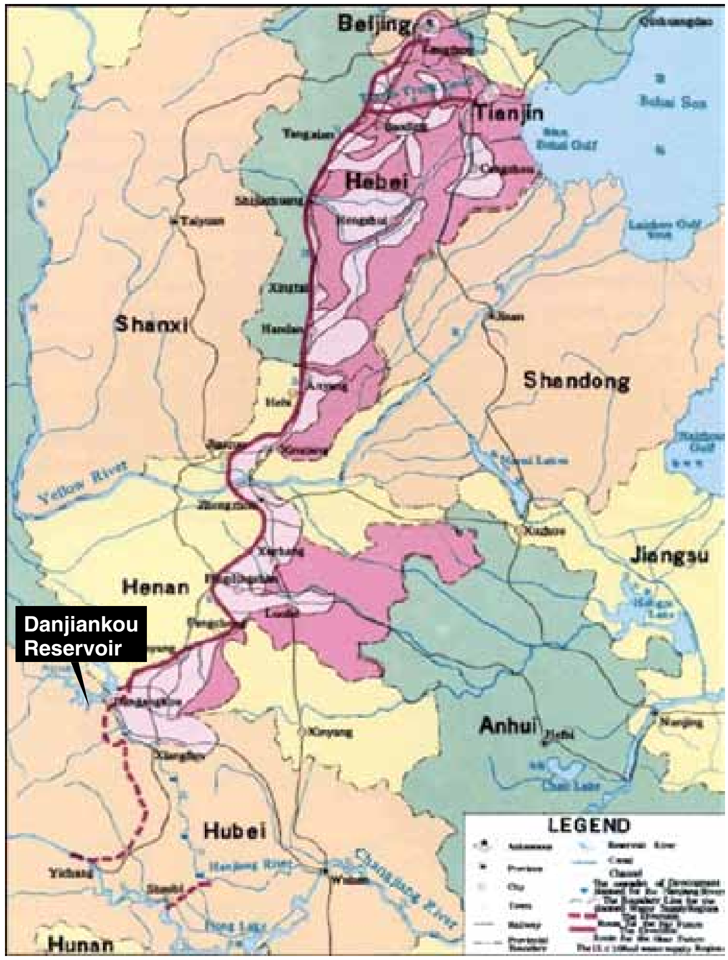
m³ of water a year, more than the average flow of the U.S. Missouri River, which is over 30 billion m³ a year. The project will link China's two greatest rivers, the Yangtze and the Yellow, with the Haihe and Huaihe rivers in the North.

By the beginning of 2012, already some 140 billion yuan (about $22 billion) had been spent for this government-funded project; another 64 billion yuan ($10 billion) will be spent this year, which E Jingping, director of the central government's South-North Water Trans-

The Central Route (MRP), 1,432 km long, will take water from the greatly expanded reservoir at the Danjiang River, at the mouth of the Yangtze tributary Hanjiang in Hubei province; the water will flow downhill from there via an entirely man-made series of canals and tunnels, to the cities Beijing, Tianjin, Shijiazhuang, and Zhengzhou. It will also supply regional irrigation and industry, starting in 2014. In addition to the Danjiankou reservoir supply, in the future water could also be taken from the Three Gorges Dam reservoir, to the south. This man-made waterway will eventually convey 12.0-14.0 billion m3 of water a year; even in dry years, the Central Route will supply 6.2 billion m3 of water. The purpose is not only to supply drinking water—water quality is better in the upper Yangtze basin—but also, during flood periods, actually replenish the heavily exploited groundwater underneath Beijing.

The reservoir's water level had to be raised to 177 m to let the water flow north; construction forced relocation of 330,000 people. (That many had already been relocated when the original dam was built in the 1960s and 1970s.) The water then flows across the valleys of the Yangtze, Huaihe, Huanghe (Yellow), and Haihe rivers.

The water passes under the Yellow River through huge tunnels, which were dug for the Central Route in 2010. These twin tunnels are 3.4 km long and more than 35 m beneath the Yellow River at Mangshan in Henan province. These tunnels have a maximum flow capacity of 320 m3 per second each. The tunnels were built to prevent the freshwater from being polluted by the Yellow River, although water could also be sent into the Yellow River channel if required.



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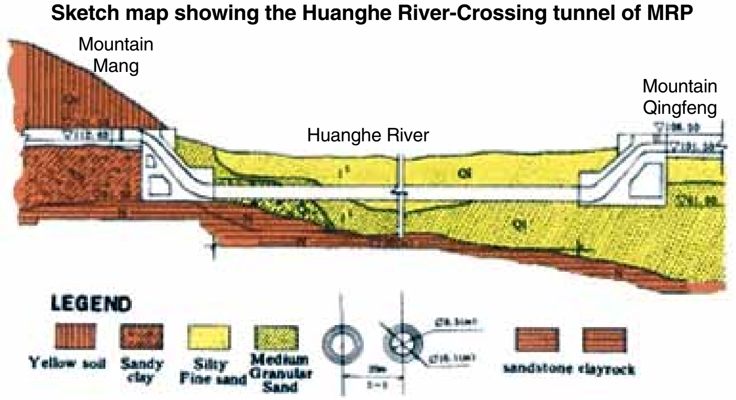


http://www.nsbd.gov.cn/zx/english/english.htm fer Project Office, called the key period in the "three-year decisive battle" to get the water flowing north. The SNWD will change China's watersheds: The waterways cut across the west-to-east flow of China's major rivers.

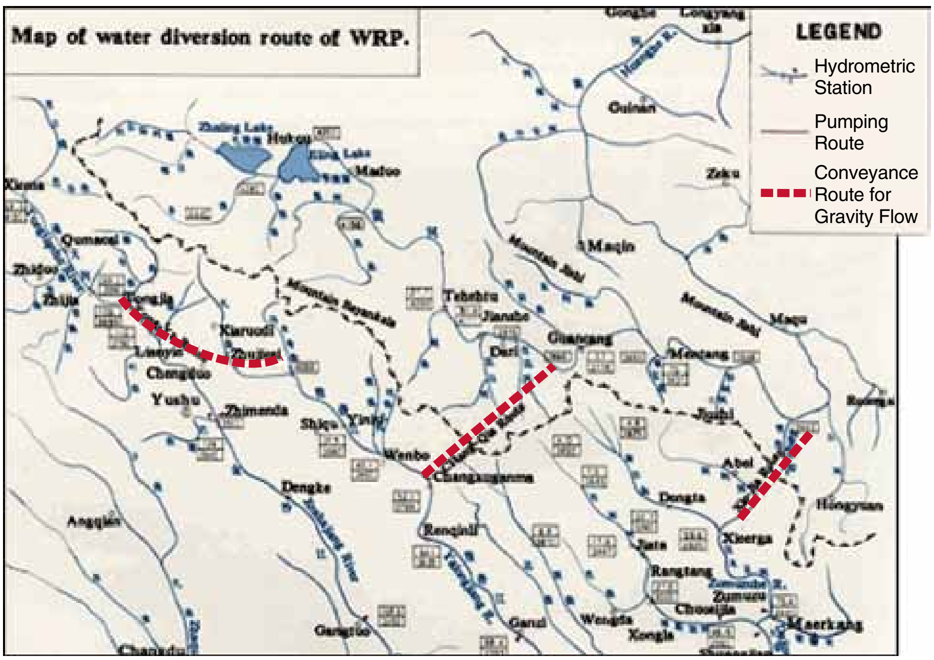
Water for China's Economy

China's annual water resources are about 2,700 km^3, the sixth most plentiful in the world, but per capita, this is just 26-28% of the world average, 88th in the world. China's current water usage per capita is only 25% of that in America in the middle 1970s, Prof. Liang Ruiju and Dr. Shen Dajun wrote in their excellent 2003 report on *The State of China's Water*, published by the Third World Centre for Water Management.

The late Professor Liang, former director of the China Institute of Water Resources and Hydropower, and Dr. Shen, a senior engineer at the China Institute of Water Resources and Hydropower Research, stressed that China's water resources are very unevenly distributed, with about 80% in southern China, and just 20% in the north. China, like the rest of Asia, has a monsoon climate, with an annual rainy season in the Summer and a dry Winter.

Rainfall is much more abundant in the South; the Yangtze valley and southern China can get more than twice the rain as the North. Long-term mean annual precipitation is 648 mm, although in 2011 it fell to 556.8 mm, the lowest since 1951. The monsoon climate gives China significant variation in the amount of rain falling in wetter and drier years, and there are often longer sequences of successive wet and dry years than in non-monsoon regions. The differences between Summer and Winter rainfall are greater in China than in other regions at the same latitude, and differences in annual runoff are even larger than in precipitation, Shen and Liang wrote. In the South, mean annual runoff is 650 mm, but in northern China, only 74 mm. Groundwater resources are rich in the South but scarce in the North.

The Yangtze valley and southern China have 36% of the cultivated land, 55% of the population, and 80% of its water resources; the Northern Plain has 45% of the cultivated land, close to 40% of the population, but less than 20% of water resources.



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The Western Route (WRP) of the project is still in the planning stage, and the map shown here is based on a preliminary study. What is being considered, is to divert what ultimately would amount to 15 to 20 billion m^3 of water from three tributaries at the headwaters of the Yangtze—the Tongtianhe, the Yalongjiang, and Daduhe—high in Tibet, into the headwaters of the Yellow River. The challenges are enormous. The water would have to cross the 3,000-5,000 meter-high Qinghai-Tibet Plateau. The channels would be relatively short—300 km—but the water would have to be pumped up at least 100 m, and the project would require construction of dams, canals, and tunnels in an earthquake-prone permafrost region.

China's renewable internal freshwater resources were 2,113 m^3 per capita in 2009, only 28% of the world national average, and low in comparison with the vast resources of Canada, 84,495 m^3; the Russian Federation, 30,393 m^3; and the United States, 9,186 m^3, according to the World Bank. They are significantly larger than those of the other population giant, India, at 1,197 m^3.

Population density is very great: There are about 400 persons per km^2 in the Northern Plain, where 440 million people live. Another 400 million live in the Yangtze valley, where population density is about 225 per sq km. Five eastern U.S. states—New Jersey, Rhode Island, Massachusetts, Connecticut, and Maryland—have population densities ranging from 450 to 220 persons per km^2, but their total population is just 25 million.

Feeding this huge population is an enormous task. Northern China is the national grain basket, growing half the wheat and a third of the corn that the nation produces. There is intense double cropping: Winter wheat is grown during the dry season, and corn in the rainy Summer. In Shandong province, a key food producer, some areas grow two wheat crops and two corn crops a year.

Other water requirements are also great: Almost 75% of China's power comes from coal; mining, processing, and burning coal consumes at least 10% of the country's water, and the use of coal causes more pollution. China is planning to add another 450 gigawatts of coal power by 2020, and to develop coal reserves in the very dry northwestern interior. While China is rapidly developing its nuclear energy—which uses far less water, which is only used for cooling, and the water is fully recyclable—even construction of some 27 planned plants will generate only about 5% of China's energy by 2020. Overall, China wants to produce 1,400 to 1,500 GW of power by 2020, primarily using coal.

Urbanization, as noted above, is another particular challenge. As of 2007, more than two-thirds of China's 600 cities were facing water shortages, 110 of them serious. Urban Chinese use 300% more water per capita than rural residents. As of 2011, China became a primarily urban nation for the first time in its millennial history. Last year, there were over 690 million city dwellers—51.3% of the population; there are now over 160 cities in China with a population of over 1 million.

Yet at the same time, fundamental infrastructure is still lacking for hundreds of millions of people, and 323 million rural Chinese still do not have access to safe drinking water.

Management and Modern Technology

To meet these huge needs, Beijing has made comprehensive water management a leading national goal. One critical issue is modernizing technology: Water is used inefficiently, and the country urgently needs adequate wastewater treatment, and greatly expanded capacity to desalinate seawater, especially for its northern cities. The Chinese economy uses between 4-10 times more water per unit GDP than more advanced industrialized nations. As of 2003, Chinese industry was using 216 m^3 of water for every 10,000 yuan worth of industrial added value, ten times more water than in developed countries, the *China Daily* reported. Wastewater is often untreated: More than two-thirds of it is directly discharged into rivers or the ocean, polluting 90% of the underground water in urban areas. The World Bank reported in 2009 that industry's recycling rate is just 40%, compared to 75-85% in developed countries.

In agriculture, productivity from irrigation (meaning the increase in value of the agricultural product) is just US$3.6 per m^3, the World Bank reported. The world average is $4.8 per m^3 in middle-income countries, and $35.8 per m^3 in high-income countries.

In January 2011, the national State Council announced that China will invest 4 trillion yuan ($635 billion) in essential water conservation projects over the next decade, doubling the amount currently being invested. In April 2012, Minister of Water Resources Chen Lei repeated the commitment. The central government's first official document of 2011 declared that water management is a national priority, the first time such a policy document has focused on water. "Floods and drought in recent years have exposed weaknesses in water conservancy infrastructure," the document said.

Under the 12th Five-Year Plan (2011-15), policy is to modernize irrigation infrastructure and build effective flood control and drought relief systems by the end of 2020, and harness important medium-sized and small rivers. All rural areas should have safe drinking water by 2015, and water availability is to be improved in the arid western interior.

Beijing also will try to hold annual water consumption to below 670 billion m^3 by 2015, which will require much improvement in infrastructure and technology.

The vital area of water management had been neglected, especially in the 1980s-'90s, *China Daily* commented in January 2011. "About one third of the irrigation facilities for the 53.33 million hectares of irrigated farmland in China have already deteriorated after years of neglect," the paper quoted Feng Guangzhi, chairman of the China Irrigation Districts Association. "With nearly no input from the central and local governments, the 1980s can be regarded as the low point for agricultural water conservancy in China. It was only in the early 1990s that the central government started constructing farmland irrigation systems again." The China Institute of Water Resources and Hydropower Research reported that investment in water facilities accounted for only 0.435% of GDP on average from 2007-09; this amount has to be doubled, the Institute said.

Between 2006 and 2010, only about 100-140 billion yuan a year was used for water management, far below the 650 billion yuan spent on road construction and 450 billion yuan for railways. Investment focuses on repairing and maintaining older reservoirs, reinforcing water facilities to withstand disasters, providing safe drinking water, and conserving water, especially in the northern Chinese granary.

China is carrying out its first-ever national water census between 2010 and 2012, to survey the state of rivers, lakes, water conservancy, and agriculture, industrial, and domestic water use. By the end of 2012, China will enact one of the world's strictest plans to monitor all important bodies of water, and will centrally allocate water resources from the 25 rivers that flow through more than one province.

Cleaning up the Water

China is committed to tackling the huge problem of pollution, but not by shutting down industry, as the greenies of the West demand. Dr. Liang and Professor Shen wrote: "China's ... concentrations of water pollutants are among the highest in the world, causing damage to human health and loss in agricultural productivity." While pollution from much of the industrial wastewater has basically been controlled, now, they wrote, the major pollutants are organic pollutants from the chemical and other industries, and untreated urban domestic wastewater.

In 2001, just 5% of China's rivers had water of Grade I and II of "The Surface Water Quality Standard." The northeastern Songliao, Haihe, Yellow, and Huaihe rivers are all heavily polluted, as are many large freshwater lakes. This especially affects the quality of the water along the SNWD's Eastern Route. By mid-2010, seven years after construction of the Eastern Route began, water pollution remained a very serious problem. The UN Food and Agriculture Organization (FAO) reported in 2010: "The project faces a number of logistical challenges, including the need to clean up water bodies at intersections through which the canals will pass. [The Eastern Route] crosses through 53 river sections in China's most heavily water-polluted area. Cleanup operations will account for 37% of the total investment. If completed on schedule, it will represent one of the most comprehensive water cleanup operations in the world."

Beijing pledged to spend well over one third of its initial 32 billion yuan ($4.6 billion) investment for the first phase of the Eastern Route on pollution control, and demanded that local authorities along the route ensure that water quality be at least Grade III—the minimum standard for water that would be drinkable after treatment. Yet, in July 2010, SNWD central office director Zhang Jiyao told *China Daily*: "There is still a long way to go before local authorities transform the Eastern Route into a clean-water corridor and ensure the quality won't decline again."

Over 400 pollution-control projects were built. As of July this year, authorities said the Eastern Route would be able to deliver clean water next year. Water quality in most of the Eastern Route's canals had been brought up from "worse than Grade V" in 2006, to Grade III. "For the Eastern Route, pollution control is the key to success, as years of industrial pollution in the surrounding areas led to the extreme decline of local water quality," according to an official on environmental protection of the SNWD, *China Daily* reported July 26. The head of the Shandong Environmental Protection Department told the newspaper, "The pollution control tasks on the Eastern Route are the most formidable that I have ever seen."

Potential of Desalination

Even the vast SNWD water project cannot meet all of northern China's urgent water requirements; as Vice Minister of Water Resources Hu Siyi warned in 2010, if the population of Beijing continues to grow at current rates, even the 1 billion m^3 water Beijing will get from the South-North Water Diversion project might not be enough. In 2011, following 12 consecutive years of drought, Beijing's daily water supply has fallen to a maximum of 3 million m^3. The capital's per-capita water resources are just 10% of the world average. Two-thirds of the water for this city of 20 million now comes from groundwater, and this extraction has caused

An 'Essential' Project

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Prof. Xia Jun said that competently managed and coordinated water projects are essential for China: "As the old Chinese saying goes, you can't expect a horse to gallop but not to graze."

Prof. Xia Jun, president of the International Water Resources Association and director of the Chinese Academy of Sciences' Center for Water Resources Research, gave an overview of the importance of the South-North Water Diversion project (SNWD), in an interview with China Dialogue on Aug. 28, 2012, in the run-up to World Water Week in Stockholm.

"The ability to move water around is essential, to distribute the water more evenly," he said. China needs such water transfer because while it has "a high global ranking on overall water resources, on a per capita basis we're much weaker. China has a large population, and while the economy has being doing well in recent years compared with the rest of the world, there are still lots of deeper issues." Prof. Xia's Center focuses on the unique challenges posed by managing water for the "high intensity" of human activity in China, including research on the impact of cross-basin water diversion projects, specifically the SNWD.

"China lies in the monsoon zone, and most of its precipitation comes during flood season—it is very unevenly distributed both geographically and over time. This leads to differences across regions, and you often have floods in the South while the North suffers drought. The North and Northeast of China produce two-thirds of its grain, and those areas have huge plains and excellent light, but lack water. The water and soil aren't in the right places. And in some sense climate change is worsening these problems. So China's water issues are quite complex, and there are significant pressures."

"China needs to figure out how to save the excess water of the flood season and use it in the dry season," he said. "In the recent droughts in the Southwest, we saw just how lacking drinking water infrastructure is in some places. And even if the infrastructure catches up, there's still a need to be able to transfer water during a drought. . . .

"Of course you need to work in coordination, to balance the ecological impact. But you can't store and transfer water without dams and reservoirs, can you? Lessons have been learned since the US was building dams in the 1960s, and the ecological impact is better understood. The question now is making environmental improvements and shifting attention from construction to overall coordination, to gain benefits from unified management. . . .

"Do we want to go back to a primitive state of nature? Nobody does. As the old Chinese saying goes, you can't expect a horse to gallop but not to graze. The overall aim of economic development is the right one, but there's a need to minimize the ecological impact. We need more high and new technology, and extremely good planning."

Water management on a national scale is vital, he said. "There's an urgent need for reform, for unified consideration of water for cities and the economy, for the ecology, for agriculture. China urgently needs to study effective coordination mechanisms." During the entire decade of the 1990s, he said as an example, so much water was being extracted from the Yellow River that it dried up downstream for about 100 days every year, never reaching the sea. Since then, management of the river has greatly improved.

"In 2030, China's population will reach about 1.6 billion, and more water use will be inevitable. Pressure on water resources will continue in the long term, and increase. The overall management of water quantities, quality, and the ecology are major challenges for any developing nation," he emphasized.

the average depth of groundwater to fall to 25 meters, down from 12 meters in 1999, the *Global Times* reported in May 2012.

Seawater desalination could make a critical difference for supplying water to the cities, if nuclear energy were used to power the process. Although technology is improving, desalination is still expensive, especially for developing nations with really big populations and water needs. The biggest current seawater desalination plant in the Western Hemisphere, for example, is the non-nuclear-powered one being constructed in Carlsbad, near San Diego, California. It will produce some 190,000 m^3 of water daily, a small fraction of the 3 million m^3 Beijing uses every day.

China's current desalination capacity is very small—660,000 m^3 a day in 2011—but the National Development and Reform Commission announced plans in February to expand that to 2.6 million m^3 a day by the end of 2015. The plan is to build a chain of desalination facilities in the coastal cities of Tianjin, Qindao, and Dalian. Advanced desalination technology could also be used for wastewater treatment and control of pollution. The *New York Times* reported in October 2011 on the new coastal Beijing desalination plant near Tianjin, built with cooperation from Israel, to develop a concept project combining desalination and a modern industrial base. When the Beijing and other coastal desalination facilities are operating at full capacity, the potential will exist to transfer water to Beijing and other cities inland.

A crucial breakthrough would be to use nuclear power. Chinese scientists are developing a modular heat-producing High-Temperature pebble-bed nuclear reactor (HTR) at Tsinghua University, west of Beijing. Such reactors are inherently safe; they were first developed, and then abandoned, by German scientists, but now China is actually building one. A key reason for this project is that HTRs can be relatively small reactors which could supply heat for whole cities, and provide the power for desalinating seawater.

China's water crisis is not only an issue of resources; it is also an issue of distribution, underdeveloped technology and industry, and management. The South-North Water Diversion project is a crucial part of beginning to meet this crisis, for one-fifth of humanity.