Special Article

Water Pressure in China: Growth Strains Resources

In China, one of the world's most water-deficient economies, water scarcity is viewed as a major threat to long-term food security. While the agriculture sector is still by far the largest user of China's water resources, rapid economic and population growth is generating rising demand for urban and industrial use, increasing pressure on water supplies.

In 1995, China's annual renewable water resources were estimated at 2.8 trillion cubic meters, which ranked fifth in the world behind Brazil, Russia, Canada, and Indonesia. The U.S. ranked sixth with 2.5 trillion cubic meters. However, in terms of per capita water resource availability, China is one of the lowest in the world.

China and the U.S. face some similar conditions with respect to water. Both countries have large agricultural economies, extensive irrigated cropland, and farmers facing increasing competition for water from urban, industry, transportation, and hydropower users. But several elements make management of water resources particularly challenging in China, including uneven rainfall distribution, a very large population, several large urban areas in a dry region covering about half the country, and a complex legal/institutional framework for water distribution and use.

China's ability to feed itself will depend, in part, on how it deals with its water problems. The linkages between China's agricultural policy and its water management policy, and implications for the timing and magnitude of water availability, are strategic issues for China's agricultural trade.

Water Resources, Population Distributed Unevenly

A monsoon climate dominates China's rainfall patterns. The monsoon arrives from southeast Asia bringing rain during the spring and summer months and receding in the fall. Normally there is little precipitation in China in winter and the early spring months. The monsoon rains are heaviest in south China, and precipitation becomes progressively less towards the north and west. For the intensively cultivated areas in the north China plain and Manchuria (northeast China), most of the annual rainfall comes in June through September.

Provinces that have an annual average rainfall of less than 600 millimeters can be found in north, northeast, and northwest China. About half of China's arable land is located in this relatively dry area that includes high plateaus and deserts.

Another characteristic of China's water resources is that only a few major rivers, including the Yangzi River (in south China) and the Yellow River (in north China), flow through an extended

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portion of the country. Many major rivers quickly exit the country and provide major water resources to neighboring countries.

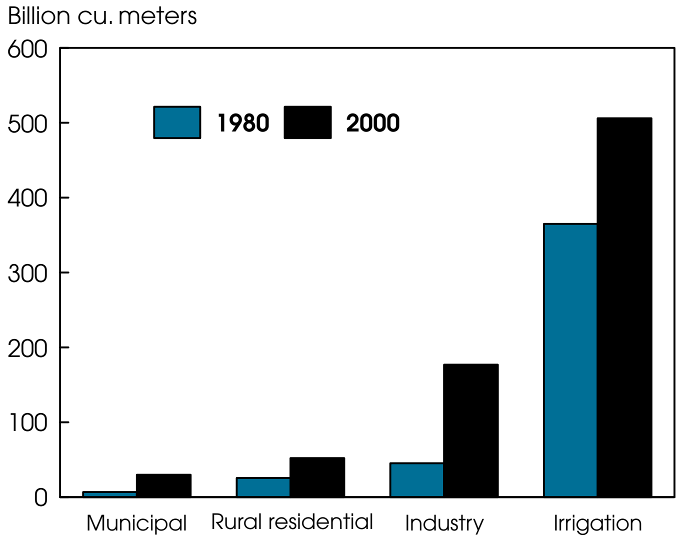
The uneven distribution of rainfall and scope and configuration of China's river basins mean that stream flows and runoff from the basins vary greatly. For example, annual runoff from the Yangzi (also know as Chang) river is estimated to be 1 billion cubic kilometers of water, compared with 0.028 billion cubic kilometers of runoff for the Hai river located in north China.

USDA's Economic Research Service estimates that 34 percent of China's population (1.2 billion total) lives largely in the relatively dry region (north, northeast, and northwest China). The rest

This article is based on 3 years of research by USDA's Economic Research Service on China's water situation and on the visit to China in September 1999 by the U.S. Water Team. The team included representatives from USDA's International Cooperation and Development Division, Foreign Agricultural Service, Agricultural Research Service, Natural Resource Conservation Service, and Economic Research Service, as well as the U.S. Geological Survey. An exchange of teams to study water issues had been proposed by USDA and China's Ministry of Agriculture in December 1997. This article also draws on the "China-U.S. Water Resources Management Workshop" held in April 1999 in Tucson, Arizona. The conference, attended by scientists and researchers from both the U.S. and China, was sponsored by a Working Group of the U.S.-China Forum on Environment and Development. At the 1997-98 meetings in the U.S. and China, both sides agreed to focus attention on environmental and water issues.

Special Article

China's Water Use is Projected Up Sharply



Source: World Bank.
Economic Research Service, USDA

live in provinces on the plains along the eastern seaboard. The dry region is host to large urban centers, including seven cities with populations of more than 2 million people and 81 cities with 200,000-500,000 people. The largest are equivalent in population to major U.S. cities: Beijing, with 7.3 million (San Francisco bay area has 6.7); Tianjin, with 5.2 million (Boston area has 5.8); and Shijiazhuang, with 1.9 million (equal to Cincinnati). These large Chinese cities compete with agriculture for scarce water resources.

The large number of people living in this relatively dry region has great impact on water resource use. In the densely populated Hai river basin, for example, industrial output is growing rapidly, and the basin is intensively cultivated (it is a major grain producing area). However, water availability per capita is only 308 cubic meters per year. In contrast, residents in the Pearl River basin in the wet area of China have 13 times more water available per capita. Clearly, low annual precipitation rates and large populations in some provinces in the dry part of China mean low per capita water resource availability.

Demand Increasing, Usable Water Availability Shrinking

Since economic reforms were initiated in the early 1980's, China's economic growth has been rapid, particularly in the nonagricultural sectors. The manufacturing sector, for example, grew 12 percent annually during the last two decades, compared with 9.8-percent growth in the overall economy.

World Bank analysts estimated that industry in 1980 used 45.7 billion cubic meters of water—10.3 percent of total water consumed. They estimate that by 2000, *industrial use* of water will more than double to 177 billion cubic meters and account for 23 percent of total water use.

Municipal (urban) demand for water has also grown, although it remains a relatively small share of total use. The number of residents in China's cities is projected to increase from 191 million in 1980 to an estimated 400 million in 2000. Urban residents with increasing incomes are buying washing machines and renting apartments that include flush toilets and individual shower facilities—activities that increase urban water use. In 1980, urban residents used 6.8 billion cubic meters of water, 1.5 percent of total water use. By 2000, they are expected to increase use to 29.4 billion cubic meters, 3.8 percent of the total.

Per capita water use in cities varies greatly by region. In Tianjin in the dry Hai basin, for example, residents use only 135 liters of water per day, compared with 339 liters per day in the wet urban areas in the southern province Guangdong. Urban water use in both areas has also increased as mayors in major cities embarked on beautification campaigns to plant trees, shrubs, flowers, and grass along roadways and in municipal parks.

Rural residential demand for water was 25.6 billion cubic meters in 1980, 5.8 percent of total use. By 2000 this use is expected to rise to 51.7 billion cubic meters, 6.8 percent of use. According to the 1997 census of agriculture, only 17 percent of rural households had access to tapwater. China's government has embarked on a program to put in tapwater systems for rural villages. As this program progresses, more households will have access to regular supplies of tapwater, and consumption (for washing machines, showers, and nonirrigation farm use) will increase.

The dry region is host to large urban centers, including seven cities with populations of more than 2 million...

China's leaders state that urban and industrial water users will have priority over agricultural water use and that the proportion of water for *irrigation purposes* will decrease incrementally in the next few decades. Nevertheless, current food security policies are inducing farmers to expand and to maintain a high level of food grain (wheat, rice, and corn) production (*AO* March 1997). These pressures have pushed farmers to use both surface and underground water resources to boost grain yields. World Bank analysts estimated irrigation water use in 1980 at 365.6 billion cubic meters, 82.4 percent of total water use. But they anticipate that even though use of irrigation water will increase to 506.4 billion cubic meters in 2000, competition for other uses will reduce the share of water for irrigation to 66.2 percent of the total. In some areas of dry north China, water tables have dropped substantially, suggesting that water is being extracted (mostly for agriculture) faster than aquifers can be recharged.

In China's dry northwest area, upstream users have increased use of irrigation water. This use has raised grain output (largely one-season grain crops) in the upland areas, and new irrigation projects are being constructed in part to boost rural income in these largely poor areas. But the resulting loss of water for

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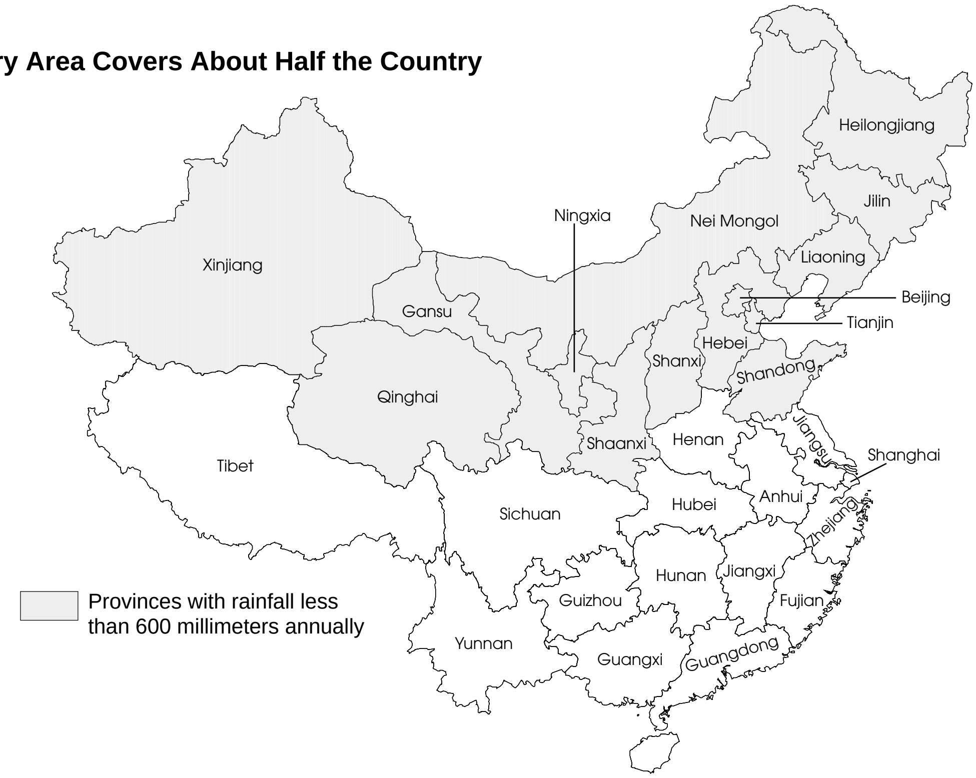
China's Dry Area Covers About Half the Country

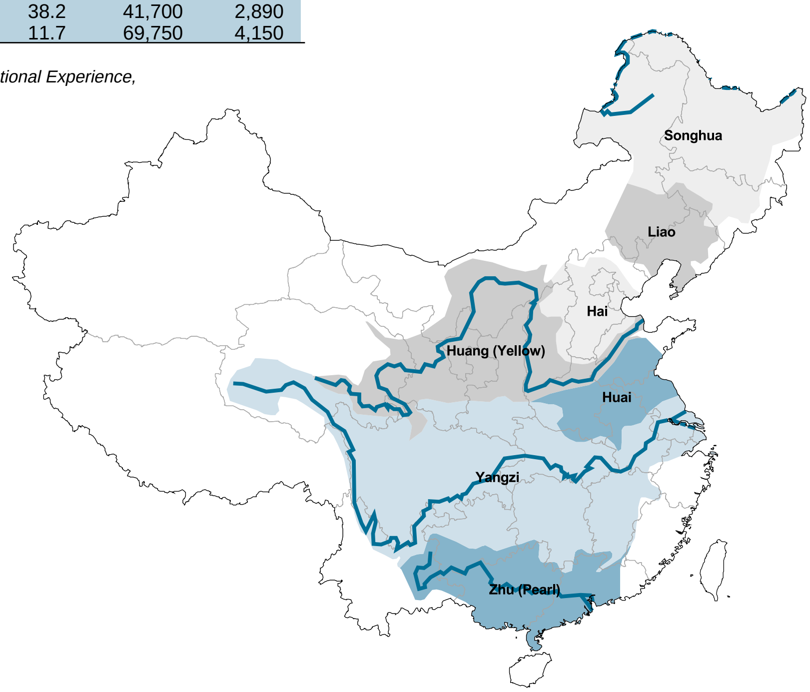


China's Stream Runoff for Water Supply Varies By Water Basin

Major river basin	Area	Population	Cultivated land	Annual stream runoff: Total volume	Share of nat'l total	Per cultivated ha	Per capita
	1,000 sq km	Million	Mil. ha	Cu km	Percent	Cu meters	Cu meters
Dry region:							
Hai	319	92	11.3	28	1.0	2,505	308
Songhua	528	46	11.7	76	2.9	6,450	1,650
Liao	232	28	4.5	15	0.5	3,375	540
Huang (Yellow)	752	82	13.1	56	2.1	4,290	683
Wet region:							
Huai	262	125	12.5	53	2.0	4,230	424
Yangzi	1,807	346	24	1,000	38.2	41,700	2,890
Zhu (Pearl)	415	74	4.4	307	11.7	69,750	4,150

1 hectare (ha) = 2.471 acres.
Source: *Long Distance Water Transfer: A Chinese Case Study and International Experience,* United Nations University,1983.
Economic Research Service, USDA

China's Major River Basins



downstream areas means, for example, that the Yellow River often now goes dry well before it reaches the sea.

Downstream users in the dry northern area have not only lost surface water to irrigate their two grain crops a year, but the decreased stream flow may well affect the recharge of some aquifers. With less surface water available downstream, municipalities, industry, and agriculture have increased their use of underground water resources. In a number of areas in dry north China, including Beijing, underground water is being depleted so quickly that there are large areas with cones of depressions (water table drops at well locations), dry wells, seawater intrusions in groundwater areas adjacent to the ocean, and land subsidence. The problem is severe in the Cangzhou area of Hebei province, for example, where 400-meter deep wells are now being used to provide irrigation water to grow wheat and corn.

The rapid rise in urban population areas and industrial growth rates has been accompanied by a rise in the pollution level in China's waterways. In the absence of sufficient water treatment plants, large volumes of raw sewage are dumped daily into local streambeds, and industrial water is often untreated. When polluted upstream water is returned to the stream flow, water quality downstream is degraded. In some cases, polluted water in the streams has seeped into ground water.

Managing the Gap Between Water Demand & Availability

Assuming the extension of current trends in water demand and availability well into the next century, the projected deficit would be huge, and several crisis scenarios could be envisioned. On the other hand, water users could conceivably adjust consumption patterns as the gap widens between demand and availability and water use becomes more costly (i.e., higher prices for water as more energy is required to extract ground water). Policymakers might also assess the situation and respond with appropriate programs. This perspective suggests significant shifts in water use but not necessarily catastrophic crises.

A team of U.S. experts recently visited China and saw evidence of both perspectives. The team concluded that while some areas continue to use water at unsustainable rates, the dominant current trend is for both policy makers and farmers to begin adjusting to conditions of less water available for agriculture.

China has the opportunity to increase its available water supplies through careful management. Water used upstream could be returned to river flows to be used again downstream if water polluted through urban and industrial use is treated appropriately first. Initiatives to encourage more efficient use of existing water supplies are already underway in some areas. The difficulties will be for national and local governments to craft policies and rules within China's complex cultural and legal-administrative system that provide incentives for users to increase efficiency of water use, and for polluters to clean up the water they use and return clean water to stream flows.

With water policies giving highest priority to urban and industrial users, China's water districts, agricultural extension personnel, and government authorities acknowledge these water use expectations and are currently promoting both technical and institutional changes to increase irrigation efficiency.

To increase efficiency, local authorities and farmers are promoting lining ditches with concrete and use of plastic pipe to reduce conveyance losses from water source points to fields. Farmers are beginning to use spray and drip irrigation systems where conditions permit, instead of less efficient flood irrigation. Research units in government ministries have projects to develop efficient irrigation systems which will fit into the structure of rural China where fields are very small, farmers are relatively poor, and individual farms lack ready access to bank loans.

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Authorities also encourage managers of irrigation districts to increase the efficient distribution and delivery of water to farmers. They are beginning to experiment with treating water as a commodity in which price becomes an important consideration. In the past 5 decades, irrigation districts have charged little or no fee for delivering water to farm fields. But irrigation districts are beginning to increase fees to cover operating expenses and plan to eventually charge full costs. Farmers have resisted paying fees for irrigation water, partly because they helped build the projects with their own unpaid labor.

The rising cost of pumping water is encouraging more efficient water use. Local government technicians are beginning to teach farmers how to efficiently use their irrigation water so that farmers will know when to apply water, how often, and how much. In the very dry areas of northwest China, farmers (with little or no assistance from the government) are developing rain catchment systems that drain water into underground cisterns. Water in the cisterns is used for domestic needs and for very efficient drip irrigation systems that deliver water to crops in small fields.

In 1999, China's Ministry of Agriculture initiated a "Dryland Farming Program" in response to the country's water scarcity and to expected decreasing available water supplies in the coming decades. The program includes a) creating seed varieties with high yields and low water use (with great hopes pinned on biotech techniques), b) developing field cultivation practices that will conserve water, and c) constructing field terraces to reduce water runoff and control erosion. Through this program, the government also pays for some equipment purchases to encourage adoption of new cultivation practices. Some farmers have reduced water losses by using plastic film between rows to limit evaporation. With the rising cost of water, farmers are beginning to switch from planting crops that have high water use to those which use less water.

The Ministry of Water Resources, which has responsibility for underground and surface water resources, is concerned about the increasing demand for water, falling water tables, increasing incidence of cones of depression, and land subsidence. The ministry has begun actively managing underground water supplies by developing rules and procedures for drilling new wells, requiring permits for extracting water from wells, and establishing measures to prevent pollution of underground aquifers. The Ministry also manages water commissions that allocate river water to provinces and oversees the building of flood control and hydro-electric facilities such as the enormous Three Gorges Dam on the Yangzi River. With China's rapidly changing economy and overlapping jurisdictions of various institutions interested in water, it will be challenging to formulate rules that will give stakeholders incentives (or penalties) for ensuring the long-term life of its aquifers.

Given water shortages in dry northern China, is it feasible to transfer water from the water-rich south to the north? Transfer projects have been discussed for more than two decades, but construction costs are high and thus far no projects have been initiated. The Ministry of Water Conservancy, charged with responsibility for projects to transfer water from south to north, has teams of researchers completing feasibility studies for an eastern route, a middle route and a western route. The ministry seems to be favoring the middle route. But little of the proposed transferred water is expected to be used for irrigation purposes. The unit cost of transferred water likely will be so high that only urban and industrial users could bear the costs.

Implications for Trade

Changes in China's water availability in the coming decade will force important changes in the country's agricultural economy. Clearly there will be less water available for irrigation purposes, and it is difficult to predict how China's farmers will adjust to the changing conditions. China's rural economy will not collapse, nor will crop production cease because of dwindling water supplies. Nonetheless, there could be substantial changes in the mix of crops planted due to changes in demand and availability of water supplies.

Farmers may switch from using scarce irrigation water on lower value grain crops to raise higher value fruit and vegetable crops instead. More dryland crops such as sorghum, millet, and cotton may be planted, rather than crops such as corn and rice which require higher water use. There could be less double cropping in China's dry northern areas. For example, farmers in the Beijing area currently raise winter wheat and summer corn in the same year. With reduced water supplies, they may have to choose between these crops.

The prospective changes in output composition will affect the kinds and quantities of agricultural products traded in the coming decades. As production of fruits and vegetables increases, some of China's products may become very competitive in international markets, while opportunities in China's market will likely develop for U.S. exports such as wheat, corn, and soybeans.

China's economy is expected to grow at an annual rate of over 7 percent during the next decade. This rapid economic growth, along with continued increases in population, will put considerable stress on China's natural resource base. Sustainable growth in the next few decade depends in part on how China crafts policies relating to land and water use. It will also depend on whether China will continue its food grain self sufficiency policies or increasingly rely on its comparative advantage and participate in world trade on a much larger scale. AO

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February Releases—USDA's Agricultural Statistics Board

The following reports are issued electronically at 3 p.m. (ET) unless otherwise indicated.

February

2	*Broiler Hatchery*
3	*Catfish Production*
	Dairy Products
	Egg Products
	Trout Production
4	*Dairy Products Prices (8:30 am)*
	Poultry Slaughter
9	*Broiler Hatchery*
11	*Cotton Ginnings (8:30 am)*
	Crop Production (8:30 am)
	Dairy Products Prices (8:30 am)
	Crop Values
14	*Potato Stocks*
	Turkey Hatchery
16	*Broiler Hatchery*
	Milk Production
18	*Dairy Products Prices (8:30 am)*
	U.S. & Canadian Cattle (8:30 am)
	Cattle on Feed
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	Cold Storage—Ann.
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23	*Broiler Hatchery*
24	*Catfish Processing*
25	*Dairy Products Prices (8:30 am)*
	Livestock Slaughter
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	Peanut Stocks & Processing
29	*Agricultural Prices*