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Essays

China's Thirsty Future
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by Vaclav Smil

An explosion in a large chemical factory releases some 100 metric tons of toxic compounds, all classed among the most dangerous carcinogens, into a major river. Consequently, a city of more than three million people that lies a few hundred kilometers downstream from the factory has to cut its municipal water supplies as a panicked population hoards bottled water and digs emergency wells.

These are not ordinary headlines. Yet in the greater scheme of things, the state of the water supply in China is so dismal that the Nov. 13 incident—the spill of benzene by the Jilin Petrochemical Company into the Songhua River, resulting in the temporary closure of Harbin's waterworks 10 days later—should not rank anywhere near the top of the country's leading water worries. Inadequate, wastefully used, continuously polluted, and grossly underpriced, China's water resources present a host of problems that could coalesce to clog the country's economic growth.

During the last 25 years, since the beginning of Deng Xiaoping's economic reforms, China's population grew by nearly 320 million people, the urban population rose by nearly 340 million, food production moved from rationed minima to comfortable self-sufficiency, and GDP (in constant monies) increased more than eight-fold. Behind all of these changes are enormous volumes of new water. Even the barest per capita minimum of 70 liters of water a day (needed for drinking, cooking, personal and clothes washing, cleaning and waste disposal) translates to an additional 8 billion tons of water a year needed for the 320 million people that have been added since 1980. Moving from the countryside to a city, meanwhile, tends to at least double the average household water consumption. Moreover, post-1980 modernization included massive increases in the output of such water-intensive industries as ferrous metallurgy, chemical syntheses, crude oil refining and food processing. And a disproportionately high share of China's food production comes from its irrigated land and every ton of rice requires about 2,000 tons of water.

Since 1980, however, China's average per capita water consumption actually declined by nearly 5%—and not because the country has become an impressively more efficient consumer of irrigation, industrial or residential water. There are increasing signs

that the country's leadership may be finally willing to go beyond exhortation and empty promises and to invest a great deal of money in order to at least partially alleviate a daunting quartet of water challenges facing today's China: severe shortages of water; its astonishingly inefficient use; its enormous pollution; and the uncertainty of future water supplies.

China's Water Supply

one of the most frequently cited figures in the Chinese media refers to the country's low average per capita availability of water resources—as of 2005, only about 2,200 cubic meters, or less than a third of the global average and just a quarter of the U.S. rate. This obviously low nationwide figure, however, hides more than it illuminates. All large countries have unevenly spaced precipitation, but China's disparities are particularly large. South China, with roughly 55% of the population and 35% of the cropland, has about 80% of the water resources. These shares are uncomfortably lopsided for the north, with 45% of the population, nearly 60% of all cropland, but less than 15% of the water.

But even this contrast does not capture the true acuteness of China's water challenge. The three principal northern water basins—those of the Yellow River, Hai River and Huai River—cover 39% of the country's arable land, contain 35% of the population (some 460 million people), and are the source of a third of China's annual GDP. But their combined water resources are merely 7.7% of the nationwide total. This means that annual per capita water availability in the area of these three watersheds, the very heartland of China's ancient civilization, is already below 500 cubic meters. Here the comparisons get truly worrisome: In per capita terms, nearly half a billion people have access to less water than does the population of Somalia, and they are just marginally ahead of Sahara-spanning Algeria.

Many northern cities, notably Beijing, already consume more water than the maximum potentially usable surface flow, i.e. the amount of water deposited by rain and snow. Those seasoned China travelers who remember Mao-era Beijing with its handful of hotels equipped with Stalinist plumbing and who read about the capital's water shortage during the late 1970s must wonder how has the city has accommodated scores of expensive hotels and apartment high-rises where residents may use more water for a single shower (it can take more than 400 liters) than a city's average family of three people uses in a day. The answer is simple—even using every drop of surface water available in the city and the nearby areas would be insufficient, so Beijing has been engaged in one of the most aggressive water-mining campaigns in history.

Because its own municipal reservoirs are so depleted, since 2003 Beijing has been bailed out by emergency infusions of water from reservoirs in northwestern Hebei Province and northern Shanxi Province. In the fall of 2005, the transfer amounted to 150 million cubic meters of water. These desperate measures only increase the city's annual water supply by less than 5%.

This reality has led to even more aggressive depletion of the

capital's remaining underground water. Like so many other places around the world, Beijing was underlain by voluminous aquifers that were tapped for centuries by shallow wells. Serious water mining started in the early 1950s with the Communist industrialization of the city. At that time the water table was in many places just two or three meters below the surface; now, slightly more than 50 years later, it has receded by as much as 50 meters. The process accelerated during the recent periods of prolonged drought. Recently the city has been using roughly 3.5 billion cubic meters of water every year, with about 75% of this total drawn from the disappearing aquifers.

With the population topping 15 million, the city's per capita mean prorates to just 230 cubic meters per annum. But as the bulk of this supply goes for suburban farming and for industries, the average public and residential rate is only about 75 cubic meters per annum (200 liters a day), and household surveys show that actual domestic per capita use ranges between 110 liters and 150 liters a day (in Japan, it is about 320 liters a day).

The same process and the same water depletion is occurring across the North China Plain with predictable results: higher costs for drilling deeper wells to pump from greater depths (eventually forcing many poorer farmers to abandon well-digging). Severe water shortages, however, extend far beyond the North China Plain. Out of China's 600 major cities, 400 have water shortages, and there are serious deficits in 110 of them.

The most alarming situation, however, is in the watershed of China's second largest river, the Yellow River. Perhaps the most dramatic sign of China's vanishing water resources has been the annual drying out of the Yellow River. The basin of this river, situated at the northern extremity of the monsoonal influence, has been subject to devastating cycles of drought and flood, but never in China's long and carefully recorded history did the stream dry up completely before reaching the sea. But between 1985 and 2000, the river dried up every year as the dry spells started earlier and lasted for longer periods (the record time span being 226 days in 1997). The length of the dry bed extended hundreds of kilometers from the river's Bohai delta. A number of measures put in place since the summer of 2000 (restricted water use, improvements in irrigation, release of stored water in reservoirs) has kept the stream flowing—but only at a fraction of its normal volume.

Wasting Water

As in all large, populous nations with intensive crop cultivation, the country's agriculture consumes most of the water (in China's case 77%), followed by industries (18%) and households (5%). But China's irrigation practices have been notoriously inefficient—the best official estimates hold that only 40% to 45% of applied water is actually used for growing crops. Raising the official irrigation efficiency rate by just 7% would save more water than is now consumed annually by all of China's households. State plans now envisage raising the irrigation efficiency by 10% (assuming the mean of 45%) by 2030, clearly too little too late. An even more egregious waste of China's irrigation water is to use it for

water-intensive cotton- and rice-growing schemes in the arid northern provinces.

Examples of water waste in China's industries have changed little for decades. For every unit of China's GDP, about six times as much water is consumed as in South Korea and nearly 10 times as much as in Japan. A few months ago China's vice minister of construction claimed that about 20% of the urban water supply (nearly 10 billion cubic meters nationwide) is lost though leaking pipes.

A gradual series of price rises eventually pushed the most expensive residential supply (in Beijing) to one yuan per ton by September 1998. By May of 2005, a further series of price hikes brought the rate to 4.5 yuan per ton, still below the real cost and equal to less than 2% of Beijing's average per capita disposable income. The World Bank, by comparison, concluded that a reliable water supply could cost up to 5% of disposable income even for the residents of low-income countries. By any standard, China's water is still underpriced, particularly when taking into account much lower price increases for irrigation water.

More than half of China's waste water does not receive even the simplest primary treatment. Tens of thousands of small and medium enterprises that make consumer products for the Wal-Marts of the world have never entertained any idea of properly disposing of toxic wastes. They simply dump them into a nearby stream or a lake.

China's intensively cultivated countryside has an even more intractable water-pollution problem. In order to feed its people, the country is now the world's largest user of nitrogenous fertilizers. More than half of the applied nutrient (and often more than 60% of all nitrogen used on China's rice fields) ends up in water rather than in the grain's proteins. Not surprisingly, in November 2005, the First National Inland Lakes Symposium was told that a recent survey found 70% of the country's rivers contaminated with industrial pollutants and 75% excessively enriched with nitrogen leached from fertilizers.

Difficult Solutions

the outcome of the largest-ever survey supervised by the State Environmental Protection Agency in April-May 2005 and involving four million people showed that more than 96% of respondents believed that the country is challenged by a water crisis and that a water-conserving society offers the most effective solution. Remarkably, 98% of respondents were in favor of special taxes to support environmental protection measures.

There are no inexpensive and rapid solutions. The megaproject designed to solve the northern water shortages—the grandiose south-north transfer of Yangtze River water all the way to Hebei province—will certainly surpass its enormous projected cost estimate, and while it will make a difference in Beijing (the city should get additional one billion cubic meters by 2010) it will make little difference across the vast North China Plain until its later

stages are completed during the coming decades. Meanwhile, the transfer scheme (part of the larger Three Gorges Project) will bring its share of problems, from resettling nearly half a million people in the upstream provinces to creating foreseeable environmental complications.

More efficient irrigation will require expensive spray and sprinkle systems fed by pumps. Traditional rainwater harvesting in arid regions will require investment in waterproof collection surfaces, runoff channels, sediment tanks and storage. Nearly complete reuse of industrial waste water will require state of the art treatment facilities. Rebuilding urban water and sewage infrastructures will take time and considerable expense, as will any massive diffusion of water-saving faucets, shower heads and toilets. Effective solutions call for a sustained, multipronged approach consisting of rational adjustment to crop production, technical fixes (ranging from more efficient manufacturing to high-level waste treatment), price incentives for water conservation, long-term investment and vigorous enforcement of environmental laws.

Seen in broader perspective, China's water challenge is just one symptom of the country's quest for modernity as industrialization and urbanization put similar stresses on air, energy resources (which are also unevenly distributed) or arable land. China has been repeatedly tempted to solve these challenges by resorting to grandiose solutions of which the south-north water transfer is just the latest example.

Given the country's population size and its economic aspirations, this approach may be defended as matching the scale of the challenge, but these steps also almost inevitably aggravate other shortages or worsen other undesirable trends. For example, a massive conversion of China's rich coal resources to liquid fuels would reduce the country's rising dependence on imported oil, but it would also call for huge amounts of water to be used in water-short north China. Similarly, substantial south-north water transfers will consume more energy and reduce farmland.

There are other options. The most feasible one: China could save huge volumes of domestic water by importing more grain—recall that one ton of rice requires 2,000 tons of water. For wheat the ratio is 1:1,500. This would require a major shift in strategic thinking as a high degree of food self-sufficiency has been one of China's core policies. Because there are no precedents for facing such a serious water problem on such a scale, China's relative success (or lack of it) will be a major indicator of the long-term viability of its ambitious economic goals.

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