Why the Water Is Running Out

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The Fabric of Space:
Water, Modernity, and the Urban Imagination
by Matthew Gandy.
MIT Press, 351 pp., $30.00

Water 4.0:
The Past, Present, and Future of the World's Most Vital Resource
by David Sedlak.
Yale University Press,
332 pp., $18.00 (paper)

Greater São Paulo, a city of 21 million people, is experiencing its worst drought since the 1870s; the city's water supply is in danger. Sewage, pesticide, and trash pollute São Paulo's rivers and reservoirs. Rain falling on the vast paved surface of the metropolis drains quickly into its polluted rivers. Brazil's ample natural resources include 13 percent of the global supply of freshwater for only 3 percent of the world's population. Yet as of August 25 South America's largest city had only enough water in its reservoirs to supply its residents for ninety-three days.

Many of the world's other thirty-six megacities, each with more than 10 million inhabitants, also struggle with limited local water supplies. As recently as 1950, New York was the only city of this size. Half of today's giant cities face mounting difficulties in securing and managing water resources for their growing populations. As in ancient times, water supply is emerging as a challenge to civilizations both rich and poor.

The Fabric of Space, by Matthew Gandy, contains six loosely connected essays with much on historic and current water problems in Paris, Berlin, Lagos, Mumbai, Los Angeles, and London. A geographer at University College London, Gandy blames the lack of water on "a mix of technical disagreements, political expediency, administrative inertia, and economic uncertainty [that] produces a common pattern of extended delay" in taking action. He warns that the accelerated rate of climate change "could overwhelm the capacity of many cities to respond" to environmental crises. This is what may well be happening in giant urban agglomerations such as Los Angeles, São Paulo, Mexico City, Mumbai, and Beijing, all of which consume water wastefully while neglecting the need for long-term supplies.

Most conspicuously in danger are the growing number of supergiant cities, with populations of at least 20 million. They are heavily concentrated in poor countries that lack the wealth and institutional strength to manage droughts, floods, and other water emergencies on this scale. Among these supergiants are Delhi (25 million), Shanghai (23 million), Mexico City, São Paulo, and Mumbai (21 million each), and Beijing (20 million). United Nations demographers expect that by 2030 Delhi's population will rise to 36 million and that Tokyo will remain the world's most populous city with 37 million. According to A.K. Biswas of the Third World Center for Water Management in Singapore:

> From Istanbul to Johannesburg, and Jakarta to Mexico City, there are simply no new sources of water that could be harnessed economically and in a socially and environmentally acceptable manner which can quench the continually increasing urban-industrial thirst.

The growth of megacities is just one part of global urbanization. According to the United Nations, while the number of megacities has nearly tripled since 1990, the number of cities with at least one million people has nearly doubled. In Brazil, where I have lived and worked for the past four decades, there now are twenty cities with more than a million people each; in 1950, Rio de Janeiro and São Paulo were the only two. In São Paulo, living standards started rising in the 1990s with the end of decades of high inflation. Welfare benefits and salaries rose and nutrition improved. Muddy alleys became paved streets. São Paulo is now a sprawling metropolis in the style of Atlanta or Los Angeles, sprouting fancy office towers, hotels, and apartment blocks in new neighborhoods as if to celebrate its leading role in finance and corporate management.

AFP/Getty Images

Children carrying bottled drinking water during China's worst drought in a century, Qinglong, Yunnan province, April 2010

At the same time, São Paulo has come to have many of the water problems of other large cities around the world. Consumers pay for only a small fraction of the operating costs of the water distribution system and many consume water wastefully. There are constant leaks from water and sewage pipes that have deteriorated for lack of maintenance during decades of use. Large volumes of untreated sewage pollute rivers, streams, groundwater, and drinking water. Land surfaces and groundwater levels sink because of excessive pumping. Large-scale theft of piped water deprives these systems of financial resources needed to run and repair them, and to develop future supplies. And governments and utilities are unable to finance and construct projects to bring new water supplies from ever-greater distances.

In his book *Water 4.0*, David Sedlak, a professor of sanitary engineering and codirector of the Berkeley Water Center at the University of California, traces the development of large-scale water and sewage systems from Roman times to the nineteenth century, when sanitation improved in response to cholera and typhoid epidemics in Europe and North America. He goes on to describe the chemical and biological treatment of water and sewage in the twentieth century. Ever since the Romans, "the big idea behind urban water systems" has, Sedlak observes, been "centralization," getting water to flow from reservoirs to treatment plants and piping systems to final consumers. "In fact, this original design principle has been so potent that each of the subsequent upgrades was built on this foundation." He adds:

> Starting with the addition of filtration and chlorine disinfection on the front end of water distribution systems . . . , and continuing to the installation of biological wastewater treatment on the sewer end . . . , modern water infrastructure is still guided by its original blueprint of ancient Roman-style aqueducts and cloacae.

What Sedlak envisions for the future is decentralized use of new technologies for communities or even neighborhoods. The technical fixes that Sedlak proposes—from desalination of seawater, to purification and reuse of sewage, to adopting flush toilets, showers, and washing machines that use less water—may be useful individually, but they won't achieve the scale that megacities need to deal with shortages.

Focusing mainly on the United States, he discusses the current four-year drought in California, which recently led the state government to order a 25 percent cut in water use. Sedlak stresses the need for changes in "public attitudes about the value of water" and for overcoming conflicting interests in a long-standing situation in which "fights over water rights among farmers, cities, and environmentalists periodically created manmade droughts." Such changes in attitudes and policy, he writes,

> tend to be unpopular with politically powerful constituencies such as real estate developers, libertarians, and members of anti-tax groups, who bristle at the idea of regulations that restrict personal liberties and increase the costs of home ownership.

In Mumbai, Gandy writes, the provision of water is subject to frequent interruption, leaving millions of poor families dependent on private tank trucks whose owners make deals with corrupt local officials and charge high prices. Gandy writes, moreover, that the municipal water system

> suffers from periodic contamination . . . from corrosion and dilapidation of the water distribution system itself that fosters the spread of bacteria within pipes and enables dirty water to enter the network through cracks and fissures.

São Paulo was founded five centuries ago as a Jesuit mission at the headwaters of rivers and creeks flowing into the heartland of South America. In 1554, the Jesuits built a chapel between two streams on a small hill, which became a provincial capital. São Paulo then stagnated for three centuries until an export boom of coffee grown on the rich soils of the interior. The city grew from a population of only 31,000 in 1870 to 21 million today, one of the fastest long-term rates of urban expansion in world history. Now engineers struggle to sustain a water supply that is often too scarce for the needs of the population while during the rainy season—from October to March—water becomes too abundant for a city vulnerable to floods. The cupidity and negligence of politicians aggravate the effects of droughts and floods. São Paulo's governor, Geraldo Alckmin, a former small-town mayor, denies the importance of water shortages while failing to educate voters about the need to invest in water supplies in order to guarantee living standards and survival. Alckmin plans to run for president of Brazil in 2018.

The metropolis has proved insatiable. Water consumption has grown about one third faster than population since 1990, owing both to better living standards and to the widespread waste of water. One of the most appalling examples of this waste is the pollution caused by the untreated sewage of two million squatters who occupy the shores of São Paulo's two oldest reservoirs in violation of environmental protection legislation. The main source of water used by the city comes from a cluster of reservoirs called the Cantareira, which is sixty miles away. Completed in the 1980s, it sends water through a series of canals, tunnels, and pumping stations to a huge treatment plant on a mountain overlooking the city.

Brazil depends heavily on hydropower to produce electricity, which is in turn used to pump water from its dams and reservoirs into the cities. So São Paulo faces both power and water shortages in the dry months as drought spreads to other heavily populated

regions. The same relation between water and electricity is also a global problem. Even before the current drought, one fifth of the electricity used in California, for example, went to moving and treating water. Worldwide, water supply networks and treatment plants consume 10 percent to 15 percent of all electricity produced. According to a group of specialists at the Brazilian Academy of Sciences:

> The water crisis, influenced by changes in climate and hydrology, is aggravated by changes in soil use, by intense urbanization, by deforestation around sources of water and, mainly, by the lack of basic sanitation and treatment of sewage.

These difficulties became clear when I talked to people in former squatter settlements in some of the newer parts of São Paulo, where living standards have risen dramatically over the past two decades. Fear is spreading in these communities. Because of rationing that was not announced by the city authorities, water supplies are cut for several hours each day. In the suburban municipality of Osasco (population 700,000), poor people rise at 3:30 AM to collect water in buckets from faucets that flow for only three hours daily. Pollution and interruption of water supplies have led to epidemics of diarrhea and other intestinal diseases. Some schools close for lack of water in their toilets and kitchens. Luncheonettes, beauty parlors, and factories curtail their working hours. Hospital administrators are anxious about water supplies, especially for the 12,000 diabetics in São Paulo needing hemodialysis three times weekly with specially treated water.

Some people talk of going home to remote communities in Amazonia and the Northeast until the crisis passes. São Paulo authorities ignored years of warnings by federal and state officials of impending water shortages; officials at the state water utility were forbidden to discuss the possibility of rationing as engineers struggled to redistribute the remaining water among local reservoirs to make supplies last through the dry season. It took until August 18 for the São Paulo state government to publicly acknowledge the severity of the crisis.

Many emergency projects are currently running behind schedule because of red tape in the bidding for construction contracts and delays in approvals by many government agencies. Paulo Massato, who manages the water and sewage system for Greater São Paulo, warned of "drastic rotation" (*rodizio*) of water supplies among neighborhoods that could remain without water five days each week. "We'll give vacations," he said ironically. "Get out of São Paulo because there's no water. Those who can will buy mineral water. Those who can't, go take a bath in your mother's house."

In the current drought, Greater São Paulo is receiving one third less water than it usually consumes. The government-owned water and sewage utility, Sabesp, is reducing consumption by lowering pressure in water mains and appealing to the public for conservation; it has ordered its workers in the streets to mechanically cut off supplies to some outlying communities for hours at a time.

But the threat of more severe shortages persists. Sabesp announced that, in an emergency, it could continue to send water to the 1,152 hospitals scattered throughout the metropolis, as well as to 116 hemodialysis clinics and to three hundred prisons and juvenile detention centers. But it could not supply 4,562 schools and other public buildings. To dramatize the scale of the challenge, Sabesp dismissed suggestions that deliveries by tank trucks could overcome shortages in piped water. To supply the 2,200-bed Hospital das Clinicas, Latin America's biggest, with the nearly 800,000 gallons it consumes daily, Sabesp said that three hundred tank trucks each carrying over 2,500 gallons of water would have to rush to unload every five minutes on a twenty-four-hour schedule. Desperate local residents also could interrupt these journeys, hijacking and draining water from the tank trucks.

Randa Bishop/Contact Press Images

The Itaipú Dam, one of the world's largest hydroelectric projects, on the Paraná River at the border of Brazil and Paraguay, 1983

While São Paulo relies on surface water supplies from a large network of reservoirs, Mexico City depends on diminishing groundwater resources as it tries to deal with a perpetual threat that the supply will collapse. Mexico City expanded outward from the dried basin of an ancient highland lake, on a plateau settled by pre-Colombian peoples. Since 1980, Mexico City's population has grown from 14 million to 21 million. The city's water supply depends on aquifers, or underground layers of water-bearing rock into which wells are drilled. Overexploitation of these aquifers, at more than twice the rate of natural replenishment, led to the sinking of land in several parts of the city and the lowering by about one meter annually of the groundwater table (the boundary between higher ground without water and lower ground with water). Losses from leaks in mains and pipes drain the distribution network of one fourth of its water intake.

The quality of Mexico City's water is so bad that it is now one of the world's biggest markets for bottled water. Poor families not connected to the distribution system must get their water from tank trucks at a cost fourteen times greater than the official price for piped water. The overall cost to the population in adapting to failures of the system including improvising with tank trucks, backyard pumps, and bottled water is more than the cost of operating the official system. In its desperate effort to supply the metropolis, the government pumps water 1,100 meters uphill from the basin of the Cutzmala River 110 miles away, consuming as much electricity as is needed to supply power to the nearby city of Puebla, with four million people.

Most great cities—among them New York, London, Paris, Cairo, Vienna, Shanghai, and Mumbai—arose along coasts or the principal rivers of their region. Supergiant cities such as São Paulo, Mexico City, and Beijing are exceptions, and must bring water over great distances in complex and costly engineering projects.

Beijing is at the core of an array of megacities on the North China Plain, where some 260 million people live. In China today there are six megacities of at least ten million people each, with another two expected to join this group over the next decade. Some three hundred of China's 657 biggest cities may well face severe water shortages during the next few years.

Beijing emerged three thousand years ago as a walled city on a dusty plain, where Chinese rulers delivered tributes of silk and silver to placate Mongol invaders, long before Kublai Khan conquered China in the thirteenth century and made Beijing the seat of his own Mongol dynasty. Early in the twentieth century, Beijing maintained low population density with about a million people. By the time the Communists came to power in 1949, its population had grown to four million; since then, it has multiplied fivefold in sudden bursts.

Over the past half-century, the government has built eighty-five dams and reservoirs for Beijing and drilled 40,000 wells in its expanding suburbs. These wells supply two thirds of all Beijing's water, and excessive pumping both of groundwater and underground water has caused the land to sink and gas pipes to fracture. The China Geology Survey reported: "Land subsidence due to excessive groundwater exploitation is a type of regional geological hazard that develops slowly and progresses to a disaster…that is difficult to control." After thirteen years of drought, Beijing's per capita water supply fell to 65,000 gallons annually, far below the threshold of 264,000 gallons that UNESCO uses to determine whether or not a country's supply is adequate.

China's rulers seek to meet this challenge with the South–North Water Transfer Project, the most costly and complex hydraulic engineering effort in mankind's history, which is beginning to send some 12.7 trillion gallons of water yearly from the Yangtze River basin in the southeast to Beijing and other cities in the North China Plain. This volume of water, contained in roughly six hundred miles of canals, mountain tunnels, and pumping stations, is some thirty times greater than the volume carried in normal years by the Colorado River Aqueduct into California and 174 times greater than the water transferred into the Los Angeles aqueduct system each year.

Despite these challenges, Beijing's planners are taking another leap. They are planning the construction of a giant airport, an "aerotropolis," as the hub of yet another satellite city at Beijing's southern outskirts. China has been able to mobilize its financial strength—some $4 trillion in central bank reserves—as well as expertise in hydraulic engineering dating back millennia to carry out audacious undertakings such as the South–North Water Transfer Project and the Three Gorges Dam, the world's largest. But these ventures can provide only short-term relief from growing pressure on water resources that are being depleted.

Sedlak argues that such huge water supply problems pose a serious threat to the continued existence of megacities. "There are few places where there is enough water in the local rivers and aquifers to support the current water demands of a city," he writes in *Water 4.0*. "Perhaps the best long-term solution to our water problems will be to abandon centralized water systems altogether." This is a bold proposition, but not a realistic option. Water has been so important to the growth of cities that decentralization of water systems may mean, in effect, the dismembering of urban agglomerations; but how this might be done is a question that is not addressed. Proposals to decentralize the water systems ignore the scale of the demands of megacities and the concentration of financial resources, skills, and political power needed to manage these complexities.

Many megacities have been living dangerously, allowing the risks of their water supply to accumulate even while they threaten to overwhelm the capacity of local institutions. Politicians are notoriously reluctant to discuss these dangers. However, the challenge of survival may create new priorities as water supplies become more precarious. We can hope that the need to safeguard the volume and quality of water for large urban populations may lead to both improved efficiency of public institutions to conserve supplies and also modernized distribution systems, reducing the scandalous levels of waste in many of them. Such civic mobilization may also require raising the price of water and regulating consumption in order to pay for costly investments. So far, in too many megacities, the water crises are growing just slowly enough to allow their citizens and leaders to avoid confronting the large-scale changes that are needed. What is lacking in policies toward water supplies is a clear sense of purpose. □