Stratfor Water Articles:

**Sao Paulo Drought Could Benefit Brazil**

[**Analysis**](https://www.stratfor.com/analysis)

 FEBRUARY 2, 2015 | 10:15 GMT

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 Text Size

**Summary**

**Editor's Note:***This is the seventh installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

The state of Sao Paulo, Brazil's financial core, remains in a drought of historic proportions, and we expect to continue seeing reports of water shortages in the greater municipal area of the city of Sao Paulo. Further water restrictions and rationing will be necessary if the region does not receive substantial amounts of rain in the next several months. While we may see a small drop in industrial activity, wealthier consumers — residential and industrial — will be able to find and use more expensive alternative sources of water. The shortage may contribute to the slowing of Brazil's economy, but it will not cause a collapse. Rather, the drought will be a relatively short-term water stressor and has the potential to be a catalyst to solve Sao Paulo's larger structural problem of inadequate and inefficient water infrastructure. In the long run, it could even benefit the industrial viability of the city and state.

**Analysis**

The worst drought in nearly a century continues to plague Sao Paulo state and neighboring Rio de Janeiro and Minas Gerais states in southeastern Brazil; the nearly 30 million people living in the extended municipal complex of Sao Paulo have been dealing with extremely low reservoir levels for more than a year. In fact, the water reserves have fallen so low that they are now below the dead level, the point at which the water must be pumped up to reach the pipes connecting the reservoir to the greater distribution system. In late 2014, the Cantareira system [authorized the use of its second quota of dead volume](https://www.stratfor.com/analysis/brazils-drought-has-political-implications). The system is at roughly 5 percent of its capacity and is considering authorizing a third quota. If usage continues and the reservoir is not replenished, projections indicate that it will run dry by September. Other reservoirs supplying the city have also declined over the past year, including the Alto Tiete, which like Cantareira has approved the use of its dead volume.

In 2014, the state government began [providing financial incentives](https://www.stratfor.com/blog/letter-brazil-sao-paulos-long-dry-spell) to encourage more efficient water use. Usage declined by 17 percent, but larger decreases will be needed until the drought comes to an end. Residents and industries in other states impacted by the drought are also being asked to decrease their consumption.

The measures may not be enough. We are already seeing reports and anecdotal evidence of limited water availability in Sao Paulo, from limited flow to lack of availability in whole neighborhoods. The consumer will feel the greatest impact of the water shortages, but it will not be just households that will have to adjust. Large commercial consumers of water such as the petrochemical, steel, ethanol and textile manufacturing industries in Sao Paulo state account for approximately 70 percent of Brazil's total industrial water use. These businesses have made adjustments that include reducing amenities in restaurants, rescheduling maintenance or even reducing production. So far, shifts in supply chain and production have mitigated the economic impacts of the drought. Still, the Water Resources Group, a collaboration between a variety of industry and think tank representatives, expects industrial water use to grow by about 2 percent a year through 2030. In particular, the petrochemical industry is projected to increase its water usage from 0.6 billion cubic meters to 1 billion cubic meters per year while steel-related activities double their consumption to more than 500 million cubic meters per year.

While the state governmental body in charge of managing water, Sao Paulo State Sanitation Co., or Sabesp, has been reluctant to admit that water rationing will be necessary, it is the most likely short-term solution available. On Jan. 7, Sabesp announced a contingency tariff to penalize above-average water use. The tariff rate would increase by 40 percent if a customer were to use between 0 and 20 percent more than the previous year's average consumption rate. Any additional water consumed above the 20 percent threshold would be taxed at a rate increased by 100 percent. Sabesp went further Jan. 27 when it admitted that it had already reduced water pressure in several neighborhoods from 1 p.m. to 7 a.m. The next day, the government of Sao Paulo state admitted that severe rationing, up to five days at a time, might be necessary in a worst-case scenario. However, it is still unclear when and how rationing might be implemented and if it would impact only areas served by the Cantareira system.

The news is not all bad, however. Though precipitation levels are below normal, Brazil is in the middle of its rainy season, which typically lasts from October through March. The wettest months are December through February, meaning that some relief may be on the way. The Cantareira system stabilized for seven days before falling slightly on Feb. 1, and the Rio Claro, Alto Tiete and Rio Grande reservoirs have seen slight increases in their volumes in recent days. Given the severity of the drought, full recovery will require more prolonged precipitation likely many months, if not years, away.

**Short-Term Response and Implications**

As long as the drought places restrictions or rationing on traditional supplies, industries and municipal consumers will seek out alternative water sources, including drilling new wells to access groundwater or building systems to reuse water. However, these solutions will be more expensive for a variety of reasons. Building new infrastructure requires capital, and some alternative sources require additional purification or transfers from other from basins, measures that increase costs.

Some of these alternative sources can be accessed more quickly than others, sometimes in a matter of weeks or months. (In 2014 alone, the greater municipal area added more than 400 new wells.) Sao Paulo's federation of industry is already conducting feasibility studies for groundwater extraction, and the mayor of Sao Paulo has said that if the drought intensifies, the city will hold auctions for groundwater extraction projects to access additional volumes. Sabesp will start receiving water from the Guaratuba River beginning Jan. 27 to partially replenish the Alto Tiete system.

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Other large projects include building a 15-kilometer (9-mile) connection that will bring water from the Paraiba do Sul River Basin to the Cantareira system. Sabesp approved the $319 million project Jan. 30. Another project is a system to transfer water from the Billings reservoir system. However, these projects will take longer to implement, and they will not begin to relieve Sao Paulo's water problems until 2016 or later.

The drought will not cause a catastrophic failure, but it will put pressure on an economy that is already [on the verge of recession](https://www.stratfor.com/analysis/difficulties-facing-brazils-new-export-plan). Many sectors, but primarily hydroelectric energy generation, will be affected. Thermal power plants have been filling the energy gap since last year, but the switch has been costly and will likely require Brazil to import more natural gas in the future, an expensive proposition. In addition to importing the fuel, maintenance is quickly emerging as a problem. Many thermal plants have been operating at or near capacity while postponing routine maintenance, further straining the aging electrical grid.

The latest polls show that 61 percent of the population blames Sabesp for the water shortages, and the threat of instability looms as long as shortages continue. Many of the short-term solutions to access alternative sources of water will be expensive and will be available only to consumers with enough money to afford the price increases, be they wealthier people or industrial firms. Social unrest could develop and the number of protests could increase in the coming months, especially because Brazil's political climate is [primed for such demonstrations](https://www.stratfor.com/analysis/protests-will-test-brazilian-governments-resolve).

**Potential Long-Term Benefits**

Still, the drought is only the manifestation of larger structural problems with water management in Sao Paulo state. Even before the drought began, a gap between renewable, sustainable supply and demand for water was emerging. In order to address the problem, Sao Paulo must now implement a multifaceted approach, including resolving efficiency issues with industrial and urban water consumption in addition to increasing its supply by extracting additional groundwater and transferring supplies from other basins. Reducing the leaks in shared water infrastructure could save 300 million cubic meters of water a year, or roughly 6 percent of total municipal consumption. Wastewater reuse, primarily from industry, could save another 80 million cubic meters annually.

These long-term solutions will be costly, however. The Water Resources Group estimates that implementing these solutions — transferring water from other basins, using more groundwater, reducing pollution and improving efficiency — will cost at least $285 million a year.

While problematic, the drought and its ensuing water shortages have drawn attention to the larger structural problems of water management in Sao Paulo state. As is often the case with water-related issues, there was little impetus to implement necessary changes because there was no immediate consequence for doing nothing. Even when used inefficiently, water was available to the end user, creating little incentive to invest in improvements with little immediate return — an estimated 86 percent of the proposed solutions had a payback time of more than five years. Now, the drought may provide the necessary momentum to bring attention to the state's water problem and begin implementing a solution.

Coping with the drought will be difficult. In the short term, Brazil will likely see reduced economic output from Sao Paulo, a development that will stress its already strained economy. Failure to address structural problems with water infrastructure could contribute to further economic decline in the state. But in the long term, this could be a blessing in disguise. The drought is bringing a long-term problem to light and could act as a catalyst to direct much-needed investment to water infrastructure, especially if there is social and political pressure to do so.

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**Mesopotamian Vitality Falls to Turkey**

[**Analysis**](https://www.stratfor.com/analysis)

 JANUARY 5, 2015 | 10:15 GMT

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**Summary**

**Editor's Note:** *This is the fifth installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Controlling the headwaters of the Tigris-Euphrates river basin gives Turkey leverage over its neighbors' water security. Turkey has talked about utilizing its water resources since the country's founding, but only since the mid-20th century has the government actively worked to develop the necessary infrastructure needed to capitalize on its advantage and boost the country's energy and agricultural sectors. Though Ankara is focused on [the Islamic State's recent advancements](https://www.stratfor.com/analysis/middle-eastern-powers-consider-their-roles-against-islamic-state) in the region*,* large water management projects are potential indicators of Turkey's long-term regional role.[The country hopes to maintain influence and power over its regional neighbors](https://www.stratfor.com/geopolitical-diary/turkey-struggles-define-its-regional-role), but its Kurdish population on and around its southern border will act as the nation's Achilles' heel.

Though water management is not necessarily Ankara's foremost concern, in the long term, water issues will contribute to conflict with neighboring states that rely on the Tigris and Euphrates. Water management will also be a source of tension for minority populations within Turkey, [especially the Kurds](https://www.stratfor.com/weekly/turkey-kurds-and-iraq-prize-and-peril-kirkuk). The massive hydropower undertaking called the Southeastern Anatolia Project demonstrates that Turkey is willing to use water infrastructure projects to manage internal minority populations. Stratfor expects this management strategy to persist and for water to be used as a political tool domestically and abroad.

**Analysis**

The Tigris and Euphrates river system, part of the fertile crescent of the ancient world, has historically helped make Mesopotamia a regional breadbasket. Archeological findings indicate that artificial water management of the rivers dates back to antiquity. The headwaters of both rivers begin in the mountainous Turkish region of Anatolia. The Euphrates then flows out of Turkey and into Syria, where it is joined by two major tributaries before flowing into Iraq. Roughly 90 percent of the Euphrates' flow originates inside Turkish borders. Turkey provides 51 percent of the annual water volume that eventually combines to make up the Tigris. Tributaries within Iraq's borders, many of which are located in the Kurdish region, contribute another 39 percent of the total flow; the remaining 10 percent comes mostly from tributaries that start in Iran.

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Like rivers in many arid regions, flow levels for the Tigris and Euphrates vary highly from season to season and year to year. Given their erratic nature, the rivers' exact natural flow rates are sometimes debated. However, the long-term average flow of the Euphrates is around 32 billion cubic meters per year, and the Tigris' average flow is around 52 billion cubic meters per year.

Given the wide fluctuations in flow, using the rivers for irrigation would be difficult without some artificial management. This is especially true for the Tigris. Recent droughts, poor water management and population increases throughout the region have placed significant stress on the basin's water resources. Studies from NASA showed an alarming decline in water levels throughout the basin between 2003 and 2009. Considering the area's heightened water stress, efforts to further utilize the available resources, especially in upstream Turkey, will likely be met with objections from the downstream nations of Syria and Iraq, as well as from the Kurdish population in Turkey and along its borders. Thus, water availability will be a geographic constraint in the unstable region and will factor into Ankara's quest to define itself as the regional power.

**The GAP Project**

Construction of the Keban Dam in Anatolia began in 1966 and was completed in 1974. The project signaled the beginning of a prolific dam building period, which became the staple of Turkish engineering and which culminated in what would eventually be called the large Southeastern Anatolia Project, known by its Turkish acronym GAP. The project was the physical manifestation of research and planning conducted in the 1980s on the potential of hydropower. Originally, the project included plans for 13 irrigation and hydropower systems, including 22 dams and 19 hydropower plants on the Tigris and the Euphrates. GAP seeks to eventually provide irrigation to nearly two million hectares — an area roughly the size of Israel — throughout the region to boost the economic output of a historically poor part of Turkey.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/turkey_dam_gap_v2%281%29.jpg)

To date, Turkey has provided the majority of the funding for the project, a reported $24 billion of its $32 billion budget. However, Ankara recently announced the cancellation of foreign irrigation deals associated with the project. GAP has also seen numerous delays in construction and investment, in part because investors are concerned that Turkey has not given enough consideration to the regional implications of its actions. The setbacks indicate that the project may be decades away from completion.

Turkey has a natural geographic advantage as the upstream nation in the Tigris-Euphrates basin, and water management projects enable the country to leverage some of this ascendancy. One of Turkey's geopolitical imperatives is to secure southeastern Anatolia, a capital-poor, parochial and introspective region that geographically lends itself to the development of independent cultures. The region is difficult to control, but it provides an ample buffer against possible attacks from the Asian continent. Managing the population of this region, especially the Kurdish areas, has been [a constant struggle for Turkey](https://www.stratfor.com/weekly/turkey-kurds-and-iraq-prize-and-peril-kirkuk).

**Containing the Kurds**

One of the major goals of GAP is to increase economic activity and social progress in southeastern Anatolia, where the majority of the population is Kurdish. On paper, the program will greatly benefit the region by increasing employment opportunities and by funding healthcare, education and infrastructure programs. However, domestic and international environmental and heritage groups have vigorously opposed many elements of the project, especially the Ilisu Dam, because of the potential for flooding that could destroy historical and archeologically important sites and possibly displace populations without appropriate compensation. Opponents of the project also question Ankara's motivation, suggesting that GAP may be used to subvert the Kurdish identity.

While the increase in irrigated acreage resulting from the project has helped Turkish cotton production rebound to one of its highest levels since the mid-2000s, it has also increased soil salinization in the region, a development that could impact the long-term viability of the project. Furthermore, many of the economic benefits of GAP have been felt outside the region because of completed hydropower projects. (The 85 percent completion rate for hydropower projects is much higher than the 24 percent rate for irrigation projects.)

Still, it is clear that the design of some of the proposed dams along the border with Iraq and Iran is meant to make cross-border movement more difficult for Kurdish militants. Moreover, the local Kurds' resentment toward the Turkish government over their exclusion from the project and over environmental concerns continues to sow discontent.

Turkey's strategy to contain the restive Kurdish population's aspirations extends beyond its borders. The Kurdish region that overlaps Turkey, Syria, Iraq and Iran will be the battleground where Ankara and Tehran fight for influence over the next several years. Turkey's water management programs, influenced by political considerations, will add stress to relations with Iraq.

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Historically, there has been a lack of formal agreements between Iraq, Syria and Turkey, adding a level of uncertainty to future water availability in the basin. The last formal treaty regarding water between Turkey and Iraq was made in 1946 — before the majority of the dams was constructed — and required Ankara to consult Baghdad before altering the flow of the Euphrates. In the 1980s, Turkey informally agreed to ensure Syria a minimal flow of 15.8 billion cubic meters of water per year from the Euphrates in exchange for help controlling Kurdish rebels. Syria and Iraq came to an agreement in 1990 in which Iraq would receive approximately 60 percent of the 15.8 billion cubic meters per year Syria received from Turkey.

In 1990, however, the flow of the Euphrates was reduced by more than 75 percent — an effective stoppage — to fill the Ataturk Dam's reservoir. This cutoff realized downstream nations' worst fears, making them hesitant to concede full control of the Euphrates' flow to Turkey. Since 1990, the 15.8 billion cubic meters per year requirement has, for the most part, been fulfilled, though Iraq complained in 2009 that Turkey had allowed the levels to fall below 9.5 billion cubic meters per year. Iraq also claims that 15.8 billion cubic meters per year is insufficient to sustain irrigation levels, although some studies suggest this amount is enough for the needs of Iraqi agriculture, especially if water from the Tigris is also used.

Turkish manipulation of Iraq's water supply for political gains will contribute to the broader regional dynamic. Tension will likely rise between Baghdad and Ankara over the long term as Iraq's agricultural sector continues to decline and a rising population puts pressure on the Iraqi government. Turkey's growing need for energy, which will probably be [satisfied in part by the Kurdish autonomous region of Iraq](https://www.stratfor.com/analysis/iraqs-kurds-baghdad-take-shaky-step-toward-compromise), will enable Baghdad to bargain with Ankara over water rights. Maintaining oil exports will be essential to Baghdad's ability to hold Iraq together and to negotiate effectively with its neighbors. Water availability is unlikely to impact Iraq's ability to produce and export oil because operators are already exploring low-water and saltwater options for extraction. Even though Iraq will face significant challenges in the years ahead, substantial oil revenues will underpin the central government in Baghdad, likely [preventing the country from completely fragmenting along sectarian lines](https://www.stratfor.com/geopolitical-diary/iraqs-new-government-must-unify-defeat-islamic-state).

In the short-term, as Turkey is forced to confront [the issues the Islamic State creates on its borders](https://www.stratfor.com/geopolitical-diary/why-turkey-will-not-help-kobani)while also attempting to assert itself as the regional power, water will not necessarily be Ankara's foremost concern. But GAP will likely continue to be one of the more subtle tools Turkey uses to assert its power in the region, to manage its Kurdish population and to shape Syria's future.

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**Industrial Expansion Will Strain Mexico's Water Resources**

[**Analysis**](https://www.stratfor.com/analysis)

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**Summary**

**Editor's Note:** *This is the eighth installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Much like its [northern neighbor](https://www.stratfor.com/analysis/us-agriculture-wilts-during-california-drought), Mexico is not water scarce when viewed as a whole. But unequal water distribution has led to significant water stress in several parts of the country. Supply has been further strained by poor infrastructure, pollution and overuse — partly attributable to inefficient management and a growing population. Still, Mexico is positioned to experience significant economic growth because of its proximity to the United States and the likely expansion of its [manufacturing sector](https://www.stratfor.com/analysis/mexico-new-manufacturing-heartland) as the country's population increases.

Recent changes to the constitution to encourage much-needed investment in the country's energy sector will further aid the faltering sector. Asymmetrical distribution and increased competition for limited water resources, however, could temper Mexico's potential for growth. Growth is still possible without addressing the problem, but it must be dealt with if Mexico hopes to fully utilize its geographic advantages, especially in the industrial and manufacturing sectors. In addition to the other obstacles that must be addressed, Mexico will need to make policy and behavioral adjustments to overcome its current water scarcity issues.

**Analysis**

[Mexico is constrained by its geography](https://www.stratfor.com/analysis/geopolitics-mexico-mountain-fortress-besieged), which consists of a limited core territory located on a plateau, surrounded by difficult-to-control mountains, desert and jungles. Rivers cut accros the terrain, headed to the Pacific Ocean, the Gulf of Mexico and towards the United States to meet the Rio Grande. In the south, much of the supply comes from Central America. Major rivers and lakes, including Lake Chapala and Lake Cuitzeo, provide surface water for Mexico's 122 million people. Groundwater from 653 aquifers provides roughly one-third of Mexico's approximately 460 billion cubic meters a year of natural renewable water resources. On paper, Mexico is not a water-scarce nation: It has 3,776 cubic meters of water per person per year. However, water is not equally allocated geographically.

The northern and central parts of the country are much drier than the southern region. But the majority of Mexico's population and economic production is located on the comparatively water-scarce central and northern plateau. In fact, 28 percent of the country's total renewable water is located in regions that produce 77 percent of Mexico's GDP and house 68 percent of its population. Furthermore, pollution — especially in the north — decreases the available usable water; nearly half of the available water in Mexico City is classified as heavily polluted. Mexico's sustainable and available water equals just less than 67 billion cubic meters per year, yet demand exceeds 78 billion cubic meters. This means that Mexico is overdrawing and dipping into the ecological flow to the tune of 11.5 billion cubic meters per year. Without a change in other variables, this gap is projected to reach 23 billion cubic meters per year by 2030 as demand grows.

Water stress is not a new problem in Mexico and the roots of current patterns of use can be traced back to the first half of the 20th century. "Ejidos," or communal farms, were instituted in the 1930s and were eventually established throughout the country. Evidence of over extraction in the aquifers was first noted around the same time, and the problem worsened between the 1940s and 1960s during the Green Revolution, when technology transfers and financial aid were provided to the developing world and significantly increased agricultural production, including in Mexico. Today, agriculture remains Mexico's most water-intensive industry, accounting for 77 percent of total use. The industrial and municipal sectors account for the remaining extractions.

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In the southeastern portion of the country — including in the Balsas, Southern Pacific and Lerma-Santiago-Pacific hydrological administrative regions — agriculture is the primary industry. The Lerma and the Balsas regions in Mexico's southwest are both classified as high water-stress areas, and threats to the water supply could lead to social unrest as local populations protest actions perceived to threaten the water supply. A social organization in Cacahuatepec has already emerged to oppose a dam on the Papagayo River, and additional social instability could result if water availability decreases to the point where current farming practices are no longer profitable. Moreover, a loss in profitability could push agricultural communities to become more economically reliant on criminal activity.

**More Manufacturing, Less Water**

Water stress is a limitation that Mexico will be forced to overcome to reach its full economic potential. Still, Mexico is on the verge of economic growth in the manufacturing and energy sectors in the coming years. Mexico's increasing population and proximity to a large consumer base in the United States leave it [poised for success as a manufacturing base](https://www.stratfor.com/weekly/pc16-identifying-chinas-successors). However, the growing population is a double-edged sword when it comes to water. Mexico's capital, with a population of more than 21 million people in the greater metropolitan area, is representative of the effects of water scarcity and stress because of overuse in the nation. Mexico City's water supply is insufficient. The water stress index there is high at 132 percent, and other studies indicate that extraction rates are even higher at about 182 percent of the supply, meaning that each year more water is used than is replenished by nature. Inadequate infrastructure and lack of wastewater treatment add to the pollution. The city requires water to be pumped in over large changes in altitude to meet demand — an expensive solution to what will only be a growing problem as the population increases.

The oil and natural gas industry will soon begin seeing the benefits of [a recent constitutional change](https://www.stratfor.com/analysis/mexico-moves-toward-political-and-energy-reforms)that allows foreign investment into the country, a necessary step given the lack of technological know-how within and the mounting financial pressure on state-owned energy company Petroleos Mexicanos, or Pemex. The real prize from [energy reform](https://www.stratfor.com/analysis/mexico-moves-open-its-energy-sector) will be offshore deep-water targets that use treated seawater. Still, water competition could play a role if or when unconventional fields are developed in the northern and central parts of the country. While some of these contracts are currently up for bidding, larger levels of exploration and production will not occur for several years, by which point waterless fracking (or other water-efficient techniques) already utilized in the United States will likely become more prevalent. Moreover, low oil prices could delay bidding on some unconventional projects. In the short term, it will be the manufacturing, municipal and agricultural sectors that will compete the most for Mexico's limited water resources.

The inception of the "maquiladora" program in 1965, bolstered by the [North American Free Trade Agreement](https://www.stratfor.com/weekly/nafta-and-future-canada-mexico-and-united-states) in 1994, has made manufacturing a key part of Mexico's economy. The maquiladoras are manufacturing operations set up in free trade zones with tax benefits that import raw materials for assembly and then export to the large U.S. market. But these operations have worsened water stress as competition, especially along the border, has significantly increased water pollution. Industry consumes more than 3 billion cubic meters of water per year, and the increase in pollution decreases the usable supply, though it is difficult to determine to what extent. Pollution from industrial activity, stemming from things such as the solvents used in the manufacturing process, can threaten surface water sources by lowering the purity of the water.

Mexico's industrial sector is already showing signs of its potential by shifting toward higher-end products such as electronics and automobile assembly. In Monterrey, electronics manufacturing is the largest industrial sector, but the San Juan Basin, in which the city is located, has less than 500 cubic meters of water per person per year. Groundwater sources in the basin are also showing signs of overuse. Still, manufacturing is expected to remain an integral part of the Mexican economy, and the industry will continue to compete for the limited water resources in the north.

**Considering Solutions**

There is a substantial framework in place to ensure the improved and appropriate use of water: the National Water Commission (Comision Nacional del Agua, or Conagua), a large agency that is the sole federal authority on water. The Law of National Water in 1994 sought to modernize the sector and decentralized management responsibilities. However, more than 20 years later, the implementation of efficient management is still a problem. Permits and other regulations are not readily enforced, overlaps in concessions and overexploitation remain and infrastructure is in disrepair or is inadequate in many areas. Furthermore, the federal water management budget is inadequate to fund the necessary modernization.

Much of the water in northern Mexico is subjected to water sharing agreements with the United States. Mexico is in a stronger position in terms of the flow of the Rio Grande than it is for its other major shared river with the United States, [the Colorado River](https://www.stratfor.com/analysis/us-mexico-decline-colorado-river). However, the 1944 treaty, which governs shared surface water distribution between the United States and Mexico, decreases the amount of water available from the Rio Grande for use in Mexico, increasing competition along parts of the border. To better utilize the limited water resources and to mitigate future constraints because of water scarcity, Mexico City will likely need to adjust the water sector policy to increase investment, as it has done with [energy and electricity](https://www.stratfor.com/analysis/mexican-electrical-reforms-will-spur-development). Investments into desalination plants could benefit coastal populations but are an expensive option, at least in the near term.

As for long-term solutions, there likely will not be a complete renegotiation of the 1944 treaty, which has only been modified through minutes to make relatively minor adjustments or clarifications. Without some sort of change, Mexico's water stress levels will only continue to grow, and competition for water — though only one of many obstacles facing Mexico — could limit the country's future growth.

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* Part 7: [Sao Paulo Drought Could Benefit Brazil](https://www.stratfor.com/analysis/sao-paulo-drought-could-benefit-brazil)

**Water Use Reform Will Be Difficult for Fractured India**

[**Analysis**](https://www.stratfor.com/analysis)

 JANUARY 28, 2015 | 10:00 GMT

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 Text Size

**Summary**

**Editor's Note:** *This is the sixth installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Because of its massive river systems and variety of climates, India is not always the first country that comes to mind when considering water stress issues, but the emerging regional powerhouse is still an agrarian society at its core. This already inefficient sector relies on inconsistent monsoons and, in some locations, on groundwater to make up for years with deficits in rainfall. Increasing urbanization and population growth have compounded demands for municipal water and increased agricultural production. By 2030, India is projected to consume nearly 1.5 trillion cubic meters of groundwater annually — more than its estimated 1.1 trillion cubic meters of usable reserves. As New Delhi faces a major challenge in managing this essential resource, India's highly decentralized system will make it difficult for the central government to effectively manage the problem.

**Analysis**

The [history of the Indian subcontinent](http://www.stratfor.com/analysis/geopolitics-india-shifting-self-contained-world) has been shaped by water. To the southeast and southwest, India's coastlines front the Bay of Bengal and Arabian Sea, while to the north, the Himalayas separate the country from Eurasia. Inside this self-contained world, a multitude of rivers have produced a variety of powerful city centers as well as the internal divisions that have resulted in India's strong regional identities — identities that centralized powers have always struggled to balance.

Today, one of New Delhi's core geopolitical imperatives is to control the fertile Ganges River Basin, which is key to [maintaining the country's agricultural sector](http://www.stratfor.com/analysis/indias-search-greater-food-security#axzz3Gh1RkV6U). Agriculture accounted for 18 percent of India's gross domestic product in 2012 and employs about half of the country's population. It also accounted for more than 90 percent of total water withdrawals. While India does possess natural renewable water resources that total roughly 1.9 trillion cubic meters, rainfall distribution is naturally erratic and dependent on seasonal monsoons, leaving agricultural production highly susceptible to fluctuations. The 2014 monsoon season officially concluded at the end of September with cumulative rainfall 12 percent below the long-term average. Increased rainfall near the end of the season meant that more dire predictions from earlier in the year did not come to pass, but many crop production estimates for 2014-2015 are still expected to fall year-on-year.

**Water Stress**

The Indian agricultural sector's reliance on groundwater irrigation to maintain crop yields, especially in weak monsoon years, has been steadily increasing since the 1950s. Over the past 20 years, 84 percent of added irrigation has come from groundwater sources. Today, 50-70 percent of India’s crops rely on irrigation — an estimated 60-80 percent of which uses groundwater. India's use of these resources is also extremely inefficient. The amount of water it takes to produce one ton of grain in India is 24 percent higher than the global average for both wheat and rice.

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Further exacerbating the water scarcity problem is the fact that not all of India’s water supplies are usable; much of the supply has been compromised by pollution or fertilizer use. Inadequate infrastructure prevents the use of some of the annual renewable water resources as well. India’s Ministry of Water Resources estimates that only 1.1 trillion cubic meters of the country's total 1.9 trillion cubic meters of natural renewable water resources are usable. Independent studies put this number at 650 billion to 750 billion cubic meters, less than half of India's total annual renewable amount.

The greatest evidence of groundwater depletion can be seen in India's north, an area that includes the fertile Indus and Ganges basins. New Delhi has made this worse by applying only limited regulation to groundwater extraction and by subsidizing electricity, which, among other things, helps makes pumping water more affordable. At the same time, the municipal sector has come to rely on groundwater to meet more than 80 percent of the urbanized population's growing demand.

India's current water withdrawals add up to between 630 billion and 760 billion cubic meters per year, and this is set to expand. India’s population is increasing at an average annual rate of roughly 1 percent, and urbanization rates are high, at 31 percent in 2010 and projected to rise to 43 percent by 2035. The government is also working to increase access to electricity and maintain food security, both of which will require steady water supplies. All of this will contribute to a projected rise in annual water demand to nearly 1.5 trillion cubic meters by 2030 — a number higher than India's existing usable water resources (which the government generously estimates to be around 1.1 trillion cubic meters) can meet. By 2030, most of India’s many river basins could face gaps between supply and demand. At the same time, the nation's per capita annual water supply fell to around 1,500 cubic meters in 2011. This is projected to approach the water scarcity line of 1,000 cubic meters per person by 2050.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/india_water_demand.jpg)

At the same time, these declines in groundwater levels could actually increase India's water demands by speeding up the rate of urbanization. As groundwater levels decline, wells become more expensive to drill and operate, meaning that more farmers will not be able to afford to water their crops using groundwater. This has already driven many subsistence farmers off the land and into cities. The urban population will increase pressure to supply municipal water and will strain the agricultural sector as India tries to maintain food security in the face of its growing population.

**Constraints on the Center**

India's water constraints will continue to worsen, but the change will be long and gradual, stretching out over several decades. The situation could ease if the country shifts its water consumption patterns or if New Delhi changes its water management policies, perhaps by regulating well drilling, implementing new water-efficient irrigation technologies or making improvements to water infrastructure. Such programs, however, will face the barrier of India's regional political fractures, which [make central management difficult](http://www.stratfor.com/analysis/indias-prime-minister-comes-washington#axzz3FekMchA5). Programs to increase efficiency or improve water management policies, such as the implementation of more efficient irrigation practices, would likely have to be implemented at the state level, resulting in regional (not national) solutions.

Indian Prime Minister Narendra Modi, despite hopes to the contrary, will likely be [limited by these same geopolitical constraints](http://www.stratfor.com/analysis/geopolitics-india-shifting-self-contained-world#axzz3GhRngj6Y). New Delhi might manage to make a slow push for higher efficiency by [reducing subsidy schemes](http://www.agrimoney.com/news/raised-india-nutrient-subsidy-bodes-ill-for-prices--7266.html), as it has done for [phosphate-based fertilizers](http://in.reuters.com/article/2013/05/01/india-fertiliser-subsidies-idINDEE94006H20130501). The phosphate fertilizer subsidy reduction showcases the difficulty of this approach: Other fertilizers are still subsidized, meaning that the problems of pollution and inefficient use or overuse of fertilizers remain. Modi is still unwilling or unable to adjust the broader fertilizer subsidy framework that plays a large role in perpetuating poor agricultural practices.

The slow and fractious nature of the reform process means that over the next 20 years New Delhi will continue to cope with increasing water stress. At the present time, India is essentially self-sufficient in agriculture. However, over the next decade, it is likely to become a food importer. Inadequate supply chain infrastructure will impede efficient food distribution. To maintain social stability in the face of this challenge, New Delhi will likely have to sacrifice some economic growth and possibly take on additional debt as its import bills rise.

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**Indonesia's Disjointed Islands Make Water Scarcity a Problem**

[**Analysis**](https://www.stratfor.com/analysis)

 DECEMBER 29, 2014 | 10:15 GMT

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 Text Size

**Summary**

**Editor's Note:** *This is the fourth installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Indonesia is in a transitional period as new President Joko "Jokowi" Widodo attempts to improve governance, fight corruption and centralize government regulations. Like his predecessors, however, Jokowi will struggle with the geographic constraints inherent to Indonesia. While Jakarta is poised to benefit from [China's shift away from low-cost manufacturing](https://www.stratfor.com/weekly/pc16-identifying-chinas-successors) and to increase Indonesia's own domestic value-added industrial sector, water availability will continue to be an underlying constraint that must be overcome. Failure to improve and expand infrastructure, including projects intended for water management, will hinder Indonesia's potential for future economic growth.

**Analysis**

Indonesia's population continues to grow and the country seeks to increase its industrial output through value-added industries following new export restrictions on raw materials. In the face of these developments, improvements in water management and related infrastructure will be an important factor in Jakarta's future economic success.

**Current Water Stress**

Statistically speaking, [Indonesia](http://www.stratfor.com/regions/asia-pacific/indonesia) is not a water-scarce nation. Its more than 2 trillion cubic meters of internal natural renewable water resources per year means roughly 8,000 cubic meters are available to every person annually. However, because of the diverse and disjointed nature of the island nation, this does not necessarily translate to assured availability of the resource. Indonesia's water resources are not evenly distributed between all of the islands, and water availability does not correspond with population distribution. Indonesia's most populous island of Java, for instance, is home to more than half the country's total population, but it contains less than 10 percent of the country's total water resources.

Not only are resources unevenly distributed throughout the country, they are unevenly distributed throughout the year, making Indonesia vulnerable to seasonal variations in water supply. A lack of adequate storage intensifies water stress during the drier June to September months. Additionally, the Solo and Brantas river basins in eastern Java are among the world's 15 most stressed, according to the World Resource Institute.

Furthermore, the majority of the available renewable water is surface water, but because the rivers are often highly polluted and subject to flash flooding during the wet season, groundwater is often the preferred water resource for both municipal and industrial consumption. This is especially true in urban areas, where groundwater is the source of clean water for 74 percent of households. Overuse has led to increased salinity in reserves near the capital city of Jakarta and has also led to a land subsidence rate, which is the settling or sinking of land when underground material such as water is moved, of up to 34 centimeters per year in east Jakarta.

Currently, roughly 85 percent of Indonesia's population has access to improved water resources, although only about 20 percent of the population has household connections. However, this does not necessarily translate to ensured access to clean water resources. Many areas, in fact, continue to lack access to improved sanitation. Only about 60 percent of the population has access to clean drinking water, and an estimated 75 percent of the rivers are classified as highly polluted. As the population continues to grow, demand for clean water is projected to increase by 47 percent by 2015.

In addition to an increasing municipal demand, water demand from the industrial sector is also expected to grow. For instance, the smelting process — one of the industries Indonesia seeks to develop — consumes large amounts of water. The municipal and industrial sectors will also have to compete with the agricultural sector, which remains the nation's largest water consumer, accounting for 81 percent of total withdrawals, especially as Indonesia seeks to implement a self-sufficient food strategy. Water shortages will likely continue to act as a constraint on Indonesia's economic growth potential.

**Attracting Foreign Investment**

This chronic mismanagement of water resources through lack of investment in infrastructure, overuse and pollution means that recent reports of localized water scarcity for both human consumption and agriculture are part of an ongoing issue Jokowi will not be able to ignore. Mitigating Indonesia's water stresses, however, will not be easy.

Upgrading and expanding Indonesia's water infrastructure will be an expensive endeavor. Estimates indicate that reaching the target to ensure clean water access to the entire population by 2019 could cost as much as $57 billion. The Indonesian government will not be able afford such an undertaking on its own and will have to rely, at least in part, on foreign investment.

However, attracting such foreign investment will be difficult. Investment in infrastructure projects does not always translate to immediate returns, especially for water management projects. As a result, many of the projects improving water availability in Indonesia are small and localized, focusing on humanitarian goals such as ensuring adequate drinking water for village populations. An example of this is Panasonic's recent efforts to provide pumps and other clean water facilities.

Attracting foreign investment is made more difficult by Indonesia's economic history. Since declaring Independence in 1945, Indonesia has swung between periods of economic nationalization and substantial inflows of foreign capital into areas such as resource extraction and manufacturing. While Indonesia is not expected to begin nationalizing industries or implementing harsh taxation policies, new restrictions on banking and plantations, as well as nationalist rhetoric in the recent presidential campaigns, indicate the country could swing back toward economic nationalism. Also, foreign ownership is being restricted in key investment areas such as the mining sector. As a result of these internal factors, coupled with unstable global economic conditions, foreign capital will remain standoffish with Indonesia for at least the next year or two.

Complicating matters further is Indonesia's push toward a more value-added model to supply both domestic and export markets. The country's established economic model relies on the export of raw materials, but its surplus of cheap labor and access to markets positions it to [capitalize as manufacturing shifts away from China to lower-cost nations](https://www.stratfor.com/weekly/pc16-identifying-chinas-successors). As part of an effort to boost value-added sectors, Indonesia implemented a [new mining law in 2014](https://www.stratfor.com/analysis/indonesia-struggles-export-ban), among other tightened regulations, that restricted the export of some raw materials and banned the export of others that have not been processed. The more stringent regulations will likely make attracting foreign direct investment more difficult, especially in the short-term. While it is possible that some adjustments will be made to the implementation of the mining law, the majority of these new regulations is expected to remain in place under the Jokowi-led government.

**A Diverse Island Country**

[Indonesia's unique geography](https://www.stratfor.com/video/indonesias-geographic-challenge) will present an obstacle to achieving these economic priorities as well. Because it is the world's largest archipelagic nation, formulating and successfully implementing a single national policy for Indonesia will be complicated.

As the new administration seeks to develop its economy, the ability to implement infrastructure improvements, including upgrading water management systems, will be required. Jokowi will need to make serious progress in resolving these issues during his first five-year term. Policy priorities will include redirecting expenditures on fuel subsidies to more productive areas of social spending and reducing government corruption. It is unclear whether Jokowi can duplicate on a national scale the success he achieved as mayor of Jakarta and Surakarta. Still, if he can implement these reforms, Indonesia will be able to benefit from its surplus of workers and access to markets.

Ultimately, continued water shortages will likely act as a constraint to Indonesia's economic growth potential. Because of the diverse nature of the island country, there will not be a universal solution to meet growing water demand and foreign investment will likely be required. But as the new administration seeks to benefit from China's economic shift with an increased focus on value-added industries, the ability to implement infrastructure improvements and expansions — including water management systems — will be a crucial factor in Jakarta's future success.

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**South Africa's Water Needs Will Be Costly**

[**Analysis**](https://www.stratfor.com/analysis)

 DECEMBER 26, 2014 | 08:56 GMT

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**Summary**

**Editor's Note:** *This is the third installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Over the coming decades, South Africa will face constraints associated with water availability that will have a broad impact on its economy and could temper economic growth. The water-intensive coal power production and mining sectors in particular will be impacted as South Africa is forced to resort to more expensive or imported sources of water. Agriculture, which remains the country's largest water-consuming sector, will likely face additional limitations. In the shorter term, rapidly growing municipal demand will also strain aging infrastructure. The dilapidated nature of much of South Africa's water infrastructure, along with other factors such as equipment theft, will likely contribute to an increase in localized water shortages like the one recently seen in Gauteng province.

**Analysis**

Numerous towns in Gauteng province experienced acute water shortages throughout September after a key pumping station failed. This is just one of several similar water outages that have occurred throughout the country over the past year. While the immediate cause of the water failure is often due to the theft of wires and the resulting power outage, South Africa has often relied on aging infrastructure and engineering projects to distribute its limited surface water resources. After the end of apartheid culminated in democratic elections in 1994, this water system became increasingly stressed because Pretoria amended its constitution to make access to water a basic right for all, requiring the government to supply water to millions of citizens it had not served before.

**The Cost of Aging Infrastructure**

After apartheid ended, new infrastructure was built to meet the new demand. Still, even with the newer systems, the current weighted average age of South Africa’s water infrastructure is 39 years old, with much of it in need of repairs, updates and expansion. Water engineering projects are a significant part of the country's 2012 National Infrastructure Plan, and several of these projects are currently underway. However, an estimated 600 billion rand (roughly $54 billion) is needed over the next 10 years to maintain and ensure water supply for the citizens of South Africa, though less than half of this money has been financed. This current rate of investment and improvements may not be sufficient to meet the growing demands of South Africa’s population.

Furthermore, South Africa lacks people with the necessary technical experience. After abolishing apprenticeship systems, Pretoria has seen a reduction of civil engineers available to municipalities and a lack of people with the necessary training to manage large new projects and system rehabilitation, making its ambitious construction plans difficult to achieve.

Years of insufficient upkeep will make maintaining a reliable supply of water for municipal and industrial demand an uphill battle for the country. Estimates indicate that it will take 1.4 billion rand per year just to maintain the current infrastructure, and an estimated 37 percent of municipal water supplies are lost simply through leaking infrastructure, costing South Africa another 7 billion rand a year.

**Stresses on the Power Sector**

Water and power production remain intimately linked in South Africa. Many of the water shortages over the past year are attributed to power outages at the pumping stations, often caused by power or structural failures due to theft of copper wires and steel. Eskom, the company that provides almost all of South Africa’s power, is also struggling to meet rising demand with aging or insufficient infrastructure, resulting in regular blackouts. South Africa is building the large Kusile and Medupi coal-powered plants as part of a bigger plan to expand power production, but neither is complete and there have been delays, specifically at the Medupi plant, due to labor strikes and contractor errors. Additionally, the power sector in South Africa will continue to be constrained by the country’s water stress throughout the coming decades. The Medupi plant, which uses dry cooling and thus requires far less water than older coal-fired plants, will provide some relief if it begins operations mid-2015, as currently scheduled. Plans to build a third large coal plant to meet increasing energy demands are also being debated.

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However, continuing to rely on coal as the primary source of electricity, especially in light of growing demand, could present a fundamental development constraint moving forward. Many of South Africa’s coal plants are old and inefficient, requiring more water use. There are plans to phase out roughly 10 gigawatts of this older capacity, with new capacity being added from non-coal sources such as natural gas, nuclear, hydropower, wind and solar sources. But the majority of the grid will continue to rely on coal as the main source of electricity. The water required to operate coal-powered electricity plants as well as the water required to mine and process the coal itself will further strain water resources. Despite these constraints, South Africa has little alternative but to continue relying heavily on coal for power production for the next two decades.

South Africa will likely remain a competitive coal exporter through the next 20 years. The coal-mining sector will be invariably restricted, however, if nothing is done to mitigate water scarcity, which could increase the cost of coal coming out of South Africa. Any additional costs will further constrain the sector, which is also coping with [problems of labor inflation](https://www.stratfor.com/analysis/escalating-south-african-labor-disputes-reflect-deeper-pressures) and the increasing cost of power. As limited natural water resources become more valuable, water-intensive energy sources such as coal may not be as competitive in the global market moving forward.

**Demand Consumes Water Supply**

Other sectors will also play a role in stressing South Africa's limited water supply. Agriculture remains the largest water-consuming sector in South Africa. While there are already irrigation caps in place to limit this, Pretoria could also increase food imports if additional water is diverted to other sectors; this would place additional limits on the country's economic growth, however. The municipal sector, the country's second largest water consumer, will see the fastest growth in water consumption, though it will also be plagued with infrastructural issues.

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The power and mining sectors are large consumers of water as well, together accounting for nearly 10 percent of South Africa’s total water consumption. Specifically, the mining sector will likely see continued priority in water access due  to its importance to the economy, though it will also face the reality of limited water resources. Over  the next two decades, more mines will likely rely on imported water from [neighboring countries and ones throughout the region](https://www.stratfor.com/image/south-africa-concerns-over-lesothos-dams-and-waterways). Ultimately, by 2030, total demand is expected to outstrip current supply by nearly 3 billion cubic meters per year, roughly 17 percent of total demand.

Pretoria will continue to face water-related constraints in the near-term due to insufficient infrastructure. To support the existing population, maintenance to infrastructure will be crucial. Expansion of both water and power infrastructure are also necessary to meet growing demands. Failure to adapt and address these shortcomings will likely result in more cases of acute water shortages and power outages in the short-term. In the long-term, limited water supplies will continue to have the potential to degrade the government’s ability to attain key goals such as reducing the income gap and increasing the size of the middle class. Altogether, theses impediments have the potential to temper South Africa’s economic growth over the next two decades.

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**U.S. Agriculture Wilts During California Drought**

[**Analysis**](https://www.stratfor.com/analysis)

 DECEMBER 16, 2014 | 10:15 GMT

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**Summary**

**Editor's Note:** *This is the second installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

Though California has received significant amounts of precipitation in recent weeks, the U.S. state continues to suffer one of the worst droughts in its recorded history. Even with the possibility of additional rainfall from an El Nino weather system, the three-year drought will likely continue through 2015. Officials enacted statewide water management restrictions in early 2014 to limit, if not completely remove, access to specific water resources. This will put additional pressure on alternative sources of water, such as groundwater, which are already under long-term pressure to support the region's growing population and large agricultural industry. Recently enacted groundwater legislation has the potential to mitigate future water stress but will not be implemented in time to prevent the impacts of the drought.

Because of the region's significance in the United States' total agricultural production, the short-term impact of the drought has resulted in decreased irrigated agricultural acreage in production and could be a contributing factor to rising food and other agricultural commodity prices. In the long term, more frequent droughts and increasing demand for the region's limited groundwater resources could hinder growth in the region's agricultural sector.

**Analysis**

California is in some ways an artificial agricultural heartland. While wet winters and dry summers allow for a mild climate with an extended growing season, much of the agricultural production would not be possible without the aid of irrigation. California accounts for almost 20 percent of all irrigated cropland in the United States, which in 2012 totaled 7.9 million acres. Roughly 80 percent of water diverted from rivers or pumped from groundwater reserves in the state is used for agricultural development.

**California's Water Use**

The natural water resources available in the state are unevenly distributed, with 75 percent of the state's precipitation falling north of Sacramento while the population and large-scale irrigated agricultural production is located in the central and southern parts of the state. To distribute surface water, California relies on massive its engineering projects: canals, aqueducts and reservoirs. These include the State Water Project, the Central Valley Project and diversions from the Colorado River to supply surface water for demand centers, many of which are in the drier part of the state. Increasing populations and urban demand, combined with frequent droughts over the last 15 years, have significantly stressed this natural water supply.

The State Water Project is one of the largest irrigation systems in California, reaching two-thirds of the state. It stretches from Redding in Northern California through the San Francisco Bay area, the Sacramento and San Joaquin valleys and the Central Coast, into Southern California. It serves approximately 25 million people and 750,000 acres of farmland, provides roughly 3 billion cubic meters of water per year on average, and has approximately 7 billion cubic meters of total reservoir storage. The water from the Central Valley Project, meanwhile, serves 3 million acres of farmland, supplying 8.6 billion cubic meters of water per year on average for all uses, with 13.6 billion cubic meters of storage capacity. The project, however, puts the highest priority on river regulation, navigation and flood control.

On Jan. 31, 2014, the California Department of Water Resources issued a notice that the amount of water allocated from the 2014 State Water Project was to be set at 0 percent. Contracted agricultural allocations for the Central Water project were similarly cut to 0 percent in 2014. The department eventually increased these allocations to 5 percent, though the increase has done little to ease the strain and is small even in comparison to low 2013 allocations, which were 35 percent. Moreover, full allocations of water have not been received since 2006. Without the water from the State Water Project, municipal, agricultural and industrial consumers alike will have to find alternative water sources. This will be more difficult for some areas; roughly 70 percent of the State Water Project's contracted supply is used for urban demand and the other 30 percent for the agriculture sector.

**Californian Groundwater**

Groundwater resources are often used more heavily during dry years (California also suffered prolonged statewide droughts from 2001 to 2004 and from 2007 to 2009) to compensate for the lack of surface water. Even in relatively wet years, groundwater plays a significant role in the overall water supply, with 25-40 percent of the total water supply coming from groundwater in any given year. And it is groundwater that has allowed California's agricultural sector to remain resilient throughout the current drought, as it replaces unavailable surface water. The largest source of groundwater in California is the Central Valley aquifer, which is divided into four different basins: the Sacramento Valley, the Delta and Eastside Streams, the San Joaquin Basin and the Tulare Basin.

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Recent satellite imaging has shown that between 2003 and 2009, the aquifer declined by roughly 30 billion cubic meters, though the different basins did not decline at the same rate. There is far more pressure on the southern half of the Central Valley, which is drier than the northern half but still has a high concentration of agricultural activity. In fact, the water of the Tulare Basin, which is located in the south, has steadily declined since the middle of the 20th century. Continued and increased pressure on groundwater resources, brought on by prolonged or more frequent droughts in California and any reduction in available water from the Colorado River, could accelerate the decline.

Additionally, the historical lack of regulation on groundwater rights has encouraged the unsustainable use of the resource. However, recent legislation, which will take effect in January 2015, allows local governments to restrict groundwater pumping and impose fines with some level of state oversight. But because the legislation does not require immediate compliance (plans for sustainable use are not required until 2020), the benefits of this new regulation will not be seen during the current drought. Moreover, water overdraft is likely to continue throughout the drought, especially as the agriculture sector continues to use groundwater to offset the lack of surface water deliveries.

**The Drought's Short-Term Effects**

In the short term, the drought will significantly affect Californian agriculture, which is an important contributor to the U.S. agricultural sector. California accounts for roughly 14 percent of agricultural sales in the United States. The state is responsible for more than 90 percent of Pima cotton production, 21 percent of rice production, 25 percent of vegetable production, 20 percent of milking cows and 90 percent of tree nut production. California also accounts for roughly 15 percent of agricultural exports by value, exporting more than $6 billion in tree nuts, $955 million in dairy products and $619 million in rice in 2012.

Furthermore, California is an intensive agricultural zone for international exports, especially for higher value goods. Currently, Canada, the European Union, China, Hong Kong, Japan, Mexico, South Korea, India, the United Arab Emirates, Turkey and Taiwan are the top destinations for the state's exports, accounting for 69 percent of the United States' 2012 export value. The percentage of total production being exported is highly crop dependent, but significant amounts of specific crops are destined for the international market; for example, 64 percent of almonds, 55 percent of cotton, 24 percent of dairy and related products and 52 percent of rice are exported.

Thus, limited access to water resources can have a profound effect on agricultural production, especially since many of the crops listed above are water-intensive and require irrigation. The production of tree nuts, for example, is vulnerable to variations in water conditions because the orchards can take more than five years to mature and require consistent water availability. For many of these high-value crops, production estimates for 2014 are expected to be down from 2013, though no official data is currently available since the harvest season is still wrapping up. Researchers at the University of California, Davis, estimate that the drought will have a total direct cost of $1.5 billion to agriculture (with $800 million lost in crop revenue in the Central Valley alone). Nearly 430,000 acres, or 5 percent of total irrigated land, will not be used and more than 17,000 seasonal jobs will be lost.

Additionally, national crop prices may be affected. The U.S. Department of Agriculture revised its food inflation forecast upward for fruits and vegetables in June, though the California drought is only one of a number of contributing factors. Still, the impact of the drought on agricultural production and prices is ultimately unknown and might still be minimized or delayed. For instance, California's drought in the early 2000s did not impact produce until 2005 and 2006, after the drought had begun to ease.

**Long-Term Competition for Limited Resources**

While California's drought is a short-term strain on limited water resources, broader overuse of the state's water will have long-term implications. The irrigation required to maintain many agricultural production areas will likely keep water demands for the agricultural sector high for the foreseeable future. Simultaneously, agriculture will also have to compete with municipal and industrial demands for limited water resources. California is expected to gain 15 million residents between 2010 and 2060, expanding the demand for water. We are likely to see increased conservation efforts and efficiency increases on the demand side, especially in light of the current drought. Additionally, coastal areas are also likely to turn toward desalination and water recycling to better service urban areas in the future. However, despite recent advancements, desalination continues to be an energy-intensive process, which in turn raises electricity consumption in the state. California's growing population and any future droughts will put additional stress on the state's natural water resources.

California's continued water stress could also have regional consequences. If groundwater resources in the region continue to decline and the availability of other sources of water, such as the Colorado River, remains uncertain, the overall viability of the region's agricultural production could be threatened. Growing stress on California's internal water sources will make it more difficult for the state to consider renegotiating agreements regarding allocation levels with the other states in the Colorado River Basin. Therefore, the current allocation system will likely stay in place. In this system, the United States has an advantage as an upstream nation, while Mexico, as the downstream nation, has fewer options to improve its [access to the waters of the Colorado River](https://www.stratfor.com/analysis/us-mexico-decline-colorado-river).

Finally, California's continued overexploitation of water resources could have global implications. In the coming years, growing worldwide demand for agricultural products will continue to affect the U.S. agriculture as a whole, California included. As urbanization levels and the middle class grow internationally, there will be more demand for the higher value agricultural products that California provides as dietary patterns shift accordingly. With increased demand, a corresponding increase in prices may occur, especially in years in which outside stressors like drought negatively impact production.

* Part 1: [Yemen's Looming Water Crisis](https://www.stratfor.com/analysis/yemens-looming-water-crisis)
* Part 3: [South Africa's Water Needs Will Be Costly](https://www.stratfor.com/analysis/south-africas-water-needs-will-be-costly)
* Part 4: [Indonesia's Disjointed Islands Make Water Scarcity a Problem](https://www.stratfor.com/analysis/indonesias-disjointed-islands-make-water-scarcity-problem)
* Part 5: [Mesopotamian Vitality Falls to Turkey](https://www.stratfor.com/analysis/mesopotamian-vitality-falls-turkey)
* Part 6: [Water Use Reform Will Be Difficult for Fractured India](https://www.stratfor.com/analysis/water-use-reform-will-be-difficult-fractured-india)
* Part 7: [Sao Paulo Drought Could Benefit Brazil](https://www.stratfor.com/analysis/sao-paulo-drought-could-benefit-brazil)
* Part 8: [Industrial Expansion Will Strain Mexico's Water Resources](https://www.stratfor.com/analysis/industrial-expansion-will-strain-mexicos-water-resources)

**Yemen's Looming Water Crisis**

[**Analysis**](https://www.stratfor.com/analysis)

 DECEMBER 1, 2014 | 10:15 GMT

[**Print**](javascript:void(0))

 Text Size

**Summary**

**Editor's Note:** *This is the first installment of an occasional series on water scarcity issues around the world that Stratfor will be building upon periodically.*

For all that is said about water scarcity, the term is somewhat misused. Often, water becomes more difficult to access or becomes more expensive; on a countrywide scale, it remains available in most cases. But some countries are actually running out of water. Yemen is one such country.

A strong central government can find solutions and adapt to slow the decline of resources. But because Yemen's weak central government cannot ensure domestic stability, the country shows little potential of being able to resolve or even mitigate its water scarcity problems in the near term, leading hydrologists to predict that it could run out of water within the decade. While there are several countries that withdraw more water than is available, their situations are not yet as dire as Yemen's. Still, Yemen can serve as a benchmark in assessing other countries in the region where changes in water management policies will be vital to watch.

**Analysis**

Throughout antiquity and even in recent history, Yemen was a paragon of water engineering. Evidenced by the Great Dam of Marib, one of the engineering marvels of the ancient world, the Yemeni populations historically have employed advanced irrigation and water management techniques effectively. Unlike those of its regional neighbors, Yemen's water supply is all internal; Yemen does not depend on neighboring countries for access to its water resources.

**Yemen's Water Crisis**

But that is where the good news ends. Yemen currently finds itself under extreme water scarcity, which is defined as less than 500 cubic meters of water per person per year. Yemen's population lives on only 88 cubic meters of water per person per year. The resource has always been precious in the region, but it is only since the second half of the 20th century that population growth and shifts in usage began what would become a sharp decline in available water. Beginning in the 1970s, agricultural expansion demanded more groundwater for irrigation. When the country began producing oil in the 1980s, increased revenue created a cash economy, which contributed to the increased use of qat, a popular narcotic. Compounded by a yearly population growth that nearly reached 3 percent in 2001 before falling slightly to the current growth rate of 2.3 percent, Yemen's meager water supplies have been severely exploited. Although the looming crisis was recognized as early as the 1980s, the country continues on a path of unsustainable water management practices.

Groundwater resources — water deposits located underground in aquifers — make up about 70 percent of Yemen's water supply, providing much of the country's available 2.1 billion cubic meters of renewable water resources a year. The country, however, withdraws some 3.4 billion cubic meters per year, creating a significant deficit in the water table. When factoring in other problems such as saltwater intrusion and pollution, experts estimate that large portions of Yemen, including the capital of Sanaa, could physically run out of water within the next decade if nothing is done.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/yemen_conflict_areas.jpg)

Groundwater resources remain Yemen's most important source of water and are recharged by the irregular surface flows of wadis — watercourses that stay dry except during periods of higher rainfall. Groundwater resources are distributed throughout the country, and the majority of aquifers are considered overexploited. Yemen is currently divided between a number of militant groups and water is a key resource to secure to have leverage over the central government. Because of the overexploited status of most aquifers, when [al-Houthi militants recently made territorial gains](https://www.stratfor.com/analysis/zaidis-re-emerge-yemens-political-scene), the group's new water resources did not significantly alter the balance of resource control. Fighters from the secessionist Southern Movement control sections of territory along the southern coast, where aquifers are not technically overexploited as a whole. Several of these aquifers, however, are experiencing salt-water intrusion, which has decreased the quality of the available water. Much of the large Mukalla aquifer complex is located in Hadramawt, where al Qaeda in the Arabian Peninsula has a strong presence. This aquifer is technically overexploited, but its vast estimated reserves make it a potential source for non-renewable water when the other sources run out. This could provide the militant group with some leverage in the future, although transporting the water to more densely populated regions would be extremely expensive.

**Economic Implications**

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/yemen_water_irrigation.jpg)

Much of Yemen's arable land is concentrated in the highland regions along the mountain plains, an area that receives a high amount of rainfall. Much of the country's population is concentrated in this area as well, which is one of the reasons that water is running out. Irrigated acres increased more than ten times over a 35-year period beginning in 1970 and the use of groundwater in agriculture became increasingly important. The agricultural sector is Yemen's main consumer of water, accounting for 90 percent of all withdrawals. Although it employs nearly half the population, it only contributes roughly 10 percent of Yemen's gross domestic product, and Yemen remains highly dependent on food imports to support a rapidly growing population. A major cause for the agricultural sector's overuse of water is qat, a water-intensive narcotic cash crop that uses nearly 20 percent of total irrigated agricultural acreage. Some studies estimate that half of all of Yemen's water consumption is used to cultivate qat.

As Yemen's population continues to grow, municipal demand for water will also increase. In order to satisfy this demand, additional resources will have to be taken from another sector's share. Water supplies will also continue to be lost due to dilapidated infrastructure and inefficient irrigation systems. As Yemen continues to combat a growing population amid ongoing political and social unrest, the economic impact of failing to address water management issues will become more evident. The United Nations Development Program estimates that roughly 1.5 percent of Yemen's GDP is lost to groundwater depletion and another 2.4 percent is lost by the country's failure to address water sanitation issues.

Yemen's water problems also constrain industrial growth, particularly in the oil and natural gas sectors. Industry accounts for only 2 percent of Yemen's water consumption, but water is still a vital component of energy extraction. Yemen's oil production, however, has been in decline since 2001, falling to 133,000 barrels per day in 2013 because fields have matured and the security situation has deteriorated. While commercial production of natural gas began in 2009, the country will continue to struggle to maintain the hydrocarbons industry, on which it relies heavily to support its economy, supplying roughly three-quarters of government revenue.

**Potential Solutions**

While Yemen's water problems continue to plague the country and will likely continue to worsen, it would cost an estimated $12.7 billion to make the necessary improvements. Updating infrastructure is among the most important measures the country could take to ensure the supply of water to the growing population. Because so much of the water supply comes from the ground, the government must improve its management and control over the number of wells drilled. This would be a monumental task, given that less than 10 percent of well drilling rigs are licensed and less than 2 percent of wells are registered. The sheer number of illegal wells and the weakness of central government authority currently make the management of groundwater resources impossible.

Embracing water conservation efforts and implementing alternative methods of procuring potable water such as desalination could also be short- and medium-term solutions to Yemen's water troubles. But the expenses put such strategies beyond Yemen's reach. In theory, countries such as Saudi Arabia could provide funding for desalination projects. While this would help provide water for coastal populations, inland cities such as Sanaa would have to pump the desalinated water over long distances, a method that would be very costly while creating an attractive target for those who want to threaten Yemen's security.

**Political Limitations**

Given Yemen's instability, however, all these solutions remain unlikely. Implementing strong water management policies and ensuring continued maintenance require a strong central government and a stable security situation — and Yemen has neither. With the rise of the al-Houthi militants and the current unrest and [political uncertainty in the capital](https://www.stratfor.com/analysis/yemeni-rebels-maneuver-government-talks), the administration of President Abd Rabboh Mansour Hadi would not be able to implement anything of consequence. In fact, the central government is currently unable to exert its will beyond the capital.

A prime example of the government's weakness is its recent failed attempt to cut diesel fuel subsidies. The initiative helped trigger an uprising by the al-Houthi tribe that risked toppling the fragile government. The move itself could have had a significant impact on the water situation; diesel pumps are widely used when extracting groundwater. Cutting the government subsidies would have disincentivized unchecked groundwater extraction. But because Sanaa was forced to roll back subsidy cuts after the al-Houthi uprising, along with similar demands from other factions, any potential reduction of groundwater use was also minimized.

It is unlikely that Yemen's political situation will change in the near future; security issues will continue to plague the country. Therefore, the onus for change will fall to the local governments, which are often corrupt, inefficient and poorly funded. Without the ability to implement the necessary water management methods, the water situation in Yemen will likely remain dire, contributing to the potential for further unrest and putting more pressure on Saudi Arabia to contain its southern neighbor.

**Other Countries at Risk**

Notably, other countries in the region share Yemen's plight. Jordan, Egypt and parts of the Palestinian Territories all withdraw as much or more water per year than is available on a renewable basis. Egypt will face uncertainty regarding the availability of water supplies from the Nile, especially as the [Grand Ethiopian Dam](https://www.stratfor.com/analysis/ethiopia-diverts-water-nile-river) progresses. Jordan, on the other hand, will likely have to [rely on the help of Israel](https://www.stratfor.com/video/preserving-dead-sea) to implement necessary alternative resources. The Palestinian Territories will also face the challenge of[sharing water resources with a hostile neighbor in Israel](https://www.stratfor.com/analysis/israels-water-challenge).

Prolonged instability in any of these nations would limit their government's ability to implement any kind of water management strategy in the future. Weak governments with little control over the population could have similar effects. Failure to implement water management practices in the short term will have long-term implications for water availability. Yemen is the first case, but it remains to be seen if other countries in the region under similar stresses are able to avoid the same fate.

* Part 2: [U.S. Agriculture Wilts During California's Drought](https://www.stratfor.com/analysis/us-agriculture-wilts-during-california-drought)
* Part 3: [South Africa's Water Needs Will Be Costly](https://www.stratfor.com/analysis/south-africas-water-needs-will-be-costly)
* Part 4: [Indonesia's Disjointed Islands Make Water Scarcity a Problem](https://www.stratfor.com/analysis/indonesias-disjointed-islands-make-water-scarcity-problem)
* Part 5: [Mesopotamian Vitality Falls to Turkey](https://www.stratfor.com/analysis/mesopotamian-vitality-falls-turkey)
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* Part 7: [Sao Paulo Drought Could Benefit Brazil](https://www.stratfor.com/analysis/sao-paulo-drought-could-benefit-brazil)
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**Central Asia's Looming Conflict Over Water, Part 2: The Downriver Countries**

[**Analysis**](https://www.stratfor.com/analysis)

 NOVEMBER 13, 2012 | 11:15 GMT

[**Print**](javascript:void(0))

 Text Size

The Kokaral dam in Kazakhstan on the Aral Sea ANTOINE LAMBROSCHINI/AFP/Getty Images

**Summary**

Even before Kyrgyzstan and Tajikistan began their recent push to build hydroelectric dams along Central Asia's two main rivers, downriver countries were coping with water scarcity challenges caused by increased demand and inefficient agricultural practices. Adjusting irrigation techniques in Kazakhstan, Turkmenistan and Uzbekistan could partially mitigate these problems, but political and economic difficulties in these countries — especially the latter two — appear likely to stymie any progress. The persistence of water competition in Central Asia has already increased regional tensions and could eventually escalate to armed conflict if the situation goes unaddressed.

**Analysis**

Shared but limited water resources are always potential catalysts for regional disputes, especially if those resources are mismanaged. However, the developing conflict involving the Aral Sea basin is unique due to its relatively recent emergence since the fall of the Soviet Union — an event that left Central Asian countries to resolve such issues on their own without mandates from Moscow for the first time in nearly a century.

**Origins of the Scarcity Issue**

During the Soviet era, the Amu Darya and the Syr Darya rivers, which feed into the Aral Sea, were tapped for irrigation. The two rivers are sourced largely from snowmelt and glacial thaw in the mountains of Tajikistan and Kyrgyzstan, keeping flows from the rivers' headwaters relatively consistent over the past 50 years. However, large-scale irrigation schemes geared toward cotton production have prevented water from reaching the Aral Sea, causing its volume to decrease by about 75 percent since the 1960s.

The future appears even more uncertain. Reliable environmental information about the region is difficult to acquire, since many monitoring stations fell into disrepair after the collapse of the Soviet Union. Still, there appears to be consensus that temperatures in the region are rising slightly, a change that could cause the glaciers to melt at a faster rate than previously recorded and reduce the annual average river flow by 15 percent or more by 2050.

While it is impossible to know with any certainty whether the glaciers will retreat as predicted, demand from downstream countries is projected to increase. Agriculture — the sector that consumes the most water — continues to use inefficient irrigation methods; more than 50 percent of allocated water is lost to evaporation or seepage into the ground in improperly lined irrigation canals.

Despite ongoing concerns about water scarcity, agriculture remains an important part of the economies of downstream states. Uzbekistan, in particular, depends heavily on continued cotton production. The country is one of the world's top 10 cotton exporters and the crop is one of Uzbekistan's largest sources of revenue from exports. Uzbekistan uses more water from the Aral Sea basin for irrigation than any other country in Central Asia, directing it mainly to the Fergana Valley. However, this area is particularly vulnerable to strife because its borders are arranged in a way that [exacerbates the region's numerous ethnic and clan divisions](http://www.stratfor.com/weekly/militancy-central-asia-more-religious-extremism) — another legacy of the Soviet era.

In Turkmenistan, the Mary clan, which dominates agriculture and the illicit drug trade along the Karakum canal, has no official role in the government, and a decline in water supply could embolden them to pressure Ashgabat. To a certain extent, [all Central Asian countries deal with ethnic discord](http://www.stratfor.com/analysis/central-asias-increasing-volatility), and their stability is highly dependent on maintaining or expanding water access. Consequently, these countries have an interest in finding ways to reverse their bleak resource outlook.

**Options for Modernizing Water Use**

Regardless of whether Tajikistan and Kyrgyzstan are able to build their [proposed hydroelectric dam projects](http://www.stratfor.com/analysis/central-asias-looming-conflict-over-water-part-1-upriver-countries), downriver countries will have some ability to mitigate water issues through the improvement of irrigation systems. Currently, the region's irrigation and canal systems are extremely inefficient and in need of maintenance, which has been lacking in both Uzbekistan and Turkmenistan since the collapse of the Soviet Union. Additionally, improper use of irrigation has led to increased salinity in the ground, which decreases the quality of the soil and can lower crop yields.

Some potential irrigation improvements include lining canals and ditches with concrete or newer synthetic materials, repairing or replacing Soviet-era equipment and implementing techniques such as drip irrigation. Each of these methods could decrease water usage. Though highly unlikely given cotton's economic importance to Uzbekistan, the region could also switch from cotton to crops that require less water.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/irrigation5.jpg)

However, the [political](http://www.stratfor.com/analysis/stronger-presidency-kyrgyzstan) and economic situations in Turkmenistan and Uzbekistan could prevent widespread improvement in the water distribution system. Improvements to the system would likely require both foreign funding and foreign expertise to implement. Due in part to their hydrocarbon reserves, the downriver countries are richer than Kyrgyzstan and Tajikistan, but they are still quite poor by Western standards. The projected costs of even a partial rehabilitation of water pumping stations, meanwhile, could be well into the hundreds of millions of dollars. At roughly $1,400 per hectare, the estimated cost of implementing drip irrigation in more than 4 million hectares of irrigated land in Uzbekistan would exceed $5 billion. Uzbekistan's annual gross domestic product was $45 billion and Turkmenistan's was $24 billion in 2011, so the countries would probably need outside assistance.

While there are several international water system initiatives in various stages of approval, including proposed projects sponsored by the World Bank and the Asian Development Bank, it remains unclear whether any of these projects will ever be implemented. Uzbekistan, which continues to receive Western criticism for child labor practices in its agriculture sector (among other issues), remains relatively closed to foreign investment and involvement. Some reports in the past year have indicated that China may be interested in investing in Uzbekistan, and Beijing's investment may well be more welcome than that of any Western partners.

Turkmenistan has a much smaller population to support than Uzbekistan, making improvements to its water usage system a somewhat less pressing concern. Still, the Turkmen government is likely to continue trying to appease the Mary clan in its main agricultural area to avoid prompting the kind of ethnic backlash that could [jeopardize political stability](http://www.stratfor.com/analysis/next-stage-russias-resurgence-central-asia).

Kazakhstan is in a slightly better position than the other two downriver countries. Because it is more open to outside assistance and has more money at its disposal, the country — in cooperation with the World Bank — has been able to launch a rehabilitation project for the Aral Sea. Under the first phase of the project, Kazakhstan completed the Kokaral dam in 2005, allowing a northern portion of the Aral Sea to be partially restored and small-scale fishing to resume. The second phase calls for the construction of another dam and the rehabilitation of other irrigation schemes along the Syr Darya.

Despite Kazakhstan's limited progress and the numerous proposed development projects of the region, comprehensive action to improve the regional irrigation situation appears to have stalled. While improvements to the efficiency of the system are possible, Uzbekistan and Turkmenistan, two of the three largest water users, appear unable or unwilling to pursue the kinds of measures that could mitigate a water crisis. Thus, as these countries compete for a limited and potentially shrinking resource, tensions are likely to rise and could eventually boil over into a military confrontation should the threats to their water supply become sufficiently dire.

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**China Tries to Overcome Its Water Limitations**

[**Analysis**](https://www.stratfor.com/analysis)

 JUNE 11, 2013 | 15:49 GMT

[**Print**](javascript:void(0))

 Text Size

The Wangkuai reservoir in China's Hebei province. (FREDERIC J. BROWN/AFP/Getty Images)

**Summary**

On June 10, the easternmost leg of the South-North Water Transfer Project, the latest in a long line of attempts by China's rulers to overcome the limits placed by water on the Chinese economy, began operations. This enormous engineering undertaking will eventually divert up to 44.8 billion cubic meters of Yangtze River water — about 10 percent of the river's annual flow and more than 170 times the amount consumed by Los Angeles yearly — to the water-scarce North China Plain. It is testament to the peculiar [role of water in contemporary Chinese geopolitics](https://www.stratfor.com/analysis/geopolitics-china-great-power-enclosed).

The project was first conceived by Mao Zedong in 1952 and has been under construction since 2002. It is one of the Communist Party's most costly endeavors yet — both directly, with an official price tag of $62 billion, and indirectly, having displaced more than 350,000 people, most of them farmers from small rural communities — to manage the ballooning imbalance between the demands of Chinese industry and the environment's increasingly limited ability to provide. The project's existence and scale alone reflect the Party's heightened fear that lack of water resources in northern China could constrict both short- and long-term economic growth in some of the country's most densely populated and industrially significant provinces.

**Analysis**

In recent years, the imbalance between economic demand and the supply of key industrial inputs such as water has been especially stark in traditional agricultural powerhouses such as Henan, Shandong and Hebei. There, the exponential growth in water consumption for both consumer and industrial purposes (most notably, by the coal and steel industries) has far outstripped native water reservoirs' capacity. Despite housing roughly one-quarter of China's population and accounting for a similar portion of gross domestic product, the provinces of the North China Plain, including Beijing municipality, hold only 8 percent of China's total water resources. The eastern stretches of these provinces' primary traditional source of water for agricultural use, the Yellow River, now runs dry up to 230 days a year.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/China_north_plain.jpg)

The eastern route of the project, the one that runs from Jiangsu through Shandong and Hebei, is in large part an update of the historical Grand Canal, which has shipped people and goods from the Yangtze River Delta to Beijing for more than 1,000 years. So far it has presented the fewest technical challenges. The middle route, which runs from Hubei province through Henan, Hebei and to Beijing, is due to be completed by 2014. This route, more than its eastern counterpart, has raised concerns over its impact on communities that rely on the Han River, one of the Yangtze's major tributaries and an important source of water for farming in northern Hubei and southern Shaanxi provinces. The more technically challenging and politically controversial western route, which will link the Yellow and Yangtze rivers nearer to their sources on the Tibetan Plateau, has yet to begin construction. According to some reports, it may not be completed until 2050, if ever.

The South-North Water Transfer Project only reinforces the [geopolitical significance of the Yangtze River](https://www.stratfor.com/analysis/geopolitics-yangtze-river-developing-interior) not only as a key transport throughput linking central and coastal Chinese provinces, but also as the economic and social foundation — through the transport of water — of northern China's industrial and agricultural heartlands. But beyond its upfront costs, the project remains shrouded in uncertainties. There are questions about its long-term environmental and social consequences for much of rural central China and for the rice-farming regions south of the Yangtze that rely heavily on rainfall from the river's wider watershed. More simply, there are doubts about its ability to meet the ambitious goals set for it by the Party leadership.

Uncertainties aside, the eastern and middle routes of the project — like the similarly criticized Three Gorges Dam in Hubei province — will [likely enter into full operations by 2015](https://www.stratfor.com/analysis/geopolitics-yangtze-river-wuhans-rise). While different in scale from past attempts to manage China's perennial water constraints, the project is by no means unprecedented in kind. The ability to control water has been an important theme in Chinese political history since the semi-mythical King Yu the Great first built dikes to stem floods along the Yellow River. For Yu and subsequent Chinese rulers, engineering the environment to meet contemporary human needs was one marker of sovereign legitimacy — a dynasty's right to the "Mandate of Heaven." Today, as China again approaches the limits of an inherited economic and environmental model, China's leaders are no doubt aware of this legacy.

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**Israel's Water Challenge**

[**Analysis**](https://www.stratfor.com/analysis)

 DECEMBER 25, 2013 | 13:53 GMT

[**Print**](javascript:void(0))

 Text Size

Filters at the Ashkelon seawater reverse osmosis plant south of Tel Aviv in 2008. (DAVID BUIMOVITCH/AFP/Getty Images)

**Summary**

Israel's successful efforts to increase water security will lessen one of the country's geographical constraints. But new sources of water are more energy intensive, and this could increase Israel's short-term dependence on energy imports unless domestic energy sources are successfully developed.

**Analysis**

While [Israel enjoys relative national security](https://www.stratfor.com/analysis/geopolitics-israel-biblical-and-modern) compared to its neighbors, which are struggling with internal fragmentation, this will probably change eventually. Because concerted military efforts have been required in the past to secure water resources, Israel has had a strong incentive to develop technological solutions to improve water security. Additional domestic water resources — including increasing desalination capacity and continued efforts to recycle water — allow Israel to mitigate one of its inherent geographic constraints.

Israel has substantially increased its capacity to desalinize water over the last decade. The arid country of roughly 8 million already has a number of desalination plants — including the Sorek plant, the world's largest desalination plant of its kind, which became fully operational in October. Israel has plans to increase total desalination capacity through 2020 such that it approaches the estimated annual amount of internally generated natural water resources.

**Naturally Occurring Water**

Israel's total annual internal renewable natural sources of freshwater stand at 0.75 billion cubic meters. It has roughly 265 cubic meters per year of water per person available. This is well below the U.N. definition of water poverty, which is anything below 1,000 cubic meters per person per year.

For groundwater, Israel relies on two main aquifers: the Coastal Aquifer and the Mountain Aquifer (which is further divided into subaquifers). Both also lie under the Palestinian territory — in Gaza and the West Bank, respectively.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/2_Israel_920%20%281%29.jpg)

Israel's surface water is concentrated mainly in the north and east of the country. Israel is part of the Jordan River system, which also includes Syria, Lebanon, Jordan and the West Bank. The major rivers in the upper part of the basin include the Hasbani, Banias and the Dan rivers. These rivers converge to form the Jordan River near the border of Israel, Lebanon and Syria before flowing into the Sea of Galilee. Downstream, the Jordan River is further fed by the major tributaries of the Yarmouk and Zarqa rivers.

Crucially, more than half of Israel's total natural water originates outside its borders: 310 million cubic meters come from Lebanon, 375 million cubic meters come from Syria and 345 million cubic meters originate in the West Bank. All the countries in this arid region compete for the limited resources of the basin. The Palestinian Authority has between 51 cubic meters per person and 333 cubic meters per person per year depending on location, while Syria and Lebanon receive water from additional river systems and operate at 882 cubic meters per year per person and 1,259 cubic meters per year per person, respectively. Jordan has 161 cubic meters per year per person.

Allocations of water from transboundary river systems are often disputed. The last basin-wide allocation scheme for the Jordan River system came in 1955 with the Jordan Valley Unified Water Plan (also known as the Johnston Plan, named after the American ambassador involved in negotiations). By allocating water based primarily on agricultural demand, the plan offered a compromise between participating nations. However, because many of the Arab states did not want to recognize Israel, the plan was never ratified. Attitudes toward cooperative distribution strategies continued to sour during the construction of Israel's National Water Carrier, which diverted water from the Sea of Galilee to other points in Israel. However, Jordan and Israel have used the Unified Plan as the basis for subsequent negotiations.

As one of the downstream riparian nations in the basin, protecting Israel's northern borders is essential to maintaining control of surface water resources. Maintaining control of the Golan Heights not only gives Israel a military advantage in dealing with adversaries to the north, it also helps to guarantee access to the Sea of Galilee.

Israel historically has demonstrated a willingness to use military force to guarantee access to water resources. In 1964, Syria, with the support of the Arab League, began devising plans to divert the Banias River, threatening roughly 10 percent of Israel's water supply at the time. From 1965-1967, Israel launched attacks to destroy the diversion projects under construction in an effort to maintain access to the water source.

Water rights and distribution parameters were included in the 1994 peace treaty between Israel and Jordan. The Oslo II agreement in 1995 between Israel and the Palestinian National Authority also outlined parameters for water cooperation in the West Bank, but in practice, joint management has often failed and the Palestinian population remains heavily dependent on Israel for access to water.

These treaties also did not remove Israel's imperative to ensure continued access to water resources, nor its willingness to threaten military action to ensure it. In 2002, villages in southern Lebanon installed small pumping stations and irrigation pipelines on the Hasbani River. Ariel Sharon, Israeli prime minister at the time, claimed these actions constituted a "case for war" and threated military action. While no action was taken, the posturing illustrates Israel's wariness of upstream water management schemes.

**Expanding Sources of Water: Conservation and Desalination**

The foundations of Israel's current water infrastructure system were laid in the 1950s and 1960s, when Israel faced a more volatile security situation. Subsequent decades saw further development of the efficient use of water and the development of alternative sources. As a result, Israel has expanded internal water resources without expanding its physical borders, helping mitigate the risk of international confrontations over water.

[**Preserving the Dead Sea**](https://www.stratfor.com/video/preserving-dead-sea)

To the same end, Israel has also developed a highly organized water management system, effectively integrating the whole country. An early project known as the National Water Carrier, which comprises a series of canals, pipelines and pumping stations, moves water from the Sea of Galilee in the comparatively water-rich north to areas of higher demand and greater need in the central and southern zones.

Israel is also a pioneer and global leader in water-efficient irrigation technology. Because agriculture remains the largest water consumer in the country, efficient use in this sector is necessary for continued sustainable water management. In addition to the irrigation technology, by effectively treating roughly 400 million cubic meters of wastewater, using it mostly to irrigate crops, Israel further reduces pressure on water resources.

Although Israel has used desalination technology on a smaller scale since the 1960s, the push for a substantial increase in desalination capacity began only after a major drought in 1998-1999. Several droughts over the course of the last 15 years drove home the vulnerability of Israel's water supply. Meanwhile, the overuse of groundwater resources, especially of the Coastal Aquifer, is degrading the quality of the water.

Israel currently consumes just under 2 billion cubic meters of water per year, and while water management has the ability to improve the efficiency of water usage, increasing populations in the region will continue to pressure these limited resources. These factors combined have pushed Israel toward desalination.

When the Sorek plant became fully operational in October, Israel gained 150 million cubic meters per year of desalination capacity. Total seawater desalination capacity is expected to reach 600 million cubic meters per year by 2015 and could reach 750 million cubic meters per year by 2020. The production cost of desalinized water depends on the plant, but averages $0.65 per cubic meter, with the new Sorek plant costing roughly $0.50 per cubic meter. This is compared to $0.15-$0.45 for water from natural sources. Advances in the technology that Israel uses, including technologies that improve the energy efficiency of the plants, have helped drive the costs down compared to previous desalination technology. But desalinated water remains far more energy-intensive than naturally sourced water, and it increases demands for power on the national electricity grid and from independent natural gas generators.

**Short-Term Dependence on Imported Energy**

Because Israel has traditionally been an energy importer, increasing reliance on an energy-intensive water resource could in turn increase Israel's dependence on energy-exporting nations. Natural gas will likely be the predominant fuel used to produce desalinated water. The Israeli electrical grid is projected to shift further toward natural gas and away from coal in the coming years, while the desalination plants often independently employ natural gas generators.

The total fuel required will vary based both on the type of desalination plant, as well as the type of power generation. Even with newer, more efficient equipment, the operation of more than 500 million cubic meters of desalination capacity could require more than 100 million cubic meters of natural gas or the equivalent energy from some other fuel sources to produce the additional power necessary to run the plants.

Israel had previously been an importer of natural gas, but the total volume of imports has declined in recent years. As of August 2013, imports were only accounting for 13 percent of total consumption. Furthermore, offshore discoveries in the eastern Mediterranean, including the Leviathan fields projected to come online as early as 2016, mean Israel has the potential to become a natural gas exporter. While there are many political and [technical constraints surrounding the development and subsequent use of these fields](https://www.stratfor.com/analysis/israel-contemplates-exporting-natural-gas), increased levels of domestic energy production could reduce dependence on foreign partners in terms of energy. This is especially important as Israel pursues a strategy of relying on more energy-intensive water resources.

**Outlook**

Israel traditionally requires a third-party sponsor to survive. And even with the added desalination capacity, Israel may still need to use water from external sources. But it has successfully adjusted to the environment and better insulated itself from its neighbors, complementing an established military superiority. And this could provide additional maneuverability in future negotiations.

Israel is [momentarily in a secure strategic position](https://www.stratfor.com/weekly/israels-new-strategic-position). Syria will likely remain in a state of civil war for an extended period, and Lebanon remains fragile and fragmented. Israel maintains a working relationship with other neighbors, such as the Hashemite regime in Jordan, as well as Fatah and the Palestinian National Authority and the Egyptian military. This status quo seems unlikely to change in the short term. But although Israel is in a relatively stable position, it knows how mercurial the surrounding region is and will likely still behave proactively around national security issues.

Israel's proactive solution to ensuring water security is to develop additional domestic resources. Though this will require more imported energy in the short term, the continued development of domestic energy resources could act as a counter-balance, even as water resources become more energy-intensive.

**Brazil's Drought Has Political Implications**

[**Analysis**](https://www.stratfor.com/analysis)

 MAY 28, 2014 | 09:03 GMT

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 Text Size

A general view shows the Jaguari Dam, one of the main reservoirs supplying Sao Paulo, Brazil, with its water level to 12 percent of its total capacity on April 25. Victor Moriyama/Getty Images

**Summary**

The current drought in [Brazil](http://www.stratfor.com/regions/americas/brazil) has already affected the country's energy and agriculture sectors. Municipalities — specifically Sao Paulo — are now facing possible supply shortages as the drought continues. A few solutions can be implemented in the short term. The government is likely to promote conservation measures, and increased water rationing appears unavoidable. This could negatively affect the ruling party in Sao Paulo state, the Brazilian Social Democracy Party, in upcoming elections.

The elections are still six months away, but water rationing in Brazil's largest voting center and the heart of the party supporting Brazilian President Dilma Rousseff's challenger Aecio Neves does not bode well for Neves or his party. Voters in the region are likely to blame the Brazilian Social Democracy Party for the water situation because water management is the responsibility of the Sao Paulo state-owned water and sanitation utility, commonly known as Sabesp, not the federal government. The ongoing water shortage could further lift Rousseff and [Eduardo Campos, the other opposition presidential candidate](https://www.stratfor.com/analysis/rising-political-dynamism-brazil), in the October vote.

**Analysis**

The drought has caused [Brazil's](https://www.stratfor.com/analysis/geopolitics-brazil-emergent-powers-struggle-geography) natural gas imports to rise at the same time as hydropower potential decreases. It has also curtailed production of many of Brazil's crops and contributed to an increase in some commodity prices, including coffee. Domestic water consumption has not remained untouched either. Although other cities in Brazil — including some suburbs of Sao Paulo — have already begun water rationing and there have been anecdotal reports of individual homes without access to water, Sao Paulo's city administration previously assured its constituents that water rationing would not be required.

However, the greater municipal region of Sao Paulo has already reached a critical point. The city relies heavily on reservoirs for its water supply as opposed to groundwater, which currently makes a minimal contribution. Now, one of Sao Paulo's key reserves, the Cantareira system, has fallen to dangerously low levels. The linked reservoirs supply roughly 45 percent of the city, more than 8 million people, with water. In February, the system as a whole fell to 10 percent of its maximum capacity. The Sao Paulo state water and sanitation utility invested $36 million in pumping system that allowed additional water at the bottom of reservoirs to be pumped out. This previously inaccessible water, known as dead water, added to the system's useable volume, bringing the maximum useful volume from approximately 980 million cubic meters to roughly 1.2 billion cubic meters. With the addition of the dead water, the stock currently in the reservoir remains at roughly 260 million cubic meters. The system still remains dangerously low. Without the dead water, the reservoir level would be at only 7.7 percent of the maximum capacity.

[Click to Enlarge](https://www.stratfor.com/sites/default/files/main/images/brazil_san_paulo_resevoirs.jpg)

The state secretary of sanitation and water resources claims that the water supply will last through March 2015, even without water rationing. Counter to this, however, other estimates from the state water utility and anti-crisis committees give a much shorter estimate of October or November. All of these predictions assume some level of rain. While water production rates have already been reduced twice during the drought, at a production rate of roughly 30 cubic meters per second, if no additional volume is added, the reservoir might only last until the end of August. The entire municipal region can consume upwards of 6 million cubic meters per day (from multiple systems, not just Cantareira).

**Deeper Issues With the Water Supply**

The quick fix of drawing on the dead water in the Cantareira system still does not solve the underlying problems Sao Paulo will face in terms of water over the next six months and beyond. The drought shows no signs of abating, and relief from Mother Nature cannot be assured (although the wetter than normal conditions which typically occur with a predicted El Nino could help in the coming months). While water transfers from rivers via pipes or channels from neighboring areas have been discussed, these solutions will take too long to have any kind of impact on the present shortage. At this time, there is no clear backup plan beyond accessing the dead water volume. Other short-term solutions, such as trucking in water, remain expensive and are politically constrained. The city has seen success over the last 15 years in decreasing average annual household consumption, but at the same time, the amount of water lost as it is distributed through the network remains high. Uncontrolled urban expansion and inadequate water infrastructure remain underlying problems for the greater Sao Paulo area.

Domestic demand will remain a priority over industrial demand. However, given the limited options for alternative water sources, there is little choice for the ruling body in Sao Paulo but to begin implementing water-rationing measures (although these measures may be given a different name). There has been an informal media campaign promoting waver-saving behavior as [the World Cup](https://www.stratfor.com/analysis/assessing-security-brazils-world-cup-2014)approaches, and financial incentives are being offered to Sao Paulo residents who reduce water consumption by a specific percentage.

**Political Blowback from Water Rationing**

These actions will almost certainly affect the popularity of the party currently holding power in Sao Paulo, the Brazilian Social Democracy Party. This is the largest opposition party in Brazil and is seeking a comeback in the general election in October. A water rationing policy (if implemented) could put pressure on the Brazilian Social Democracy Party at the state level, which has been in power in Sao Paulo state since the 1990s. Incumbent Gov. Geraldo Alckmin retains a substantial lead over the nearest competitor, Paulo Skaf (of the Brazilian Democratic Movement Party) in the most recent polls, with 43 percent to only 19 percent. However, Skaf has not shied away from bringing attention to the ongoing water crisis in public statements. With its very large voting population, Sao Paulo, along with Minas Gerais, is a key state for the Brazilian Social Democracy Party to carry if it is to win the upcoming presidential election.

On the national level, the Brazilian Social Democracy Party's presidential candidate, Aecio Neves, is the main opposition for current president, Dilma Rousseff, in the coming elections. Neves is second to Rousseff in the most recent polls; Rousseff had 40 percent of the vote, and Neves had 20 percent. However, losing support from the voters in Sao Paulo as they are forced to ration water could widen the gap.

The election is six months away. The drought — and possible relief from it — remains beyond the government's control. If relief were to come sooner than expected, the political situation could shift once again. Both the weather and elections are extremely difficult to predict. However, if nothing changes, the reservoir supplying water for nearly half of Brazil's largest city could run dry within the next six months. Trucking in additional water would be costly both in financial and political terms because Sao Paulo is not the only region experiencing drought. Continuing water problems could also be used as an additional trigger for [ongoing protests](https://www.stratfor.com/analysis/evaluating-national-effect-brazilian-protests) in the area. Ultimately, the management of vital resources, even through unpopular policies such as water rationing, will be necessary in light of the severity of the drought. This could negatively affect the ruling party in Sao Paulo State, the Brazilian Social Democracy Party.

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