Putting California's Latest Drought in Context

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California's latest drought has focused attention on water management practices and policies. This article describes how the system has adapted to managing water scarcity and recurring droughts. It identifies some of the early lessons learned, including promising ways to adapt to water scarcity and areas of continued vulnerability.

California remains in the grip of a major drought. Four consecutive years of below average to critically dry conditions have affected all aspects of water use in the state, with agriculture and the environment hit the hardest. The drought has also brought considerable attention to water management practices and policies, with abundant calls for reforms and for the construction of new water supply infrastructure.

Droughts, like any other natural disaster, can be a catalyst for change, and this drought has been no exception. In 2014 the California Legislature passed the most comprehensive groundwater legislation in state history—the Sustainable Groundwater Management Act. In that same year, the voters passed a new bond bill that provides $7.5 billion for expanding water supplies, promoting conservation, and improving ecosystems. And the Governor has issued several emergency declarations that contain unprecedented requirements for water conservation in the urban sector. As this drought continues, there will likely be many new proposals.

This article provides an overview of California's water management and use and the way the system has adapted to managing water scarcity and recurring droughts. In addition, we describe the characteristics of this latest drought and identify some of the early lessons learned, pointing both to promising ways to adapt to water scarcity and to areas of continued vulnerability.

California's Water in Context

California's water supply infrastructure and system of water laws and rights reflect decades of adaptation to a unique climate. Though rarely appreciated during a drought, California is actually a water-rich state, receiving a statewide average of more than 200 million acre-feet of precipitation annually. Roughly two-thirds of that water returns to the atmosphere through evaporation and transpiration by plants and trees, with the remaining flowing down rivers and into aquifers.

However, this abundant water is not distributed equally in space or time. Almost three-quarters of the precipitation that falls on California occurs north of Sacramento, while three-quarters of water use is to the south, with the highest uses in dry agricultural regions of the San Joaquin Valley and Tulare Basin. California also has the distinction of

Figure 1. An Extensive Conveyance and Storage Network

Source: California Department of Water Resources

having the most variable climate in North America, with dramatic year-to-year variations in precipitation.

To adapt to this variable climate, in the mid-20th century, Californians developed one of the world's most vast, complex networks of water storage and conveyance facilities (Figure 1). More than 1,400 surface reservoirs have the capacity to store more than 40 million acre-feet of water—approximately equal to the average annual water use by cities and farms. In addition, more than 500 groundwater basins store at least three times that amount.

Snowpack—principally in the Sierra Nevada—typically provides temporary seasonal storage of as much as a third of the water used annually. Thousands of miles of aqueducts move water from the northernmost watersheds of the state to farming centers in the Central Valley, and San Francisco Bay Area, and Southern California urban centers. The state also augments supply by diverting more than a quarter of the annual runoff of the Colorado River, supplying farms in the Imperial Valley and urban uses in Southern California.

Who Uses How Much?

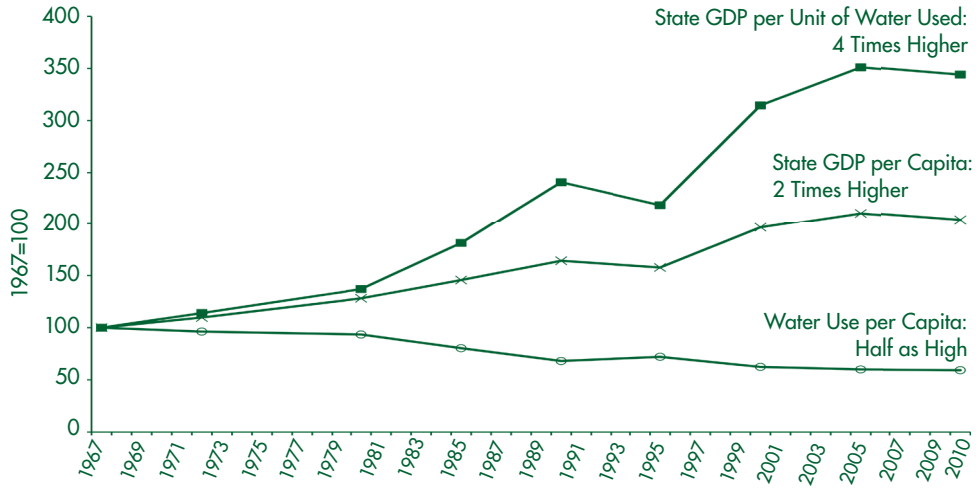
Water use in California—as accounted for by the California Department of Water Resources—is concentrated in the environmental and agricultural sectors. Roughly 40% of water use is assigned to agriculture, 50% is assigned to the environment, with the remaining 10% for urban uses. (These figures are for the period 1998-2010, the last year for which statewide water use estimates are available; this is the same source used to produce the other commonly cited breakdown for water directly used by people: 80% by farms and 20% by cities.)

Urban and agricultural water use is governed by the state's seniority-based water-rights system, established soon after statehood. As in other western states, priority of use generally goes to those who claimed the right first. (In California, those with property directly adjacent to rivers have a special type of seniority known as a riparian right, a type of right more commonly found in the wetter, eastern U.S.)

The seniority-based water rights system is one of the many adaptations the state has made to manage its variable climate. When there is insufficient water to meet all water rights, the State Water Resources Control Board curtails diversions by those with more junior water rights. During the current drought, the Board has found it necessary to curtail water rights established as far back as 1903 and may well go back even further before this summer is over.

In contrast to common understanding, most environmental water is not in direct competition with human uses. For example, most water in Wild and Scenic Rivers—which accounts for over half of environmental water—flows down North Coast rivers where there are no alternative uses. And a large share of required outflow from the Sacramento-San Joaquin Delta—another category counted as environmental water—is needed to maintain salinity standards for agricultural and urban water uses. However, regulatory decisions in some watersheds have resulted in supply reductions for farms and cities in recent years; San Joaquin Valley farmers dependent on water shipped through the delta are among those affected.

Figure 2. Some Key Water and Economy Trends



Source: Ellen Hanak et al., 2012. "Water and the California Economy," PPIC, updated to 2010 with data from the Department of Water Resources, the Department of Finance, and the U.S. Bureau of Economic Analysis.

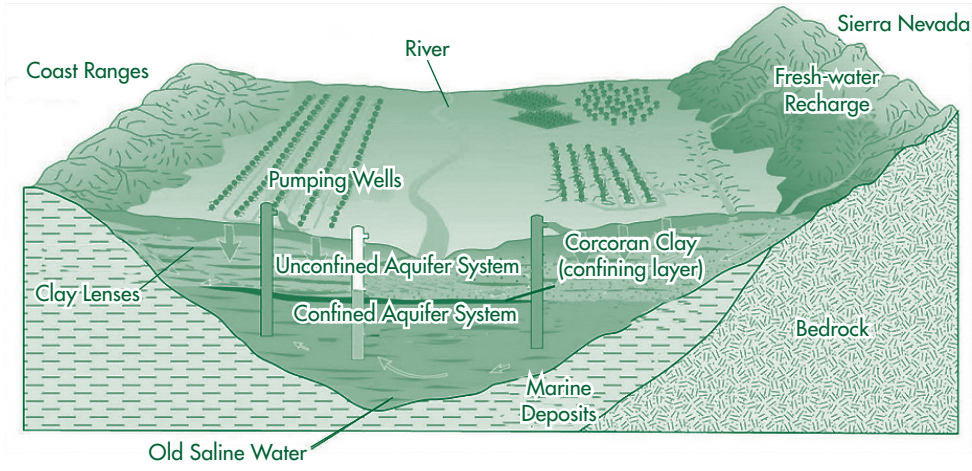
Notes: State GDP (gross domestic product) is adjusted for inflation. Water use estimates are for applied use in the agricultural and urban sectors.

A History of Adapting to Water Scarcity

Since the early 1970's, the state has added nearly 20 million people to its population. During this time, there has been only limited expansion in water supply infrastructure, and yet the state's economy has continued to grow. From 1967–2005, statewide per capita water use declined by half, real state GDP doubled, and the economic value of each unit of water increased fourfold (Figure 2). These trends—temporarily slowed by the recent recession—reflect increased efficiency of water use in all sectors.

Although agricultural water use likely peaked in the early 1980s, productivity growth and shifts toward higher-value activities have spurred continued increases in the economic value of crop and livestock

Figure 3. Schematic of Groundwater in the Central Valley



Source: U.S. Geological Service

production, which now generate over $22 billion in GDP and over $48 billion in revenues (2012$)—roughly double the size in the late 1960s.

Urban use (including all residential, commercial, and industrial water) plateaued later, once utilities began to significantly promote water use efficiency in the 1990s. Daily per capita urban use fell from a peak of 247 gallons in 1995 to 199 gallons in 2010, enabling California to accommodate continued population growth without expanding total urban supply.

What Makes This Drought Unique?

The latest drought, which began in 2012, is not without precedent. Climate scientists have noted that the aggregate amounts of precipitation fall within the range of normal variability. Rather, the drought's hallmark has been its warmth. Statewide and regional temperatures have dramatically exceeded historic highs going back to the late 1800's. Warm temperatures increase the length of the growing season while also reducing soil moisture due to evaporation.

Unusually warm temperatures during the winter led to a higher proportion of rain to snow, resulting in record low snowpacks in 2015. Water stored in both the soil and snow is critical to managing water demand in California and to the health of river and stream ecosystems. These losses amplified the effects of low amounts of precipitation.

The consecutive dry years, coupled with unusual warmth, led to reductions in available surface water, with dramatic declines in year-to-year storage in the state's large reservoir systems. As outlined in the companion articles in this issue, these shortages hit the agricultural sector particularly, requiring extensive use of groundwater and fallowing of land.

Drought Adaptation Using Portfolio Approaches

California's cities—and particularly the large metropolitan areas—have weathered the drought better than the agricultural sector. This stems in part from some key lessons learned during a major drought from 1987 to 1992, when urban areas were hit very hard.

Following that drought, cities made major investments in portfolio approaches to water. In addition to increasing water use efficiency through new technology and improved pricing approaches, urban utilities diversified their supplies. This included development of nontraditional sources like recycled wastewater, new local surface and groundwater storage, new interties for emergency water sharing among local agencies, and long-term water purchase agreements from some farmers.

In this drought, attention has focused on bringing down outdoor water use, which still accounts for roughly half of total urban use (and more in hotter, inland areas)—thanks in part to the continued prevalence of thirsty, cool-season turf grass in urban landscapes.

Farming in California is inherently more vulnerable to droughts because it requires large volumes of water for irrigation, and some portfolio tools are less effective in the farm sector. Improving irrigation efficiency stretches on-farm supplies and enhances crop productivity, but it generally does not create basin-wide water savings because it does not lower net crop water use. (Indeed, more efficient irrigation technology often increases net water use per acre by facilitating productivity gains.)

New storage is also a more limited option for farmers. Although some have invested in relatively economical groundwater storage, agriculture cannot generally support the cost of new surface storage. However, the growth of a statewide water market since the early 1990s has significantly improved agriculture's adaptation capacity. The market enables farmers growing higher-revenue crops to purchase water from those with more reliable supplies and lower-revenue cropping opportunities. During this drought, water trading has made it possible to keep orchards alive in some areas that would otherwise have received little or no water deliveries.

Remaining Hurdles

Although improvements in the economic efficiency of water use and diversification of supply portfolios have helped limit the impact of periodic droughts and growing water scarcity in California, several issues remain to be addressed.

Groundwater Management

Groundwater is still California's best hedge against drought. But since the 1960's, California's water supply has been augmented by approximately two million acre-feet per year by groundwater overdraft. This has greatly diminished the utility of groundwater as a drought supply. Figure 3 shows the structure of the groundwater basin in the Central Valley.

As the companion article by Medellín-Azuara and others points out, in 2014 and 2015, farmers will have pumped at least 11 million acre-feet of additional groundwater to make up for lost surface supplies, with prospects for much more if the drought continues. Although the 2014 Sustainable Groundwater Management Act requires that groundwater basins be brought into balance, the reform will be phased in over 25 years. To address growing water scarcity in the agricultural sector, early adoption and accelerated implementation will be beneficial.

The Delta Conundrum

The Sacramento-San Joaquin Delta remains the weak link in California's water supply grid. Approximately 15% of the state's farm and urban supplies comes from the delta. Increasing regulatory pressures and the fragility of the levee network make supplies from the delta increasingly unreliable. Efforts to craft a solution have proven politically difficult and costly. Yet the unsustainable status quo in the delta is harmful to all parties. Resolving the delta conflicts and improving supply reliability are key to managing water scarcity in the Bay Area, the San Joaquin Valley, and Southern California.

Changing Crop Types

To tap favorable world market conditions, farmers have been shifting towards higher-value orchard crops (e.g., almonds, pistachios, wine grapes). From 2000 to 2010, orchard acreage rose by nearly 20% in the southern Central Valley, reaching 40% of irrigated crop acreage, and this acreage continues to expand during the drought. This expansion, while generating more "cash per drop," also reduces flexibility to cope with droughts in regions that are particularly susceptible to supply cutbacks. It also increases pressure on overtaxed groundwater basins (and provides an added incentive for farmers to accelerate groundwater management to protect their investments).

Declining Environmental Conditions

The continued decline in populations of native fish, wetland and riparian species poses a major challenge for managing water scarcity. These declines affect water supply operations across the state, as water managers struggle to manage the trade-offs between healthy ecosystems and reliable supplies. The trade-offs are particularly acute during severe droughts such as this one.

Summary

The latest drought has highlighted both the strengths and the weaknesses of California's water supply systems. Long-term improvements in the economic efficiency of water use and investments in portfolio approaches to diversify supply and reduce demand have yielded significant benefits. This drought will likely accelerate these trends, resulting in lasting improvements.

However, state and local agencies will also need to invest in resolving some significant challenges. Although recent legislation holds promise for improving groundwater management, the state would benefit from speeding up implementation where possible. The shift to perennial, high-value crops in the Central Valley makes improving groundwater management even more urgent. Finally, the Sacramento-San Joaquin Delta remains the most challenging water supply and ecosystem health issue in the state. The effectiveness of efforts to improve conveyance, build new storage, resolve groundwater overdraft, and expand water markets will all be reduced if water management in the delta is not resolved.

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For additional information, the authors recommend:

Hanak, E., J. Lund, A. Dinar, B. Gray, R. Howitt, J. Mount, P. Moyle, and B. Thompson, 2011. "Managing California's Water: From Conflict to Reconciliation." Public Policy Institute of California. www.ppic.org/main/publication.asp?i=944.

Hanak, E. et al., 2012. "Water and the California Economy." Public Policy Institute of California. www.ppic.org/main/publication.asp?i=1015.

Hanak, E., J. Lund, J. Mount et al., 2015. "California's Water." Public Policy Institute of California. www.ppic.org/main/publication.asp?i=1130.