PPIC

Storing Water

PPIC WATER POLICY CENTER

NOVEMBER 2018

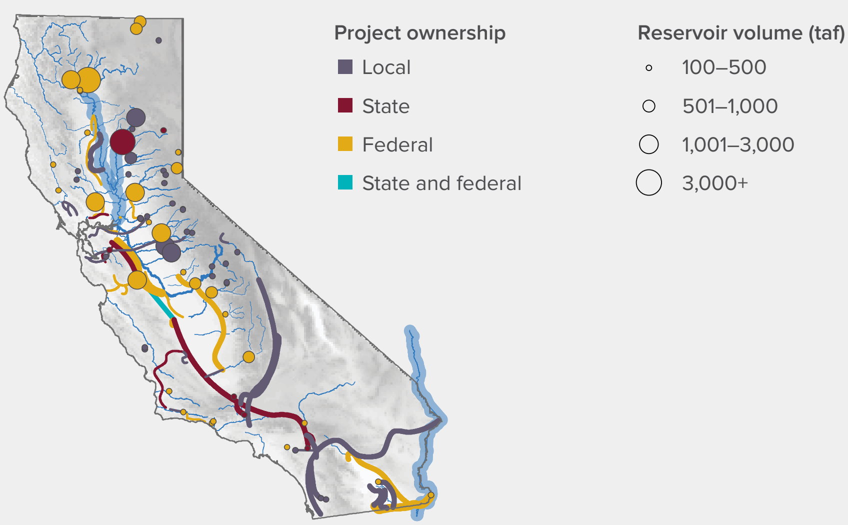
Storage is essential for managing California’s water

California’s “water grid” is a vast interconnected surface and groundwater storage network linking major water demand centers via rivers and aqueducts. Water stored during wet winter and spring months provides supplies for dry summers and frequent droughts. It is also used for recreation and hydropower, and to mitigate harmful effects dams have on river and wetland ecosystems. During large storms, storage also reduces downstream flood damage.

Water storage in California takes many forms. As much as a third of all supply comes from snowpack, which releases water during spring and summer when demand is highest. Water stored in soils supports plant growth and helps regulate storm runoff. Nearly 1,500 surface reservoirs can store up to 43 million acre-feet (maf)—a year’s supply for farms and cities. The state’s 517 groundwater basins hold considerably more water than these reservoirs. And many aquifers could store more water because decades of groundwater depletion have created unused space.

Managing water storage is complex. Its competing priorities must be balanced. These include flood protection and water supply, reducing environmental harm from dams, addressing long-term excess pumping and pollution of groundwater, maintaining and updating infrastructure, and adapting to a smaller snowpack and more intense storms as the climate warms. Groundwater users across California have begun implementing the 2014 Sustainable Groundwater Management Act (SGMA), the first statewide effort to manage groundwater. And $2.7 billion in bond funds will support water storage projects under 2014’s Proposition 1. But major challenges remain.

CALIFORNIA’S “WATER GRID” IS A STATEWIDE NETWORK OF STORAGE AND CONVEYANCE FACILITIES



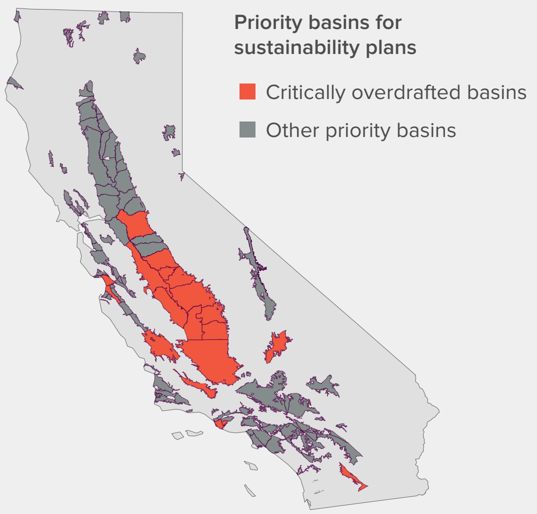
SOURCE: Developed by the authors using information from the California Department of Water Resources.

NOTES: “Taf” is thousands of acre-feet. The map shows 62 surface reservoirs with storage capacity over 100 taf, scaled to size. Their combined capacity is 36.5 million acre-feet (maf). The lines show rivers in blue and built conveyance facilities (canals, aqueducts) colored by ownership. Not shown are more than 1,400 smaller reservoirs (with a total capacity of less than 7 maf) and the state’s 517 groundwater basins.

Groundwater is California’s most important drought reserve

Groundwater is California’s largest source of storage. In non-drought years, it supplies about a third of the water for cities and farms, and more in some regions. During severe droughts, groundwater provides more than half of water used statewide. Although aquifers fill more slowly than surface reservoirs, they can be replenished.

BASINS ACROSS CALIFORNIA MUST COMPLY WITH THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT



SOURCE: California Department of Water Resources, California Statewide Groundwater Elevation Monitoring Program.

NOTES: Under SGMA, groundwater users in critically overdrafted basins must adopt sustainability plans by 2020 and attain sustainable management within 20 years; for other priority basins, plans must be adopted by 2022. In all, 127 basins, accounting for 96 percent of annual groundwater pumping, are considered priority basins that must comply within this time frame. Some additional basins may need to comply as a result of a basin prioritization update now under way.

- **Unregulated pumping causes multiple problems.**
Until 2014, the state regulated groundwater loosely. As a result, many basins are in overdraft (when excess pumping causes long-term declines). Low levels increase energy costs of pumping, dry out shallower wells, reduce flows to rivers and wetlands, allow seawater intrusion in coastal areas, and cause land to sink (or "subside"), which damages water canals and other infrastructure.

- **Many cities have effective groundwater management programs.**
Many cities in Southern California and the San Jose area resolved problems from past overdraft by regulating, metering, and charging for pumping. Local management agencies replenish basins with local rainfall, water imported from distant rivers, and recycled wastewater and stormwater. Recharge methods include moving water into ponds, injecting it into wells, and allowing it to seep through permeable pavement and rain gardens.

- **Limited groundwater oversight in agricultural areas has fueled overdraft.**
The San Joaquin Valley's overdraft averages about 2 maf annually, and problems are also acute in the Central Coast. New challenges to sustainable groundwater management are arising. Many farms are shifting to orchards and vineyards, which are costly to fallow and often rely on groundwater to survive droughts. Meanwhile, as farmers adopt more efficient technology, recharge from irrigation is declining.

- **Poor groundwater quality is also a problem.**
Many basins have problems with arsenic and other naturally occurring contaminants that can pose health problems. In some urban areas, industrial pollutants limit groundwater for drinking. In farming regions, shallow groundwater is often polluted by high levels of nitrate from fertilizers and manure. Salt accumulation is a growing problem for farming in the San Joaquin Valley and coastal areas. Treatment is an option for large urban systems, but it is usually too costly for small communities and farms. Recharging basins with clean water can improve quality.

- **The Sustainable Groundwater Management Act holds promise.**
SGMA requires water users in the most stressed basins to develop groundwater sustainability plans by 2020 and bring their basins into balance by 2040. More than 250 groundwater sustainability agencies are developing plans, and the law authorizes them to measure use and charge fees for pumping and to cover recharge project costs. The State Water Board can intervene if it deems local efforts inadequate, or if local authorities request assistance.

Surface reservoirs provide California's most flexible storage

California's surface reservoirs can be filled and emptied quickly to meet demands for water supply, aquatic habitat, flood control, recreation, and hydropower.

- **Surface storage has limited value during long droughts.**
Reservoirs store water for seasonal uses and reserve some water for dry years. Extended drought depletes these reserves. At the height of the 2012–16 drought, most large reservoirs were at or near record lows.

- **Flood storage competes with water supply storage.**
Many large, multipurpose reservoirs release water in fall and winter to free up space for winter flood flows. Under US Army Corps of Engineers rules, this flood reserve cannot be refilled until late winter or spring, when the flood season has passed. If the winter is dry, reservoirs won't fill up.

- **Dams disrupt river ecosystems.**
  Dams limit access to fish spawning habitat and alter natural flow patterns, harming native fish, plants, and animals. Reservoir releases can sometimes mitigate these impacts—for example, by releasing cold water for salmon. Some dams are being removed to restore more natural flows and give fish access to better upstream habitats. Plans are under way to remove four aging hydropower dams on the Klamath River.

- **Climate change will complicate reservoir operations.**
  Climate pressures include rising temperatures, declining snowfall, more intense storms, and more extreme wet and dry years. Increased winter runoff will make it harder to manage reservoirs for flood control and store enough water for other purposes. Rising temperatures will also make it harder to provide cold water for fish.

- **New surface storage may be costly relative to its water supply benefits.**
  New storage could improve water system flexibility. But the average volume of new water from these facilities is small, and costs are high. Four projects deemed eligible for state matching grants under Proposition 1 would expand statewide reservoir *capacity* by about 3.3 million acre-feet, but they would raise annual average *supply* by only 760,000 acre-feet, or 2 percent of annual farm and city use. Their combined cost would be nearly $10 billion.

Managing California's storage resources as a system can boost benefits

Many reservoirs have their own set of rules and are operated by an array of agencies. And surface reservoirs aren't currently operated to maximize groundwater recharge. Modernizing operations and integrating management of above- and belowground storage can boost usable supplies, improve quality, and help lessen the impacts of climate change.

- **Groundwater and surface storage work better together.**
  Some storm runoff and water in surface reservoirs can be moved to groundwater basins. Such joint management of groundwater and surface water—known as conjunctive use—can boost resilience to droughts. It may also ease the growing conflict between using reservoirs for flood protection and water storage as winter runoff increases.

- **Conveyance is often a bigger bottleneck than storage capacity.**
  Without investments to improve water conveyance reliability across the Sacramento–San Joaquin Delta, significantly expanding groundwater storage in the southern half of California—where basins are most depleted—will be hard. Subsidence has also reduced the capacity of the Friant-Kern Canal and the California Aqueduct. Some conjunctive use projects also need local conveyance investments.

- **Institutional bottlenecks are also an issue.**
  More flexibility in reservoir operations would increase the benefits of conjunctive use, but this requires lengthy federal and state agency approvals. Better local aquifer management is also needed. And the state should clarify the rules on water available for recharge.

- **Better flood management can help …**
  Setting back levees to give rivers more room to move into their floodplains can improve flood protection and help store some floodwaters. This practice can also recharge local aquifers, improve habitat, and preserve open space for farming and recreation. Spreading excess winter flows on farmland is also promising but requires careful consideration of water quality.

- **… and so can better watershed management.**
  Forest management in upper watersheds can increase available streamflow by as much as 5 percent by decreasing water used by plants and improving storage in snowpack and soils. Yet implementing these changes on millions of mountain acres is a challenge.

Looking ahead

California has made good progress on addressing storage challenges, but much hard work lies ahead.

Update aging infrastructure. California's water grid—including important aqueducts that help recharge groundwater, deliver surface water, and manage floods—is aging and needs repair. The 2017 Oroville Dam spillway failures prompted new safety laws and reviews of existing dams, but more should be done to improve safety and prepare the system for a changing climate. Conveyance improvements to support groundwater storage are also a priority.

Promote flexibility and integrate operations. Operational changes are needed to make the system more flexible in light of a more volatile climate. Priorities include modernizing and integrating operations of multipurpose reservoirs to ensure they work together as an integrated water supply and flood management system, and increasing the flexibility of reservoir operation rules to allow more efficient use of above- and belowground storage.

Ensure effective groundwater sustainability plans. Delay will encourage more overdraft and make future choices harder. State bonds provide resources for local planning, and 2015 legislation makes it easier for agencies to allocate pumping rights. One urgent state priority is to clarify water available for groundwater recharge.

Protect and restore groundwater quality. Controlling new sources of pollution and cleaning up contaminated basins can improve groundwater storage. Meanwhile, safe drinking water is urgently needed in rural, groundwater-dependent communities. Bond funds are available for both purposes, but reliable funding is needed for ongoing costs of safe drinking water programs in disadvantaged communities.

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