Storing Water

PPIC WATER POLICY CENTER

OCTOBER 2016

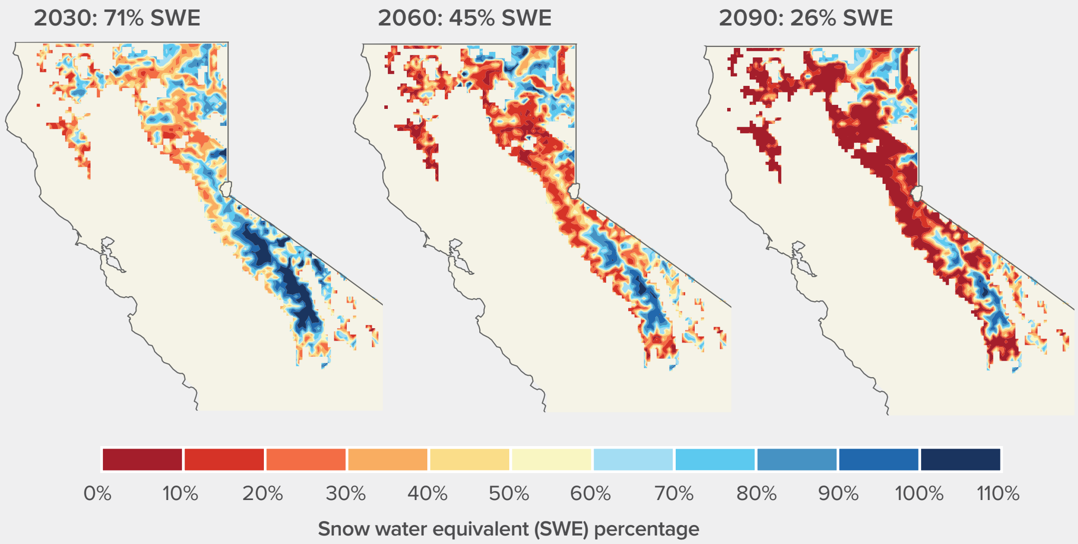
Storage is essential for managing California's water

Water stored during California's wet winter and spring months provides supplies for its dry summers and frequent droughts. Stored water is also used for recreation, hydropower, and to mitigate harmful effects of dams on river and wetland ecosystems. During large storms, storage reduces peak flood flows and downstream damage.

Water storage in California takes many forms. As much as a third of the state's 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. Some 1,400 surface reservoirs can store up to 42 million acre-feet—a year's supply for farms and cities. The state's 515 groundwater basins hold at least three times as much usable water as the surface reservoirs, and decades of groundwater depletion have created unused space in many aquifers.

California faces numerous challenges in managing water storage: balancing competing goals, such as flood protection versus water supply; reducing environmental harm from dams; addressing long-term deterioration of groundwater resources from excess pumping and pollution; and adapting to a smaller snowpack 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. The state has also been preparing to disburse $2.7 billion in bond funds for water storage projects under 2014's Proposition 1.

RISING TEMPERATURES WILL SHRINK THE SIERRA NEVADA SNOWPACK



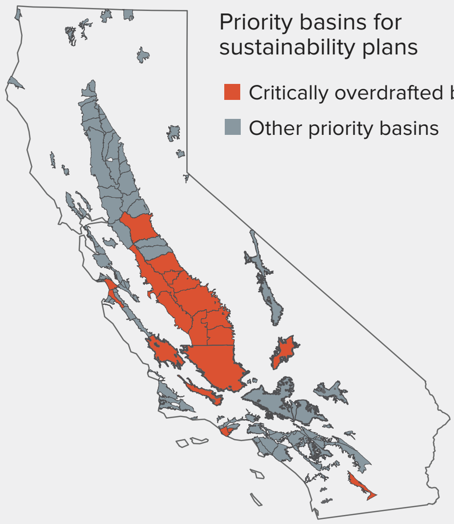
SOURCE: Modeling and mapping by Daniel Cayan, David Pierce, and Laurel DeHaan, Scripps Institution of Oceanography, and Noah Knowles, US Geological Survey (2016), with support from the California Energy Commission, California Department of Water Resources, the US Geological Survey (Southwest Climate Science Center), the National Oceanic and Atmospheric Administration (through the California Nevada Applications Program), and the US Army Corps of Engineers.

NOTES: Snow water equivalent (SWE) measures the amount of water stored in the snowpack. It is expressed as a percentage of estimated recent historical conditions (1965–2005). These scenarios are based on projected temperature increases—1.8˚C (2030), 3.5˚C (2060), and 5.2˚C (2090)—from 10 different climate models, over temperature averages during recent historical conditions (1965–2005). SWE and temperature values for 2030, 2060, and 2090 are averages over 19 years centered on these dates. These projections are based on the Representative Concentration Pathways 8.5 high greenhouse gas emissions scenario, in which emissions continue to rise throughout the 21st century.

Groundwater is California's most important drought reserve

Groundwater is California's largest source of storage. On average, it supplies about a third of the water cities and farms use annually, and more in some regions. During droughts groundwater can supply more than half of statewide water. Aquifers can be replenished, but they fill more slowly than surface reservoirs.

THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT APPLIES TO BASINS ACROSS CALIFORNIA



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. Priority reflects reliance on groundwater; current and projected population and irrigated acreage in the basin; and documented impacts, including overdraft, subsidence, and water quality degradation.

- **Unregulated pumping causes multiple problems.**
Until recently, the state only loosely regulated groundwater use. Many basins have experienced overdraft—excess pumping that causes long-term groundwater declines. Lower groundwater levels increase energy costs of pumping, dry out shallower wells, reduce flows to rivers and wetlands, and cause land to sink—damaging roads and other infrastructure.

- **Many urban areas now have well-developed groundwater programs.**
In the early-to-mid 20th century, many Southern California cities and the San Jose area faced problems from unregulated pumping. They now have tightly managed basins and regulate, meter, and charge for pumping. Local management agencies replenish basins from local rainfall, distant rivers, and, increasingly, recycled wastewater and stormwater. Recharge methods include placing water in ponds and injecting it into wells. To store excess stormwater, some cities are installing permeable pavement and rain gardens.

- **Groundwater oversight in agricultural areas is limited.**
Groundwater overdraft in agricultural regions—mostly in the southern Central Valley and Central Coast—averages about 2 million acre-feet annually. Many farms are shifting to orchards and vineyards, which are costly to fallow and often rely on groundwater to survive droughts. Meanwhile, irrigation is declining as a source of recharge as farmers adopt more efficient technology.

- **Poor groundwater quality is also a problem.**
In Southern California and the Sacramento area, industrial pollutants limit groundwater use for drinking and hinder some basins from being replenished. In farming regions, much of the shallow groundwater contains high nitrate concentrations from fertilizers and manure. This contamination deteriorates drinking water quality. Salt accumulation is a growing problem for farming in the San Joaquin Valley and coastal areas, where overdrafting draws in seawater. 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 new groundwater law holds promise.**
SGMA requires water users in the most stressed basins to develop sustainable groundwater management plans by 2020 and reach sustainability by 2040. The law gives local agencies authority to implement these plans, including the ability to measure use and charge fees for pumping and to cover the cost of recharge projects. The State Water Resources Control Board can intervene if it deems local efforts inadequate, or if local authorities request assistance.

Surface reservoirs provide California's most flexible storage

The state's surface reservoirs—mostly constructed between the 1930s and 1970s—serve many purposes. They are a flexible form of storage that can be filled and emptied quickly to meet water supply and hydropower demand.

- **Surface storage has limited value during long droughts.**
Reservoirs store water for seasonal uses and reserve some water for dry years. During extended droughts, these reserves are depleted. By the fourth year of the latest drought, most large reservoirs were at or near record lows.

- **Flood storage competes with water supply storage.**
Many large, multipurpose reservoirs release water in the 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. So early releases can reduce water supply for the year ahead.

- **Dams disrupt river ecosystems.**
  Dams limit access to fish spawning habitat and alter the natural patterns of flow, 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—the nation's largest dam removal project.
- **Climate change will complicate reservoir operations.**
  Most climate models predict rising temperatures, increasing climate variability, and more rain than snow. A decrease in snowpack storage and corresponding rise in winter runoff will increase the challenges of managing reservoirs for flood control, water supply, and summer hydropower. 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. Five proposed projects—costing roughly $9 billion—would expand statewide reservoir *capacity* by about 4 million acre-feet but raise annual average *supply* by just 410,000 acre-feet, or 1 percent of annual farm and city use.

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

California has a vast interconnected surface and groundwater storage network, linked to major water demand centers by rivers, canals, and aqueducts. Operating this network as a system can boost usable supplies, improve quality, and help mitigate 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 and a warming climate and improve groundwater quality.
- **Conveyance is often a bigger bottleneck than storage capacity.**
  Significantly expanding groundwater storage in the southern half of California—where basins are most depleted—will be hard without investments to improve the reliability of water conveyance across the Sacramento–San Joaquin Delta. 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 state law regulating groundwater recharge may be too restrictive.
- **Better flood management can help …**
  Making more room on floodplains by setting back levees can improve flood protection and create temporary storage for 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.
- **… and so can better watershed management.**
  Forest management in upper watersheds can increase available streamflow by as much as 10 percent by reducing losses from plant growth and improving the storage of water in snowpack and soils. However, implementing these changes on millions of mountain acres is a challenge.

Looking ahead

In 2014, California took important steps to address water storage by enacting landmark groundwater management legislation and approving bond funds for new storage projects. But the hardest work lies ahead.

Develop groundwater sustainability plans. Delay will encourage more overdraft and make future choices harder. Proposition 1 provides resources for local planning efforts, and legislation enacted in 2015 makes it easier for agencies to allocate pumping rights. Additional state action may be needed to clarify groundwater recharge and storage rights.

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

Promote flexibility and integrate operations. The state and its federal partners should establish more flexibility in reservoir operation rules to allow more efficient use of storage. Modern forecasting technology and better system coordination can help improve the timing and uses of reservoir releases.

Prioritize bond investments in storage. Proposition 1 supports the public benefits of new storage projects—including environmental restoration, flood protection, recreation, and emergency preparedness. When evaluating them, the state should seek maximum flexibility and the highest return on public dollars. This may favor improvements in groundwater storage and conveyance facilities that connect surface and groundwater.

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