PPIC

Climate Change and Water

PPIC WATER POLICY CENTER

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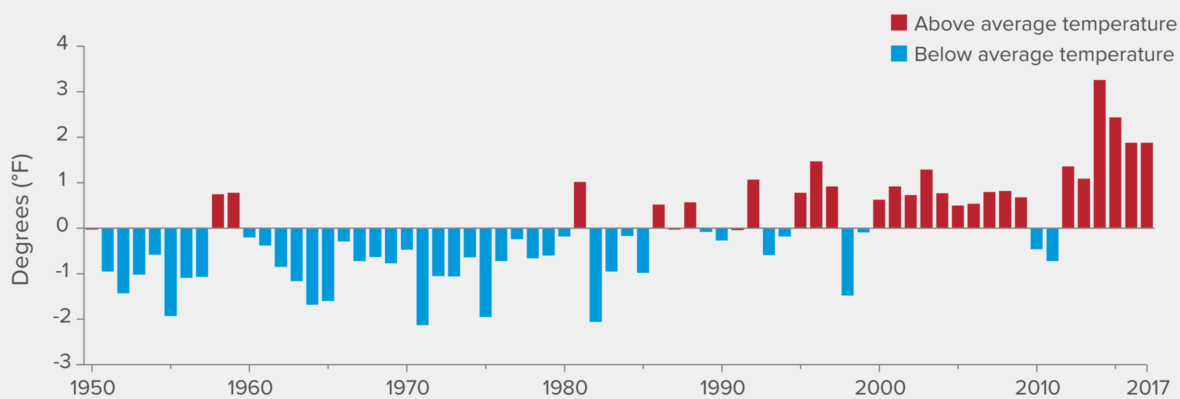
Climate change will affect California water management in many ways

California's climate is highly variable, with frequent droughts and floods. Climate models predict significant changes: warmer temperatures; shorter, more intense wet seasons; and more volatile precipitation—with wetter wet years and drier dry years.

Warming is already a reality. California's four warmest years on record have all occurred since 2014. Warming has complex and interrelated effects: it reduces the share of precipitation falling as snow, causes earlier snowpack melting and increased winter runoff, raises water temperatures, and amplifies the severity of droughts and floods. Sea level has been rising, increasing pressure on coastal flood defenses. This and larger freshwater floods threaten fragile levees in the Sacramento–San Joaquin Delta, an important water supply hub.

California is a national leader in addressing greenhouse gas emissions that contribute to climate change. However, water policies for adapting to a changing climate are still in early development. California's "water grid"—the linked network of storage and conveyance systems that connects most water use in the state—was designed for 20th-century conditions. Climate pressures will make it harder to simultaneously store water for droughts, manage flood risk, and protect freshwater ecosystems. Making this system more climate-ready is a major challenge that will require a concerted effort on multiple fronts, involving all levels of government and the private sector.

CALIFORNIA IS GETTING WARMER



SOURCE: Western Regional Climate Center.

NOTE: The figure reports degrees above or below the average statewide temperature (57.8° F) for 1981–2000.

Water supply management must adapt to a warmer, more variable climate

More intense floods and droughts will complicate water supply management. Rising temperatures and longer dry seasons could also increase demand for irrigation and the volume of water used by natural landscapes.

- **There are no easy substitutes for lost snowpack.**
  California's mountain snowpack has historically provided critical storage for meeting summer irrigation needs. A greatly reduced winter and spring snowpack—and increased precipitation variability—will stress supply. New surface storage can add flexibility, but it is costly, unlikely to provide abundant new supplies, and may become difficult to operate as runoff becomes more volatile. Given its high costs, seawater desalinization is also unlikely to yield large new supplies, though it could be a useful part of some urban water portfolios.

- **Adaptation will require changes in storage management.**
  Addressing snowpack loss and more variable precipitation will require coordinated management of water stored in surface reservoirs and groundwater basins. Conjunctive use—moving some water from reservoirs into groundwater basins for dry periods—will be especially valuable. This will require upgrades and expansion of water conveyance systems. Improving the reliability of conveyance through the Delta may allow more storage in the southern half of the state.

- **Urban water managers can adapt in many ways.**
  Options include expanding connections between urban systems with different supply sources, trading water with other cities and farmers, and using more treated wastewater and captured stormwater. Urban areas can also reduce water demand through reductions in water loss, technological innovations, and pricing and other incentives such as rebates for water-saving technology or replacing lawns with less thirsty landscaping.

- **California's agricultural sector can also adapt …**
  With forward-looking strategies, productivity gains from technical improvements, and more flexible management of water supply, farm revenues can continue to rise. Key flexibility tools include water trading—which helps avoid the costliest water cuts during droughts—and groundwater banking—which enables farmers to store water during wet times for use during dry times.

- **… but adaptation will be more difficult without better groundwater management.**
  Farms have become increasingly reliant on groundwater to manage droughts, particularly in the Central Valley. Excessive pumping today will make it harder to manage aquifers in the future. Effective implementation of the 2014 Sustainable Groundwater Management Act, the first statewide effort to manage groundwater, can reduce the impacts of climate change on the farm sector.

Managing water to preserve species and ecosystems will become more difficult

Rising temperatures and changing runoff patterns may stress many native riverine and wetland species whose populations are already depleted by habitat loss, water operations, and other factors.

- **Approaches based on entire ecosystems will be needed.**
  Past approaches to managing environmental water have focused on improving habitats for one species at a time, typically once a species gets listed under state or federal endangered species acts. Future approaches should be adaptive and ecosystem-based to benefit multiple species.

- **Competition for water will probably increase.**
  Difficult trade-offs are likely. For instance, timing cold water releases from reservoirs to protect downstream salmon populations can mean less water for farms and cities at other times of the year. Reusing treated wastewater—a growing strategy for stretching supplies—can reduce water for the environment, particularly in urban settings.

- **State and federal policies will need to address trade-offs.**
  State policy—along with federal and state environmental laws—may need to be modified to manage difficult trade-offs both *between* human and environmental water uses and *among* environmental uses. For example, in warm, dry years increasing outflows for native fish in the Delta can conflict with maintaining cold water in reservoirs for salmon late in summer.

Flood planning must anticipate population growth and changing hydrology

Rising sea level, bigger and more frequent floods, growing population, and more building in vulnerable areas will increase the economic and social risks of flooding.

- **Major new investments will be needed.**
  To manage future urban and coastal flooding, state and local agencies must invest a minimum of $34 billion to improve dams, levees, coastal defenses, and urban stormwater systems. These infrastructure investments should be part of an integrated approach that also improves water supply and ecosystem health.

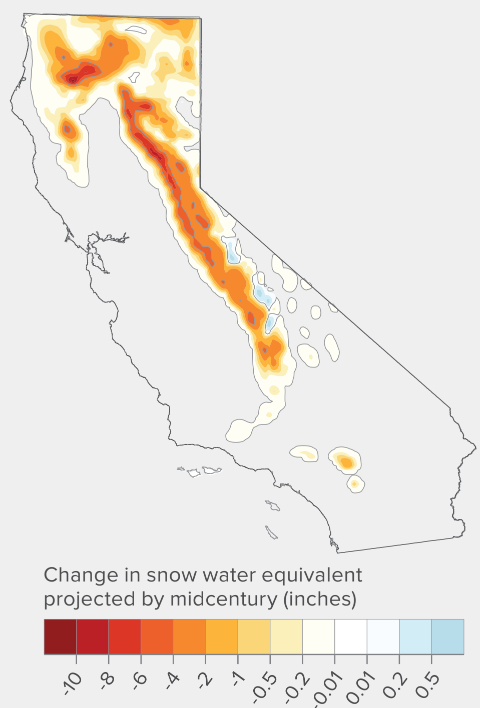
- **Flood management tools must be updated.**
  Regional flood management will require coordinated, forecast-based reservoir operations. This can be accomplished as part of conjunctive use strategies that make more room for floods by moving water into groundwater storage. Modest investments to improve forecasting—and better use of existing forecasting tools to reduce flood risk while increasing stored water—will significantly cut the costs of managing supply and responding to floods.

- **Nonstructural approaches will become more valuable.**
  To reduce risks from more volatile precipitation, California must go beyond infrastructure improvements and emphasize flood-smart land use planning, flood insurance, flood-proofing buildings, and emergency preparation. Local hazard mitigation plan requirements should include these approaches and anticipate future conditions.

Climate change will affect the water-energy relationship

In-state hydropower is a clean energy source that provides 15 percent of California's electricity on average. Snowpack changes will reduce the output of some hydropower reservoirs. Warming will also boost energy demand, particularly in summer months.

SHRINKING SNOWPACK REQUIRES CHANGES IN STORAGE MANAGEMENT



SOURCE: P. Ullrich et al., "California's Drought of the Future: A Midcentury Recreation of the Exceptional Conditions of 2012–2017" (*Earth's Future*, 2018).

NOTE: Figure shows the projected decline in snow water equivalent (the amount of water stored in snowpack) relative to 2017 for a similar wet year in midcentury (2047); the total statewide decline is projected at 25 percent.

- **The effects of warming on energy production will vary.**
  In most years the state's large, multipurpose reservoirs have enough storage to adapt to changes in the timing of snowmelt runoff. Not so for California's high-altitude hydropower reservoirs—among the most important sources of peaking power during hot summers. As temperatures rise, power availability from these reservoirs will shift to late winter and spring—when electricity demands are lower.

- **Some water management changes could increase energy demand.**
  Climate change and increased competition among users are likely to make surface water scarcer, particularly in agricultural areas. Farmers may respond by using more groundwater and switching to more efficient, pressurized irrigation systems. Both strategies will increase farm energy use. In urban areas, increasing temperatures will likely boost energy demand for cooling. Increased efficiency in urban water use and development of local water sources can reduce overall energy demand while helping communities adapt.

Looking ahead

California needs to adopt water supply, flood control, and ecosystem management strategies that will prepare the state for a changing climate and rising sea level.

Integrate climate change into water grid management. Adapting to a warmer, more volatile climate will require more flexible operations of storage and conveyance facilities and ensuring they work together as an integrated water supply and flood management system. Strategies include promoting conjunctive use; more flexible, forecast-based reservoir operations; and water trading. Conveyance investments are critical to support groundwater recharge and trading and to maintain water supplies drawn through the Delta, which could be disrupted by rising seas, seasonal flooding, and earthquakes. Conservation will continue to be important, especially in urban areas.

Prepare for bigger floods. In the next 20 to 50 years, floods will likely be quite different than what the state's flood management system was designed to handle, with substantially increased risks. In addition to more integrated management of the water grid, state and local agencies need to incorporate climate change projections into land use planning decisions, flood insurance programs, the design of new flood infrastructure, and the rehabilitation of aging dams. Legislation may be required to encourage adoption of important risk-reduction strategies such as insurance.

Use recharge as a flood and supply management strategy. With increased storm intensity and changes in snowmelt timing, current reservoirs might need more space to manage larger floods. Managing reservoirs to recharge aquifers with excess floodwaters is a promising strategy that can also provide water supply and ecosystem benefits.

Upgrade information systems. Federal, state, and local agencies should upgrade information technology for water and ecosystem management. One priority is enhancing decision makers' ability to use existing water-related data. Implementation of the Open and Transparent Water Data Act (AB 1755) is an important first step. Strategic investments are also needed in modeling of weather and water supply and demand.

Develop an environmental stewardship strategy. Adapting to a warmer, more variable climate requires watershed level planning, especially to make ecosystems more drought-resilient. Actions can include water acquisitions, building ecosystem resilience through habitat restoration, and prioritizing conservation areas for greatest impact—including protecting environmental strongholds that can support species during droughts. These plans should inform water supply and flood management decisions.

Consider energy implications. Given the links between water and energy use, it is important to consider how California's water strategies affect energy demand, costs, and greenhouse gas emissions.

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