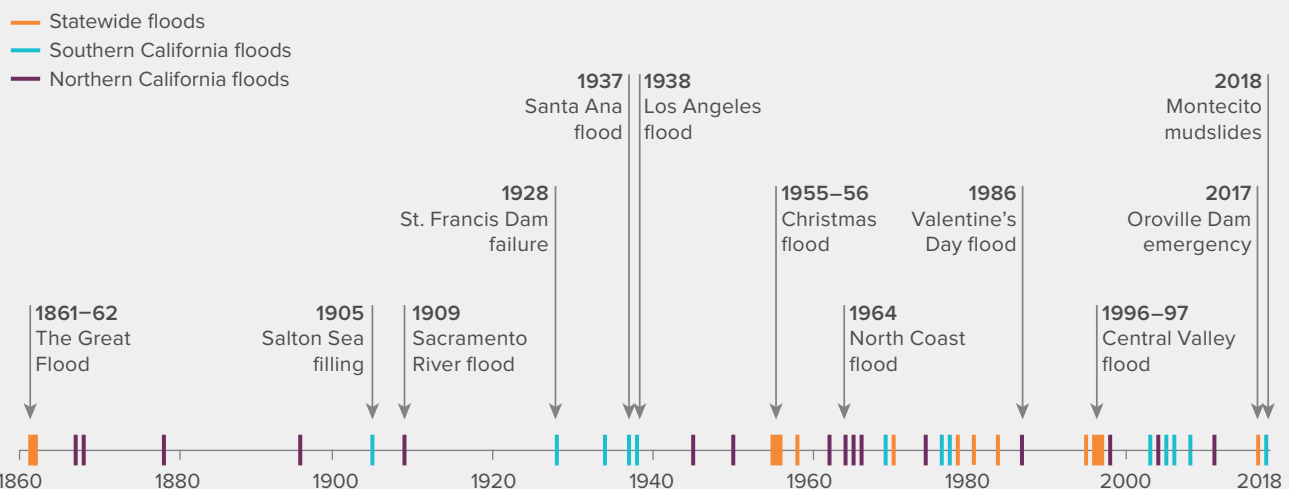


California is flood prone

Damaging floods are common throughout California. Since 1950, every county has been declared a state or federal flood disaster area multiple times. And since the early 1980s, Central Valley levees have failed on more than 70 occasions, including more than 40 times in the Sacramento–San Joaquin Delta. More than 7 million residents and hundreds of billions of dollars in assets are vulnerable to floods.

Flood management in California faces significant challenges. There is a large and growing gap between flood infrastructure needs and rates of investment. Population growth and new development increase flood risks. The *Paterno v. State of California* court decision in 2003 held the state liable for damages from the failure of a locally maintained levee, exposing taxpayers to billions of dollars in potential costs. The changing climate is likely to bring larger and more frequent floods, increasing pressure on flood management systems designed for early 20th-century conditions. Finally, rising seas and extreme high tides increase flood risk in communities bordering the ocean, the San Francisco Bay, and the Delta.

DAMAGING FLOODS ARE COMMON IN CALIFORNIA



SOURCE: Developed by the authors using California Department of Water Resources and US Army Corps of Engineers, *California's Flood Future: Recommendations for Managing the State's Flood Risk* (2013).

NOTES: The figure depicts floods that caused significant property damage and/or loss of life. Floods named above are the largest and most damaging. Thicker lines indicate floods that crossed over two calendar years.

Vulnerability to floods is high and rising

Most of California's annual precipitation occurs in a few intense storms. One type—an atmospheric river—is California's version of a hurricane, with extreme rainfall, high winds, and coastal storm surges. When these storms occur, runoff flows rapidly into valleys and coastal areas, potentially creating widespread flooding.

- **One in five residents lives in a flood-prone area.**

Four percent of all Californians live in areas that flood frequently. Another 17 percent are protected by levees and other infrastructure against a "100-year" flood—a flood with a 1 percent chance of occurring in any year. But these people remain vulnerable to larger, less frequent floods that can cause levee failures. The 100-year flood standard is generally considered insufficient for urban areas, where damages from larger floods would be quite high.

In the San Francisco Bay Area and South Coast, coastal flooding from extreme tides, waves, and storm surges is a

growing concern. Inadequate drainage systems also make many cities vulnerable to localized flooding from intense storms. The replacement value of vulnerable buildings exceeds \$575 billion. Roads, airports, and other public infrastructure also are exposed.

- **Major losses would occur from a disaster like the Great Flood of 1861–62.**

The US Geological Survey recently assessed the probable effects of a series of intense atmospheric rivers similar to those in the early 1860s. One in five California homes would be damaged or destroyed, and loss of life would be extensive. More than 1.5 million people would require evacuation, and economic losses would approach \$725 billion. Such losses far exceed those from large earthquakes, which occur with similar frequency—on average, once every few centuries. Although it is not economically feasible to protect against all flood losses, it is essential to prepare for these rare events by developing evacuation and recovery plans and reducing impacts where possible.

- **The likelihood of large and small floods is growing.**

Climate change simulations for California suggest that conditions that cause flooding, including atmospheric rivers and extreme high tides, may increase in intensity. This would mean an increase in large, dangerous floods and more “nuisance” urban floods, which are smaller but more frequent. One study projects that by mid-century the state is more likely than not to have a flood similar to the Great Flood of 1861–62.

- **Aging flood infrastructure needs more attention.**

The 2017 failure of two flood spillways at Oroville Dam highlighted the need for safety upgrades for older infrastructure. Two-thirds of the roughly 1,250 dams within the jurisdiction of the Division of Safety of Dams are at least 50 years old and more than 90 need significant upgrades. The cost of fixing Oroville exceeds \$1 billion. More than \$1 billion in damage claims have also been filed against the state.

Flood risk management requires a comprehensive tool kit

People living in flood-prone places will always face some risk. Reducing the frequency and consequences of flooding will require a mix of approaches. California needs to invest in infrastructure to improve flood protection, while strengthening floodplain planning and building codes to keep people out of harm’s way. The state must also raise public awareness about flood risk to improve local decision making.

- **California’s flood infrastructure is underfunded.**

A recent state study put the cost of upgrading levees and other defenses at more than \$34 billion. PPIC found an annual funding gap of \$800 million to \$1 billion for flood investments within a 25-year time frame. Because federal and state funds are limited, the funding burden will increasingly fall on local communities. Local taxes and fees currently cover most maintenance but less than half of needed investments. Filling the gap would require roughly doubling local spending, with even larger increases in the flood-prone Sacramento and San Joaquin River regions.

- **Better land use planning can reduce risk ...**

Land use planning is widely seen as the most sustainable and cost-effective way to reduce economic and social risks from floods. This approach keeps new high-value development away from vulnerable areas. Although it can be both politically unpopular and costly, relocating or raising vulnerable buildings and infrastructure may be desirable in some low-density areas—and even necessary as the climate changes.

- **... but policies do not adequately discourage floodplain development.**

To participate in the National Flood Insurance Program (NFIP) and to be eligible for federal disaster relief, communities must require protection for new buildings that would be inundated by a 100-year flood. Many California communities have built levees and other infrastructure that protect entire neighborhoods to this minimum federal standard. But concentrated development within these areas increases the economic risk from inevitable flooding—a risk borne by the NFIP, state and federal taxpayers, and local residents. In 2007, the state doubled the protection standard for Central Valley cities, which may discourage some risky development.

- **Federal flood insurance is undersubscribed in California ...**

Flood insurance reduces flooding’s economic costs by helping homeowners, businesses, and communities recover more quickly. Flood insurance purchases vary with risk perception. In 1998—following widespread flooding in the Central Valley—flood insurance policies hit a historic high of nearly half a million. A decade later, the number of policies had fallen by half. In mid-2018, just 231,000 homes and businesses had flood insurance.

- ... yet costs can be high for low- and middle-income homeowners.

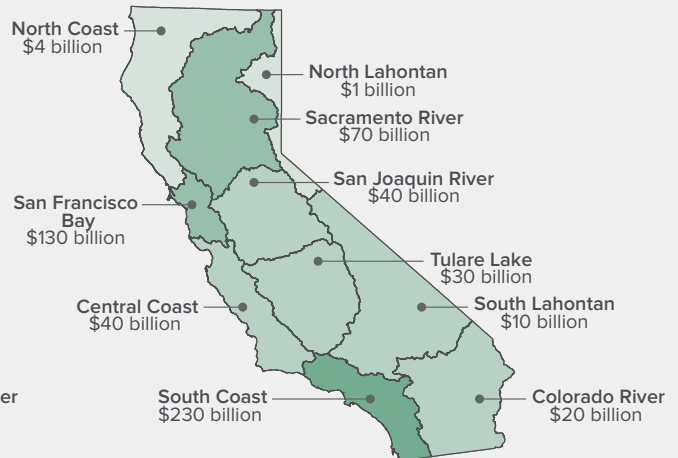
Congress recently required the phaseout of some insurance discounts for older properties. Along with new mandated fees, this may significantly increase premiums for some homeowners and create disincentives for buying insurance.

MILLIONS OF RESIDENTS AND MANY BILLIONS OF DOLLARS IN PROPERTY ARE VULNERABLE TO FLOODS

Population living in 500-year floodplain



Value of structures in 500-year floodplain



SOURCE: Adapted from California Department of Water Resources and US Army Corps of Engineers, *California's Flood Future: Recommendations for Managing the State's Flood Risk* (2013).

NOTES: The figure shows population and structures in the 500-year floodplain—the area susceptible to floods so large they have just a 0.2 percent chance of occurring in a given year. Levees protect much of this area from a 100-year flood, which has a 1 percent chance of occurring in a given year. Population is adjusted to 2010 levels. Value of structures is based on the depreciated replacement value of structures and their contents in 2010 dollars.

- **Flood infrastructure can provide environmental and water supply benefits.**

Flood protection can be improved by setting levees back from rivers and allowing waters to spread on undeveloped floodplains. Such an approach also boosts habitat, as the Yolo Bypass near Sacramento shows. Planning for flood-water capture—such as with permeable pavement and rain gardens—can reduce urban nuisance flooding, improve surface water quality, and recharge groundwater basins.

- **Rising sea level will force difficult planning decisions.**

Traditional infrastructure for protecting coastal communities—such as seawalls and levees—is costly and can cause beach erosion and environmental harm. To balance flood protection with other coastal management goals, California should consider where to protect existing development with new infrastructure and where to retain or restore more natural coastal features such as beaches and marshes.

- **Protecting farming in floodplains may require special policies.**

Farming on floodplains reduces pressure to develop these lands. That helps avoid the high costs of large flood protection infrastructure. But federal rules on new construction can make it very costly to maintain farms in the Central Valley's deep floodplains.

Looking ahead

Wet conditions in 2017 and the spillway failures at Oroville Dam renewed attention to flooding problems and the need to upgrade infrastructure. More volatile conditions from a changing climate and population growth in vulnerable regions make it necessary to take action.

Update aging infrastructure. California's water grid—the storage and conveyance system that stores water supply and helps manage floods—is aging and needs repair. Operational changes are also needed to make the system more flexible in light of a changing climate. Priorities include safety upgrades of dams and modernizing and integrating operations of multipurpose reservoirs to ensure they work together as an integrated water supply and flood management system.

Raise public awareness. To build support for local flood management actions, communities need to better understand flood risk and the potential array of responses.

Expand local funding tools. Since 1996, constitutional restrictions have made it difficult to fund needed flood investments. The funding gap could be reduced by treating flood agencies like water and sewer utilities—requiring transparent accounting but allowing elected governing boards to raise fees.

Increase incentives to carry flood insurance. To help manage risk, California should expand flood insurance purchases. One novel approach to increasing coverage and cutting costs would be to authorize local agencies to buy insurance for all properties within a community. And given that Californians pay much more into federal flood insurance than has been reimbursed, there may also be an opportunity for a state program with lower rates.

Build on Central Valley reforms. The 2007 package of reforms for this region included higher protection standards, greater risk-reduction responsibility for communities, new planning tools, and incorporation of ecosystem objectives and the risks from climate change. Many of these reforms should be adopted in other flood-prone regions.

Prioritize state funding. Since 2006, the state has used bonds to finance flood projects. State funding should prioritize those projects that take integrated approaches to water management—benefiting water supply, water quality, ecosystems, and open space—in addition to flood protection.

CONTACT A PPIC EXPERT

Jeffrey Mount
mount@ppic.org

Ellen Hanak
hanak@ppic.org

CONTACT THE RESEARCH NETWORK

Matt Kondolf, kondolf@berkeley.edu
Carolyn Kousky, ckousky@wharton.upenn.edu
Jay Lund, jrlund@ucdavis.edu
Nicholas Pinter, npinter@ucdavis.edu
Brett Sanders, bsanders@uci.edu

READ MORE

- CLIMATE CHANGE AND WATER
- THE COLORADO RIVER
- ENERGY AND WATER
- MANAGING DROUGHTS
- PAYING FOR WATER
- PREPARING FOR FLOODS
- PROTECTING HEADWATERS
- PROVIDING SAFE DRINKING WATER
- THE SACRAMENTO–SAN JOAQUIN DELTA
- STORING WATER
- WATER FOR CITIES
- WATER FOR THE ENVIRONMENT
- WATER FOR FARMS

This series is supported by the annual sponsors of the PPIC Water Policy Center.

The PPIC Water Policy Center spurs innovative water management solutions that support a healthy economy, environment, and society—now and for future generations.

The Public Policy Institute of California is dedicated to informing and improving public policy in California through independent, objective, nonpartisan research. We are a public charity. We do not take or support positions on any ballot measure or on any local, state, or federal legislation, nor do we endorse, support, or oppose any political parties or candidates for public office. Research publications reflect the views of the authors and do not necessarily reflect the views of our funders or of the staff, officers, advisory councils, or board of directors of the Public Policy Institute of California.

Public Policy Institute of California
500 Washington Street, Suite 600
San Francisco, CA 94111
T 415.291.4400 F 415.291.4401
PPIC.ORG/WATER

PPIC Sacramento Center
Senator Office Building
1121 L Street, Suite 801
Sacramento, CA 95814
T 916.440.1120 F 916.440.1121