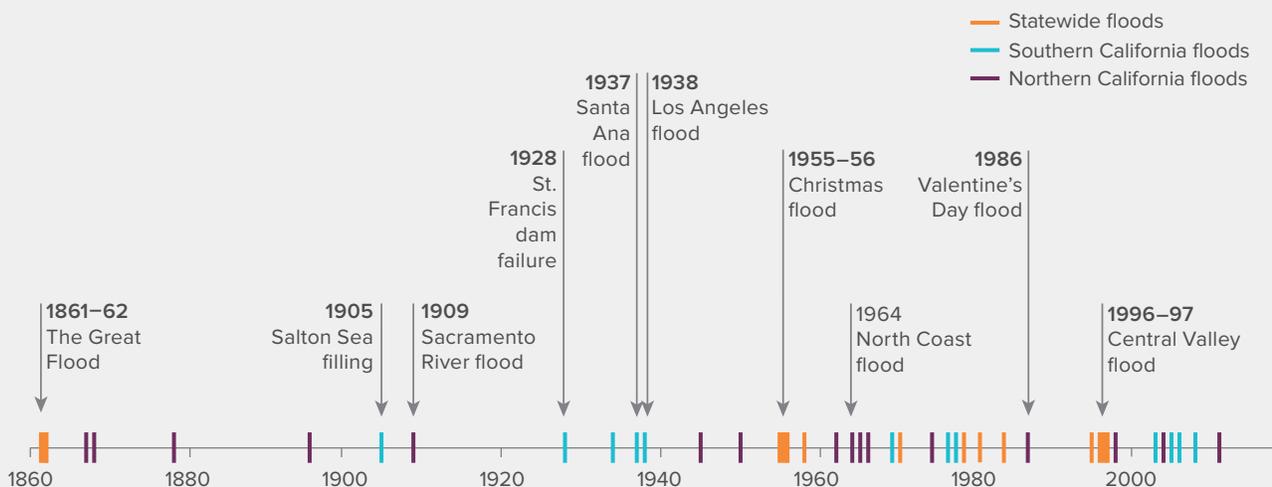


California is flood prone

Damaging floods are common throughout California. Over the past 60 years, 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.

California flood management faces significant challenges. There is a large and growing gap between flood infrastructure needs and rates of investment. Population growth and new development are increasing the threats to public safety and the economic risk from flooding. The *Paterno v. State of California* court decision in 2003 held the state liable for damages caused by 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 that were designed for conditions in the early 20th century. Finally, a rising sea level and extreme high tides are increasing 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 during a few intense storms. One type of storm, called 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, damaging floods. Exposure to both large and smaller floods is already high and on the rise.

- **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 often 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 is a concern from extreme tides, waves, and storm surges. Inadequate drainage systems also make many cities vulnerable to localized flooding from storm runoff. The replacement value of buildings vulnerable to floods exceeds \$575 billion. Roads, airports, and other public infrastructure are also 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 late 1861 and early 1862. 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. It is not economically feasible to protect California against all losses. Still, it is essential that the state prepare for these rare events, developing evacuation and recovery plans and reducing impacts where possible.

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

Recent climate change simulations for California suggest that conditions that cause flooding, including atmospheric rivers and extreme high tides, may increase in intensity and frequency. This would mean more large, dangerous floods and more “nuisance” floods—which are smaller but more frequent, and can be very disruptive for communities. These changes, coupled with a growing population, will require significant investments in flood protection infrastructure and innovative approaches to reducing risk.

Effective risk management requires a comprehensive tool kit

People living in flood-prone areas—particularly those behind levees—will always face some risk. Reducing the frequency and consequences of flooding will require a combination of approaches. California needs to make infrastructure investments to strengthen flood protection and to take nonstructural measures, such as better land use planning and stronger building codes, to keep people and buildings out of harm’s way. The state must also invest in communicating 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 making these 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 fund most maintenance but pay for less than half of infrastructure investments. On average, filling the gap would require roughly doubling local spending. In the flood-prone Sacramento and San Joaquin River regions, the increases would need to be much larger.

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

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

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

To participate in the National Flood Insurance Program 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 constructed levees and other flood infrastructure that protect entire neighborhoods to this minimum federal standard. Concentrated development within these minimally protected areas increases the economic risk from inevitable flooding. The state recently doubled the protection standard for urban areas in the Central Valley. The cost of meeting this standard will probably discourage some development.

- **Federal flood insurance is undersubscribed in California, but the recent El Niño caused an uptick ...**

Federal flood insurance reduces flooding’s economic costs by helping homeowners, businesses, and communities recover more quickly. Purchases of flood insurance vary with the perception of risk. In 1998—the year following widespread flooding in the Central Valley—flood insurance policies hit a historic high of more than half a million.

A decade later, the number of policies had fallen by half. However, late 2015 saw a sharp increase in anticipation of potential El Niño flooding.

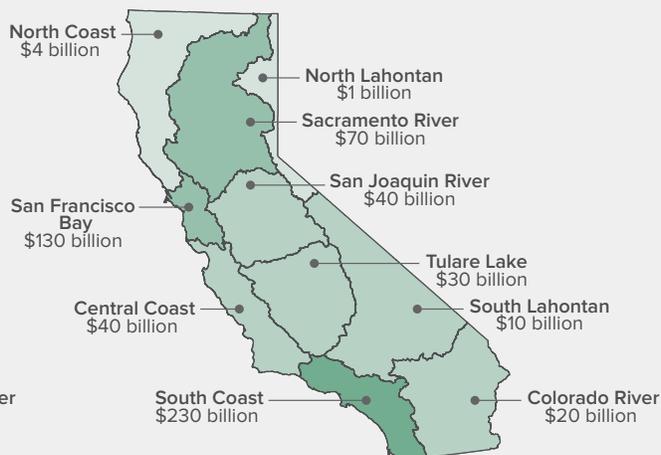
- yet costs can be high for low- and middle-income homeowners. Congress recently required the phaseout of some insurance discounts for older properties. Along with new mandated fees, this may significantly increase premiums for many homeowners and create disincentives for buying insurance.

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 that 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 out on undeveloped floodplains. Such an approach also boosts habitat, as the Yolo Bypass near Sacramento shows. Better fire management in upstream forests can diminish peak flood flows and mudslides. Low-impact development—such as permeable pavement and rain gardens that capture urban stormwater so that it soaks into the ground—can reduce nuisance flooding, improve surface water quality, and recharge groundwater basins.
- **Adapting to a rising sea level will require balancing goals.** Traditional infrastructure for protecting coastal communities—such as seawalls and levees—is costly, restricts public coastal access, and harms the environment. To balance flood protection with other coastal management goals, California should consider where to protect existing development by building new infrastructure and where to retain or restore more natural coastline features such as beaches and marshes.
- **Protecting farming in floodplains may require special policies.** Viable farms on floodplains reduce pressure to develop these lands. That helps to avoid the high economic, social, and environmental costs of large flood protection infrastructure. But federal rules on new construction can make it very expensive to maintain farms in the Central Valley's deep floodplains.

Looking ahead

It is hard to draw attention to flood management during a drought, although heightened awareness of the recent El Niño helped. Nevertheless, this is precisely the time to act to reduce future flood risk.

Expand local funding tools. Since 1996, constitutional restrictions have made it difficult to fund needed 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.

Improve flood risk information and communication. To promote flood resilience, communities need to better understand flood risk. This includes utilizing modern technology to identify vulnerable areas, and using new tools for communicating risk and the potential array of responses.

Increase incentives to carry flood insurance. To help manage risk, California should expand flood insurance purchases. One novel approach would authorize local flood management agencies to buy insurance for all properties within a community. This could increase coverage and cut costs. The legislature could encourage it by creating mechanisms to recover costs through assessments or fees and by subsidizing costs for low-income homeowners.

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 of the state.

Prioritize state funding. Since 2006, the state has used bonds to finance flood projects. Proposition 1, approved in November 2014, earmarks an additional \$595 million for flood and stormwater management. State funding is especially useful for projects that take integrated approaches to water management—benefiting water supply, water quality, ecosystems, and open space—in addition to flood protection.

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