Is California Ready for Flood?

Informational Hearing of the Assembly Water, Parks, and Wildlife Committee
9:00 AM, Tuesday, March 11, 2025
Background Paper

"And it never failed that during the dry years the people forgot about the rich years, and during the wet years they lost all memory of the dry years. It was always that way."

--John Steinbeck, *East of Eden* (1952)

Introduction. Flooding is a natural part of California's hydrology, climate, and landscape and every region of the state has experienced destructive flood events at some point in its history. Most recently, in the winter of 2023, the communities of Pajaro, Planada, and Allensworth flooded when a succession of atmospheric rivers hit California; these communities are still recovering from these disasters. Other recent major disaster events include flooding on the Russian River in 2019, the Oroville Spillway failure in 2017, and the "New Year's Day floods" that hit northern California in 1997, resulting in 120,000 people evacuated and 23,000 homes and businesses flooded.[1] Since 1992, every county in California has been declared a federal disaster area at least once due to a flooding event.[2]

Estimates suggest more than 7.3 million people and structures valued at nearly $600 billion statewide are located in areas that have at least a 1-in-500 probability of flooding in any given year.[3] In the Central Valley, 1.3 million people, $17 billion in agricultural economic activity, and $223 billion in homes, businesses, and structures are in flood risk areas. Unfortunately, climate change is increasing flood risk so these figures will continue to rise. Current projections indicate that peak flood flows in the Central Valley will increase up to five times by 2072 compared to past records.[4]

Despite their damaging potential, floods can also have positive effects, including replenishing groundwater basins, creating habitat for fish and wildlife, and improving water quality by flushing out contaminants. To realize some of these benefits, the Governor and Legislature enacted SB 122 (Committee on Budget and Fiscal Review) in 2023 to allow entities to divert "floodflows" from rivers and streams without obtaining a permit to recharge groundwater basins to alleviate water supply challenges.

Defining floods and flood risk. Flood risk is commonly described using the terms "100-year flood," "200-year flood," or "500-year flood." Many flood managers eschew these terms because they can lead to a misconception that a severe flood will only occur once in a century or more when, in fact, the terms describe the probability of a severe flood event occurring in any given year. So, a "100-year flood" has a 1-in-100 (or 1%) chance of occurring *every* year; a

[1] DWR and USACE, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, (2013), 2-18.
[2] Ibid., 1-2.
[3] Ibid., 3-43.
[4] *Central Valley Flood Protection Plan 2022 Update* (2022): 2-29, http://cvfpb.ca.gov/cvfpp/.

"200-year flood" has a 1-in-200 (or 0.5%) chance of occurring *every* year; and, a "500-year flood" has a 1-in-500 (or 0.2%) chance of occurring *every* year. As such, it is certainly possible (and maybe even likely) that a resident of California will experience a severe flood disaster multiple times in their lifetime.

California experiences different types of floods depending on the climate and geography of a given region. These include:

Type of flood	Regions/areas affected	Description
Fluvial	Statewide, deep floodplains, and low-lying urban areas	Gradual flooding as waterways overflow their banks from heavy precipitation and/or snowmelt; also referred to as river flooding.
Pluvial	Statewide, localized urban areas	Quick-forming and fast-moving floods, often from heavy rain falling on saturated or dry soil that has poor absorption ability. Also, localized flooding during or after a storm, generally due to blocked storm drain systems failing to properly convey stormwater runoff
Debris flow	Statewide, downstream of denuded hillsides	Quick-forming and fast-moving floods made of water liquefied mud, and debris, from rain falling on hillsides lacking vegetation
Coastal	Coast and San Francisco Bay Area	Encroaching seas due to storm surges, high winds, and/or exceptionally high tides

SOURCE: *Managing Floods in California*, Legislative Analyst Office (LAO), *California's Flood Future: Recommendations for Managing the State's Flood Risk*, and Public Policy Institute of California.

Flood Management Infrastructure and Responsibilities. Local, federal, and state agencies all play a role in managing floods and protecting communities. All levels of government have helped to develop a variety of physical structures to regulate flood flows, including levees, channels, and weirs to convey and control floodwaters, as well as dams, reservoirs, and bypasses to collect or store water. Physical structures are oftentimes paired with nonstructural approaches such as land use planning (e.g., limiting development in floodplains), emergency response planning, and flood insurance to manage flood risk.

Flood infrastructure across California includes more than 20,000 miles of levees and channels and more than 1,500 dams and reservoirs. Most of these facilities are owned and managed by local governments, reflecting the history of how the facilities were developed and aligning primary responsibility for the projects with their beneficiaries. Local agencies do the lion's share

of the work when it comes to flood management; more than 1,300 local agencies across the state take on this responsibility.[5]

The State Plan of Flood Control (SPFC). Over 1,600 miles of levees, four dams, five major weirs, and seven bypasses are overseen by the state and are considered part of SPFC, a system of flood protection infrastructure along the Sacramento and San Joaquin Rivers and their main tributaries. The Central Valley Flood Protection Board (CVFPB) oversees SPFC facilities and levees (often called project levees) on behalf of the state. For most segments of SPFC levees, the state has developed formal agreements with local governments to handle regular operations and maintenance responsibilities. The Department of Water Resources (DWR) maintains approximately 300 miles of SPFC levee segments not covered by such agreements.

In 2003, a state appellate court found the state responsible for the February 1986 Linda Levee failure on the Yuba River just upstream of Marysville. Although the levee was constructed by local entities and improved twice by the U.S. Army Corps of Engineers (USACE), *Paterno v. State of California* held that the state undertook liability when it assumed control of the levee in 1953 from USACE. As a result of the *Paterno* case, California paid $464 million in damages to the nearly 3,000 plaintiffs and the standard of care applicable to the state for the protection and maintenance of the levee and flood system was greatly increased.

Hurricane Katrina striking New Orleans in 2005, and serious flooding in Northern California in 2006, serve as reminders of the continuing vulnerability of the state's flood control system. In response to these disasters and the *Paterno* ruling, the Legislature took a series of actions in 2006–07 which included placing a general obligation bond (Proposition 1E) before voters (which voters approved) and passing a package of six flood protection bills. The flood legislation package included state and local planning requirements, higher flood protection standards (i.e., urban areas need to achieve "200-year" protection by 2025), local development requirements, and updated flood risk mapping goals.

Federal government role. With the exception of around 20 dams and reservoirs operated by USACE or the Bureau of Reclamation, the federal government generally does not directly operate or maintain flood control facilities in California today. While the federal government did initially build and maintain many components of SPFC, in the 1950s, the state committed to oversee and maintain these facilities pursuant to federal standards.[6] USACE inspects federally constructed levees for compliance with federal standards while the Federal Emergency Management Agency operates the National Flood Insurance Program (NFIP). NFIP includes mapping of flood risk and establishing floodplain management standards.

In addition, the federal government has historically been a very important partner in funding flood management projects, typically covering 65% of the total cost of a flood management project that has been authorized by the U.S. Congress.

[5] DWR and USACE, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, (2013), 3-22.
[6] LAO, *Managing Floods in California* (2017), 15.

Central Valley Flood Protection Plan (Flood Plan). As part of the 2007 flood legislation, CVFPB was required to adopt an integrated flood management plan for the Sacramento-San Joaquin River Flood Management System by July 2012. On June 29, 2012, CVFPB unanimously adopted the Flood Plan to meet this requirement, which CVFPB states, "provides conceptual guidance to reduce the risk of flooding for about one million people and $70 billion in infrastructure, homes, and businesses with a goal of providing 200-year (a 1-in-200 chance of flooding in any year) protection to urban areas, and reducing flood risks to small communities and rural agricultural lands." CVFPB's adoption of the Flood Plan triggered the requirement that cities and counties incorporate data and analysis from the Flood Plan into their general plans by 2014 and update their zoning ordinances by 2015 to prohibit development on property within a flood hazard zone unless the required levels of flood protection are met.

The Flood Plan was first updated in 2017 and again in 2022. The 2022 Flood Plan update estimates that the state invested roughly $4.1 billion to reduce flood risk from 2007 to 2021, an important accomplishment; however, it also notes that climate change is making floods more extreme and identifies a funding need of between $25 billion and $30 billion over the next 30 years to fulfill the goals of the Flood Plan. This breaks down into an annual need of $315 million to $390 million for routine operations and maintenance activities and a total capital investment in construction activities of $18 billion to $23 billion. In the near-term, the 2022 Flood Plan update estimates an investment need of $3.2 billion from 2023 to 2028. The update also emphasizes the themes of multi-benefit projects and flood system climate resiliency while also acknowledging the historic inequity in flood protection and the vulnerability of certain communities.

Flood Control Subventions Program (FCSP). The primary goal of FCSP is to increase flood protection for communities outside of the Central Valley. Under FCSP, local agencies (i.e., non-federal sponsors) that are partnering with the federal government to construct flood management projects receive financial assistance from the state. A project must be authorized by both the U.S. Congress and State Legislature in order to be eligible for funds from FCSP. The Legislature created FCSP in 1945 because most local agencies lacked the financial wherewithal to partner with the federal government on flood management projects.

FCSP authorizes and administers reimbursements to non-federal partners for the state's share (up to 70%) of non-federal costs associated with federally approved flood management projects, including land acquisition, land easements, rights-of-way, relocation, fish and wildlife conservation, recreation, disposal, and other multipurpose objectives. Reimbursements under FCSP are made in arrears after the local agency (i.e., non-federal partner) has incurred and paid for these costs; funds have historically come from the General Fund and/or general obligation bonds (e.g., Proposition 1E).

There are currently at least 12 authorized projects receiving funding from FCSP (Water Code § 12671 *et seq.*). Examples of these projects include:

- The Santa Ana Mainstem Project that will provide "100-year" protection to over 3.4 million people in the counties of Orange, Riverside, and San Bernardino. In 2023, this project had an estimated cost of $1.5 billion;

- The South San Francisco Bay Shoreline Project that will provide coastal flood protection through a combination of levees, wetlands, and transitional habitats. In 2023, this project had an estimated cost of $545 million;
- The Pajaro River Flood Risk Reduction Project that will improve levees and include multi-benefit features to protect residential communities, disadvantaged communities, and prime agricultural land in the Salinas Valley. In 2023, this project had an estimated cost of $544 million; and
- The Westminster Flood Damage Reduction Project to provide increased flood protection in Orange County. In 2023, this project had an estimated cost of $1.2 billion.

Flood Control Funding. A 2017 Legislative Analyst's Office report, *Managing Floods in California*, notes that estimating flood management funding needs is difficult for multiple reasons but points to a 2013 study by FloodSafe and 2014 study by the Public Policy Institute of California (PPIC) that estimated local, state, and federal spending ranges between $2.2 and $2.8 billion annually, with nearly two-thirds the funding coming from local sources.

PPIC estimates that the state spent an average of $574 million annually on flood management between 2008 and 2011. A lot of the state funding came from general obligation (GO) bonds approved by the voters. GO bonds continue to be one of the primary ways that the state funds flood management in this century. Since 2006, voters have authorized more than $6.5 billion in spending for various flood management activities; these include:

- Proposition 1E (2006) – $3.8 billion for various flood management activities
- Proposition 84 (2006) – $800 million for flood control projects and planning
- Proposition 1 (2014) – $395 million for flood protection
- Proposition 68 (2018) – $550 million for flood protection and repair
- Proposition 4 (2024) – $1.1 billion for flood management, dam safety, and stormwater management

The federal government has historically played an integral role in flood management and has annually contributed an estimated $254 million to $470 million for flood management activities in California.[7] For projects approved by the U.S. Congress, USACE covers 65% to 75% of the total project cost (the "federal share") with the state and local agency sponsor covering what remains (the "non-federal share"). Given the current federal Administration, there is a question about whether the federal government will continue to play a similar role in flood management going forward.

How bad might it get? In 2010, the United States Geological Survey (USGS) led a multidisciplinary team of leading earth scientists, engineers, and social scientists to create the ARkStorm scenario: a detailed and realistic depiction of how a severe winter storm could affect the state. ARkStorm shows that atmospheric rivers represent a nearly existential threat to California's people, economy, and culture.

[7] Ibid., 24.

The 2010 ARkStorm is patterned after the 1861–62 historical flood events but uses modern modeling methods and incorporates data from 20th century storms. The ARkStorm draws heat and moisture from the tropical Pacific, forming a series of atmospheric rivers that approach the ferocity of hurricanes and then slam into the U.S. West Coast over a period of several weeks.[8] The ARkStorm analysis suggests that such an event would produce widespread, catastrophic flooding, displace millions of people, lead to the long-term closure of critical transportation corridors, and result in up to $1 trillion in overall economic losses (in 2022 dollars).[9]

If that does not sound bad enough, researchers developed a new ARkStorm scenario ("ARkStorm 2.0") in 2022 to reflect climate change data and advances in modeling to evaluate the impact of a 30-day storm in a future climate (2071–80). This new modeling finds that "climate change has already doubled the likelihood of an event capable of producing catastrophic flooding"[10] and that peak runoff will be 200% to 400% higher than that shown under ARkStorm 1.0.[11] The increased precipitation is very likely to increase the severity of geophysical hazards such as flash flooding and debris flows, especially in the vicinity of large or high-intensity wildfire burn areas, which are themselves increasing due to climate change and yielding large increases in associated compound hazards.

The atmospheric river events in 2017 and 2023 demonstrated the plausibility of the ARkStorm scenarios though neither approached the severity of the megaflood modeled by ARkStorm: a flood 200 miles long and 12 to 20 miles wide that would effectively be an inland sea in the Central Valley.

[8] Keith Porter *et al.*, "Overview of the ARkStorm Scenario," U.S. Geological Survey Open-File Report (2010): v, https://pubs.usgs.gov/of/2010/1312/.
[9] Xingying Huang and Daniel Swain, "Climate Change is Increasing the Risk of a California Megaflood," *Science Advances* 8 no. 31 (2022): 1, https://www.science.org/doi/10.1126/sciadv.abq0995.
[10] Ibid., 1.
[11] Ibid., 6.