

Sea Level Rise in California

Letitia Grenier and
Gokce Sencan

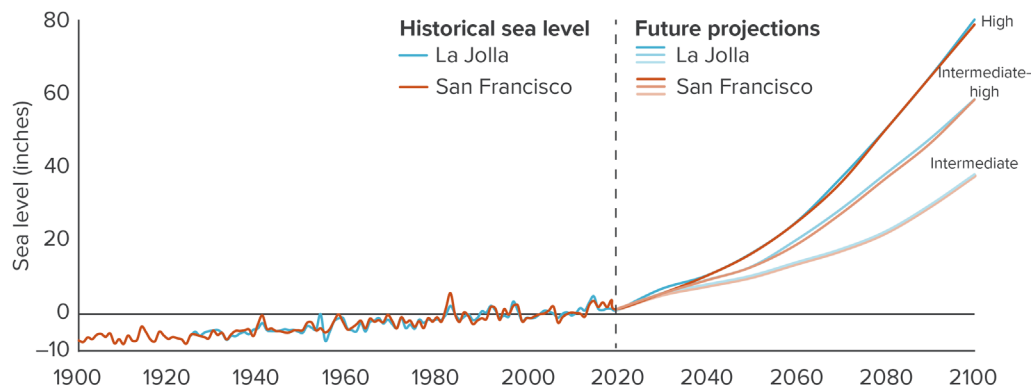
Sea levels are rising due to increasing temperatures from climate change.

- ▶ As the atmosphere warms, ocean water warms—causing the water to expand—and land-based ice melts. Both of these processes raise sea level.
- ▶ Future sea level rise is inevitable, as greenhouse gases (GHGs) already in the atmosphere continue to trap heat. Reducing GHG emissions in the coming decades would reduce the rate of sea level rise in the long term.
- ▶ The rate of sea level rise will also depend on whether large ice sheets melt steadily or collapse rapidly. [Recent evidence](#) suggests that ice sheets are melting faster than expected, which could lead to more rapid sea level rise.

Californians are already impacted by sea level rise, and it is getting worse.

- ▶ California has experienced about [8 inches of sea level rise](#) over the past century, and this pace will accelerate after 2050. Many areas along California's coast already flood on a regular basis, and [low-income communities of color](#) are particularly impacted.
- ▶ One- to two-thirds (31–67%) of Southern California beaches may [completely erode](#) by 2100 without costly, large-scale interventions like breakwaters and beach nourishment. Such investments can be expensive and may cause erosion or other negative environmental impacts.
- ▶ Assuming high GHG emissions continue, the state of California recommends preparing for [3.1–6.6 feet of sea level rise](#) by 2100.

Past sea level rise and future sea level scenarios for adaptation planning



Sources: National Oceanic and Atmospheric Administration (past data); California Ocean Protection Council and California Ocean Science Trust, *DRAFT: State of California Sea Level Rise Guidance: 2024 Science and Policy Update* (future projections).

Notes: To match the future projection baseline, the authors adjusted the past data baseline (1983–2001 average) to the average for 1991–2009. The state of California's draft 2024 guidance recommends using these three high-emission scenarios for planning purposes. The intermediate-high and high scenarios include increasing contributions from rapid ice sheet loss. Sea level rise will continue to be variable, as in the past.

Sea level rise brings a variety of consequences and costs.

- ▶ Sea level rise pushes up groundwater and increases flooding, bringing contaminants to the surface and moving saltwater inland, which harms coastal aquifers. Combined flooding—when storm runoff meets high groundwater and ocean levels—can have severe local impacts.
- ▶ Twenty inches of sea level rise, which could occur as soon as 2050, could inundate [\\$17.9 billion worth of buildings](#) in California. Higher water levels will necessitate a major reworking of coastal sewage infrastructure and wastewater treatment plants, which are often found at very low elevations.
- ▶ The San Francisco Bay Area alone, with its long and vulnerable shoreline, faces [a funding gap of \\$105 billion](#) to implement full adaptation measures by 2050; the cost of failing to adapt is estimated at over \$230 billion.

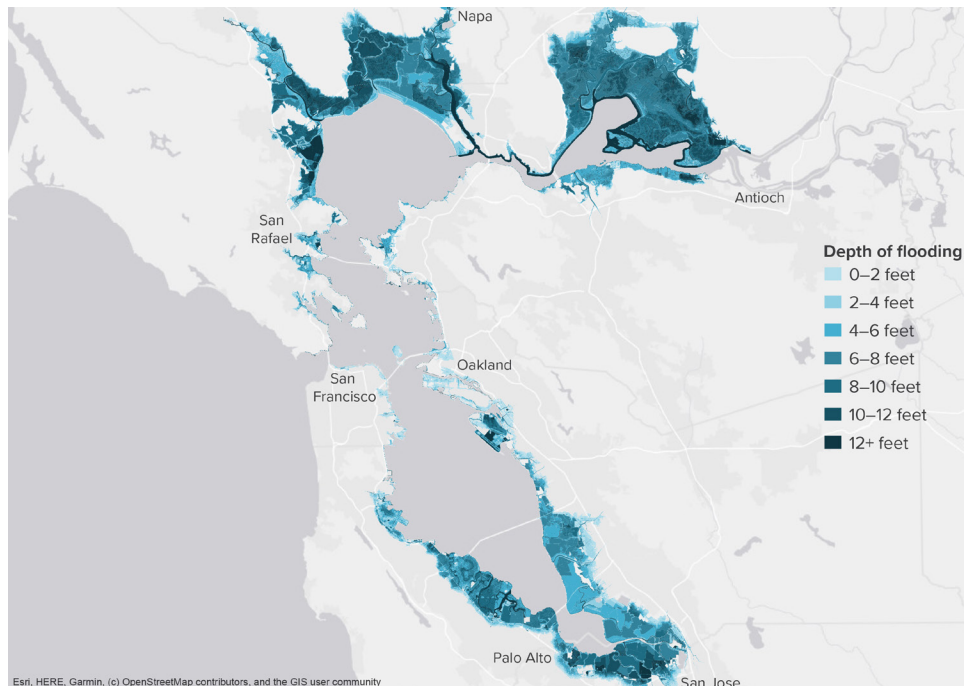
Working with nature will be an important ingredient for success.

- ▶ Nature-based solutions like marshes, reefs, and beaches are good long-term investments in sheltered areas—buffering shorelines against waves, providing habitat, and sequestering carbon.
- ▶ Hybrid solutions that combine engineered and natural elements can balance costs and benefits. And while engineered protection such as seawalls and levees will be critical in many places, it is essential to avoid approaches that ultimately [worsen the problem](#).
- ▶ Over the long run, getting out of the way of the advancing ocean, also known as managed retreat, will be necessary in some areas. A few such projects are already underway, including at [Ocean Beach](#) in San Francisco.
- ▶ Policy and funding [tools for adaptation](#) include updating zoning, building codes, and rebuilding restrictions, as well as implementing Geologic Hazard Abatement Districts (GHADs) and development rights transfers.

Sea level rise adaptation requires intensive and novel coordination.

- ▶ All levels of government have important roles to play in sea level rise adaptation, including creating regulations, setting goals, and funding and implementing projects.
- ▶ A [recent state law](#) requires coastal cities to plan for sea level rise, and a 2020 [executive order](#) requires considering nature-based solutions for adaptation. The state’s regular [climate change updates](#) and [guidance on sea level rise](#) help standardize approaches.
- ▶ The California Coastal Commission and the Bay Conservation and Development Commission regulate the coastline, though adaptation is largely planned by local governments, with many overlapping jurisdictions.
- ▶ Actions on one site can negatively impact neighbors: for instance, sea walls can increase wave erosion elsewhere. In the Bay Area, where sea level rise will be especially costly, local entities are [coordinating on sea level rise adaptation planning](#) for projects whose impacts cross jurisdictional lines.

Coastal flooding in the Bay Area could be widespread with 3 feet of sea level rise



Source: [ART Bay Shoreline Flood Explorer](#).

Notes: The figure shows 3 feet of sea level rise and a 25-year storm surge that adds 30 inches more, bringing the total increase in water level depicted in the map to 66 inches. This scenario could occur as early as 2070, but the state’s sea level rise guidance indicates that 2100 or later is more likely. The flooding is projected onto the current landscape and does not reflect future adaptation of levees and other protection.

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