Selecting Climate Scenarios

ADAPTING TO RISING TIDES PROGRAM

This guide helps with…

Understanding the building blocks of a climate scenario, and factors to consider in selecting scenarios for an adaptation planning project that addresses sea level rise and storms.

Climate Scenario Building Blocks

Scenarios describe the projected future conditions that will be used to evaluate potential exposure of assets to climate impacts. Refer to the How-to Guide: Communicating About Climate Impacts ( ) and ART Portfolio: Findings by Issue > Climate Impacts and Scenarios webpage for more information about the sea level rise and storm flooding impacts that the ART Program has addressed in past projects. To preview how the scenariosare used in the evaluation of exposure to impacts, refer to the How-to Guide: Exposure Analysis ( ).


Photo: BCDC

For sea level rise, the future climate condition is a combination of two factors: (1) the projected amount of sea level rise and (2) the extreme or daily tide level[1].

1. Sea Level Rise Projections

Projections are a calculated climate system response. They are most often based on climate model simulations and therefore depend on assumptions about future global socio-economic and technological conditions. For the West Coast of the United States (California, Oregon, and Washington), the most recent, science-based sea level rise projections were published by the National Research Council in 2012. These regional projections, which take into account global factors, are summarized for coastal areas south of Cape Mendocino, below.

[1] Extreme tides are the maximum high tide level that has occurred over a specific return period (recurrence interval) that correlates to a specific occurrence probability. For example a 100-year extreme tide has a return period of 100 years, and therefore a 1% chance of occurring in any given year.

REGIONAL SEA LEVEL RISE PROJECTIONS (IN INCHES) RELATIVE TO YEAR 2002 FOR THE CALIFORNIA COAST SOUTH OF CAPE MENDOCINO.

	Projected Sea Level Rise: Likely sea level rise values based on a moderate level of greenhouse gas emissions and extrapolation of continued accelerating land ice melt patterns, plus or minus one standard deviation[3]	**Range of Sea Level Rise:** Extreme limits of the ranges represent unlikely but possible levels of sea level rise utilizing both very low and very high emissions scenarios and, at the high end, including significant land ice melt that is not anticipated at this time but could occur[3]	
Year	Mean ± standard deviation[4]	Low[5]	High[6]
2030	6 ± 2	2	12
2050	11 ± 4	5	24
2100	36 ± 10	17	66

2. Tide Levels

Sea level rise will increase the risk of permanent inundation and temporary flooding[7]. Permanent inundation occurs when an area is exposed to the regular tides. In the San Francisco Bay, intertidal mudflats are inundated by the tide daily, while tidal marshes are inundated only during higher high tides (e.g., MHHW, mean higher high water[8]). For many built and natural assets, including shoreline protection and many marshes, exposure to daily tidal inundation will lead to a slow, but steady, degradation.

Temporary flooding occurs when an area is exposed to extreme tide events that are higher than normal high tides. Large storms, and in particular those that generate large waves or occur during the regular high tide, have the potential to flood large inland areas moreso as sea levels rise. In addition, annual high tide events, such as the King Tides or atmospheric and oceanic conditions such as El Niño, can also cause temporary flooding of inland areas. Although extreme tides are less frequent than regular tides, they can result in extensive flooding, deeper flooded depths, higher water velocities, and a greater likelihood that wind-driven waves will overtop existing shoreline protection. Temporary flooding may be short in duration but many assets can be irreversibly damaged if exposed to any amount of water or salinity.

[2] *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past Present and Future*. Prepared by the Committee on Sea Level Rise in California, Oregon, and Washington; Board on Earth Sciences and Resources; Ocean Studies Board; Division on Earth and Life Studies; National Research Council 2012. http://www.nap.edu/catalog.php?record_id=13389.

[3] *Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability, Risk and Adaptation.* Prepared by the Sea Level Rise Committee of SF Adapt for the San Francisco Capital Planning Committee; July 2014. http://www.acfloodcontrol.org/SFBayCHARG/pdf/sf_slr_guidance.pdf.

[4] Based on the A1B is balanced scenario. The A1 scenario family that assumes high economic growth, low population growth that peaks mid century, and the rapid introduction of more efficient technologies.

[5] Based on the B1 scenario family assumes the same low population growth as the A1 scenarios, but a shift toward a lower-emission service and information economy and cleaner technologies.

[6] Based on the A1FI fossil fuel intensive scenario. A1 scenario family assumes high economic growth, low population growth that peaks mid century, and the rapid introduction of more efficient technologies.

[7] AECOM. Adapting to Rising Tides Alameda County Shoreline Vulnerability Assessment Report, Draft May 2014.

[8] Mean higher high water (MHHW) is calculated as the average of the higher of the two daily high tides over a 19-year tidal epoch.

Developing Scenarios

Because the sea level rise (SLR) scenarios describe the climate conditions that could lead to permanent inundation or temporary flooding and future conditions are uncertain, they need to include a range of SLR projections and tide levels. Using multiple projections helps to uncover the possible timeframes and frequencies that flooding might occur as well as the magnitude of the potential consequences. As an example, the ART Program has used the following climate scenarios:

- Daily tide at mid-century, similar to today's King Tide water levels (12 inches SLR + MHHW)
- 100-year extreme tide at mid-century, similar to end-century 2-year extreme tide (12 inches SLR + 100-year tide event)
- Daily tide at end-century (36 inches SLR + MHHW)
- King Tide at end-century (36 inches SLR + 1-year tide event)

When selecting climate scenarios, it is important to balance the most recent climate science with the availability of maps and models and the project's resilience goals. Project partners, working group members, and ART Program staff can assist in the selection of the climate scenarios, and can be excellent source of data and information that can be used to understand both existing and future climate impacts.

Avoid getting stuck in the selection of the "right" climate scenarios by taking a broad view that includes today as well as the near future (e.g., mid-century), where there is less uncertainty in the amount and timing of climate change. For the more distant future, where the amount and timing of climate change is more uncertain, choose the most plausible scenario and acknowledged it will be necessary to revisited the extent and timing of impacts in the future.

Mapping Tools

A number of publically available sea level rise and storm event mapping tools for the San Francisco Bay Area can be used in the analysis of temporary inundation and permanent flooding. These include:

NOAA SEA LEVEL RISE AND COASTAL FLOODING IMPACTS VIEWER

A national tool that depicts potential impacts to marshes and human communities from a range of sea level rise projections from 0 to 6 feet coupled with mean higher high water (MHHW). It also illustrates changes in flood frequency and includes visual simulations of flooding at local sites. coast.noaa.gov/slr/

OUR COAST, OUR FUTURE (OCOF)

A regional tool that provides locally relevant, online maps of forty possible climate futures based on the USGS's CoSMoS Model. The tool helps users understand, visualize, and anticipate sea level rise and storms within the San Francisco Bay and on the outer coast from Half Moon Bay to Bodega Bay. data.prbo.org/apps/ocof/

CLIMATE CENTRAL'S SURGING SEAS

A national tool that allows users to see maps of 0 to 10 feet of sea level rise coupled with mean higher high water (MHHW). The tool also provides statistics of population, homes and land affected by city, county and state, plus links to factsheets, data downloads, action plans, and more. sealevel.climatecentral.org/ssrf/california