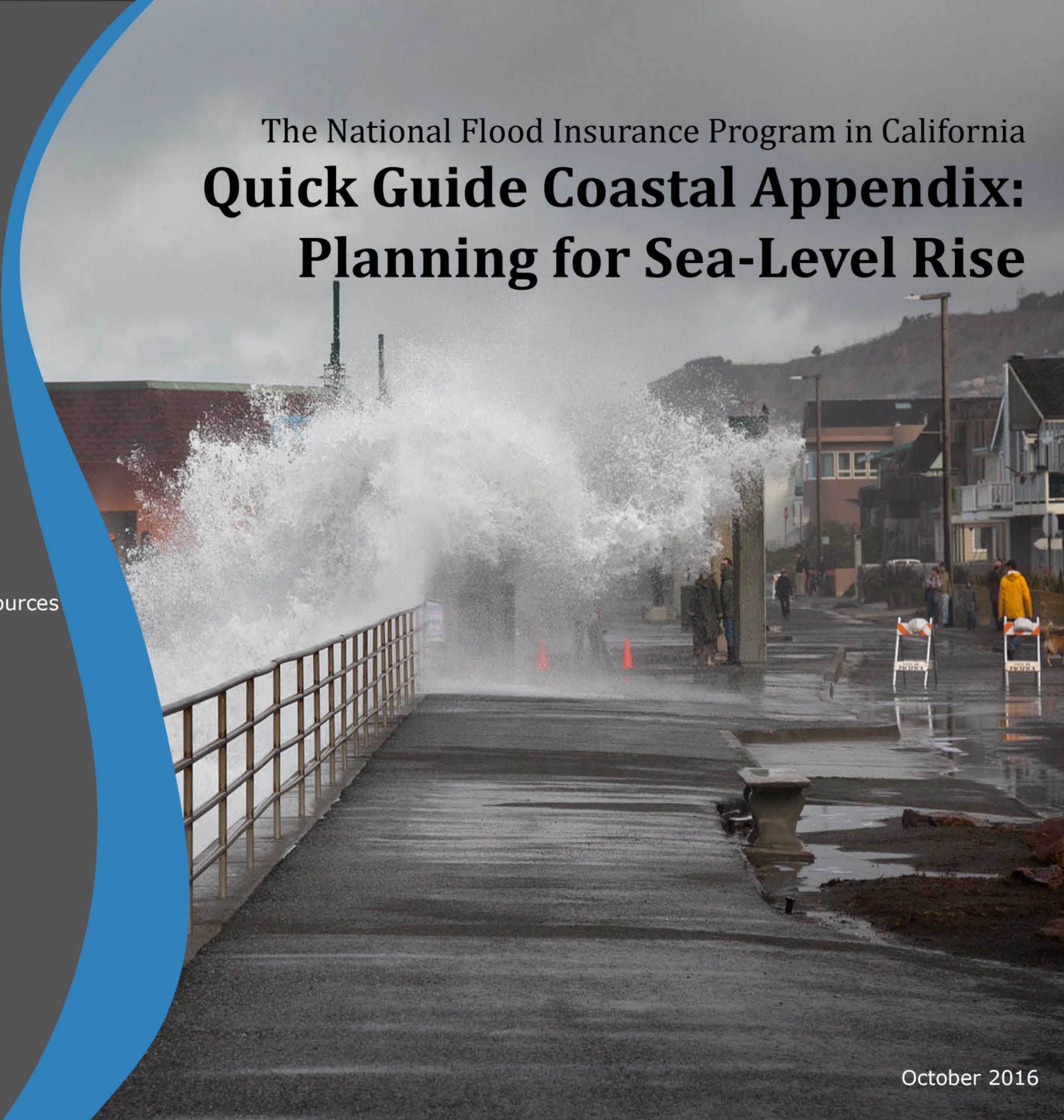
The National Flood Insurance Program in California

Quick Guide Coastal Appendix: Planning for Sea-Level Rise



California Department of Water Resources
http://www.fpm.water.ca.gov

October 2016

Why consider sea-level rise in coastal floodplain planning?

The 2007 California Quick Guide focuses on “existing condition” flood hazards. This appendix to the Quick Guide is for floodplain managers, planners, and community leaders who need to understand the effects of future sea-level rise in order to enhance their communities’ mitigation plans and take action to better protect their citizens.

This appendix provides information and resources on the following topics:

- Regulatory and non-regulatory FEMA mapping efforts.
- Defining sea-level rise.
- Why communities need to plan for sea-level rise.
- How communities can plan for sea-level rise.
- General approaches for mapping sea-level rise.

Bluff-top homes in Pacifica, San Mateo County, were undermined and ultimately demolished during the 1997-1998 El Niño event (Source: Russell and Griggs, 2012)

The California shore is subject to increasing hazards resulting from sea-level rise caused by climate change (California Energy Commission, 2012). Higher sea levels could worsen existing coastal flooding hazards by:

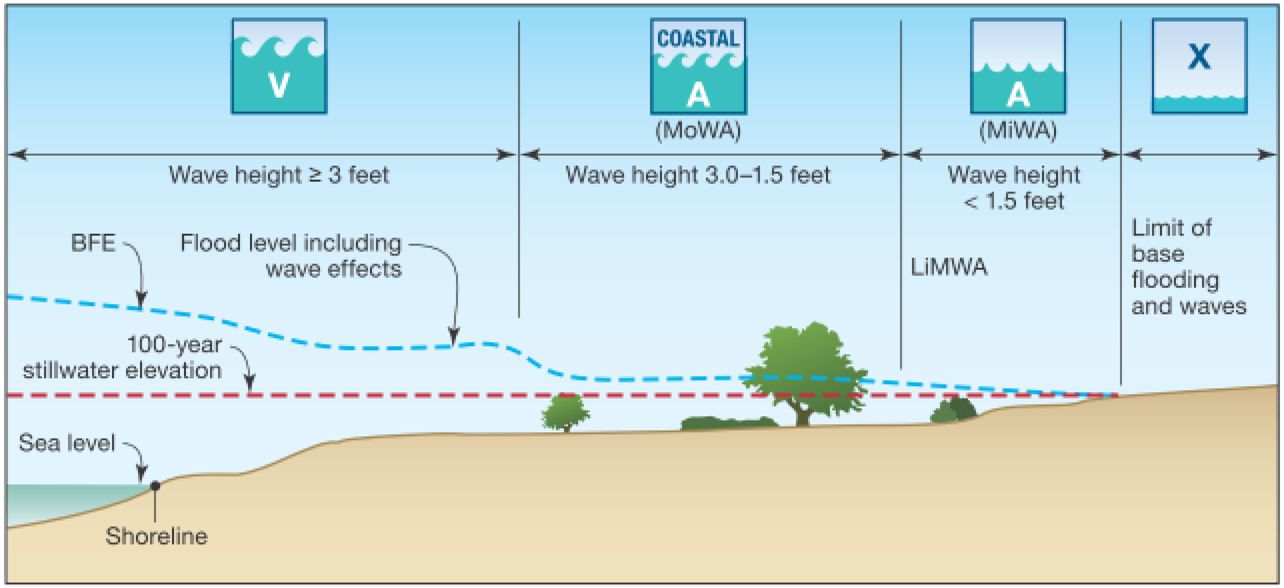
- Increasing the frequency of flooding.
- Increasing the extent of the coastal flood hazard further inland.
- Accelerating shore erosion.
- Preventing storm water drainage from reaching the ocean and bays.
- Possibly increasing coastal stream flooding.

In particular, coastal flooding caused by the simultaneous occurrence of extreme storm events and high tides is exacerbated by sea-level rise and the El Niño phenomena. For example, a strong El Niño combined with a series of storms during high-tide events caused more than $200 million dollars in damage (in 2010 dollars) to the California coast during the winter of 1982-83. In the next few decades, most of the damage along the coast will likely result from extreme events (Coastal and Ocean Working Group of the California Climate Action Team, 2013). In recognition of the hazard posed by future extreme events, the State has been urging implementation of flood projects that forecast these extremes which will be heightened by sea-level rise (California Water Action Plan, 2016).

Note: This appendix focuses primarily on coastal flooding and not on shore erosion or the combination of ocean and stream/estuary flooding. The California coast also includes the shorelines of bays affected by sea-level rise, tides, and other oceanic processes.

How does FEMA map existing coastal flood hazards?

Flood Insurance Rate Maps (FIRMs) are National Flood Insurance Program (NFIP) regulatory products that show coastal flood hazards based on the current sea level and shore conditions at the time of the Flood Insurance Study conducted by the Federal Emergency Management Agency (FEMA). They show Special Flood Hazard Areas (SFHAs), which are areas subject to flooding from the one-percent annual chance flood.



FIRM Coastal Special Flood Hazard Areas (SFHAs). BFE is Base Flood (100-year) Elevation, MoWA is moderate wave action, MiWA is minimal wave action, and LiMWA is Limit of Moderate Wave Action. Zone X is outside the SFHA. (Source: FEMA)

The coastal SFHAs are:

- Zone V. These zones are the Coastal High Hazard Areas subject to high-velocity wave action from storms or seismic sources with wave heights equal to or greater than 3.0 feet.
- Zone A. These zones identify portions of the SFHAs not within the Coastal High Hazard Area. Zone A has two areas separated by the Limit of Moderate Wave Action (LiMWA) boundary. The area between the LiMWA and the Zone V limit is known as the Coastal A Zone; it has moderate wave action (MoWA)

with wave heights between 3.0 and 1.5 feet. The area between the LiMWA and the landward limit of Zone A is known as the minimal wave action (MiWA) area, with wave heights less than 1.5 feet. [Note: FEMA issued LiMWA guidance in 2008; it is not included in the 2007 California Quick Guide.]

FIRMs currently do not show changes in SFHAs attributable to future sea-level rise.

How will FEMA map future coastal flood hazards?

FEMA is developing guidance on mapping future coastal hazards related to sea-level rise that can be used for non-regulatory (community planning) and regulatory (permitting and zoning) purposes:

- For non-regulatory purposes, the Risk Mapping, Assessment, and Planning (Risk MAP) program provides communities with flood risk information and tools they can use to better protect their citizens. One of the Risk MAP products is a Flood Risk Map (FRM), which can display the effects of future sea-level rise.
- For regulatory purposes, FEMA does not presently have authority to show future conditions directly on a community's FIRM. However, communities can take the initiative to incorporate future watershed conditions on their FIRMs. For example, the City of Charlotte and Mecklenburg County, North Carolina, have done this in a riverine context. Other communities have incorporated future conditions in their planning documents. For example, the City of Roseville, California, provides "Regulatory Floodplains" in its general plan's safety element used to regulate development based on future conditions, also in a riverine context.

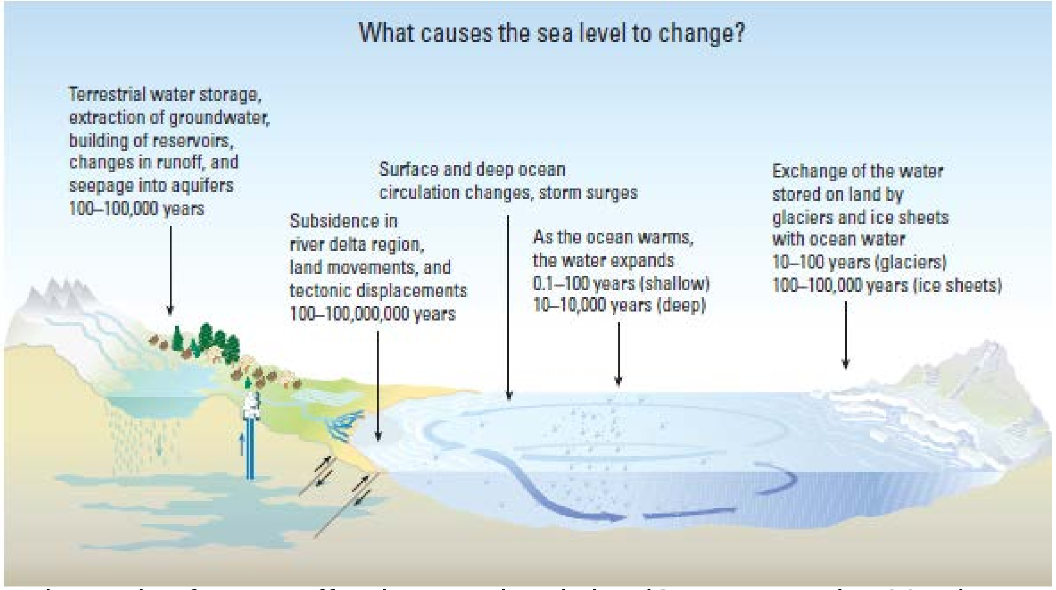
FEMA's Risk MAP program includes assessing present and future flood risks (Source: FEMA Risk Map program)

Properties in coastal communities that prepare for future flood hazards caused by sea-level rise may be eligible for reduced flood insurance premiums through the NFIP Community Rating System (CRS) credit earned for specified activities. These activities could include providing information about areas not mapped on the FIRMs but are projected to be susceptible to flooding in the future because of sea-level rise.

[Note: when used in this Quick Guide Appendix, the terms *regulatory* and *non-regulatory* refer only to NFIP regulations. Other local and state regulations may govern various aspects of coastal floodplain management.]

What is sea-level rise and what contributes to it?

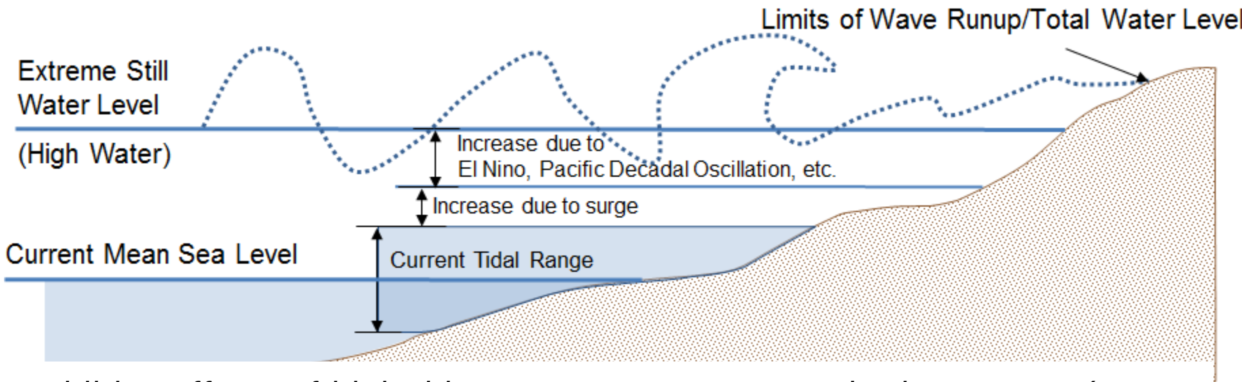
Sea-level rise is an increase in the mean (average) level of the ocean (USACE, 2013). During the 20th century, mean (average) sea level has risen by about 7 inches along most of California's coastline (A.L. Leurs, et al., 2006).



The major factors affecting sea-level rise (Source: Doyle, 2015)

Sea level is affected by various factors:

- Global factors that have been and will very likely continue to cause sea level to rise include:
  - Heating and expansion of ocean water.
  - Melting of the world's ice sheets and glaciers.
- Regional and local factors that cause changes (either rise or decline) in regional or local sea level include:
  - Fluctuating ocean and atmospheric patterns (e.g., El Niño, which usually causes regional sea level to rise along the California coast for several months).
  - Vertical land movement from tectonic forces, sediment compaction, water or hydrocarbon extraction.
  - Changes in the hydrologic cycle (e.g., river flows) that affect runoff.
  - Other additive factors, such as storm surge and wave runup during severe storm conditions.



Additive effects of high tides, storm surge, atmospheric patterns (e.g., El Niño) and large waves can result in coastal flooding (Source: adapted from California Coastal Commission, 2015)

Definitions (FEMA):

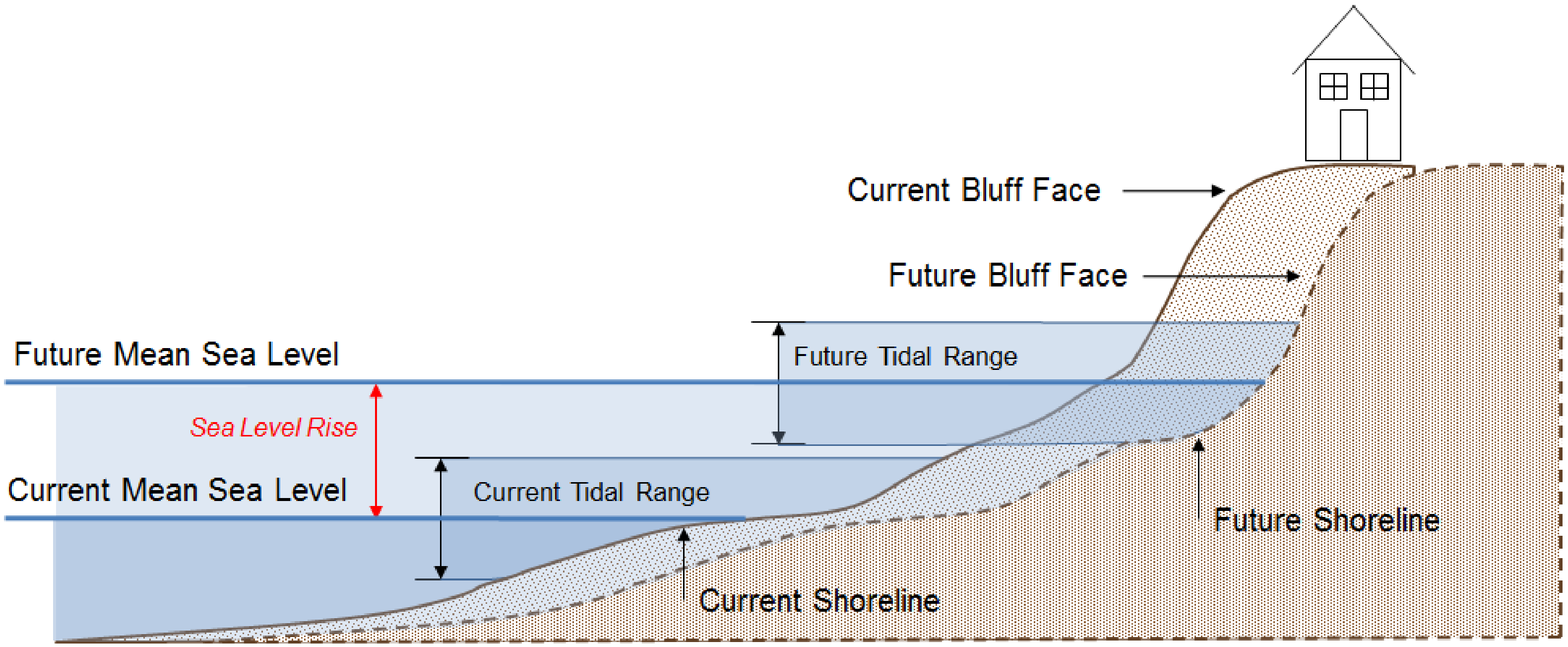
Storm surge: The water that is pushed toward land from the high winds of a major storm.

Wave runup: The rush of wave water up a slope or structure.

Total water level: The maximum water level taking into account wave runup, storm surge, and tides.

The highest California sea levels have occurred during abnormal events, such as the simultaneous occurrence of high astronomical tides, low atmospheric pressure, and big storms inducing high winds, especially during large El Niños (e.g., 1983 and 1998). As mean sea level rises, projections indicate a marked increase in the likelihood of exceeding historical extreme (e.g., strong storm) levels. Finally, rare extreme events can raise sea level much faster than long-term changes in mean sea levels. Such events include temporary changes caused by earthquake-induced tsunamis and immediate and permanent changes in land subsidence and/or uplift caused by a great earthquake, the latter (uplifts) causing a decline in sea level.

Rising water levels (in combination with waves) can also result in coastal bluff erosion, although bluffs may be stable for years and then retreat by many feet in a few hours or days.



Bluff erosion with changes in sea level (Source: California Coastal Commission, 2015)

Why should communities plan for future sea-level rise?

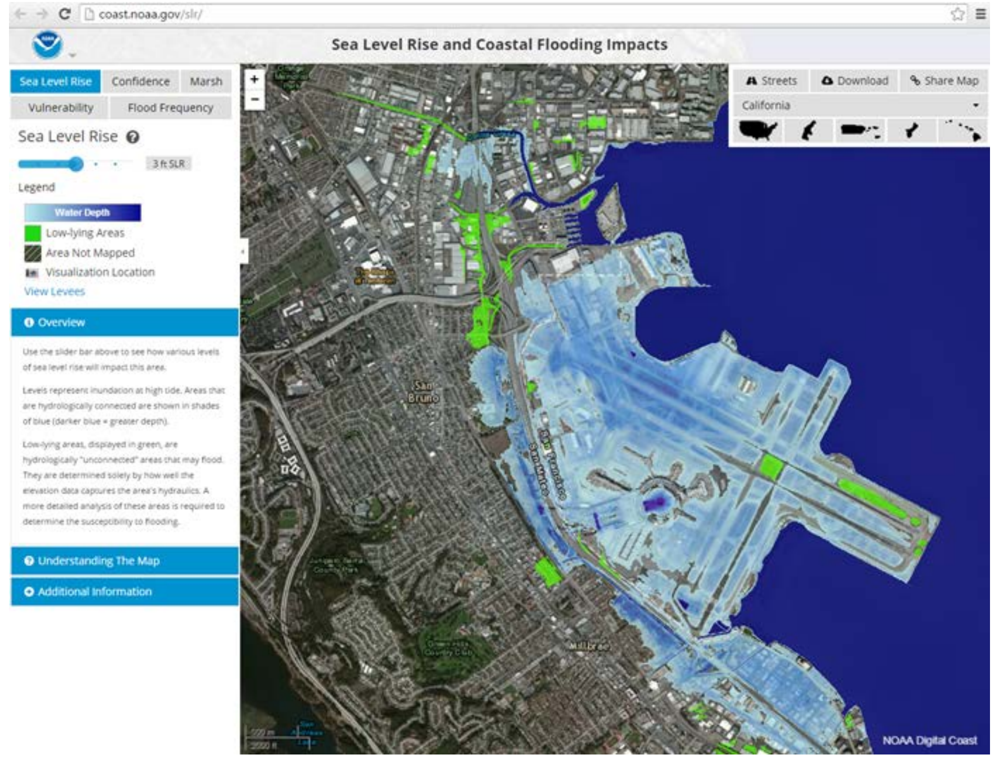
Rising sea levels have significant implications for California coastal planning and existing development, including increased potential of:

- Coastal inundation and erosion.
- Loss of marshes, wetlands, and beaches.
- Saltwater intrusion into aquifers.
- Storm water drainage being pushed back further inland and causing flooding.

Critical infrastructure and other developments are exposed to flooding along the California coast. For example, at elevations less than 4 feet above high tide in 2010, there was found to be:

- About 172,000 homes, in which 410,300 Californians lived.
- Critical infrastructure, including two major airports (San Francisco and Oakland international airports).
- Property values totaling almost $84 billion.

(Source: Climate Central Surging Seas Viewer)



Potential inundation at San Francisco International Airport caused by 3 ft of future sea-level rise (Source: NOAA Sea-Level Rise Viewer)

How can a community plan for future sea-level rise?

Coastal communities should begin planning on how to adapt now to prepare for future sea-level rise. As Russell and Griggs (2012) noted, "[f]or most coastal communities, adaptation to sea-level rise is likely to be costly, but ignoring it will likely be a far more expensive choice over the long term." Planning should focus on these types of potential hazards:

- A continuing rise in sea level with gradual flooding of low-lying areas in the short term and permanent inundation in the long term.
- Combined effects of short-term increases of sea level, high tides, and large waves that are often associated with El Niño storm events and that can produce short-term flooding and accelerated erosion rates.
- Increased wave heights and increased or accelerated rates of cliff, bluff, or dune retreat.

Communities that have been historically prone to coastal flooding and/or shore erosion will likely be affected by sea-level rise, and areas not now prone to flooding or erosion may be at risk in the future. The same information about sea-level-rise hazards can be incorporated into a range of planning efforts, such as Multi-Hazard Mitigation Plans, General Plans, and Local Coastal Programs.

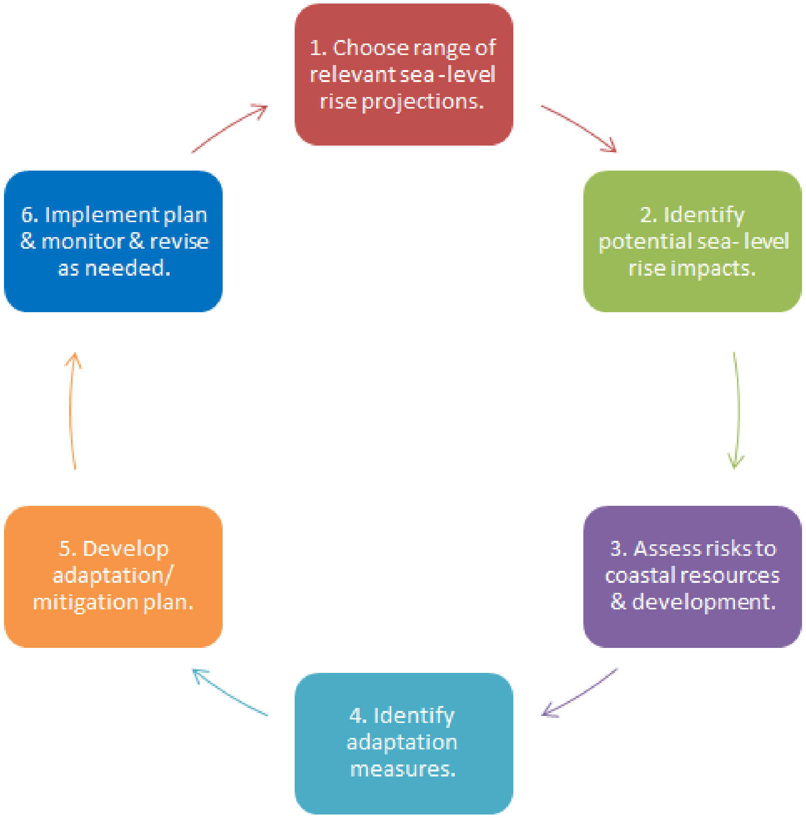
Definitions (used in California Coastal Commission guidance, 2015):

Adaptation: Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which minimizes harm or takes advantage of beneficial opportunities.

Flooding: Refers to normally dry land becoming temporarily covered in water, by waves, wave runup, tides, surge, and/or atmospheric forcing, either periodically (e.g., tidal flooding) or episodically (e.g., storm or tsunami flooding).

Inundation: The process of dry land becoming permanently drowned or submerged, such as from dam construction or from sea-level rise.

Local agencies within these communities can adhere to the following major steps involved in the iterative planning process for sea-level rise (adapted from California Coastal Commission, 2015):



The iterative steps involved in developing and implementing a sea-level rise adaptation plan for communities (Source: adapted from California Coastal Commission, 2015, which describes the planning process specific for Local Coastal Programs administered by the Commission)

Step 1. Choose range of relevant sea-level rise projections.

a. Select sea-level rise scenarios based on best available science (e.g., the NRC Sea-Level Rise report [2012]).

b. Modify projections to incorporate local vertical land motion.

Step 2. Identify potential sea-level rise impacts.

Identify current and future sea-level rise impacts and related hazards, such as submerged and intertidal lands, cliff and beach erosion, flood zones and wave impacts, saltwater intrusion, and coastal water pollution issues.

Step 3. Assess risks to coastal resources and development.

a. Describe the exposure, sensitivity, and adaptive capacity of each coastal resource.

b. Assess consequences of sea-level rise impacts on those resources.

Step 4. Identify adaptation measures.

Identify measures to address issues identified in Step 3, such as revised land use designations, policies, and standards; building codes; and other implementing ordinances.

Step 5. Develop adaptation/mitigation[1] plan and update Local Coastal Program (LCP) and local planning documents.

Develop an adaptation/mitigation plan describing sea-level rise policies and selected measures.

Step 6. Implement the plan; monitor, and revise the plan as needed.

a. Establish indicators for measuring progress, track indicators, and make necessary changes.

b. Assess best available science on sea-level rise and update every five years or as needed.

[1] Note that mitigation in this case does not denote the reduction of greenhouse gas emissions, as is commonly used in climate science, but rather to avoid or compensate for injury or adverse impacts, including offsetting impacts to natural resources.

General approaches for mapping sea-level rise

Mapping areas affected by sea-level rise is a challenge for communities because sea-level rise is region-specific and requires many assumptions about future conditions. General approaches available for communities to map areas ("draw the line") potentially affected by future sea-level rise include:

- Approach 1: Using *State of California Sea-Level Rise Guidance Document* (2013) projections.
- Approach 2: Analyzing increased flooding scenarios.
- Approach 3: Applying climate-informed science.

Note: It is not known how much the global community will actually reduce its emissions of greenhouse gases, the main driver in climate change. Global climate models use several emission scenarios to gauge a range of possibilities; nevertheless, the range of projections increases the further out we look into the future. Because of this uncertainty, it is difficult to project exactly how much sea levels could rise, and by when, for communities along the California coast. However, understanding that sea-level rise is a rapidly emerging science can help inform a community's efforts in planning mitigation for coastal flood hazards. The purpose of this Quick Guide Appendix is to summarize existing State and Federal recommendations and approaches regarding sea-level rise, recognizing that these are likely to change over time.

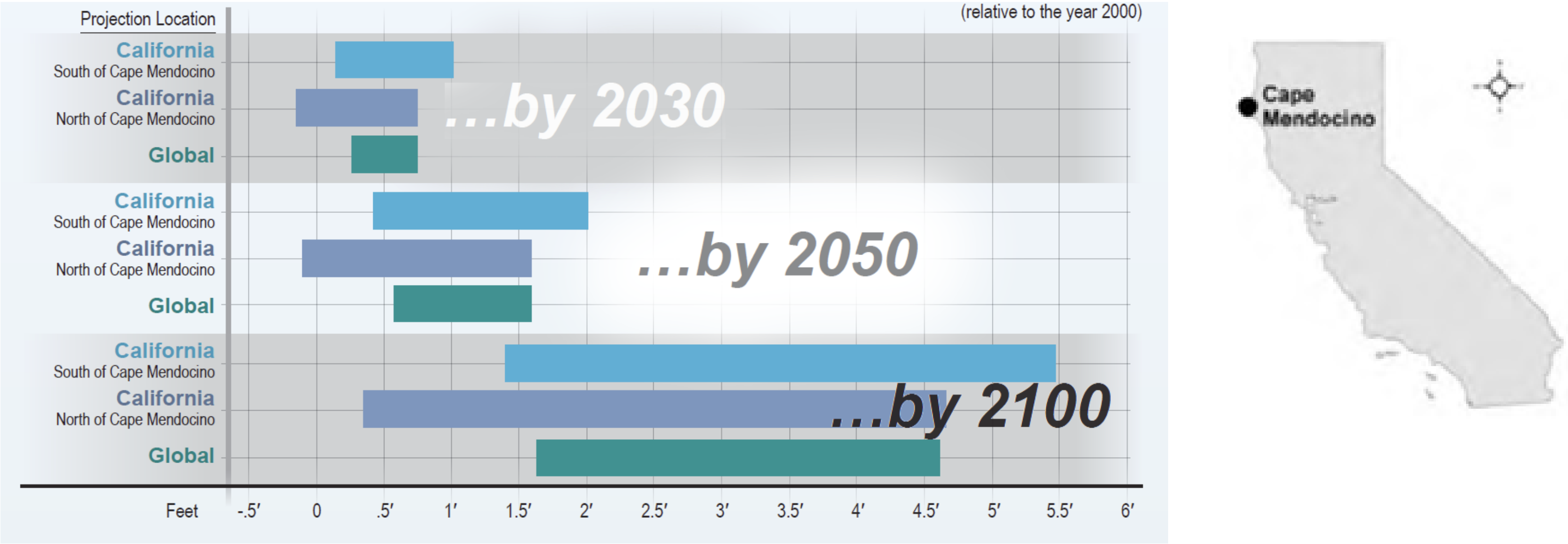
Approach 1: State of California Sea-Level Rise Guidance Document projections

The *State of California Sea-Level Rise Guidance Document* (2013) provides California-specific sea-level rise projections that are based on projections developed by the National Research Council. This *Guidance Document*:

- Provides different projections north and south of Cape Mendocino to reflect different rates of vertical (tectonic) land movement.

- Estimates sea-level rise for three time periods: 2000-2030, 2000-2050, and 2000-2100.
- Provides ranges of sea-level rise to reflect the uncertainty of the projections, with ranges increasing over time to reflect increasing uncertainty over longer time horizons.
- Encourages engineering analysis on the local scale to include historical erosion, tides, storm surge, and wave runup to develop erosion, flood, or inundation risk for ranges of sea-level-rise scenarios.
- Does not translate sea-level projections into map products.
- May not be site-specific enough to meet a community's planning needs.

The 2013 *Guidance Document* provides a consistent set of projections for State agencies to use "where appropriate and feasible," but they may use other values and/or develop guidance specific to their agency's requirements (such as the California Coastal Commission and California Energy Commission). One local agency that is using the California sea-level rise projections and added potential storm and wave effects to inform the capital planning process is the City and County of San Francisco (2014).

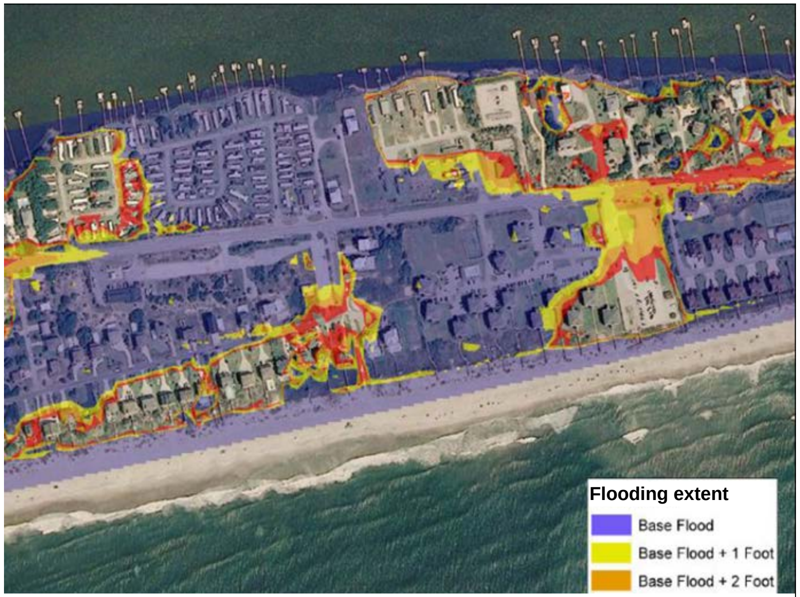


(Source: Department of Water Resources, 2013; adapted from National Research Council, 2012)

Approach 2: Increased flooding scenario analysis

An increased flooding scenario analysis:

- Identifies the current condition coastal base flood (one-percent annual chance flood) elevation in a community (total water level).
- Adds to this coastal base flood elevation hypothetical increases in flood depths due to future sea-level rise (for example, +1-foot, +2-feet, and +3-feet scenarios or specific scenarios based on the State projections [2013]).
- Does not include changes to wave run-up or overtopping associated with deeper water levels.
- Does not provide information for flood risks associated with higher sea-level-rise projections.
- Maps the larger flooded areas and estimates the increased depths caused by the hypothetical increased flood elevations.
- Assesses the impacts of the greater depths on building stock and infrastructure using FEMA'S HAZUS multi-hazard loss estimation software or similar risk assessment methods.



Example of use of increased flooding scenario analysis with hypothetical flood depths (Adapted from: FEMA Coastal-Specific Non-Regulatory Datasets, May 2014)

- Incorporates adaptation mitigation strategies into local and regional planning documents including hazard mitigation plans.

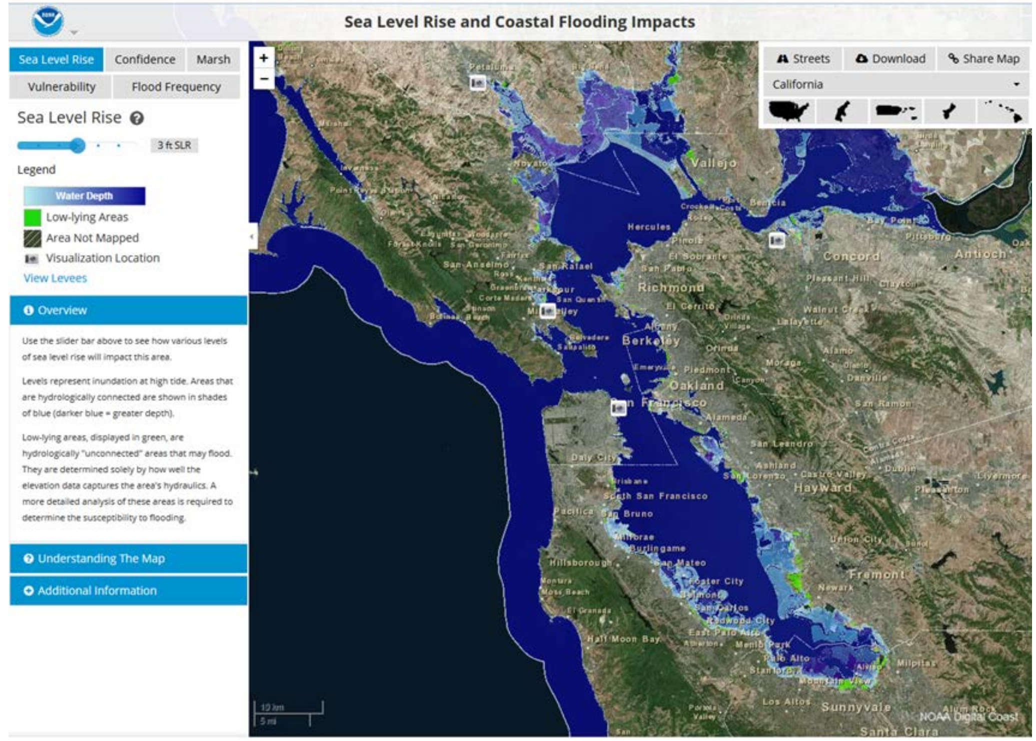
A variation of increased flooding scenario analysis is to use a larger flooded area associated with a less-frequent event (for example, 0.2-percent annual chance flood) to approximate the extent of future flooding associated with sea-level rise.

Applying Risk MAP methods, the FEMA west coast sea-level-rise pilot study is one example of an increased flooding scenario analysis that assisted San Francisco's hazard mitigation planning.

Approach 3: Climate-informed science

Climate-informed science incorporates "best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science" (EO 13690). This method uses computer models to evaluate one or more of these factors:

- Global sea-level rise.
- Regional and local sea-level rise.
- Storm surge and wave runup.
- Shore change/erosion.



A screenshot of the NOAA sea-level rise viewer (taken April 2015) (Source: NOAA)

Outcomes from different climate-informed-science models may vary because of several critical factors, including:

- Geographic scales (e.g., global, national, statewide, regional, and/or local levels).
- Temporal scales (e.g., current conditions or future conditions such as 2030, 2050, or 2100).
- Analysis approaches (e.g., event-based models or long-term trend analysis).

- Global and regional climate uncertainty and differences in projected climate model scenarios used in developing coastal sea level, storm surge, and wave runup estimates.

Online GIS-based viewers illustrate the outcomes of various climate-informed-science models. These viewers:

- Display potential inundated areas for user-selected future hypothetical depths of sea-level rise.
- Estimate the total number of people and numbers and values of infrastructure and other assets located within the potentially inundated areas.

Examples of the climate-informed-science approach include:

- A collaborative effort by the California Department of Water Resources, Ocean Science Trust, and Scripps Institution of Oceanography to develop a climate-informed-science model that estimates future local wave runup influenced by sea-level rise. As part of this work, a Comprehensive Report and Technical Methods Manual have been prepared, which describe how to apply the Scripps model to communities along the California coast. More information on this model, including an example illustrating the application of this model, can be found in the Technical Methods Manual results produced by Scripps work and located at http://www.water.ca.gov/floodmgmt/lrafmo/fmb/fas/nfip/.
- The Coastal Storm Modeling System (CoSMoS) developed by the US Geological Survey, which makes detailed projections of storm-induced coastal flooding, erosion, and cliff failures over large geographic scales. More information on this model can be found at: https://walrus.wr.usgs.gov/coastal_processes/cosmos/.
- Science-based shore response modeling funded by the State of California (ESA-PWA-PI Future Coastal Hazard Mapping), which originally included the California coast north of Santa Barbara. Refined planning studies developed at higher resolution using updated methods are available for Ventura County (ESA 2013), Monterey Bay (ESA 2014), and Santa Barbara County (ESA 2015). This information can be found on The Nature Conservancy Coastal Resilience website: http://maps.coastalresilience.org/california/#.

What resources are available to help communities plan for future sea-level rise?

Background science

- Bay Area Council Economic Institute (2015). *Surviving the Storm.*
- Cayan, Daniel, et al. (2009). *Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment*.
- Flick, Reinhard, et al. (2011). *A Framework for the Assessment of Sea Level Rise Vulnerability at Coastal Military Installations: Coastal Setting, Sea Level, Waves, and Shoreline Change at Marine Corps Base Camp Pendleton and Naval Station Coronado.*
- Heberger, Matthew, et al. (2011). *The Potential Impacts of Increased Coastal Flooding in California Due to Sea Level Rise.*
- National Research Council (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*.
- Parris, Adam, et al. (2012). *Global Sea Level Rise Scenarios for the United States National Climate Assessment*.
- Phillip Williams & Associates (2009). *California Coastal Erosion Response to Sea Level Rise and Mapping.*
- Revell, David, et al. (2011). *A Methodology for Predicting Future Coastal Hazards Due to Sea-Level Rise on the California Coast.*

State guidance

- California Coastal Commission (2015). *Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits.*
- California Energy Commission Climate Change Center (2012a). *Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment.*
- California Energy Commission Climate Change Center (2012b). *Coastal Flooding—Potential Projections: 2000-2100.*
- California Energy Commission Climate Change Center (2012c). *Our Changing Climate 2012: Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*.
- California Natural Resources Agency: *California Water Action Plan 2016 Update*.
- California Natural Resources Agency. *Safeguarding California: Reducing Climate Risk—An Update to the 2009 California Climate Adaptation Strategy.*
- Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) (2013). *State of California Sea-Level Rise Guidance Document.*
- Russell, Nicole, and Gary Griggs (2012). *Adapting to Sea Level Rise: A Guide for California's Coastal Communities.*

Additional tools

- Climate Central Surging Seas – http://sealevel.climatecentral.org/.
- Inner and outer San Francisco Bay: Our Coast Our Future - http://data.prbo.org/apps/ocof/.
- The Nature Conservancy Coastal Resilience Mapping Portal – http://maps.coastalresilience.org/network/.
- NOAA Sea-Level Rise Viewer - http://coast.noaa.gov/digitalcoast/tools/slr.

Example California efforts on planning for sea-level rise

- California Climate Change Assessments – http://www.climatechange.ca.gov/climate_action_team/reports/climate_assessments.html.
- City of Los Angeles - http://dornsife.usc.edu/uscseagrant/la-slr/.
- City of Santa Barbara – http://www.energy.ca.gov/2012publications/CEC-500-2012-039/CEC-500-2012-039.pdf.
- City of Santa Cruz – http://www.cityofsantacruz.com/home/showdocument?id=23644.
- Humboldt Bay - http://humboldtbay.org/humboldt-bay-sea-level-rise-adaptation-planning-project.
- Inner and Outer San Francisco Bay: Our Coast Our Future - http://data.prbo.org/apps/ocof/.
- Marin County C-SMART - http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise.
- San Diego Bay - http://sdclimatecollaborative.org/project/san-diego-bay-sea-level-rise-adaptation-strategy/.
- San Francisco Bay Region: Adapting to Rising Tides Program, San Francisco Bay Conservation and Development Commission - http://adaptingtorisingtides.org.
- San Francisco City/County - http://www.spur.org/publications/article/2009-11-01/sea-level-rise-and-future-bay-area.
- UC Irvine FloodRISE Project - http://floodrise.uci.edu/.
- Ventura County: Coastal Resilience Ventura - http://coastalresilience.org/project-areas/ventura-county-solutions/.

Other agencies and programs that may also have information on sea-level rise

- Association of State Floodplain Managers (http://www.floods.org/).
- California Coastal Commission (main site: http://www.coastal.ca.gov/; sea-level-rise information: http://www.coastal.ca.gov/climate/slr/; LCP information: http://www.coastal.ca.gov/lcps.html).
- California Department of Water Resources (http://www.water.ca.gov/).
- California Ocean Protection Council (http://www.opc.ca.gov/).
- California Office of Emergency Services (http://www.opc.ca.gov/).
- California State Lands Commission (http://www.slc.ca.gov/).
- Floodplain Management Association (http://www.floodplain.org/).
- Ocean Science Trust (http://www.oceansciencetrust.org/).
- San Francisco Bay Conservation and Development Commission (http://www.bcdc.ca.gov/).
- State Coastal Conservancy (http://scc.ca.gov/).

References

California Coastal Commission (2015). *Sea Level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Program and Coastal Development Permits*.

California Energy Commission Climate Change Center (2012). *Our Changing Climate 2012: Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*.

Climate Central. Surging Seas Sea Level Rise Analysis Viewer. http://sealevel.climatecentral.org/ssrf/california. (Accessed June 30, 2015.)

Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT). 2013 update. *State of California Sea-Level Rise Guidance Document*.

Cover Photo: Pacifica, California, 2016. (Source: Alan Grinberg, https://www.flickr.com/photos/agrinberg/24573501275/in/pool-1603092@N20/). License, Copyright and Disclaimer at https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode. Image cropped.

Department of Water Resources (2013). *California Water Plan Update 2013: Investing in Innovation & Infrastructure – Highlights.*

Doyle, T.W., Chivoiu, B., and Enwright, N.M. (2015). *Sea-level rise modeling handbook—Resource guide for coastal land managers, engineers, and scientists: U.S. Geological Survey Professional Paper 1815*, http://dx.doi.org/10.3133/pp1815. (Accessed August 25, 2015.)

Environmental Science Associates (2013). *Final Coastal Resilience Ventura: Technical Report for Coastal Hazards Mapping.*

Environmental Science Associates (2014). *Final Monterey Bay Sea level Rise Vulnerability Assessment: Technical Report for Coastal Hazards Mapping.*

Environmental Science Associates (2015). *Santa Barbara County Coastal Hazard Modeling and Vulnerability Assessment: Technical Report for Coastal Hazards Mapping.*

Executive Order No. 13690, 80 Fed. Reg. 6425 (Jan. 30, 2015).

Federal Emergency Management Agency (FEMA) (2011). Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas, Fourth Edition, FEMA P-55, Volume 1, August.

FEMA Risk Map Program, http://www.fema.gov/risk-mapping-assessment-and-planning-risk-map. (Accessed July 1, 2015.)

FEMA (May 2014). *Guidance for Flood Risk Analysis and Mapping: Coastal-Specific Non-Regulatory Datasets*.

Luers, A.L., Cayan, D.R., Franco, G., Hanemann, M., and Croes, B. (July 2006). *Our Changing Climate: Assessing the Risks to California.* The 2006 Summary Report from the California Climate Change Center. CEC-PIER Report, CEC-500-2006-077, Sacramento, CA.

National Oceanic and Atmospheric Administration (NOAA), “Digital Coast” Sea Level Rise Viewer, http://coast.noaa.gov/digitalcoast/tools/slr. (Accessed April 24, 2015.)

National Research Council (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*.

Russell, N. and Griggs, G. (January 2012). *Adapting to Sea Level Rise: A Guide for California’s Coastal Communities*. Prepared for the California Energy Commission Public Interest Environmental Research Program.

Sea Level Rise Committee of San Francisco (July 2014). *Draft Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability, Risk, and Adaptation.*

United States Army Corps of Engineers (December 2013). Engineer Regulation 1110-2-8162, *Incorporating Sea Level Change in Civil Works Programs*.

Acknowledgements

Special recognition, in the support of this document, goes to the following public and private entities:

AECOM
California Coastal Commission
California Ocean Science Trust
California Office of Emergency Services
California Office of Planning and Research
City of Chula Vista
City of Seattle
County of Los Angeles Department of Public Works
County of Santa Cruz
David Ford Consulting Engineers
Environmental Science Associates
Federal Emergency Management Agency
Marin County
National Oceanic and Atmospheric Administration
NextGen Engineering
San Francisco Bay Development and Conservation Commission
San Francisco Public Utilities Commission
Scripps Institution of Oceanography
State Coastal Conservancy
United States Army Corps of Engineers
United States Geological Survey