

Appendix 11: Matrices of Flooding and Marsh Evolution

of the *Wetlands on the Edge: The Future of Southern California's Wetlands*
Regional Strategy 2018



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Flood Hazard Models

Tools	Sea Level Rise and Coastal Flooding Impacts Viewer	Surging Seas	Pacific Institute - The Impacts of Sea Level Rise on California's Coast	Cal-Adapt - Exploring California's Climate	Coastal Resilience Ventura	Our Coast, Our Future	CoSMoS 3.0 *
Geographic Scope	National	National	California	California	Ventura County	North-central CA Coast (Bodega Head to Half Moon Bay) and San Francisco Bay	Point Conception (Santa Barbara) to the US-Mexico Border
Organization/Sponsor	NOAA Office for Coastal Management	Climate Central	California Energy Commission, California Environmental Protection Agency, Metropolitan Transportation Commission, California Department of Transportation, and the California Ocean Protection Council	California Energy Commission; UC-Berkeley Geospatial Innovation Facility	The Nature Conservancy	Point Blue Conservation Science; USGS; Gulf of the Farallones National Marine Sanctuary; Coravai LLC	USGS
Link	http://coast.noaa.gov/slr	http://sealevel.climatecentral.org/	http://pacinst.org/publication/the-impacts-of-sea-level-rise-on-the-california-coast/	http://cal-adapt.org/sealevel/	www.maps.coastalresilience.org/ventura	http://pointblue.org/ocof	
Description	A visualization tool for coastal communities showing potential impacts from sea level rise and coastal flooding as well as a planning level tool.	Searchable toolkit including 1) detailed maps; 2) individual community analyses; 3) area comparisons; and 4) local sea level and flood risk projections. Over 100 demographic, economic and infrastructure variables analyzed for 1000s of communities from zip code to statewide levels.	Provides access to sea-level rise scenarios generated by the Pacific Institute, ESA PWA and the U.S. Geological Survey as part of the CA Energy Commission's Public Interest Energy Research Program (PIER). The tool shows the threat of coastal erosion and inundation due to flooding over three depths based on a 100 year flood scenario.	Provides access to sea-level rise flooding scenarios generated by the Pacific Institute, ESA PWA and the U.S. Geological Survey. The tool shows the threat of inundation due to flooding over three depths based on a 100 year flood scenario.	A visualization tool for local and state decision makers showing potential impacts from sea level rise and coastal hazards designed to help communities develop and implement solutions that incorporate ecosystem-based adaptation approaches	A collaborative, user-driven project focused on providing San Francisco Bay Area coastal resource and land use managers and planners locally relevant, online maps and tools to help understand, visualize, and anticipate vulnerabilities to sea level rise and storms.	
Target Audience	Decision makers, planners, coastal managers, floodplain managers, emergency managers, coastal scientists and engineers, general public	Decision makers, planners, coastal managers, emergency managers, federal and state agencies, journalists and the general public	Public, community planners, businesses	Public, community planners, businesses	Decision makers, planners, coastal managers, emergency managers, coastal scientists and engineers	Including but not limited to: Land Use Planners, Coastal Resource Managers, Restoration Managers, Hazard Mitigation Planners, Floodplain Managers, Stormwater Managers, Municipal Engineers, Municipal Leaders, Zoning and Permitting Officials, Public Works Officials, and Conservation Organizations	Including but not limited to: Land Use Planners, Coastal Resource Managers, Restoration Managers, Hazard Mitigation Planners, Floodplain Managers, Stormwater Managers, Municipal Engineers, Municipal Leaders, Zoning and Permitting Officials, Public Works Officials, and Conservation Organizations
Skill Level	Low	Low	Low	Low	Low-Medium	Low	
Main Tool Outputs	Maps, photo simulations, flood frequency graphs	Maps, community analyses, wide area analysis comparisons, projections	Maps	Maps, reports of inundation threat by county	Maps (on-screen and pdf), Summary reports (on-screen), Bookmark links, Downloadable spatial data	Maps (on screen; summary reports (on screen and pdf); downloadable data; SLR projection comparison by both amount and year	
Year Released	2012 (West Coast of US) December, 2015	Rolling: Fall 2013 - Summer 2014 December, 2015	2009 May, 2014	2011 May, 2014	2013 (Ventura) December, 2015	2013 Half Moon Bay to Bodega Head, 2014 SF Bay May, 2014	
Top Three Strengths	1) Easy to use via Web browser, with GIS analysis results and map services available; 2) Uses consistent data sets and analysis for coastal areas nation-wide; 3) Includes photos and allows users to visualize impacts of sea level rise at known locations.	1) Comprehensive tool providing exposure analysis, comparisons, and projections, as well as an interactive map. 2) Analyses cover ~100 variables, and conducted for 1000's of individual areas (zips, cities, counties, states, planning and legislative districts at all levels). 3) Local projections combine sea level rise and storm surge to give integrated risk estimates by decade.	1) First comprehensive analysis of the impacts of sea level rise across the state of California. 2) Considered impacts from several depths of inundation, coastal storms and erosion. 3) Used FEMA's HAZUS model to estimate level of economic risk from inundation	Same as Pacific Institute	1) DESIGN: The tool has a modular, plugin architecture: Coastal Resilience "apps" can be developed by anyone and plugged into the web-based mapping platform. This allows developers to design a specific application to highlight a coastal management issue, respond to a disaster for post-storm decision making, or emphasize nature-based alternatives; 2) PERFORMANCE: Coastal Resilience 2.0 runs faster; operates on tablets; works nationally and globally; is open source, and it's easy to share results and data; 3) PARTNERSHIPS: Developed among core partners including The Nature Conservancy, University of Southern Mississippi, The Natural Capital Project, NOAA Coastal Services Center, and the Association of State Floodplain Managers	1) The model underlying the tool, CoSMoS, applies a deterministic modeling framework to cover large geographic scales but with fine local resolution. The system incorporates atmospheric forcing (i.e., wind and pressure fields) from Global Climate Models and accounts for all the relevant physical processes that will contribute to the vulnerability of the coast now and in the future (e.g., SLR, tide, waves, surge, fluvial discharge, storm variability) and the resulting coastal hazards. 2) One of the primary objectives of this project is to understand regional coastal flood planning information needs and develop our tools based on those needs. Three scoping meetings with over 140 planners, managers, and scientists were held. In addition, a subset of these attendees took part in an Outer Coast Focus Group to help beta test the North-central coast flood map and a San Francisco Bay Advisory Committee currently advises on the development of the Bay flood map. 3) Three areas of technical assistance is provided: 1. Targeted Trainings to agency/org staff on how to utilize the OCOF decision support tools and apply them to relevant on the ground projects; 2. Integration Support for organizations that want to bring OCOF's SLR scenarios into their own GIS environment or decision support tool; and 3. Technical Assistance Engagement for organizations that want to use OCOF in a planning process and need assistance with scenario planning, tool modification or application, etc.	
Top Three Limitations	1) Inundation scenarios do not include coastal storm surge, erosion or other coastal processes; 2) Cannot customize outputs or load additional local inputs directly into the tool; 3) Appropriate for use as a screening-level or planning tool allowing zoom in scale of approximately 1:18,055.	1) Map should not be used for site-specific decisions (supplement with direct field measurements of elevation), as wider-area analyses are more robust than point-by-point mapping; 2) Levee data are incomplete, and maps/analyses incorporating levees assume condition good and heights infinite; 3) No physical modeling of storm surge or waves on top of sea level rise.	1) Elevation dataset is inconsistent in terms of resolution and vertical accuracy. 2) Shoreline location is inexact and probably subjective. 3) Flooding is classified by depth only and does not take into account the flow pathway (i.e. are low lying areas hydrologically connected)	Same as Pacific Institute	1) ONLINE-ONLY: No ability to access the tools with limited or lack of connectivity; 2) USER-FRIENDLINESS: Not catered to general public, so training is requirement to engage stakeholders so they can fully utilize the tool and understand the data and analyses; 3) COMMUNICATIONS: With so many tools now available on the web, it is hard to decipher the niche and therefore use of this tool relative to others that address similar issues	1) No side by side comparisons of scenarios or overlays of different scenarios are provided except in the "Detailed View" which requires more technical expertise (overlays are possible there); 2) Doesn't currently model projections of shoreline change specific to SLR and storm scenarios; 3) Labels or tags are not currently provided to help users delineate areas of interest, infrastructure, etc. and actual parcels can't be delineated.	
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Matrix adapted from: http://sealevel.climatecentral.org/matrix/CA.html?v=1							

Appendix 11: Matrices of Flooding and Marsh Evolution Models

Marsh Evolution Models

Model	Agency/ organization	Appropriate scale	Spatial resolution	Temporal scale	Input parameters	Vegetation classification	Output parameters	Validation	Citations	Application to So Cal
Barataria-Terrebonne Ecosystem Landscape Spatial Simulation (BTESS)	Louisiana State University	Local, regional (such as <1 km ² -100,000 km ²)	1 km ²	Variable time steps (daily, annual), simulation time up to 100 yr	Elevation and bathymetry, air temperature, wind speed and direction, precipitation, river discharge, sediment load, wetland land cover, regional salinity, plant growth and mortality rates, salinity and flooding tolerances of plants	NWI	Maps of land change (habitat switching), flooded and eroded areas, plant productivity, salinity, open-water circulation, and sediment transport	Hindcast	Reyes and others (2000, 2004); Martin and others (2000); Voinov and others (1999, 2007); Binder and others (2003).	
Coastal Ecological Landscape Spatial Simulation (CESS)	Louisiana State University	Local, regional (such as <1 km ² -100,000 km ²)	1 km ²	Variable time steps (daily, annual), simulation time up to 100 yr	Elevation and bathymetry, air temperature, wind speed and direction, precipitation, river discharge, sediment load, wetland land cover, regional salinity, plant growth and mortality rates, salinity and flooding tolerances of plants	NWI	Maps of land change (habitat switching), flooded and eroded areas, plant productivity, salinity, open-water circulation, and sediment transport	Hindcast	Costanza and others (1990); Sklar and others (1991).	
Sea Level Affecting Marshes Model (SLAMM 1-5)	Warren Pinnacle Consulting, Inc.	Local, regional (such as <1 km ² -100,000 km ²)	10-100 m	Time steps of 5-25 yr can be used on the basis of sea-level rise scenario, simulation time up to 100 yr	Elevation maps (lidar preferred), wetland land cover (such as NWI), development footprint, dike location, sea-level rise projections	NWI	Maps of areas/habitats potentially vulnerable to inundation (land cover and elevation maps)	None	Park and others (1989); Galbraith and others (2002, 2003); National Wildlife Federation (2006); Craft and others (2009).	
Sea Level Affecting Marshes Model (SLAMM 6)	Warren Pinnacle Consulting, Inc.	Local, regional (such as <1 km ² -100,000 km ²)	10-100 m	Time steps of 5-25 yr can be used on the basis of sea-level rise scenario, simulation time up to 100 yr	Elevation maps (lidar preferred), wetland land cover (such as NWI), development footprint, dike location, sea-level rise projections	NWI	Maps of areas/habitats potentially vulnerable to inundation (land cover and elevation maps)	Hindcast	Clough and others (2010); Geselbracht and others (2011).	
Sea Level Over Proportional Elevation (SLOPE)	U.S. Geological Survey	Regional, national	County	Monthly or annual time step, simulation time up to 100 yr	Saltmarsh/mangrove area, monthly tide gage records, sea-level rise projections, tidal range by county	NWI	Maps of land change, habitat migration and displacement	Hindcast	Doyle and others (2010).	
NOAA Sea Level Rise Viewer: Marsh Migration Maps *	National Oceanic & Atmospheric Administration	National	Regional	None	Sea level rise values, Tidal surfaces (MHHW, MTL, MLLW, and MHS) in NAVD88 values, FVUB surface in NAVD88, Digital elevation model, Accretion rates, Wetland habitat data	NOAA's Coastal Change Analysis Program (C-CAP)?	Maps of marsh migration	???	NOAA Coastal Services Center. <i>Detailed Method for Mapping Sea Level Rise Marsh Migration</i> (2012).	Available in So Cal
Wetland Accretion Response Model for Ecosystem Resilience (WARMER)*	U.S. Geological Survey	Local	3m?	1.24 m of SLR by 2100?	Projected changes in relative sea-level, subsidence, inorganic sediment, accumulation, aboveground and belowground organic matter productivity, compaction, and decay	On-the-ground vegetation surveys?	One-dimensional model of wetland accretion	???	Takekawa, J.Y., et al	Available in So Cal
Marsh Equilibrium Model (MEM)*	U.S. Geological Survey	Local	5m?	Time steps of 10 years up to 2110	Estimates of mean annual suspended sediment concentration (SSC), organic matter decay rate, root to shoot ratio of dominant vegetation, refractory fraction of carbon, root depth, trapping efficiency, and sediment settling velocity	On-the-ground vegetation surveys?	Maps of vegetation migration	???	Takekawa, J.Y., (2013). Downscaling climate change models to local site conditions: San Diego National Wildlife Refuge Complex. Unpubl. Data Summary Report, U.S. Geological Survey, Western Ecological Research Center, Vallejo, CA. 88pp.	Available in So Cal

Matrix Adapted From: Doyle, T.W., Chivou, Bogdan, 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, 76 p., <http://dx.doi.org/10.3133/pp1815>.