

# Science and Tools for Understanding Coastal Vulnerability of Energy Facilities

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# Scope of Talk

- State mandates regarding adaptation and sea-level rise
- Sea level rise guidance documents
- Gallery of tools portraying coastal vulnerability
- Tour of the Our Coast, Our Future tool



# State Mandates:

## Climate Adaptation and Sea Level Rise

- Executive Order **B-30-15**: Resources Agency must
  - Update state's climate adaptation strategy (*Safeguarding California*) every three years
  - Oversee implementation
- **AB 2516** requires State to create a Sea-Level Rise Planning Database. Entities required to provide planning information include:
  - Energy Commission
  - Investor-owned utilities
  - Publicly owned electric and natural gas utilities



# State Guidance Documents: Sea Level Rise

- Ocean Protection Council: 2013 Update to Interim Sea-Level Rise Guidance document
  - Incorporates [2012 NAS report](#) on SLR off coasts of California, Oregon, Washington
  - Similar central estimates for “expected” SLR in 2030, 2050, 2100; but wider range of uncertainty
  - Incorporated vertical land movement based on north (uplift) vs. south of Cape Mendocino
- CA Coastal Commission: Sea Level Rise – [Draft Policy Guidance](#) currently in public review.

# Tools for Exploring California SLR

- **Cal-Adapt:** State-of-the-art results from USGS's Coastal Storm Modeling System, as well as "bathtub" model results for the entire coast. <http://cal-adapt.org/sealevel/>
- **Our Coast, Our Future (CoSMoS model):** Partnership between USGS, Point Blue, and others for sophisticated modeling of storm, tides, SLR, and erosion processes. <http://data.prbo.org/apps/ocof/>
- NOAA's **Sea Level Rise Viewer** and Climate Central's **Surging Seas Risk Finder** apply modified bathtub models to coastal California.
- *Under development:* Data Basin's **Climate Console**

Other projects that explore particular regions of California:

- Humboldt Bay Sea Level Rise Adaptation Project: <http://scc.ca.gov/webmaster/ftp/pdf/humboldt-bay-shoreline.pdf>
- Adapting to Rising Tides (in Alameda county): <http://www.adaptingtorisingtides.org/>
- Coastal Resilience Ventura (The Nature Conservancy): <http://coastalresilience.org/project-areas/ventura-county-challenges/>

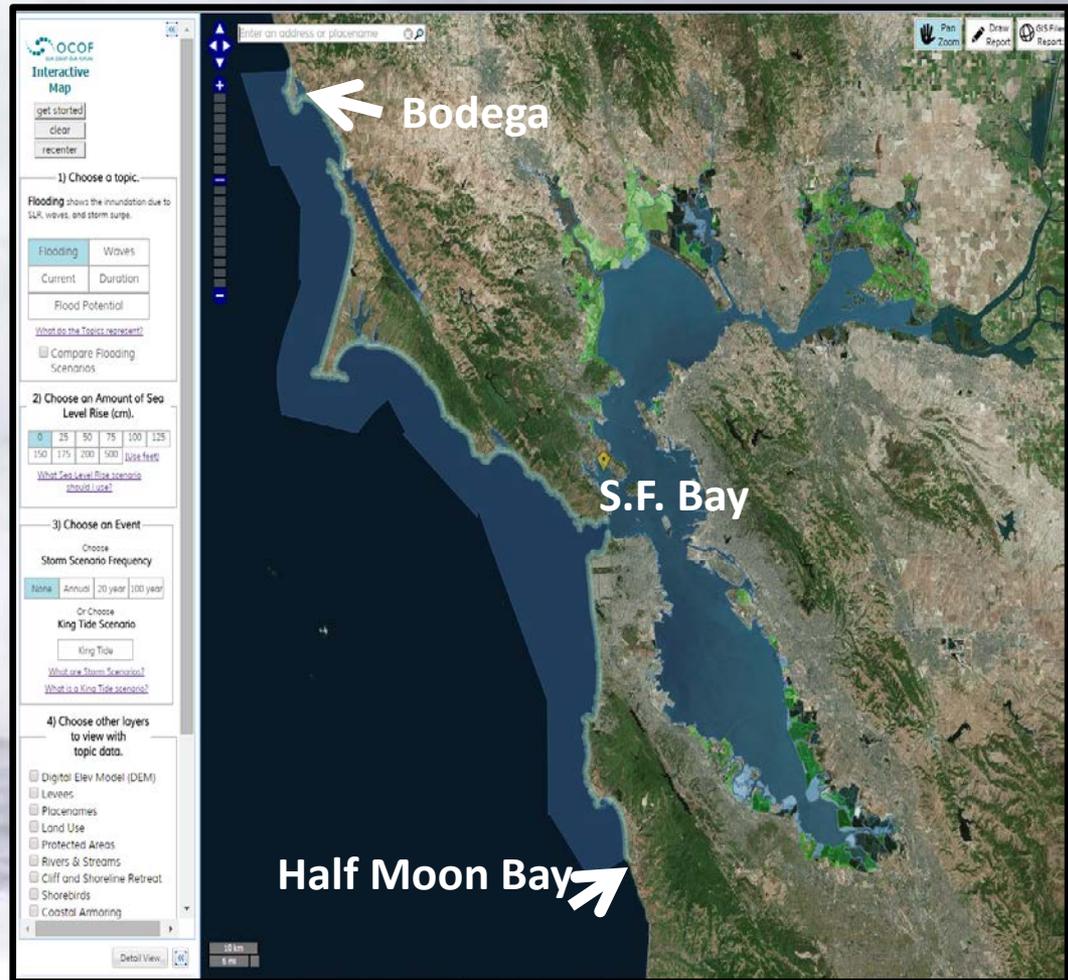
## Additional Sea Level Rise Tools & Resources

A number of tools and models are available for the California coast. A comparison of these tools is available [here](#). The links below connect to externally developed resources.



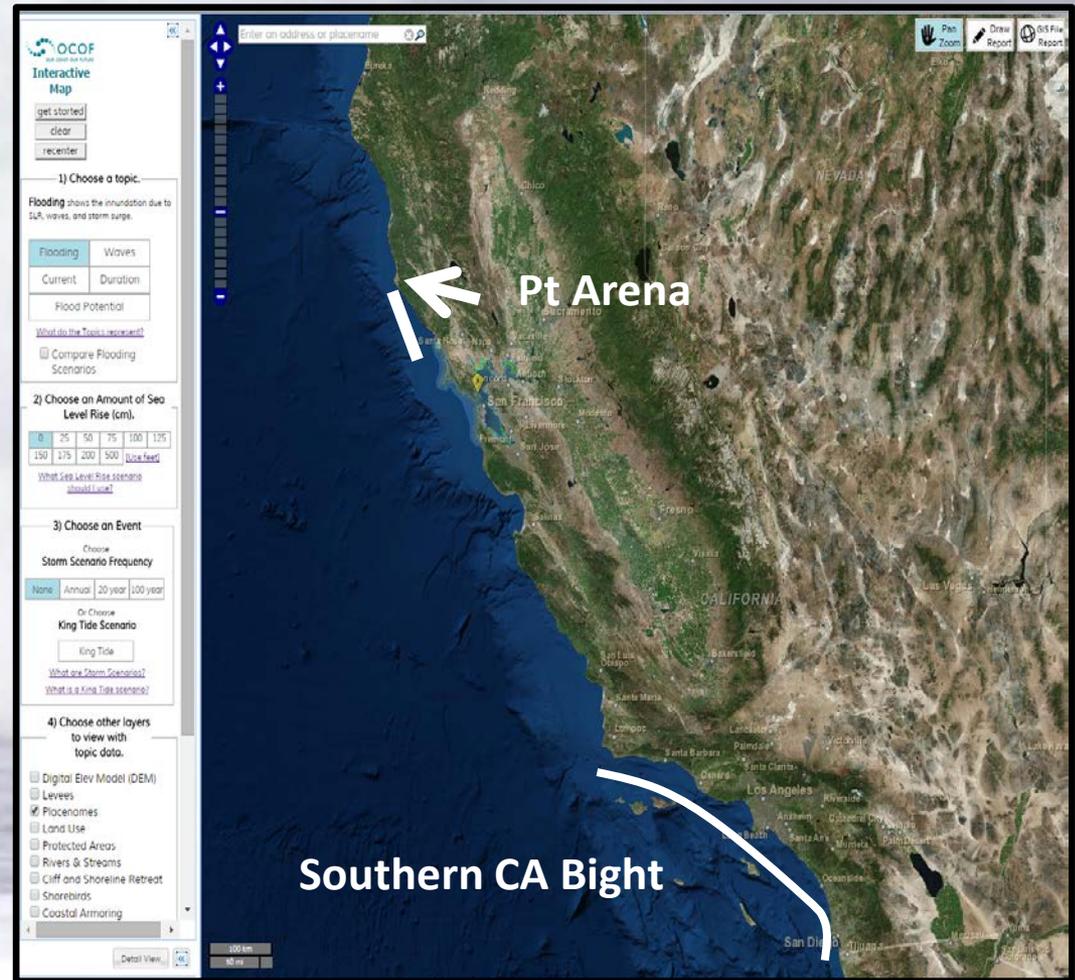
# Tools: Our Coast, Our Future

- **OCOF**: Interactive tool that can be used to explore multiple storm scenarios, king tides, wave heights, ocean currents, and more.
- **CoSMoS**: Coastal Storm Modeling System. Results from this model are used in the **OCOF tool**. Currently available only for the Bay Area and portions of north coast.
- More regions are being modeled.



# Tools: Our Coast, Our Future

- Extending geographic scope to Pt. Arena, and to include Southern California



# What makes CoSMoS unique?

- **Explicit, deterministic modeling of all the relevant physics of a coastal storm with regional consistency**
- **Wave climate developed from the most sophisticated Global Climate Models (GCMs) developed for IPCC 2013**
- **Waves are modeled at the global scale, and then dynamically downscaled, along with regional additions of wind, atmospheric pressure, tides and sea level rise, to produce hazards projections at the parcel scale**
- **Scenarios feature the full spectrum of SLR rise (0-2 m, 5 m) and coastal storms (daily-100 year return) to meet every possible planning horizon**



# OCO2 tool: GIS layers

The screenshot displays the OCO2 tool's GIS interface. The main map shows Richardson Bay, CA, with various GIS layers overlaid, including flood potential, roads, and buildings. The control panel on the left is divided into four sections:

- 1) Choose a topic.**

Flooding shows the inundation due to SLR, waves, and storm surge.

Flooding	Waves
Current	Duration

Flood Potential

[What do the Topics represent?](#)

Compare Flooding Scenarios
- 2) Choose an Amount of Sea Level Rise (cm).**

0	25	50	75	100	125
150	175	200	500	<a href="#">[Use feet]</a>	

[What Sea Level Rise scenario should I use?](#)
- 3) Choose an Event**

Choose **Storm Scenario Frequency**

None Annual 20 year 100 year

Or Choose **King Tide Scenario**

King Tide

[What are Storm Scenarios?](#)

[What are King Tide scenarios?](#)
- 4) Choose other layers to view with topic data.**
  - Digital Elev Model (DEM)
  - Levees
  - Placenames
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  - Cliff and Shoreline Retreat
  - Shorebirds
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  - Roads and Transportation
  - Trails
  - Buildings
  - Utilities & Services

[What do Other Layers represent?](#)

Opacity

5 km  
2 mi

Detail View

Search: richardson bay, ca

Map controls: Pan, Zoom, Draw Report, GIS File Report, Kind 155

# OCOF tool: GIS layers

richardson bay, ca

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[What do Other Layers represent?](#)

**Legend:**

- Flood-prone Low-lying Areas 100cm SLR + Wave 100
- Flood Hazard 100cm SLR + Wave 100
- Flood Depth 100cm SLR + Wave 100
  - 0 cm
  - 250 cm
  - 500 cm
  - 750 cm
- Public Transportation
  - Ferry Landing
  - BART Station
- Public Parking
- Roads
  - Ferry Route
  - State
  - Major Roads
- Rails
  - Heavy Rail
  - BART
  - SF MUNI
- Airports
- Utilities and Infrastructure
  - Dam or Weir
  - Radio Tower
  - Electrical
  - Water Treatment
- Public Services
  - Post Office
  - Correctional Facility
  - Government Building
- Emergency Services
  - Hospital
  - Police
  - Fire
- Commercial Activity



# Easily flip through SLR scenarios...

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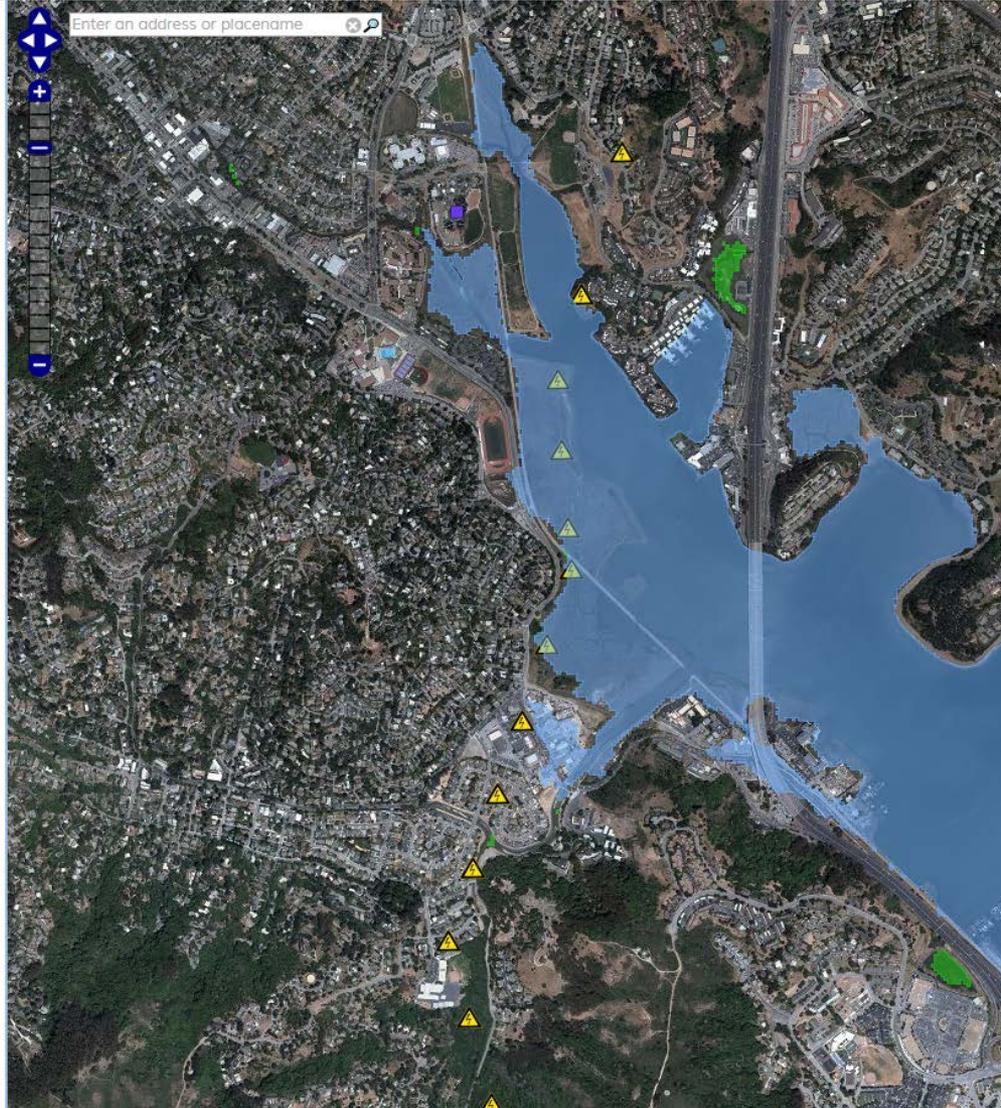
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Enter an address or placename

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Flood Depth 100cm SLR + Wave 100

0 cm

250 cm

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750 cm

**Public Transportation**

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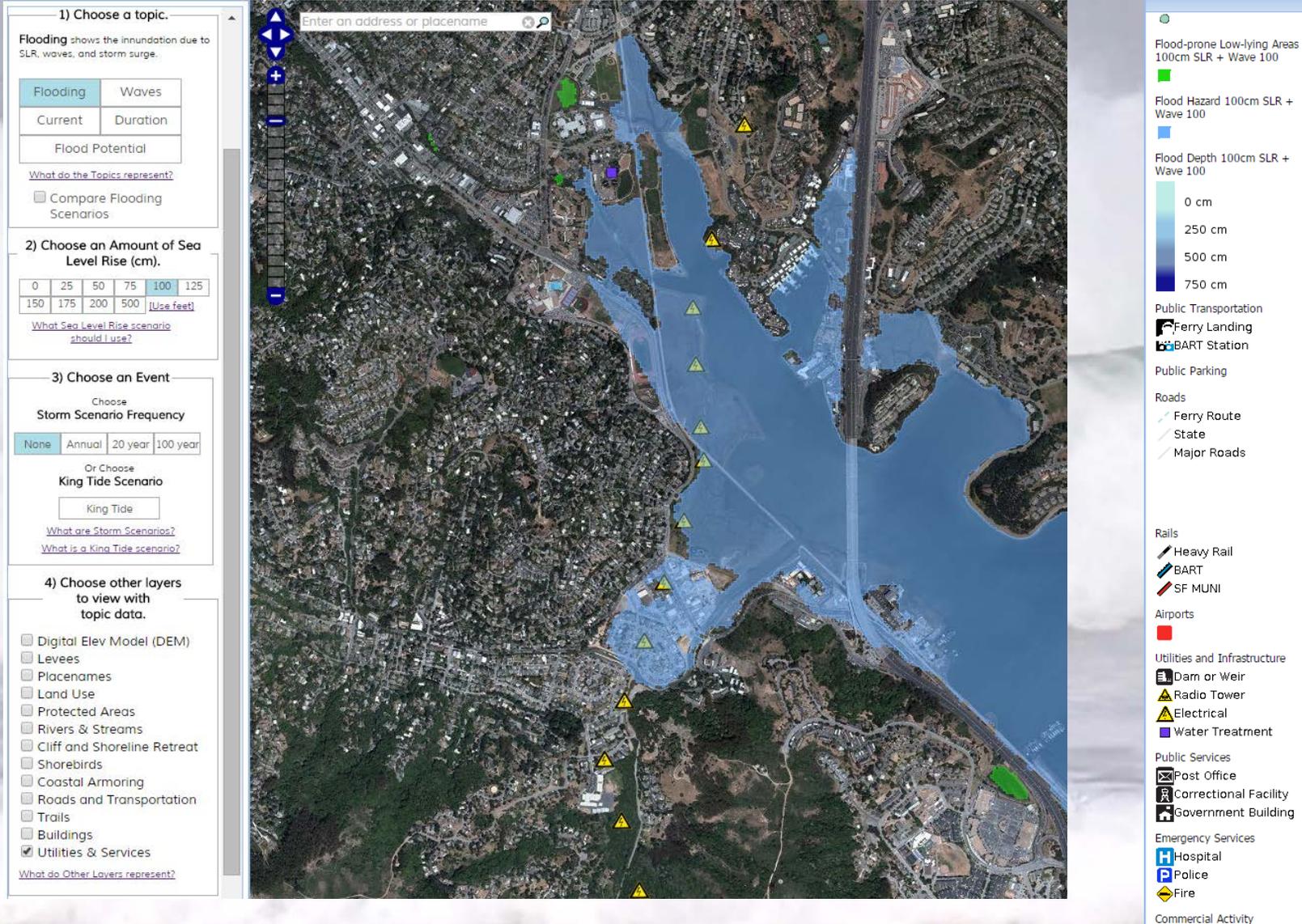
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**Emergency Services**

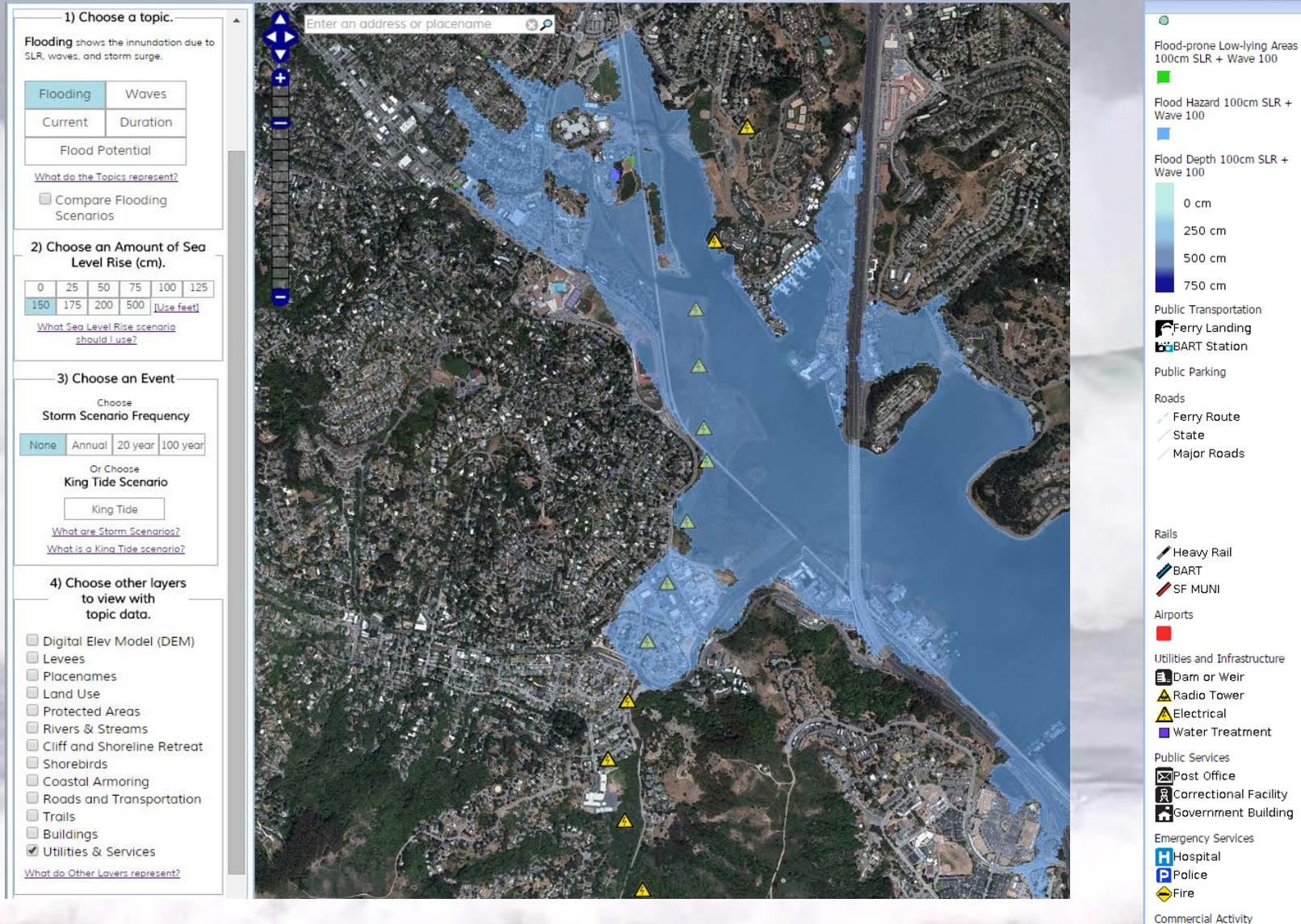
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**Commercial Activity**

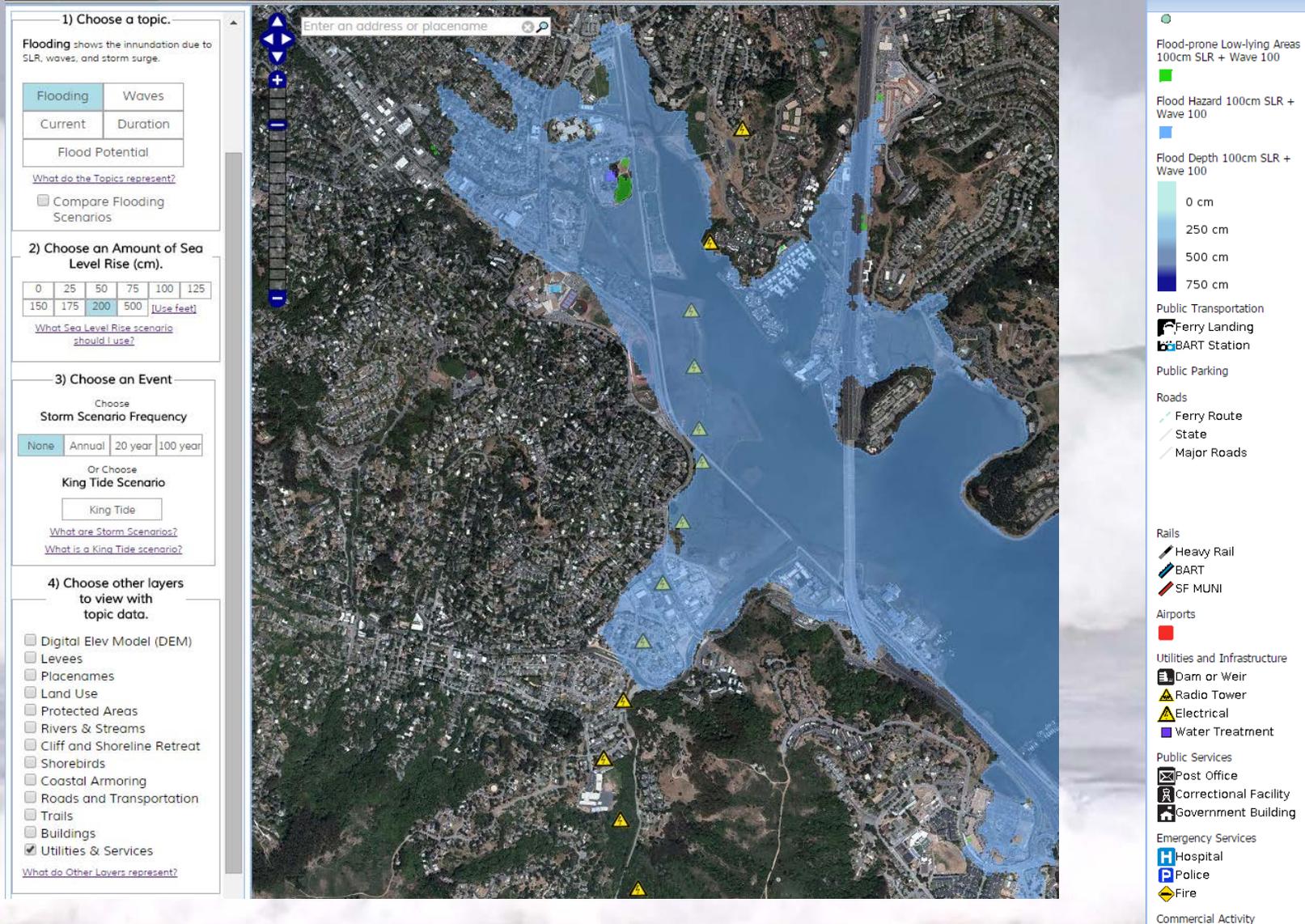
# Easily flip through SLR scenarios...



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# What SLR should I use?

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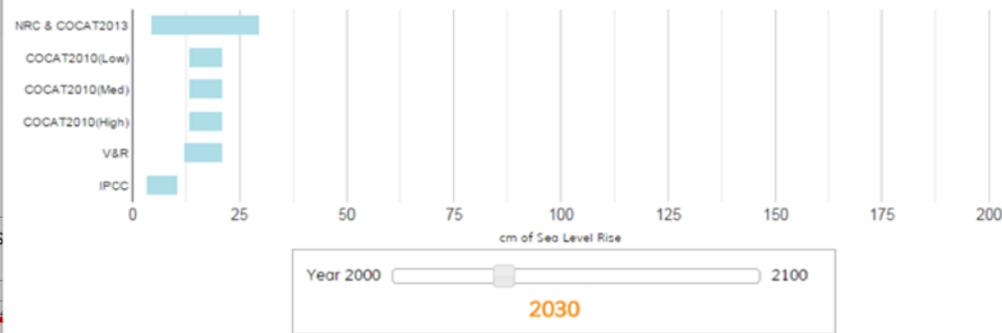
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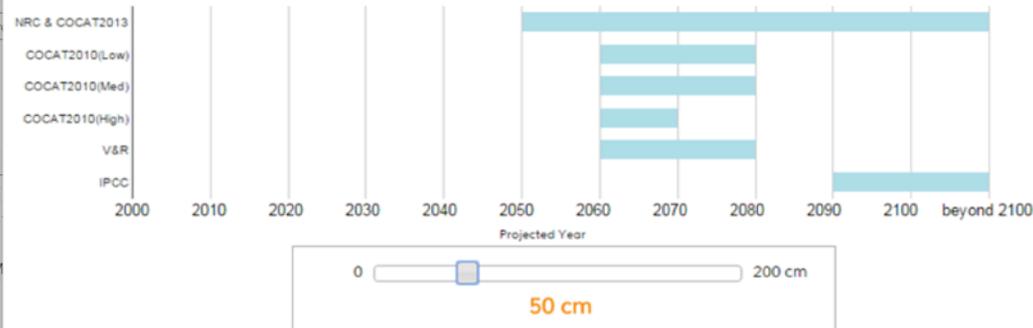
## What projections are likely to occur in a given year?

Move the slider control below the graph left and right to see how different climate experts projections of sea level rise compare to one another. Hold your mouse over each bar for details.



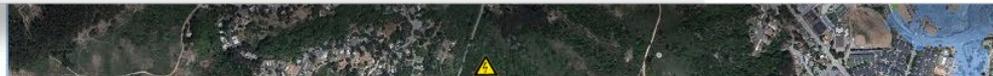
## When is a projection likely to occur?

Move the slider control below the graph left and right to see how different climate experts projections of when sea level rise will occur compare to one another. Hold your mouse over each bar for details.

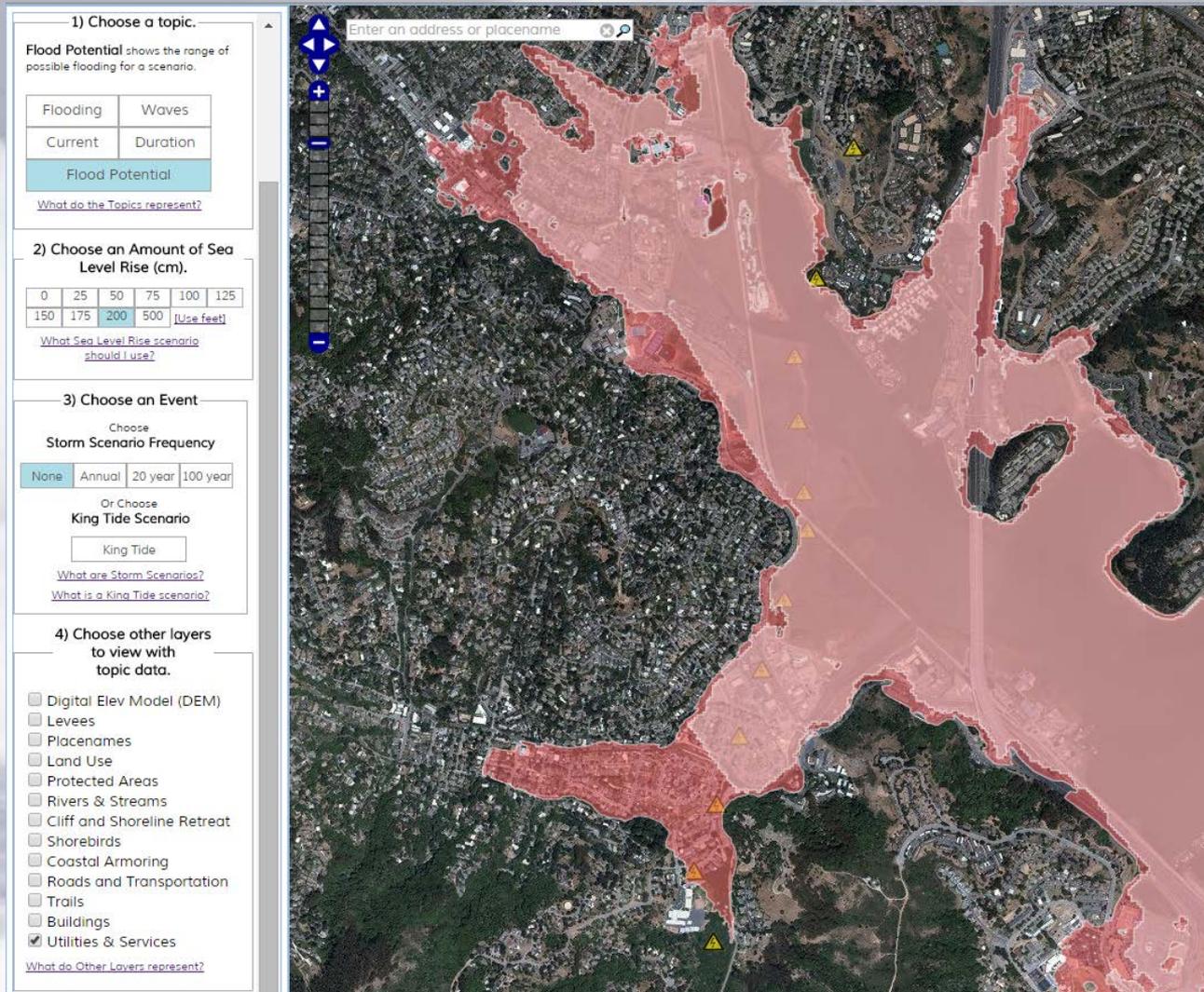


## Citations

- NRC - [National Research Council. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Washington, DC: The National Academies Press, 2012.](#)
- COCAT2013 - [Coastal and Ocean Working Group of the California Climate Action Team. State of California Sea-Level Rise Guidance Document, March 2013.](#)
- COCAT2010 - [Coastal and Ocean Working Group of the California Climate Action Team. State of California Sea-Level Rise Interim Guidance Document, October 2010.](#)
- V&R - [Martin Vermeer and Stefan Rahmstorf. Global sea level linked to global temperature. Proceedings Nat. Acad. Sci., vol 106, no. 51, pp. 21527-21532. DOI: 10.1073/pnas.0907765106. 2009](#)
- IPCC - [IPCC. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change \(Core Writing Team\).](#)



# Flood potential and uncertainty



Flood potential maps include estimates of

- Vertical land movement
- Marsh accretion
- Elevation uncertainty
- Model uncertainty

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<input type="checkbox"/> Current	<input type="checkbox"/> Duration
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 Compare Flooding Scenarios

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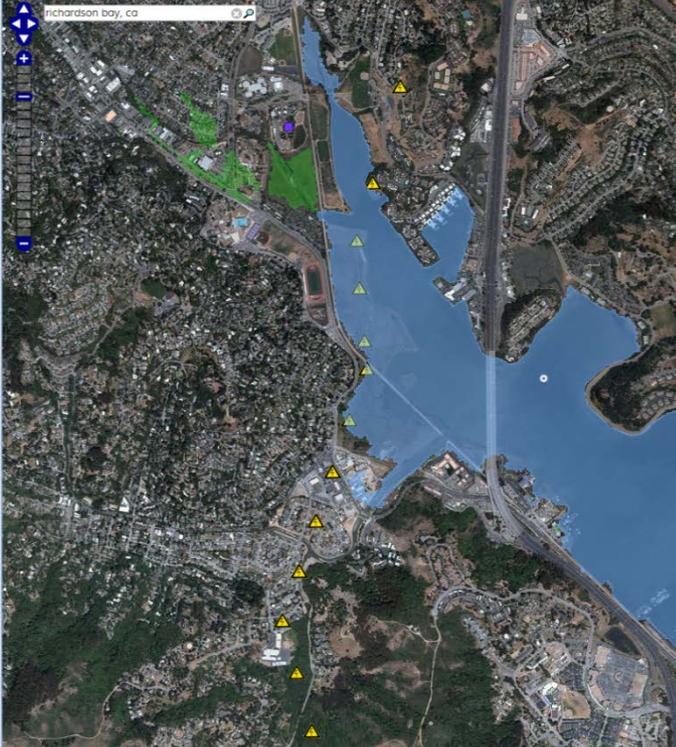
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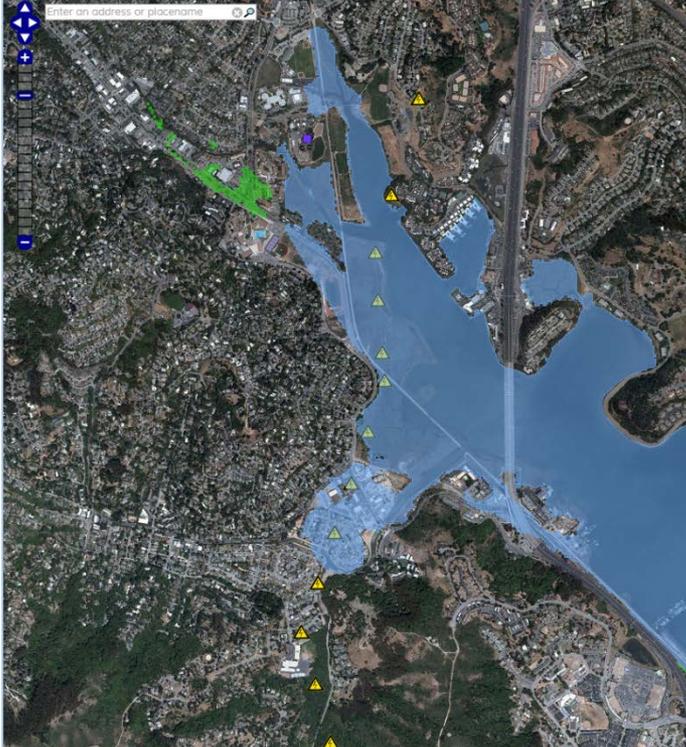
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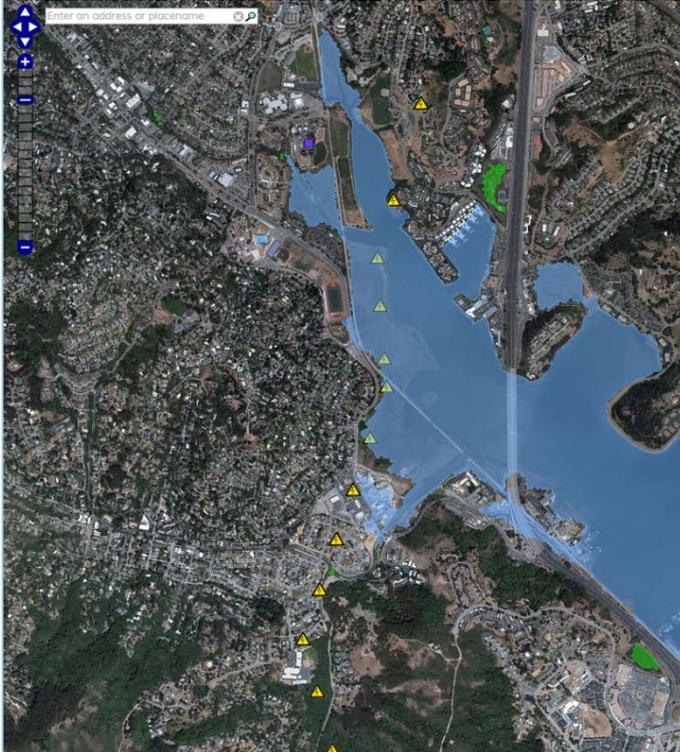
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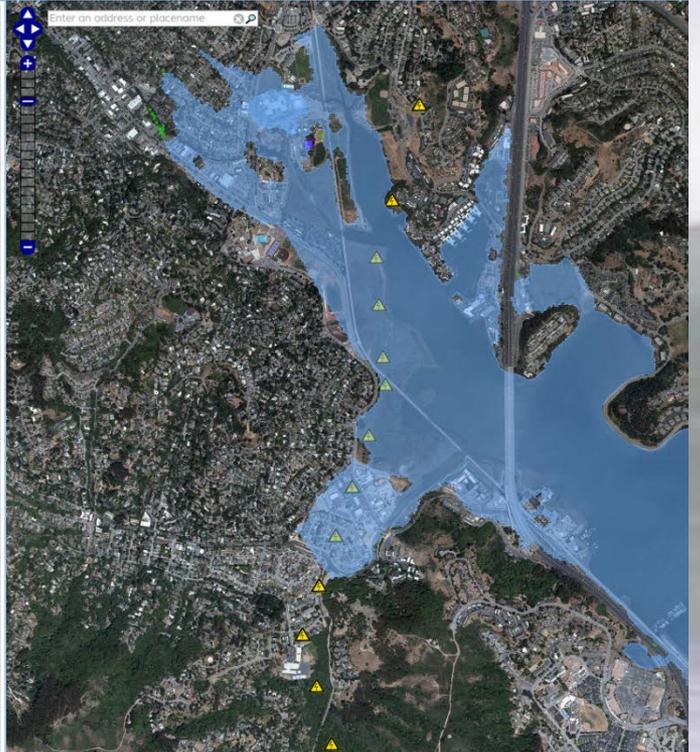
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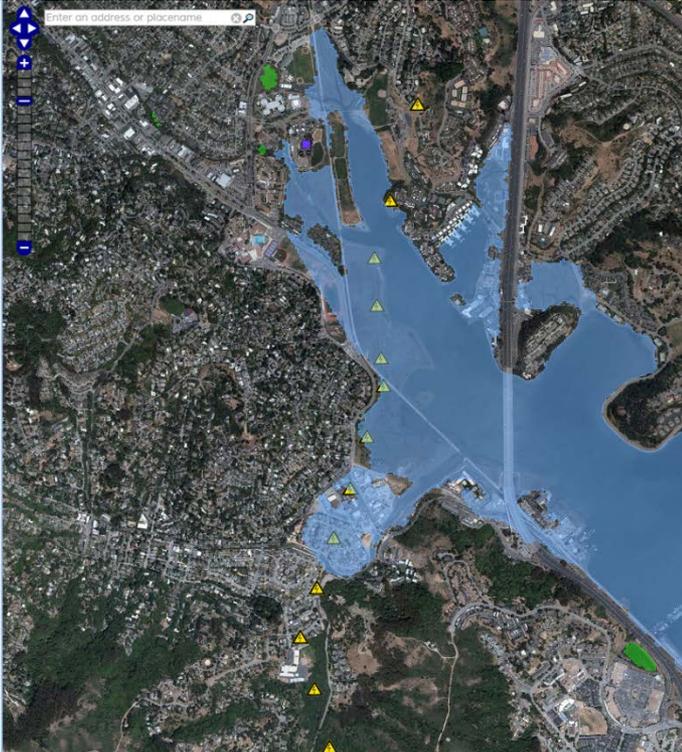
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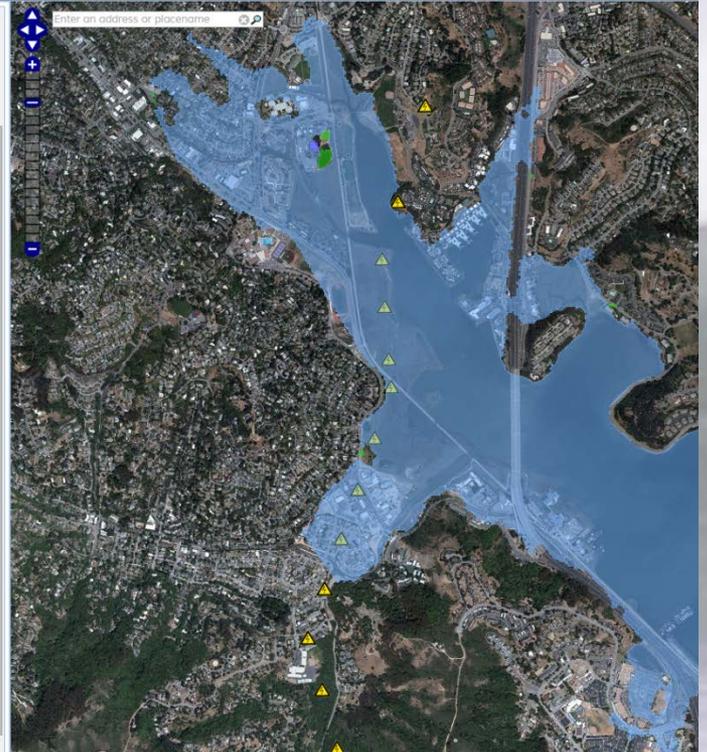
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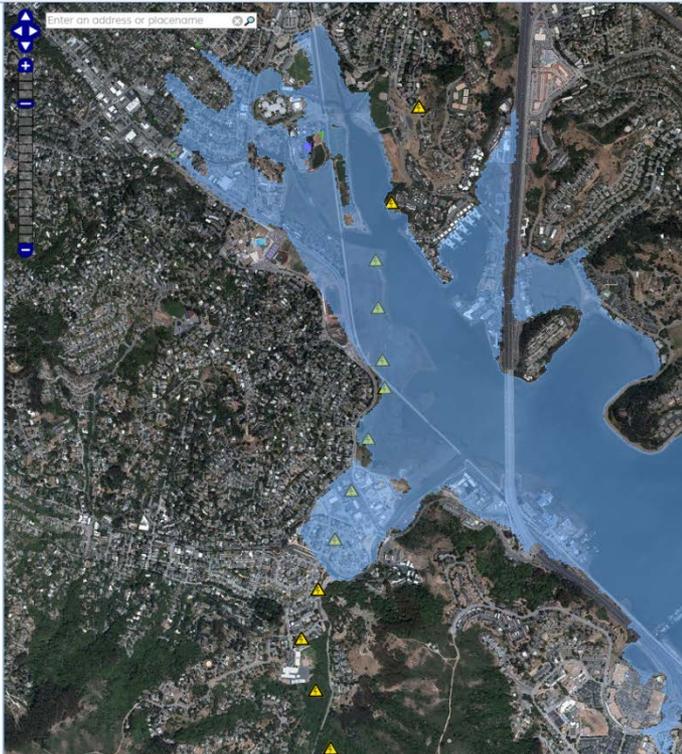
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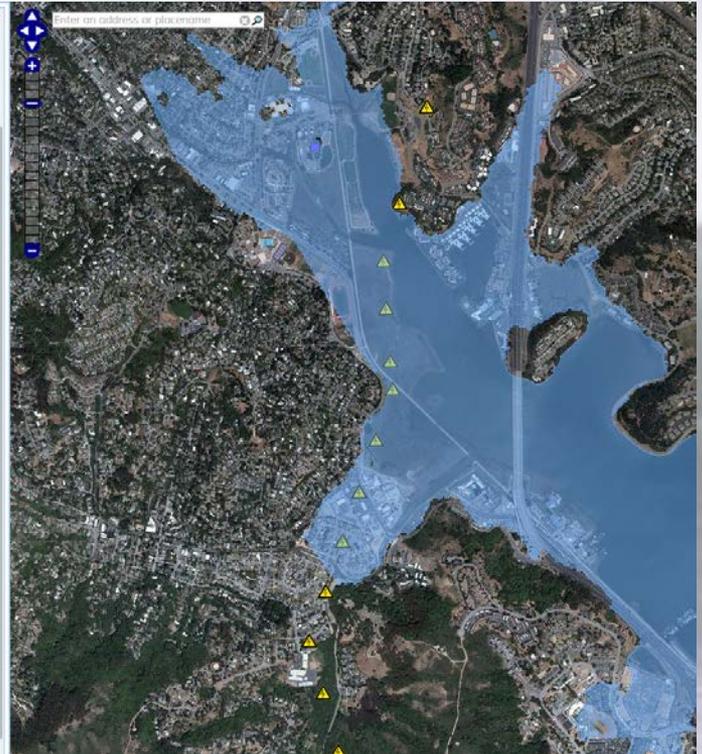
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- Trails
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- Utilities & Services

[What do Other Layers represent?](#)



# Generate summary reports of your area of interest...

**1) Choose a topic.**  
 Flooding shows the inundation due to SLR, waves, and storm surge.  
 Flooding Waves  
 Current Duration  
 Flood Potential  
[What do the Topics represent?](#)  
 Compare Flooding Scenarios

**2) Choose an Amount of Sea Level Rise (cm).**  
 0 25 50 75 100 125  
 150 175 200 500 [\(Use feet\)](#)  
[What Sea Level Rise scenario should I use?](#)

**3) Choose an Event**  
 Choose Storm Scenario Frequency  
 None Annual 20 year 100 year  
 Or Choose King Tide Scenario  
 King Tide  
[What are Storm Scenarios?](#)  
[What is a King Tide scenario?](#)

**4) Choose other layers to view with topic data.**  
 Digital Elev Model (DEM)  
 Levees  
 Placenames  
 Land Use  
 Protected Areas  
 Rivers & Streams  
 Cliff and Shoreline Retreat  
 Shorebirds  
 Coastal Armoring  
 Roads and Transportation  
 Trails  
 Buildings  
 Utilities & Services  
[What do Other Layers represent?](#)



**OCOF Sea Level Rise and Scenario Report**  
 by Our Coast Our Future project  
[www.pointblue.org/ocof](http://www.pointblue.org/ocof)

Report created: Jul 10, 2015 12:48 pm

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This is the sea level rise and storm scenario report for the area you selected. This report was designed to provide information to help you identify vulnerabilities to sea level rise and storm surges.

### Area and Elevation Information

Area is the size of selected polygon, in square meters, acres and hectares, and Elevation is the average, minimum and maximum elevation from the Digital Elevation Model (DEM) within the polygon.

Area:	383,654.79 m <sup>2</sup> 94.80 ac 38.37 ha	Elevation:	Mean - 8.21 meters Minimum - 0.26 meters Maximum - 53.72 meters
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### Projected Percent Area Flooded for the Selected Area

Values indicate the percentage of the selected area flooded for the Storm and Sea Level Rise Scenario combination.

Storm Scenario	Sea Level Rise Scenario								
	100 yr Storm	20 yr Storm	Annual Storm	No Storm	50 cm	100 cm	150 cm	200 cm	500 cm
Storm Scenario	100 yr Storm	38%	47%	51%	53%	54%	59%		
	20 yr Storm	12%	45%	50%	53%	54%	59%		
	Annual Storm	1%	22%	41%	47%	51%	56%		
	No Storm	5%	10%	39%	47%	50%	56%		
	none	50 cm	100 cm	150 cm	200 cm	500 cm			

under 25% flooded
 25-50% flooded
 50-75% flooded
 over 75% flooded

### Projected Average Flood Depth for the Selected Area

Values indicate the average flood depth (in feet and centimeters) over the Mean Higher High Water (MHHW) within the selected area for each Storm and Sea Level Rise Scenario combination. Values include modeling uncertainty bracket of +/- 40 cm.

Storm Scenario	Sea Level Rise Scenario								
	100 yr Storm	20 yr Storm	Annual Storm	No Storm	50 cm	100 cm	150 cm	200 cm	500 cm
Storm Scenario	100 yr Storm	55 - 135 cm 1.8 - 4.4 ft	85 - 165 cm 2.8 - 5.4 ft	125 - 205 cm 4.1 - 6.7 ft	165 - 245 cm 5.4 - 8 ft	210 - 290 cm 6.9 - 9.5 ft	480 - 560 cm 15.7 - 18.4 ft		
	20 yr Storm	35 - 115 cm 1.1 - 3.8 ft	65 - 145 cm 2.1 - 4.8 ft	110 - 190 cm 3.6 - 6.2 ft	160 - 240 cm 5.2 - 7.9 ft	210 - 290 cm 6.9 - 9.5 ft	485 - 565 cm 15.9 - 18.5 ft		
	Annual Storm	55 - 135 cm 1.8 - 4.4 ft	25 - 105 cm 0.8 - 3.4 ft	65 - 145 cm 2.1 - 4.8 ft	95 - 175 cm 3.1 - 5.7 ft	150 - 230 cm 4.9 - 7.5 ft	425 - 505 cm 13.9 - 16.6 ft		
	No Storm	40 - 120 cm 1.3 - 3.9 ft	35 - 115 cm 1.1 - 3.8 ft	60 - 140 cm 2 - 4.6 ft	95 - 175 cm 3.1 - 5.7 ft	125 - 205 cm 4.1 - 6.7 ft	415 - 495 cm 13.6 - 16.2 ft		
	none	50 cm	100 cm	150 cm	200 cm	500 cm			

average less than 1 ft
 1 to 3 ft
 3 to 5 ft
 over 5 ft

\*For more information on CoSMoS model and OCOF tool, contact

Patrick Barnard at [pbarnard@usgs.gov](mailto:pbarnard@usgs.gov) or Li Erikson at [lerikson@usgs.gov](mailto:lerikson@usgs.gov)

- USGS CoSMoS website:

[http://walrus.wr.usgs.gov/coastal\\_processes/cosmos/index.html](http://walrus.wr.usgs.gov/coastal_processes/cosmos/index.html)

- Our Coast- Our Future tool: <http://data.prbo.org/apps/ocof/>