Coastal Storm Modeling System (CoSMoS)
CA Central Coast

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Central Coast Climate Collaborative | Aug. 23, 2017

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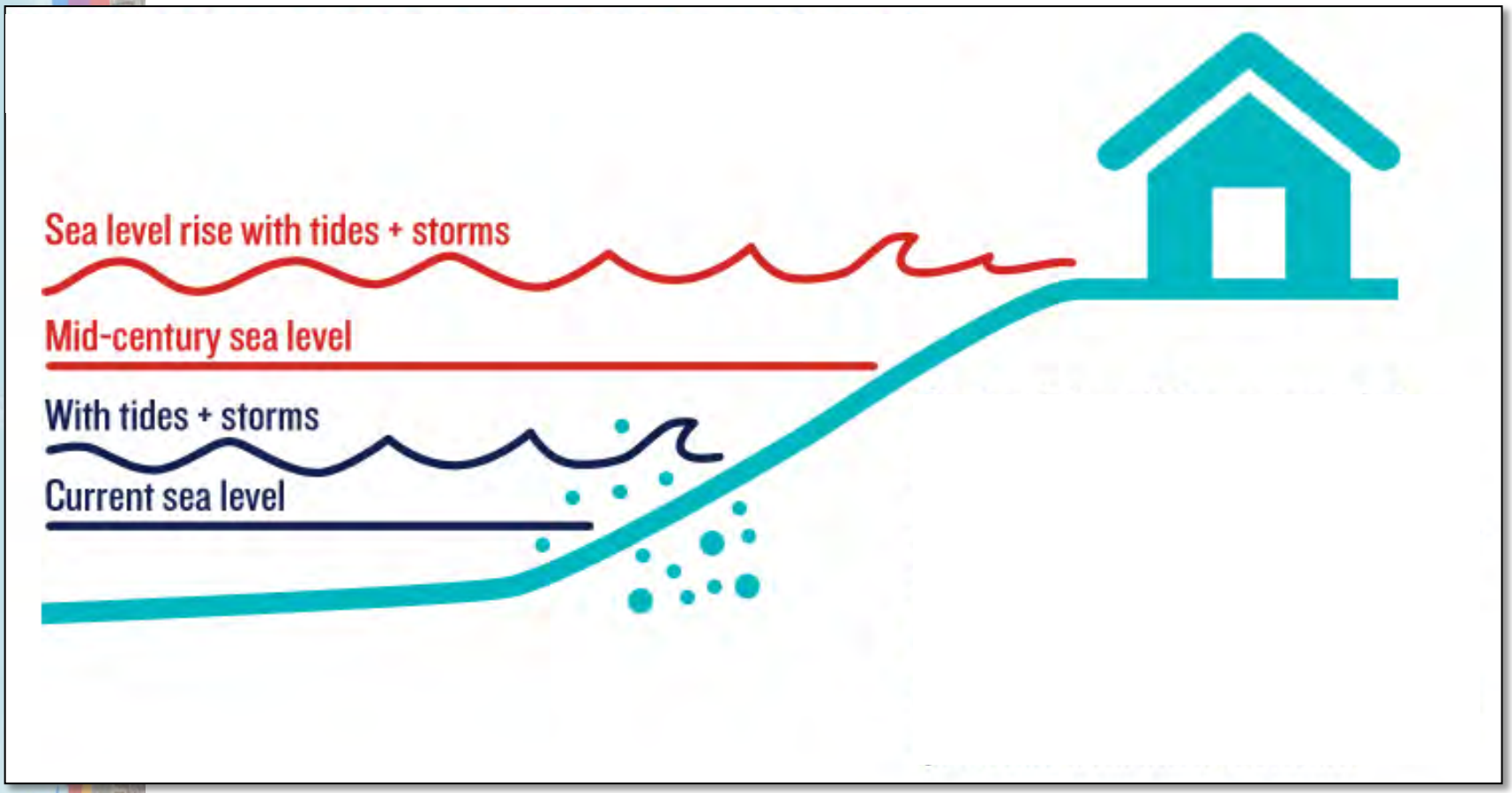
Beyond SLR…storms & tides



Coastal Flooding graphic courtesy of Climate Education Partners

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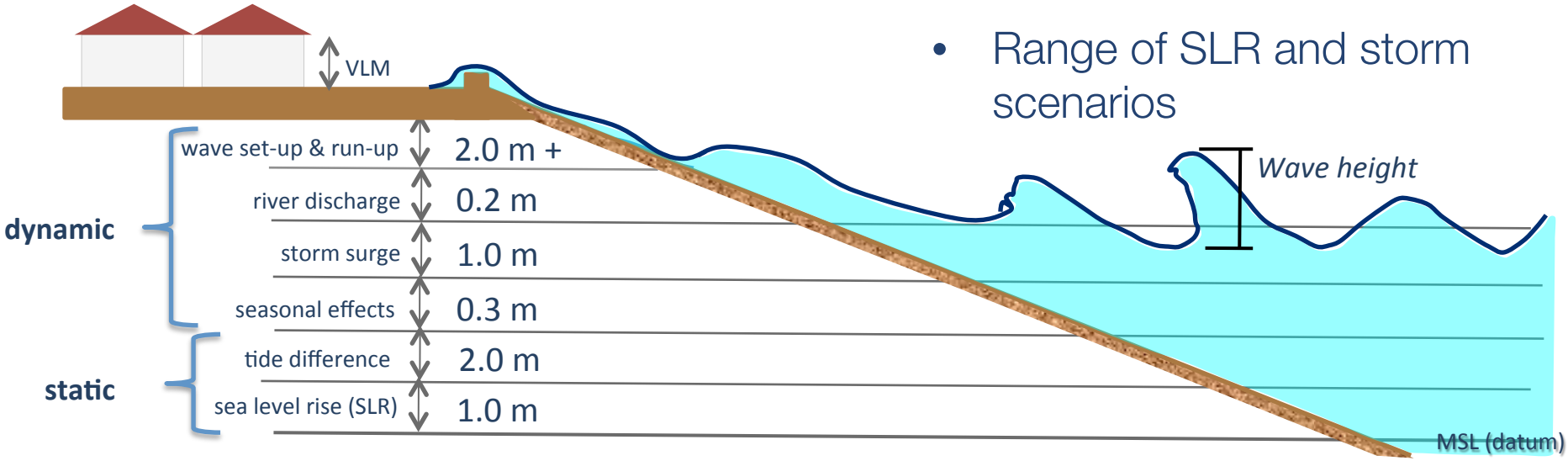
Coastal Vulnerability Approaches

Static: NOAA SLR Viewer

- Passive model, hydrological connectivity
- Tides only
- '1st order screening tool'

Dynamic: USGS-CoSMoS

- All physics modeled
- Forced by Global Climate Models
- Includes wind, waves, atmospheric pressure, shoreline change
- Range of SLR and storm scenarios



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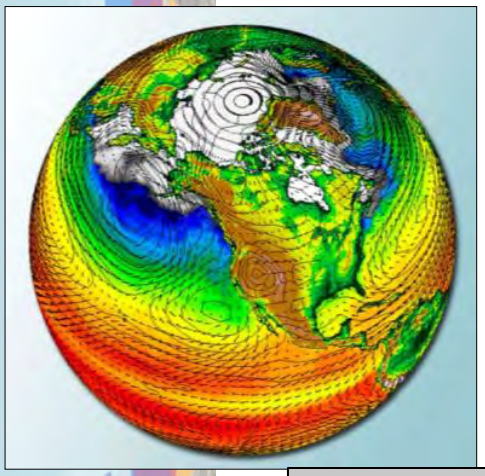
What is CoSMoS?

- Physics-based numerical modeling system for assessing coastal hazards due to climate change
- Ongoing development for the last decade
- Utilizes models that have been developed over the past several decades
- Predicts coastal hazards for the full range of sea level rise (0-2, 5 m) and storm possibilities (up to 100 yr storm) using sophisticated global climate and ocean modeling tools
- Emphasis on directly supporting federal and state-supported climate change guidance (e.g., Coastal Commission) and vulnerability assessments (e.g., LCP updates, OPC/ Coastal Conservancy grants)
- Developed for community-scale planning

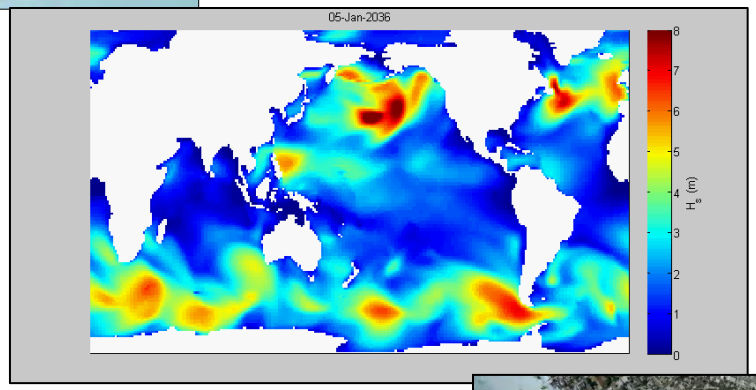
Dave Hubbard

CoSMoS Coastal Storm Modeling System USGS

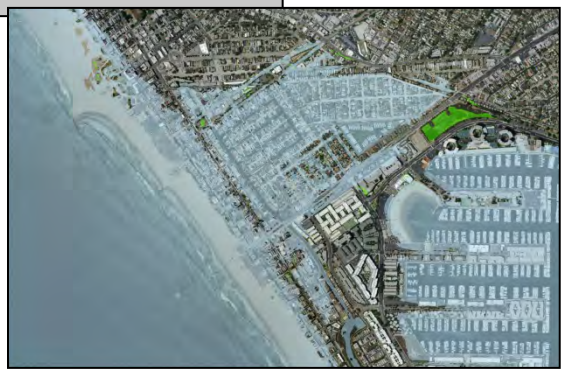
USGS Coastal Storm Modeling System (CoSMoS)



1. Global forcing using the latest climate models



2. Drives global and regional wind/wave models



3. Scaled down to local hazards projections

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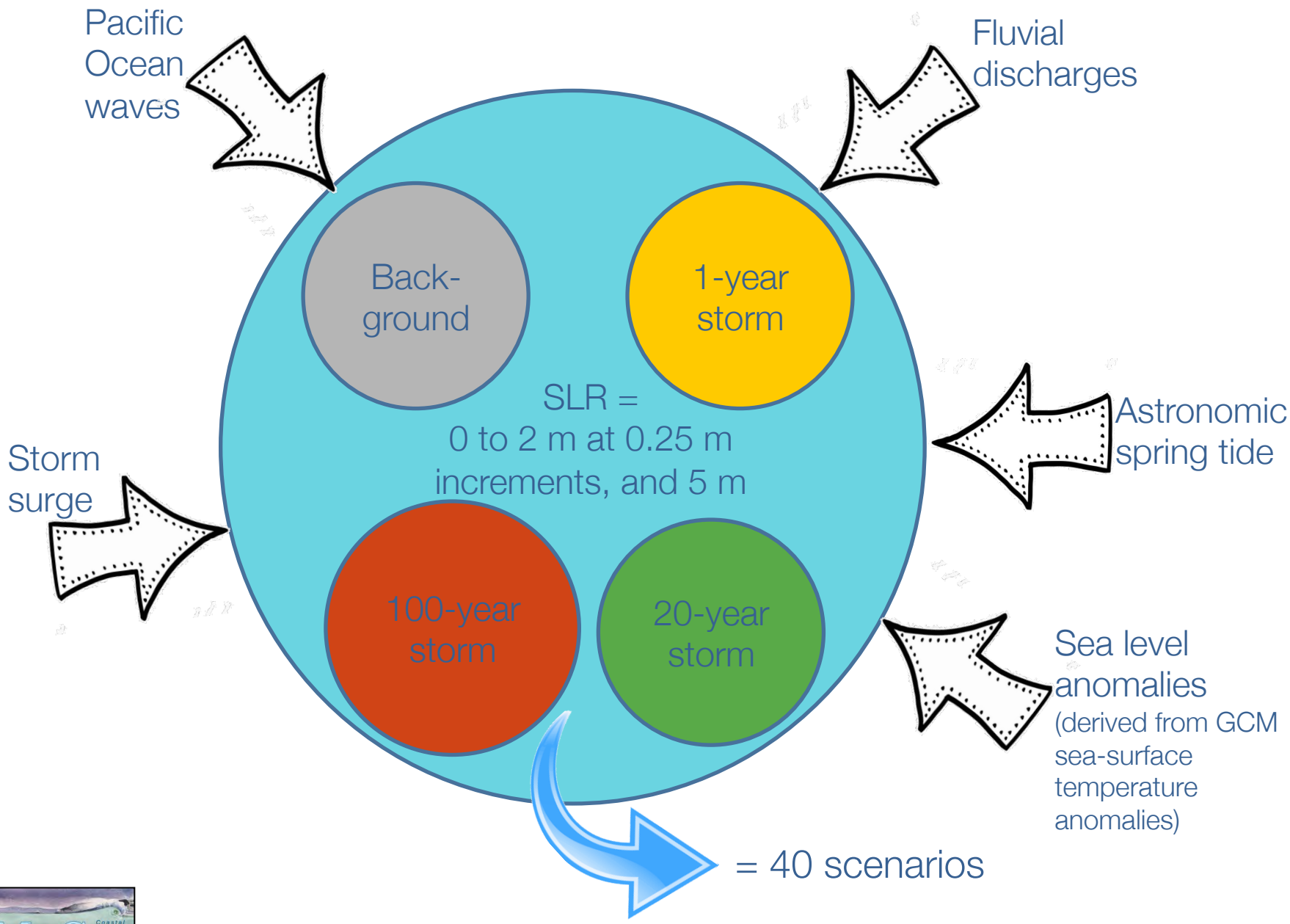
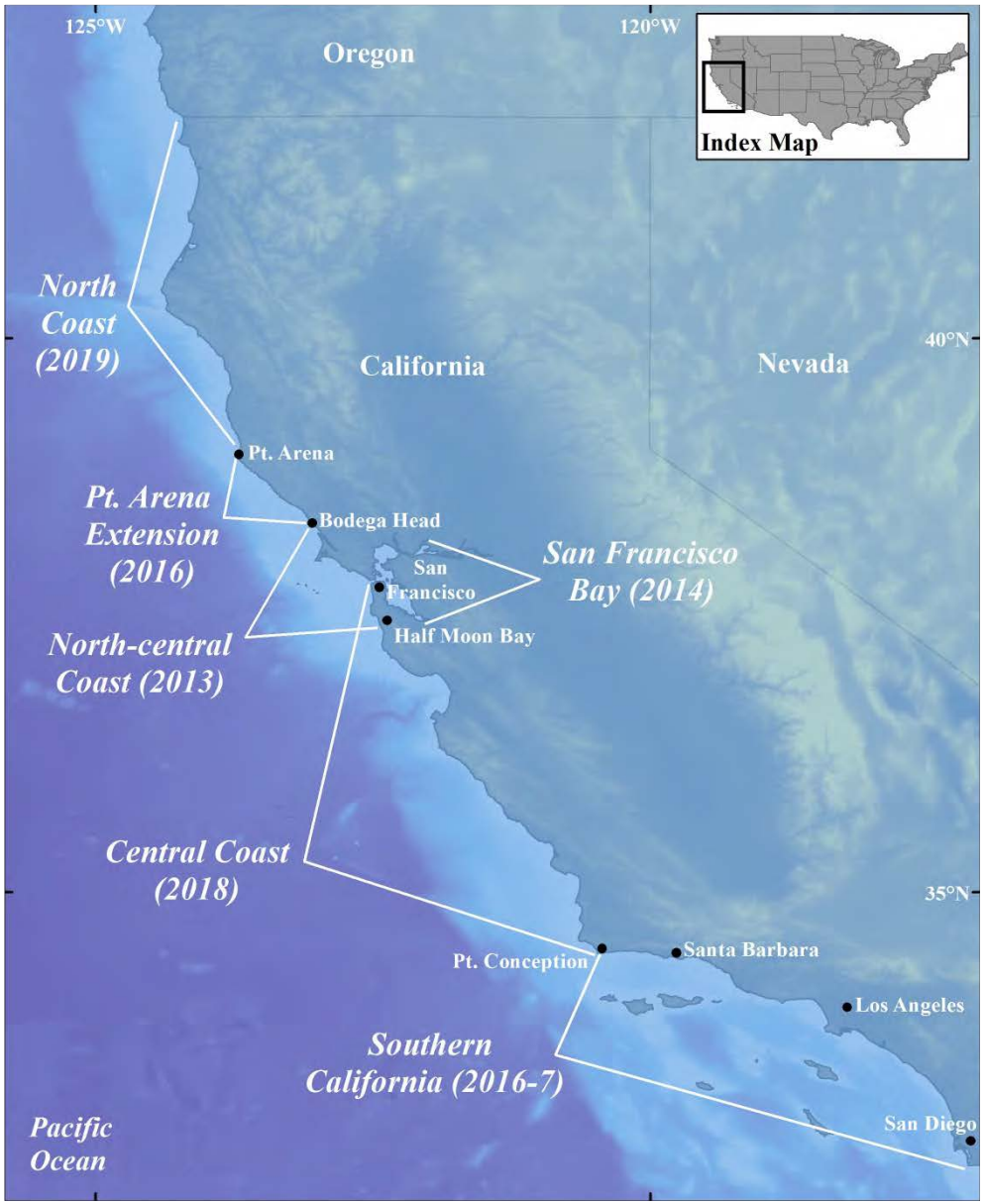

Pacific Ocean waves
Fluvial discharges
Back-ground
1-year storm
SLR = 0 to 2 m at 0.25 m increments, and 5 m
Storm surge
Astronomic spring tide
100-year storm
20-year storm
Sea level anomalies (derived from GCM sea-surface temperature anomalies)
= 40 scenarios

CoSMoS Coverage



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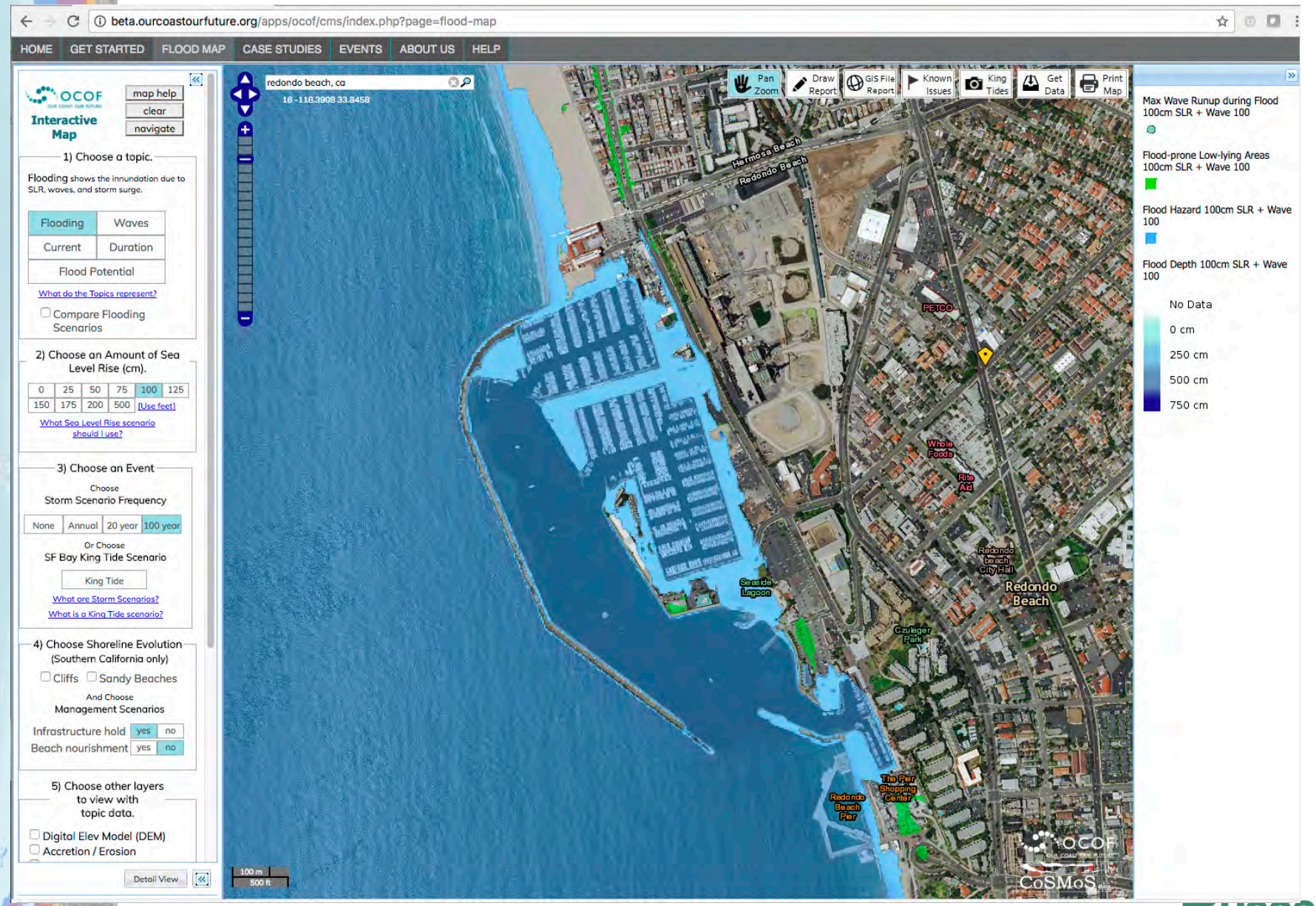
Coastal Flooding



Our Coast, Our Future tool: betaourcoastourfuture.org

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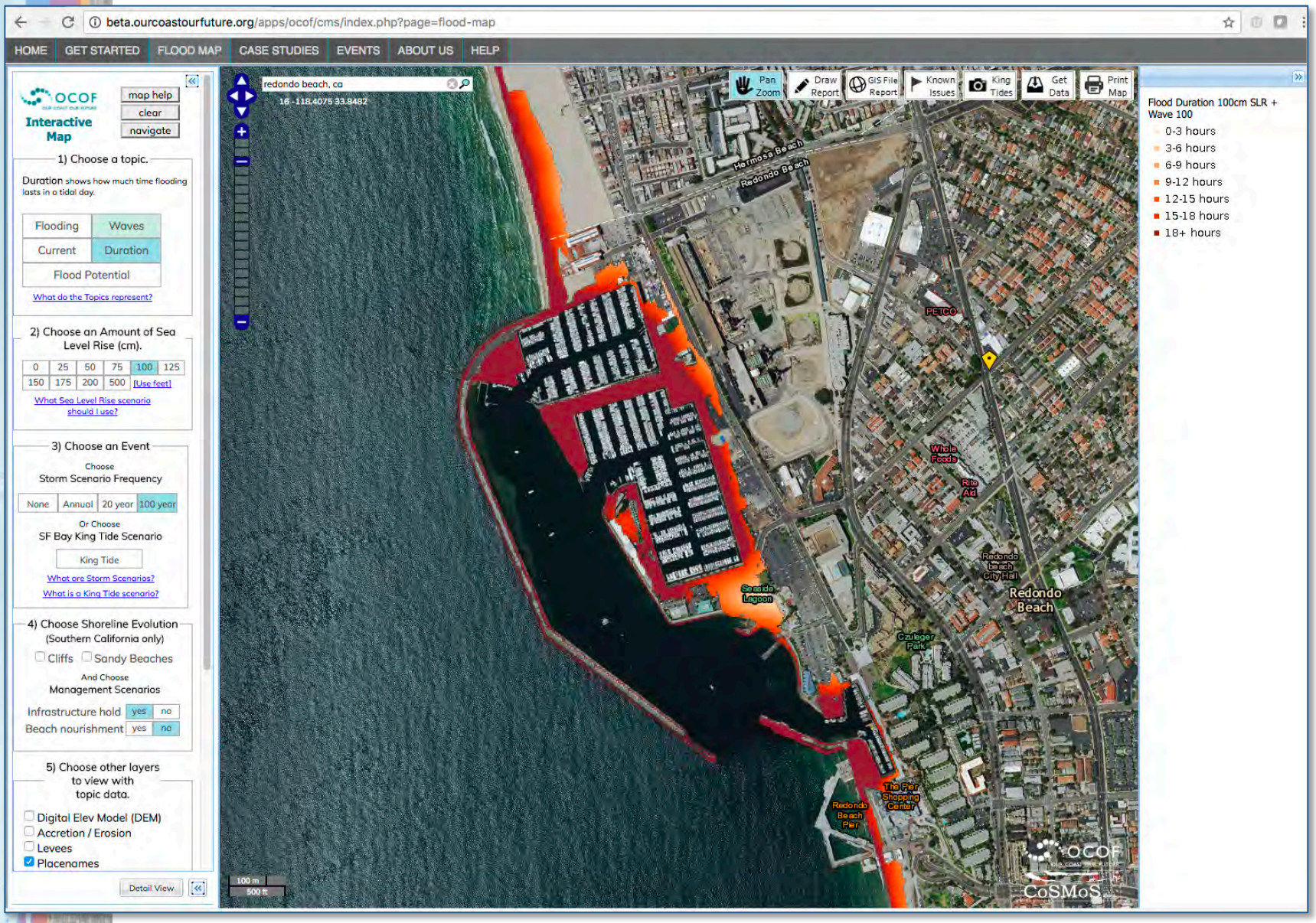
Flood Duration



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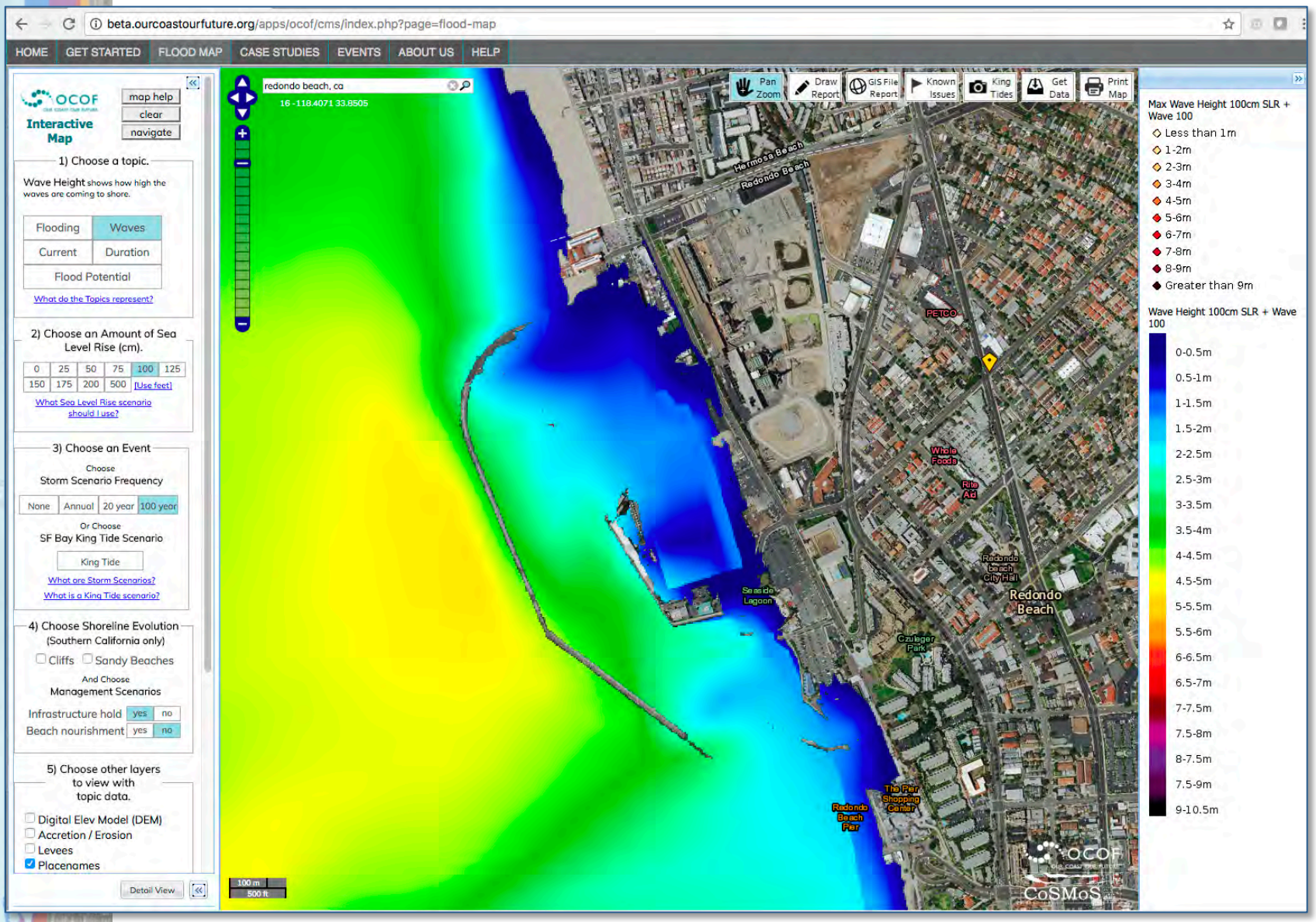
Waves



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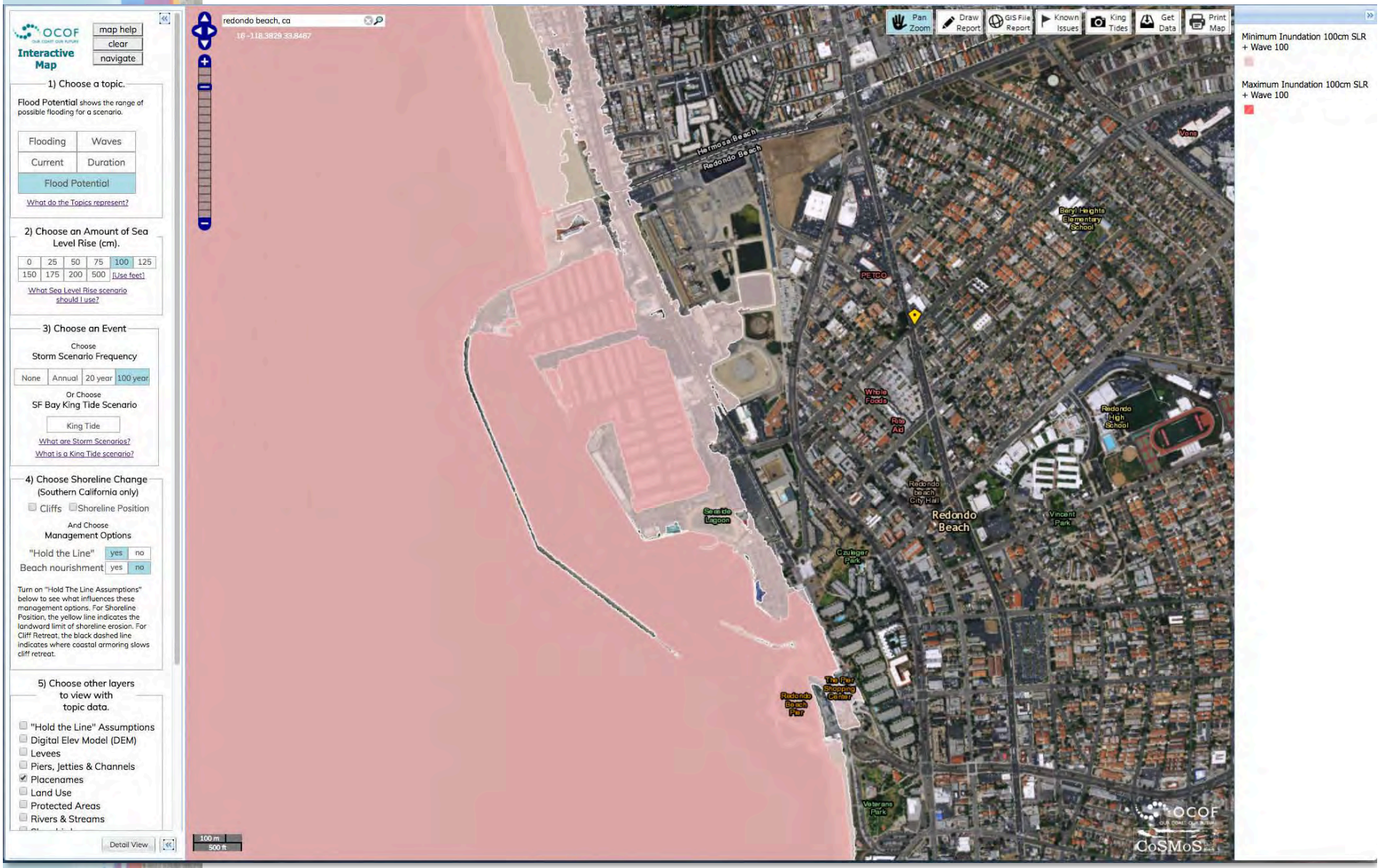
Flood Potential (aka Uncertainty)



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Shoreline Projections

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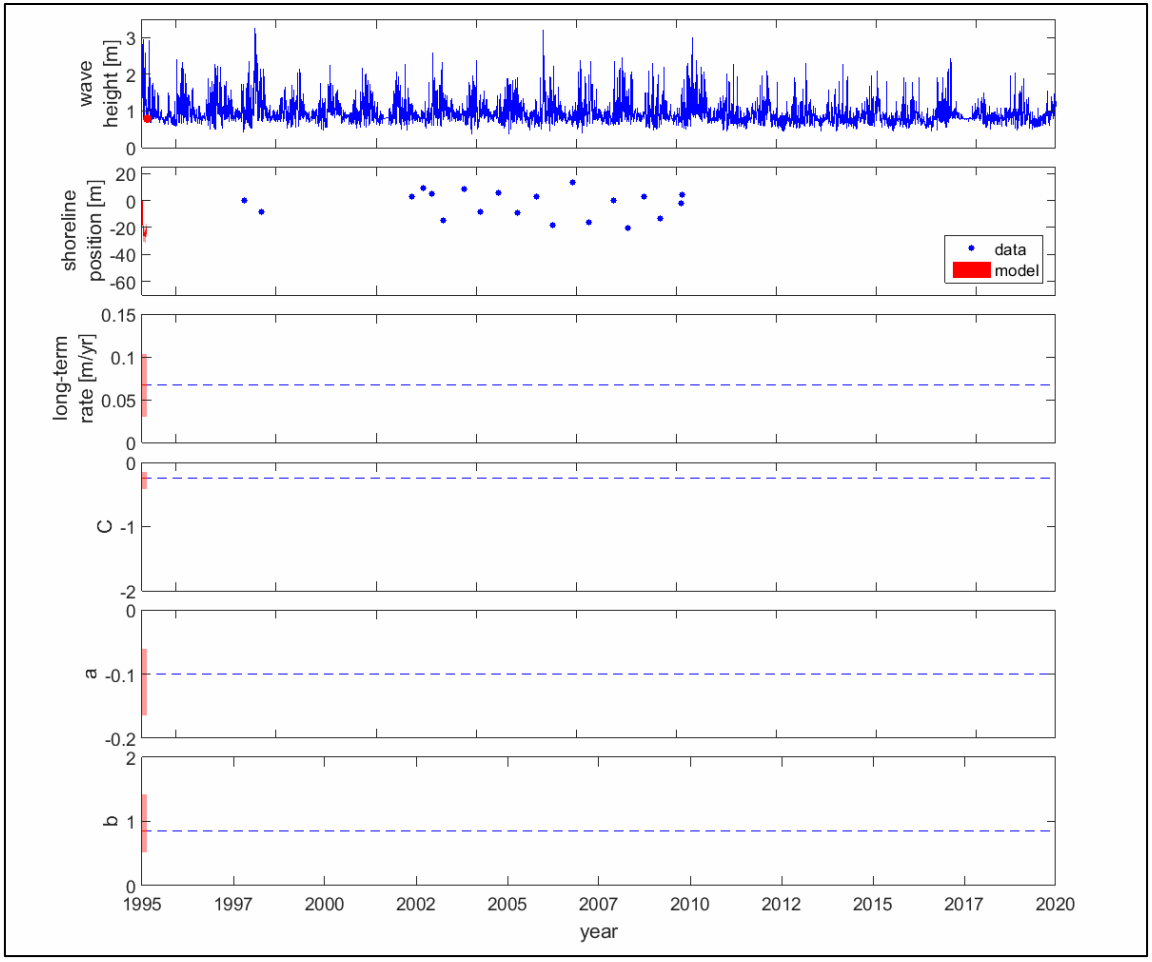
CoSMoS-COAST: Coastal One-line Assimilated Simulation Tool

- A (hybrid) numerical model to simulate long-term shoreline evolution
- Modeled processes include:
  - Longshore transport
  - Cross-shore transport
  - Effects of sea-level rise
  - Sediment supply by natural & anthropogenic sources

Vitousek, S., et al 2017



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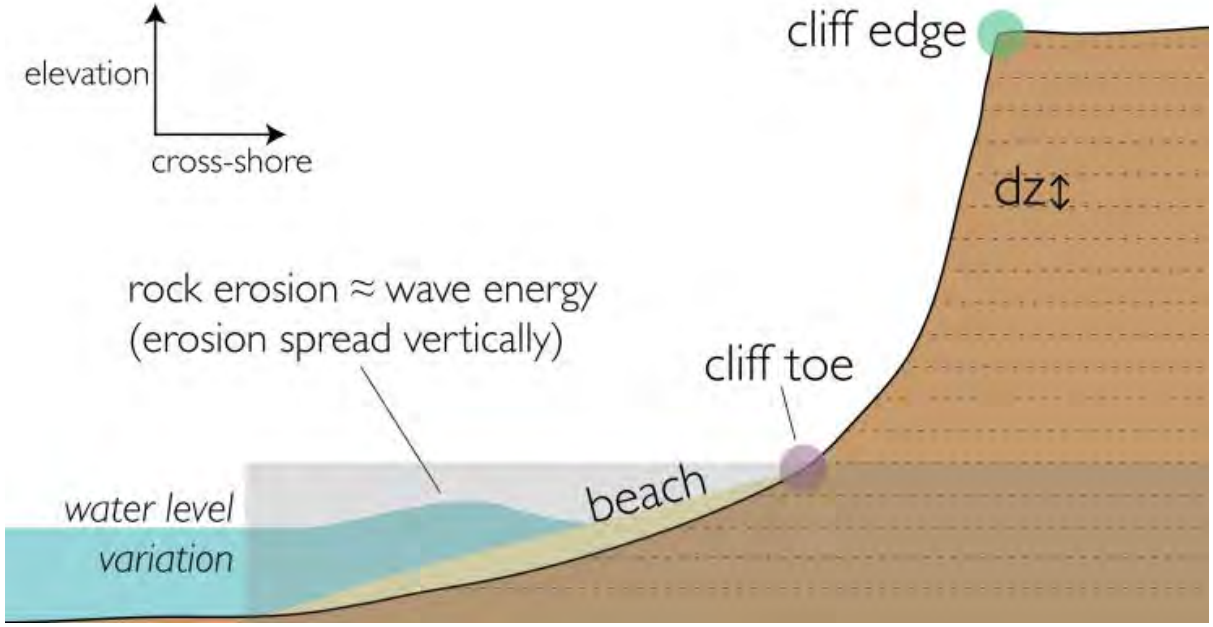
Long-term Cliff Retreat

- Uses an ensemble of up to 6 cliff models per transect
  - Beach protects cliff from waves
  - Includes water level variations (tides, run-up, set-up, surge, etc.)
- Synthesized from models in scientific literature (with several improvements)
- Uses machine learning (Artificial Neural Networks) to estimate model coefficients and extrapolate model behavior over study area



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Cliff Retreat Projections

SLR of 1 m could increase retreat rates by ~60% over historical rates.

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What outputs are available?

- Long term (LT) cliff recession and sandy beach shoreline change

4 coastal management scenarios + SLR

- Flood depths, extents, and low-lying vulnerable areas (including integration of LT morphodynamic change)
- Maximum water levels
- Flood duration
- Maximum wave heights
- Maximum velocities
- Maximum wave runup
- Flood extent uncertainties (model + DEM uncertainties, & vertical land motion)

40 scenarios of SLR + storms

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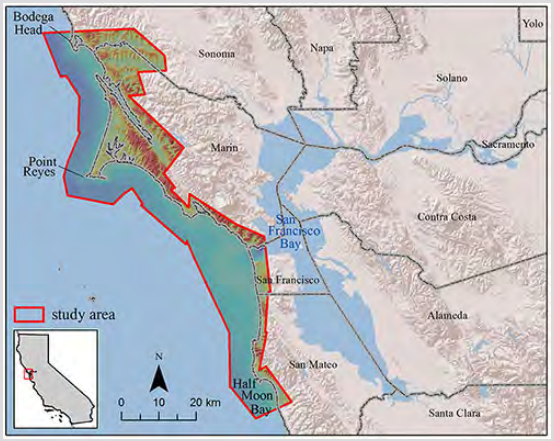
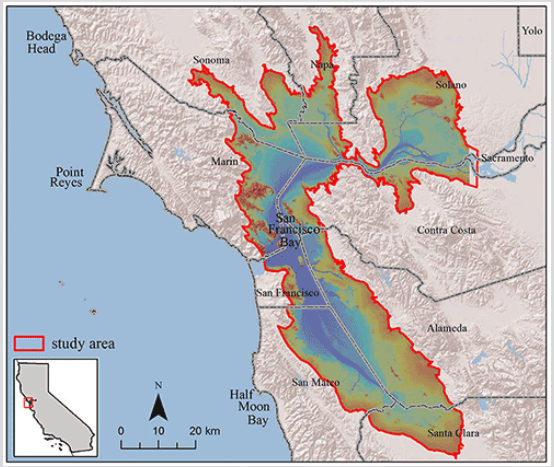
GIS-Based Exposure to Hazards

JURISDICTIONS





9 COUNTIES
56 INCORPORATED CITIES

ASSETS

RESIDENTS (w/ demographics)

EMPLOYEES (by sector)

BUSINESS SECTORS
PARCEL VALUES
BUILDING REPLACEMENT VALUE

ROADS AND RAILWAYS

LANDCOVER

HAZARD

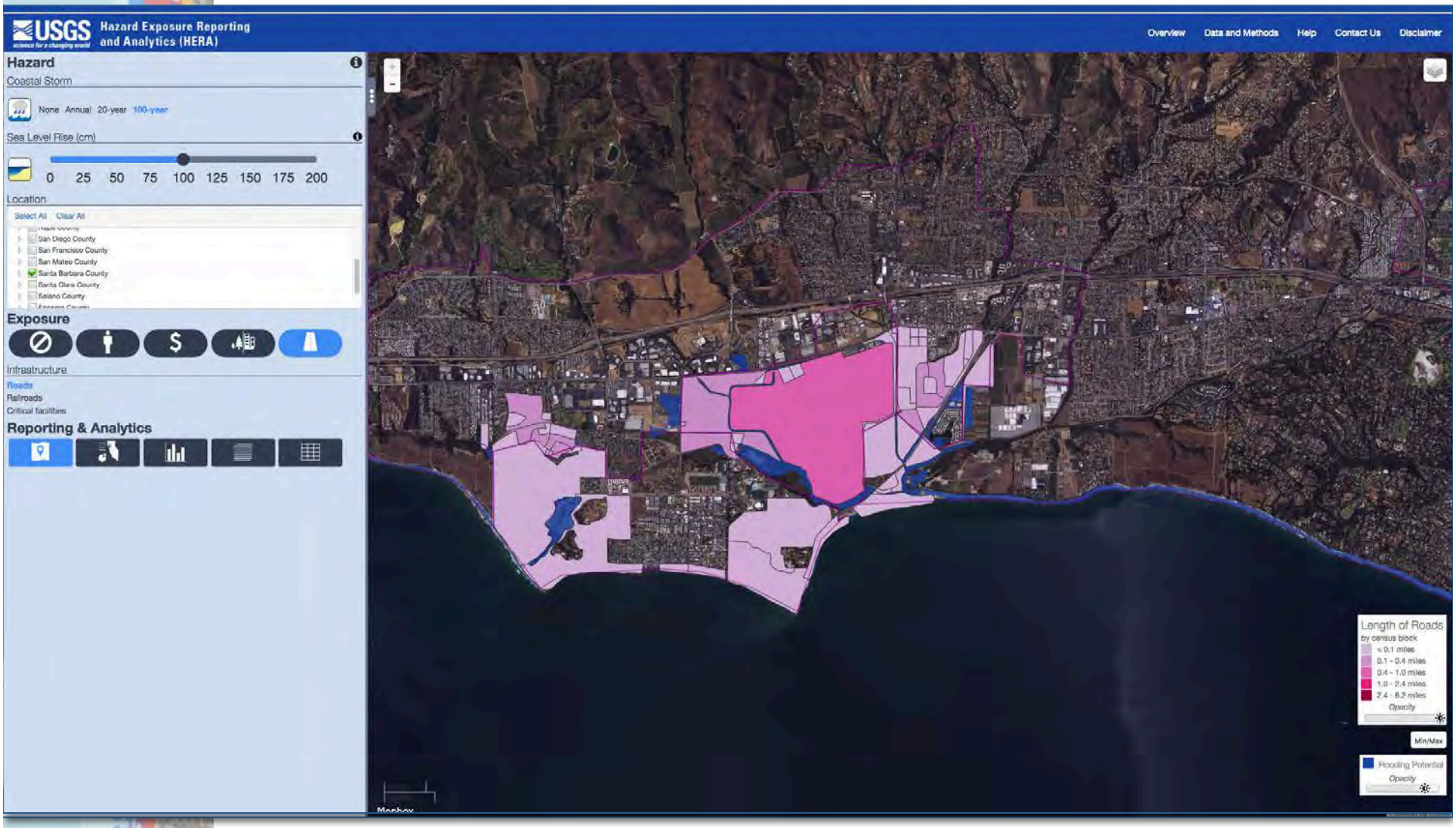
FLOODING EXTENT based on:

STORM FREQUENCY
None
Annual
20-year
100-year

SEA LEVEL RISE SCENARIOS

0 cm	100 cm
25 cm	125 cm
50 cm	150 cm
75 cm	175 cm
	200 cm

Socioeconomic Impacts



www.usgs.gov/apps/hera

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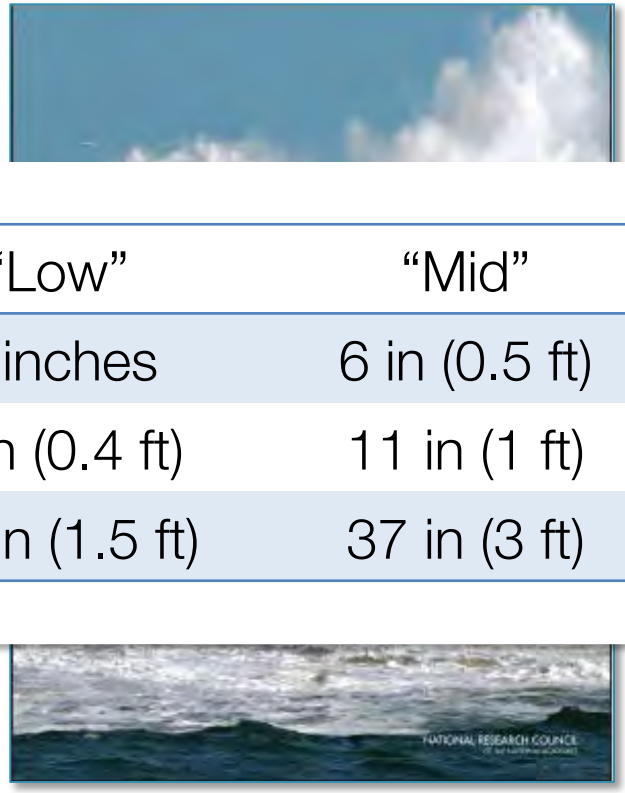
Sea level rise (SLR) in California



Time Period	"Low"	"Mid"	"High"
2000 – 2030	2 inches	6 in (0.5 ft)	12 in (1 ft)
2000 – 2050	5 in (0.4 ft)	11 in (1 ft)	24 in (2 ft)
2000 – 2100	17 in (1.5 ft)	37 in (3 ft)	66 in (5.5 ft)

http://www.nap.edu/catalog.php?record_id=13389

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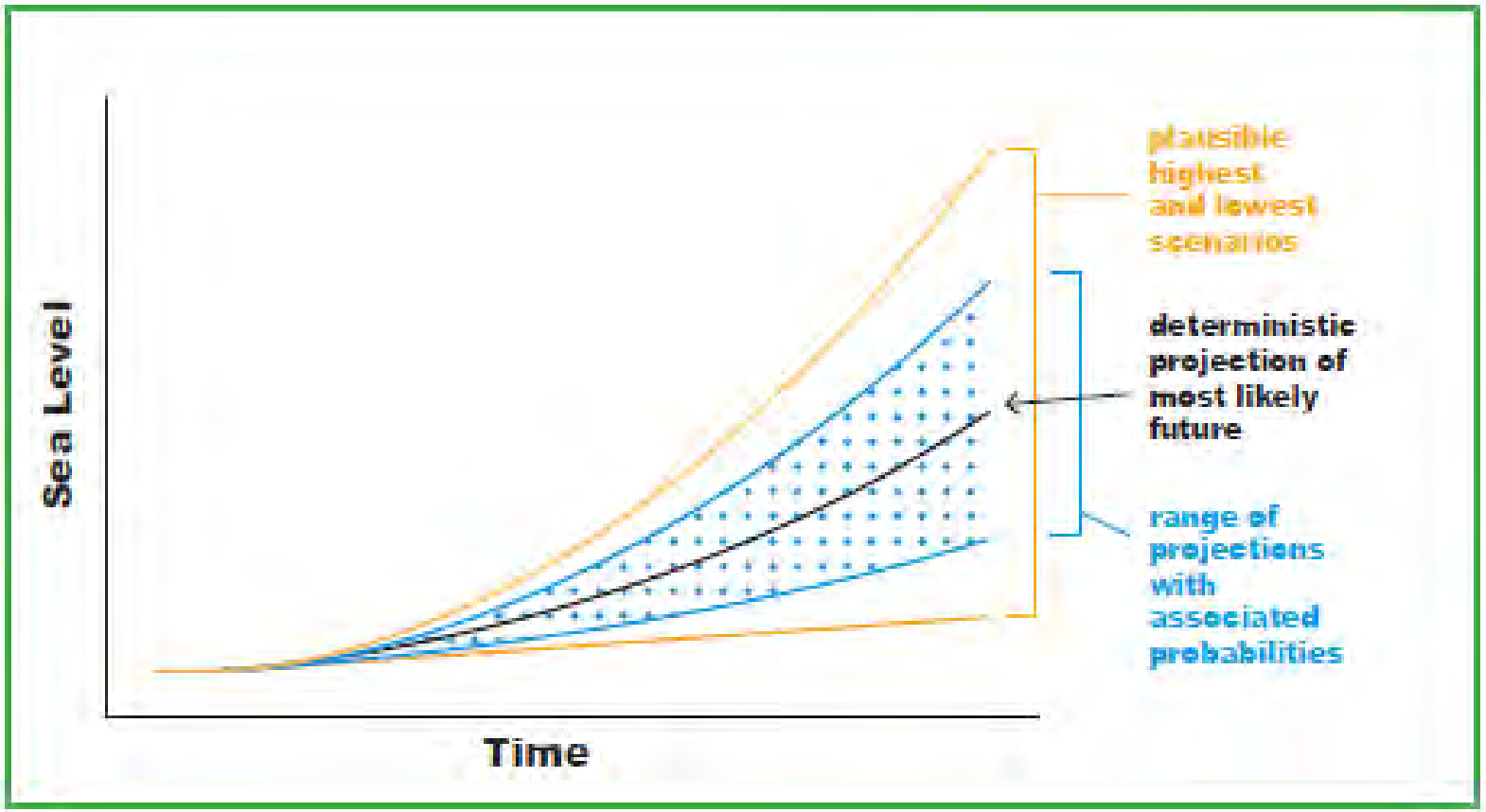
Deterministic, Probabilistic, & Plausible, Oh My!



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Feet above 1991-2009 mean	MEDIAN	LIKELY RANGE	1-IN-20 CHANCE	1-IN-200 CHANCE
Year / Percentile	*50% probability SLR meets or exceeds...*	*67% probability SLR is between...*	*5% probability SLR meets or exceeds...*	*0.5% probability SLR meets or exceeds...*
2030	0.4	0.3 — 0.5	0.6	0.8
2050	0.9	0.6 — 1.1	1.4	1.9
2100 (RCP 2.6)	1.6	1.0 — 2.4	3.2	5.7
2100 (RCP 4.5)	1.9	1.2 — 2.7	3.5	5.9
2100 (RCP 8.5)	2.5	1.6 — 3.4	4.4	6.9
2100 (H++)	10			
2150 (RCP 2.6)	2.4	1.3 — 3.8	5.5	11.0
2150 (RCP 4.5)	3.0	1.7 — 4.6	6.4	11.7
2150 (RCP 8.5)	4.1	2.8 — 5.8	7.7	13.0
2150 (H++)	22			

http://www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf

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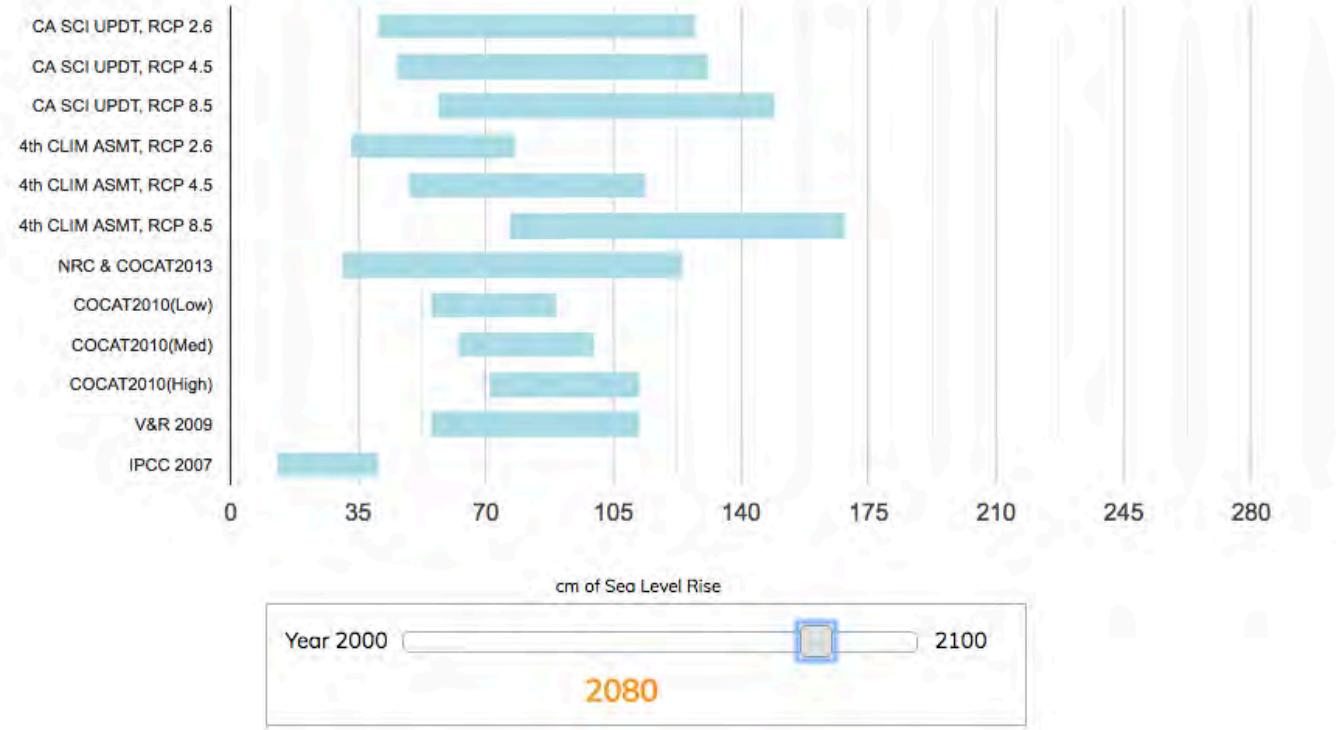
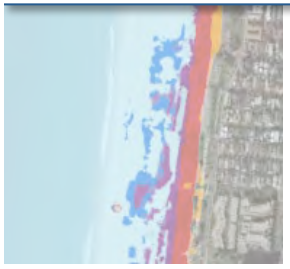
Huh?

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.





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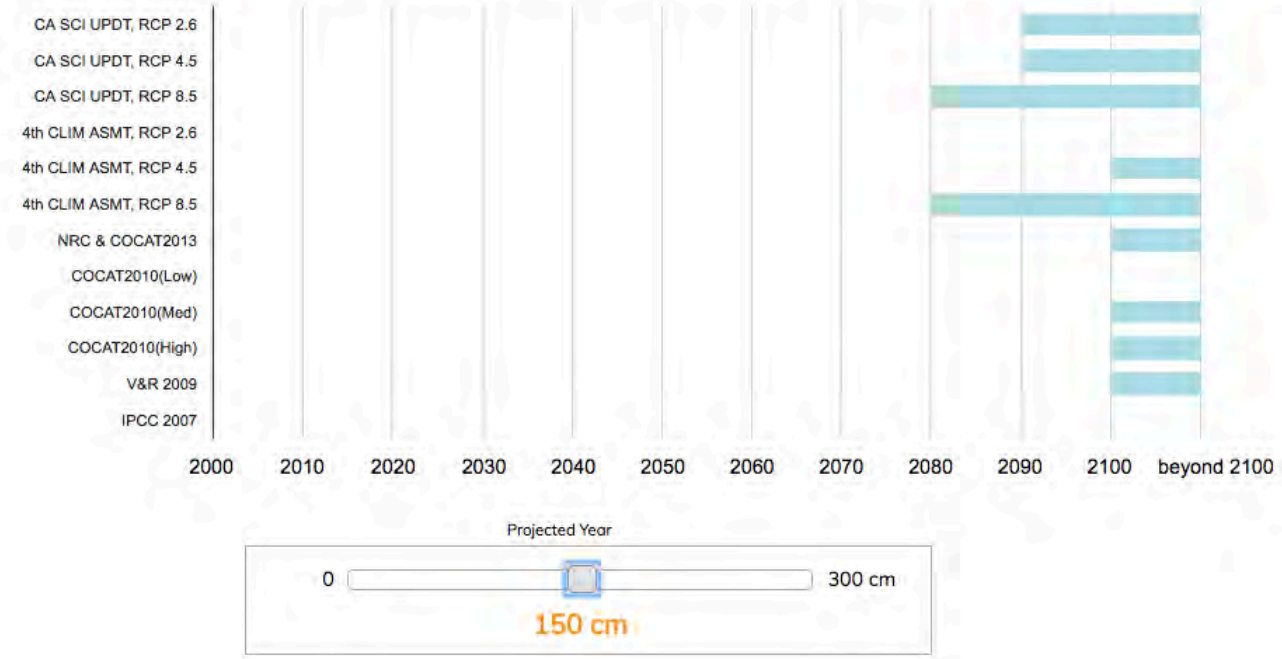
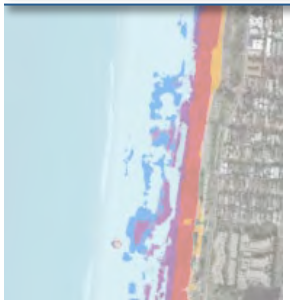
Wait, what?

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.





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CoSMoS in action…

County
- Sonoma County
- Marin County
- Santa Mateo County
- Santa Clara County
- Santa Barbara County
- Los Angeles County
  - Office of Emergency Management
  - Department of Beaches and Harbors
- San Diego County

State
- California Coastal Commission
- California Coastal Conservancy
- California Department of Emergency Services (CalOES)
- California Department of Fish & Wildlife
- California Department of Transportation (CalTrans)
- California Energy Commission
- California Natural Resources Agency
- California Ocean Protection Council

Federal
- National Park Service
- NOAA Gulf of Farallones National Marine Sanctuary
- NOAA Office for Coastal Management
- National Estuarine Research Reserve (NOAA)

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CoSMoS in action…

City

- City of San Francisco
- City of Pacifica
- City of San Jose
- City of Santa Barbara
- City of Los Angeles
- City of Santa Monica
- City of Hermosa Beach
- City of Long Beach
- City of Huntington Beach
- City of Imperial Beach
- City of Oceanside
- City of Encinitas
- City of Carlsbad
- City of San Diego
- City of Imperial Beach

Regional Scale

- AdaptLA: Coastal Impacts Planning for the LA Region
- California Climate Science Alliance
- Coastal Ecosystem Vulnerability Assessment (CEVA, Santa Barbara)
- LA Regional Collaborative on Climate Action and Sustainability (LARC)
- Regional Water Quality Control Board for LA and Ventura Counties
- San Diego Regional Climate Collaborative
- Southern California Coastal Water Research Project (SCCWRP)
- Wetlands Recovery Projects (San Diego - Orange County region & LA - Ventura - Santa Barbara region)

LARC & CoSMoS

Prepare coastal infrastructure for higher sea levels and coastal storms

Read more

GOAL 2 **Prepare communities for higher sea levels and coastal storms**

Read more

GOAL 3 **Protect natural resources from higher sea levels and coastal storms**

Read more

GOAL 4 **Maintain and improve coastal and ocean health**

Read more

GOAL 5 **Begin exploring opportunities and policies to move the built environment back from the shoreline in at risk areas**

http://climateaction.la/

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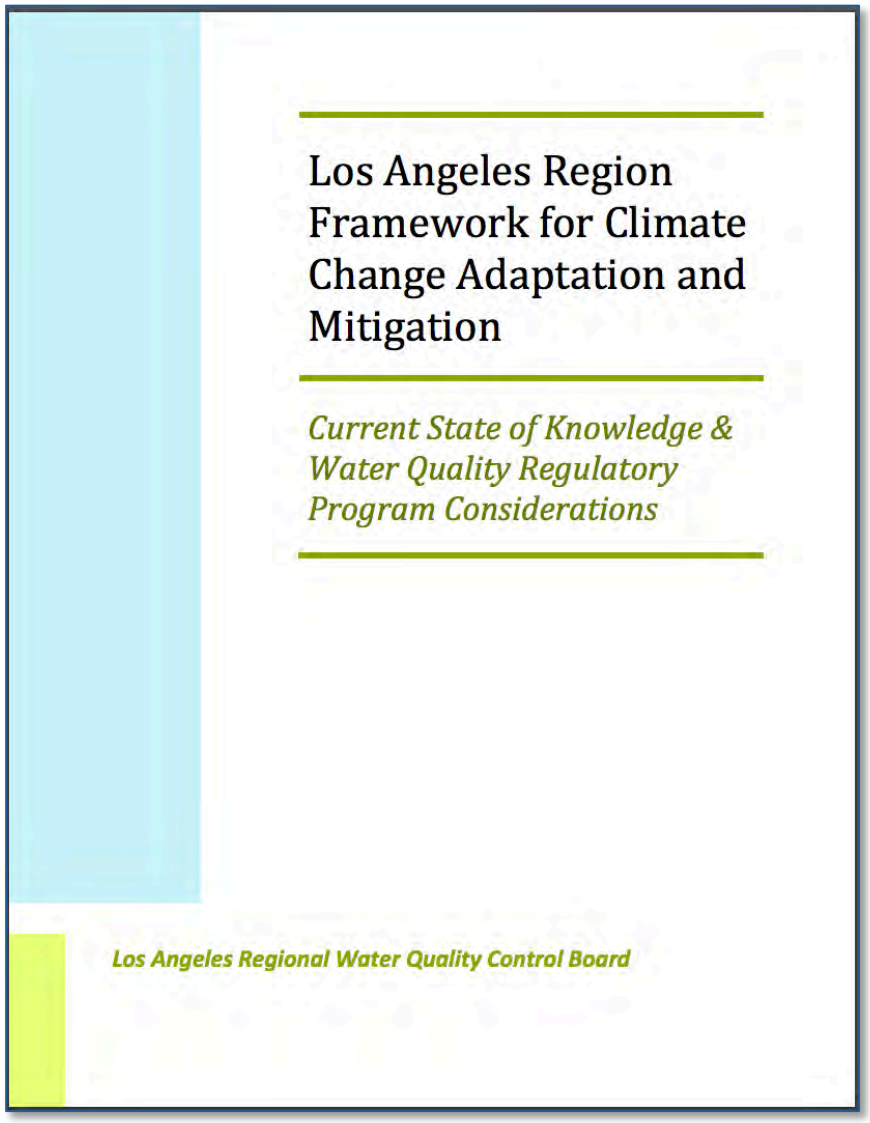
LA/Ventura
Regional Water Quality Control Board



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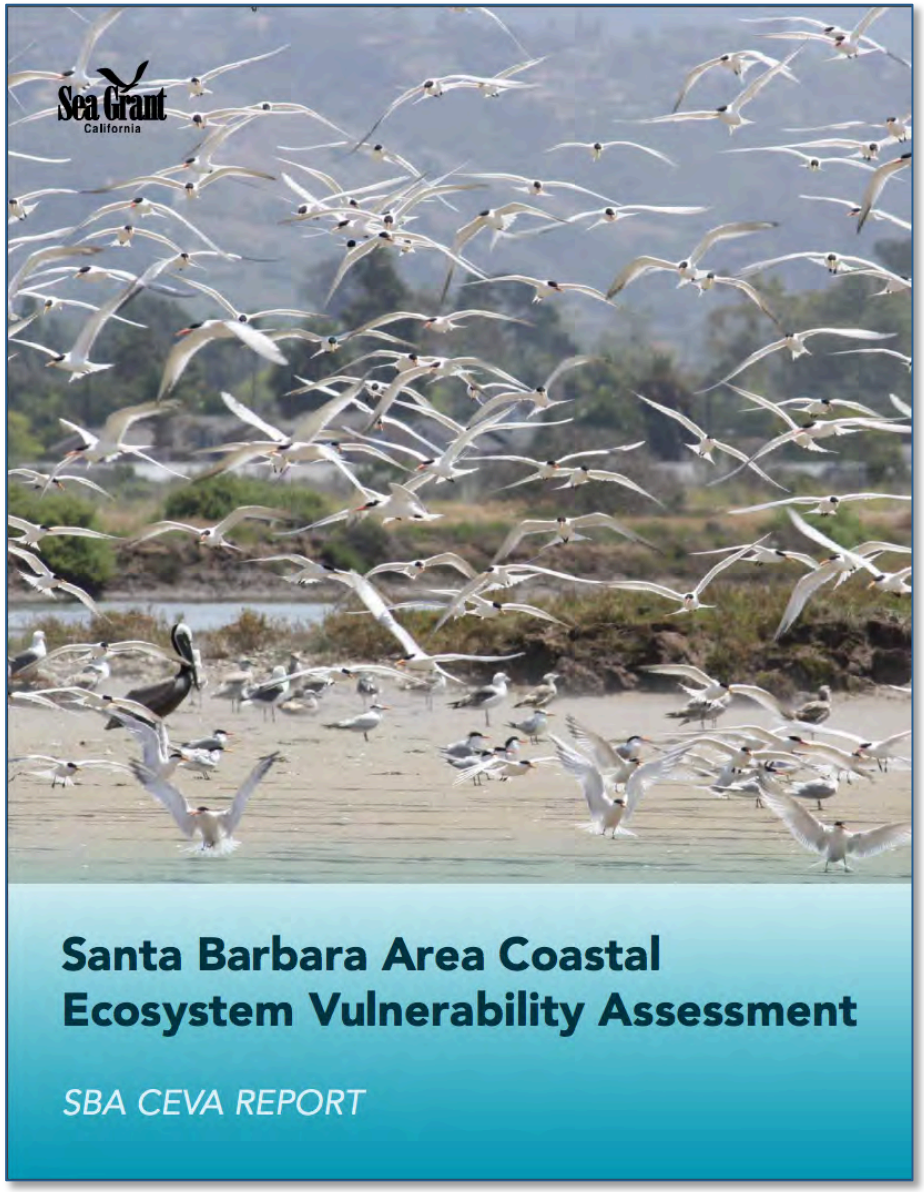
Santa Barbara Area
Coastal Ecosystem Vulnerability Assessment



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Central Coast CoSMoS

- Wave modeling nearing completion
- Coastal change projections to be completed in fall 2017
- Flooding projections to be completed in 2018, with Our Coast, Our Future and HERA web tools

USGS CoSMoS website: https://walrus.wr.usgs.gov/coastal_processes/cosmos/index.html

Our Coast, Our Future tool: www.ourcoastourfuture.org

HERA Tool: www.usgs.gov/apps/hera

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thank you!

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Scripps Institution of Oceanography UCSD

Point Blue

Coastal Conservancy

California Coastal Commission

National Oceanic and Atmospheric Administration NOAA U.S. Department of Commerce

California Department of Fish & Wildlife

California natural resources Agency

California's Fourth Climate Change Assessment

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