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science for a changing world

Impacts of Sea Level Rise and Storm Events on Planning for Transportation

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Pacific Coastal and Marine Science Center

Santa Cruz, CA

U.S. Department of the Interior
U.S. Geological Survey

California's Fourth Climate Change Assessment

Point Blue

California natural resources agency

CoSMoS USGS science for a changing world


Newport Blvd
Balboa, Peninsula
NO LEFT TURN

Sunset Beach, Sean Hiller

Sunset Beach, Allan J. Schaben

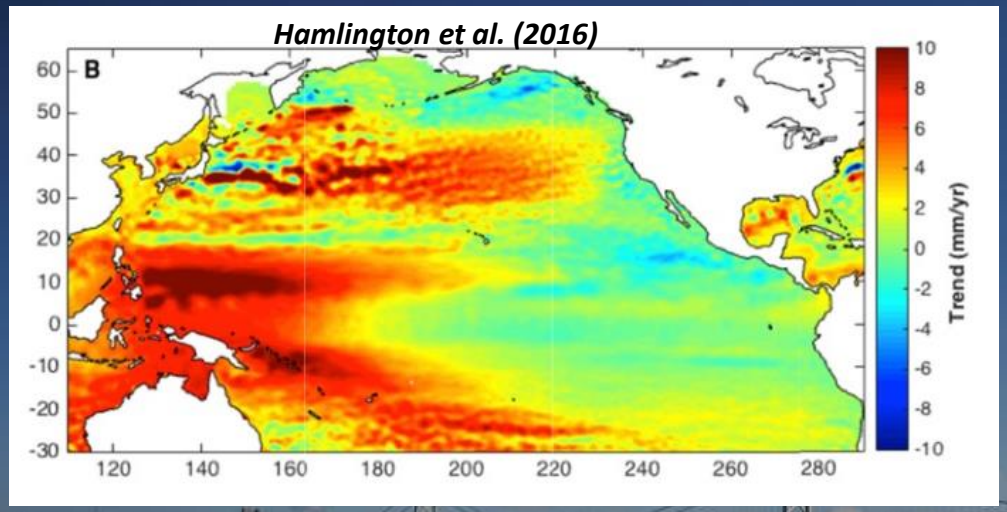

Sunset Beach, Mark Rightmire

Newport Beach, August 31, 2011 (L.A. Times)

Newport Beach, August 31, 2011 (Patch.com)

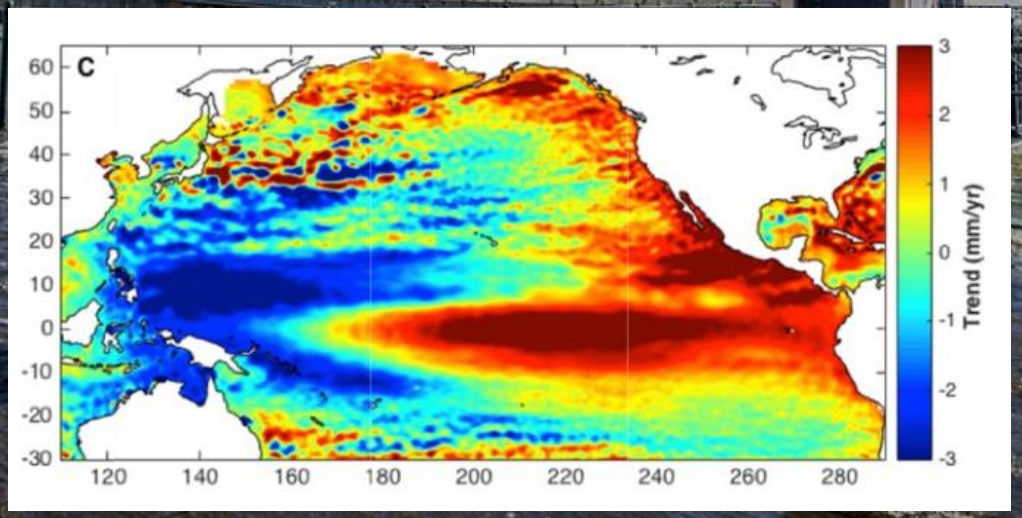
Recent Sea Level Rise

Hamlington et al. (2016)



1993-2011

2011-2015



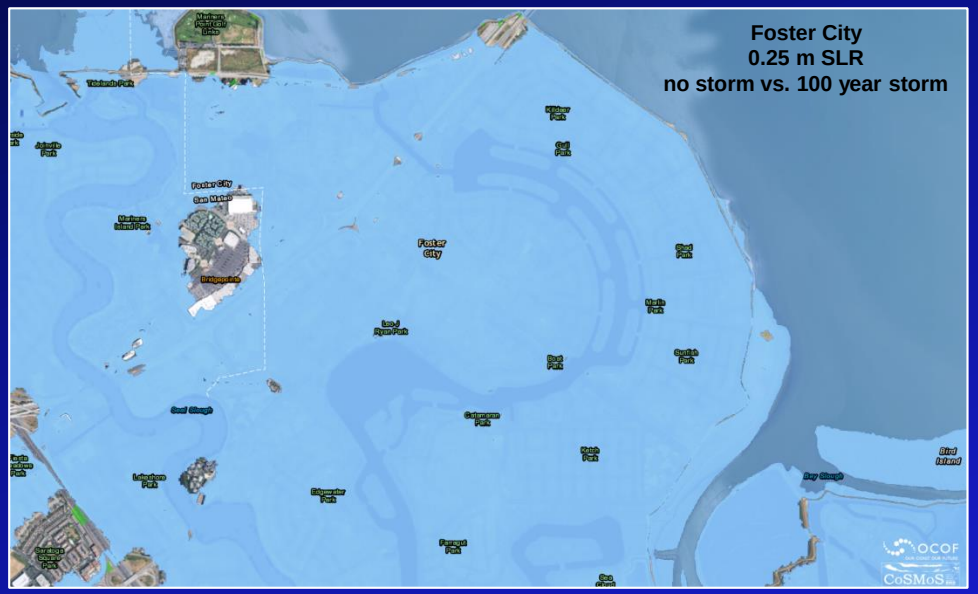
How Big is the Problem?

- Over 1 billion people are expected to live in the coastal zone by 2050
- 27 million people presently live in CA coastal counties
- Over 600,000 people in CA exposed to flooding by the end of the century, in addition to over $150 billion in property at risk
  - 500,000 employees
  - 5,400 km (3,400 mi) of roads
  - 177 schools
  - 87 fire and police stations
  - 126 medical facilities (incl. 3 hospitals)
- Exposure by 2100 is over ~$1 trillion dollars (assuming 2% inflation), ~6% of CA GDP
- Socioeconomic exposure can increase up to a factor of seven when storms are considered

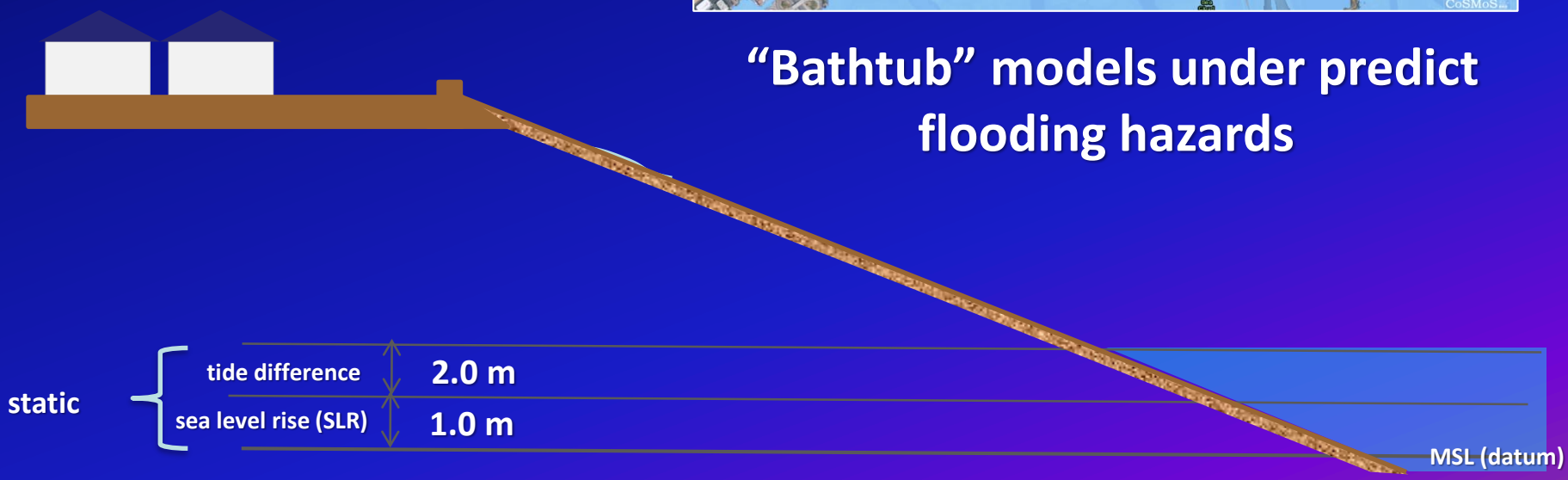
Coastal Vulnerability Approaches

Static

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



"Bathtub" models under predict flooding hazards



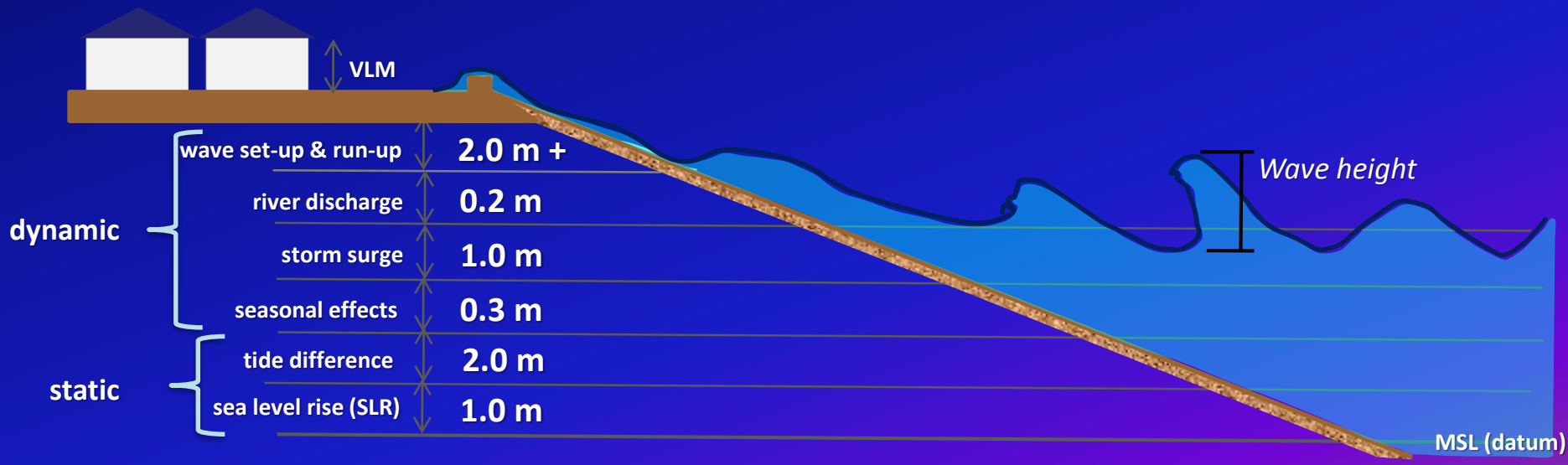
Coastal Vulnerability Approaches

Static

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

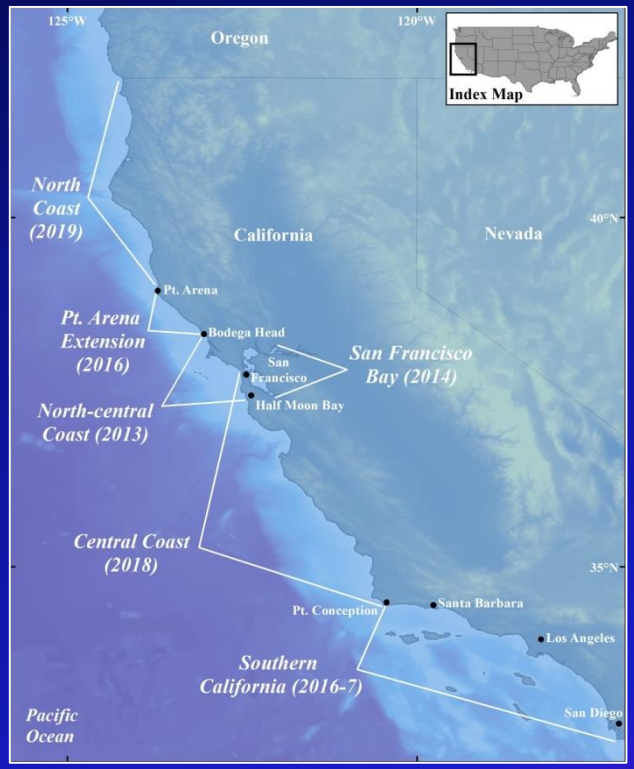
Dynamic: USGS-CoSMoS

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



CoSMoS: A Tool for Coastal Resilience

- **Physics-based numerical modeling system for assessing coastal hazards due to climate change**
- **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**
- **Developing coastal vulnerability tools in collaboration with federal, state, and city governments to meet their planning and adaptation needs**



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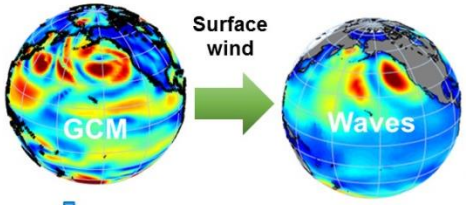
CoSMoS Framework

Global Scale

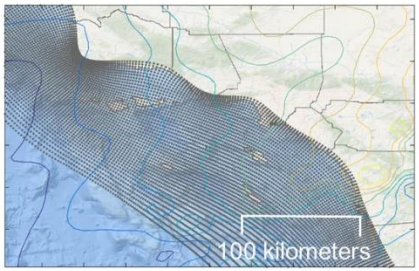
Deep water wave generation and propagation using climate change influenced future winds.



Downscaled winds and atmospheric pressures

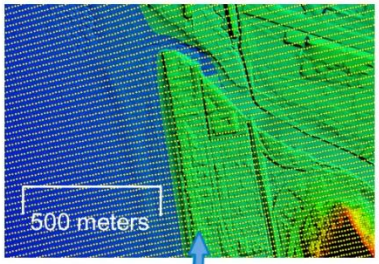
Regional Scale

Swell propagation, wave generation, storm surge, and astronomic tides.



Local Scale

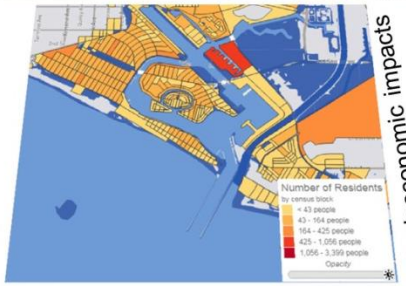
High-resolution hydrodynamics: nearshore waves, wave setup and runup, storm surge, tides, overland flow, fluvial discharge.



Long-term cliff recession and shoreline change

Web-based tools for data visualization and analysis

Flood maps



Socioeconomic impacts

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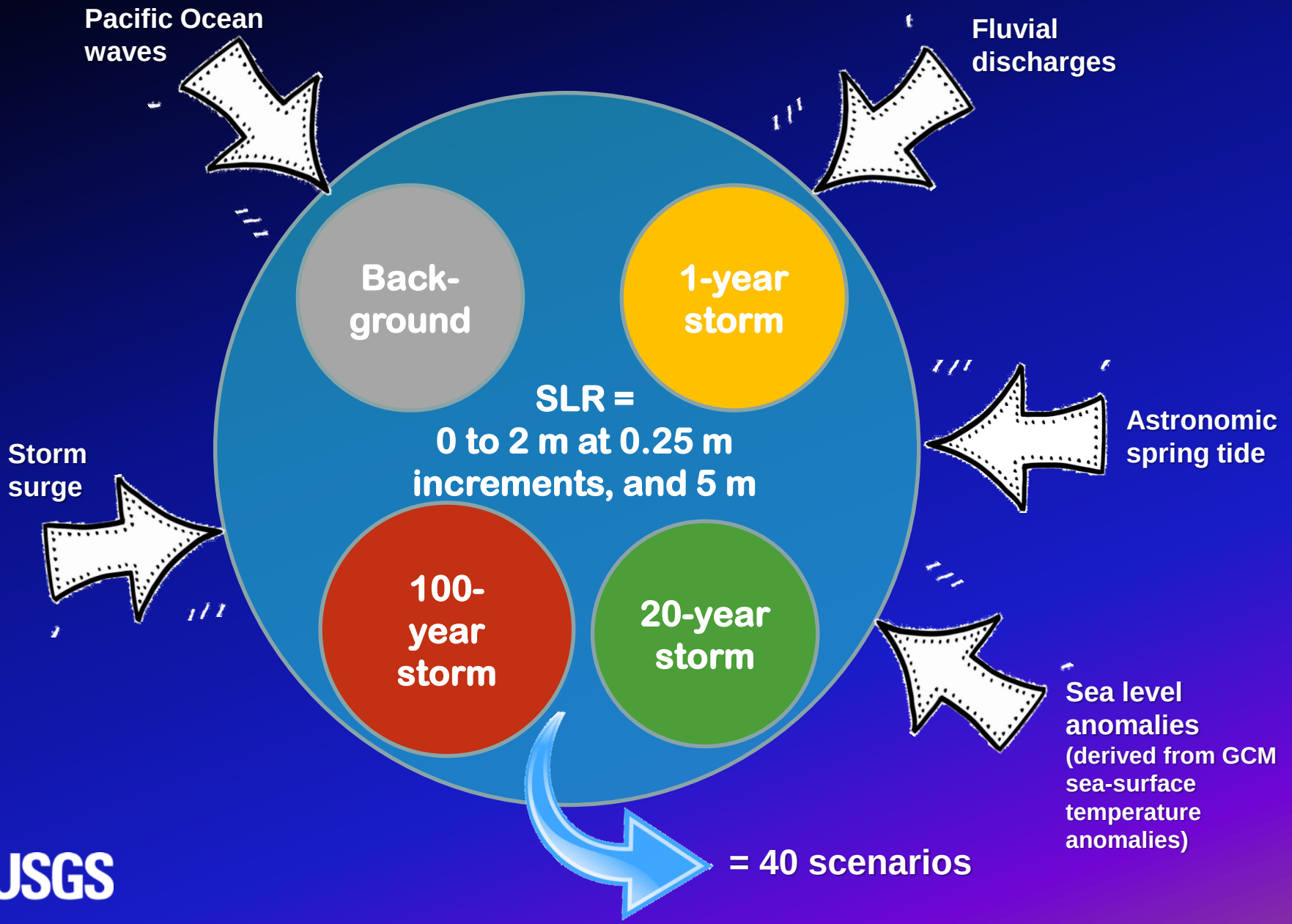
CoSMoS Scenarios



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Web Tool – Future Flooding

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

Web Tool – Future Flooding

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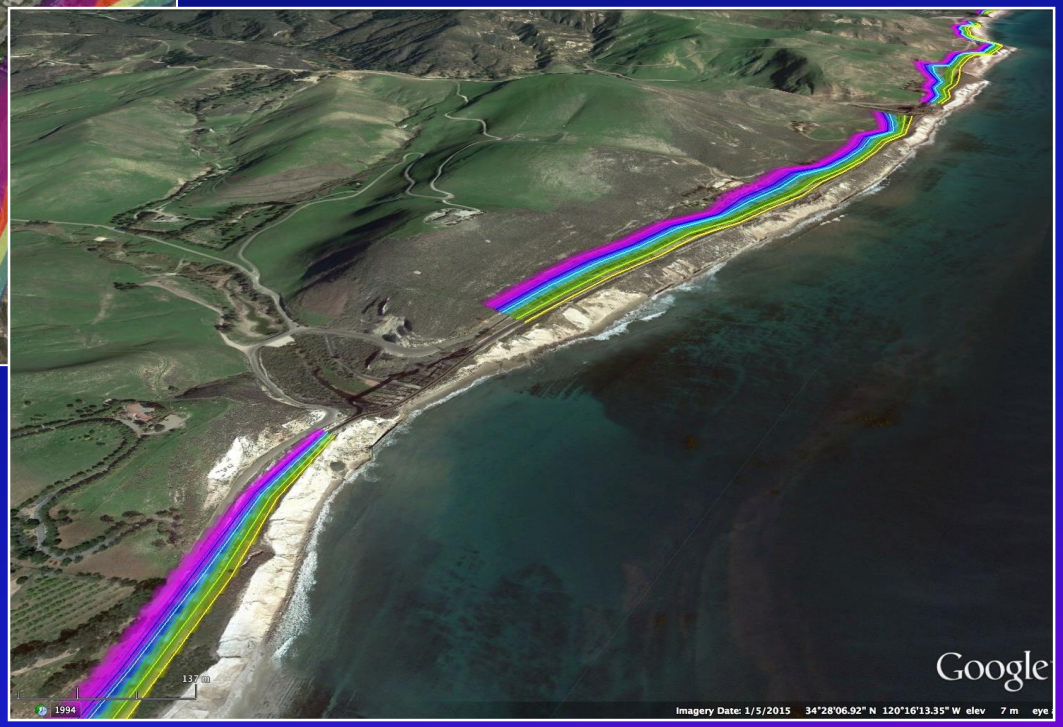
Cliff Retreat Projections



Cliff retreat rates could double over historical rates by 2100.

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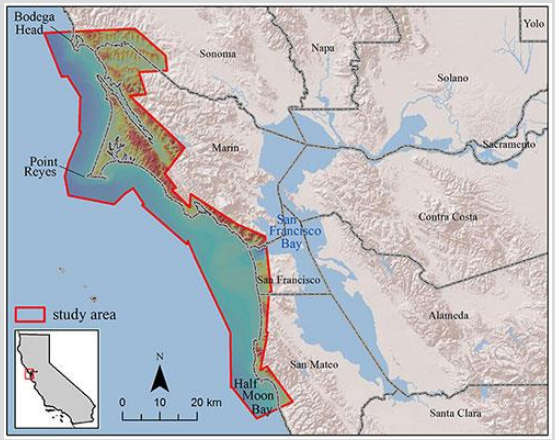
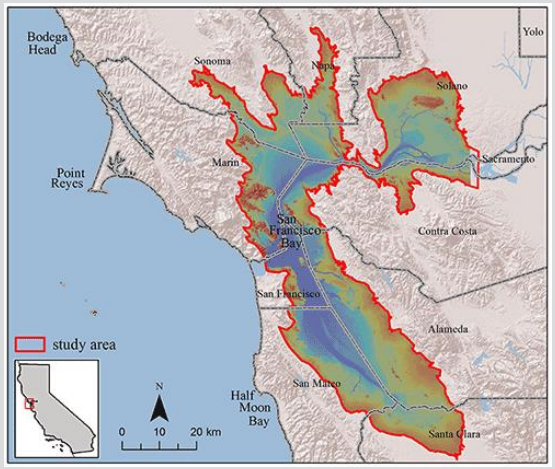
GIS-Based Exposure to Hazards

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

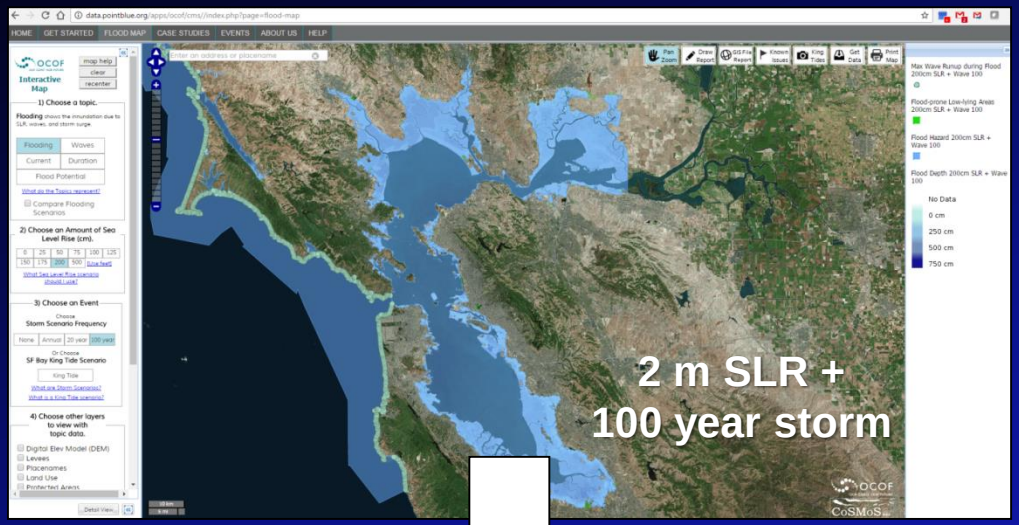
FLOODING EXTENT based on:

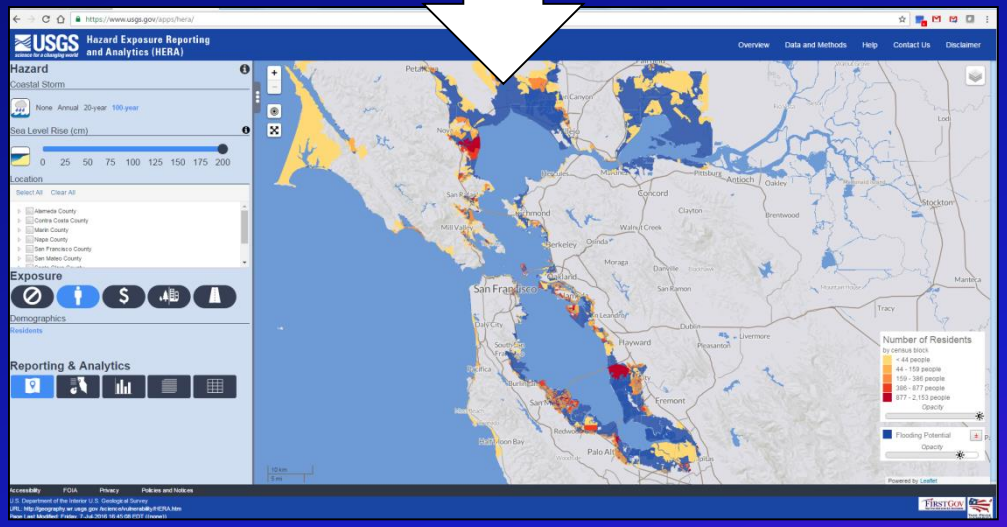
STORM FREQUENCY
None
Annual
20-year
100-year

SEA LEVEL RISE SCENARIOS

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

Coastal Climate Impacts by 2100





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California

- 600,000+ residents
- $150 billion in property
- 5,400 km of roads
- 390 critical facilities (e.g., schools, police stations, hospitals)

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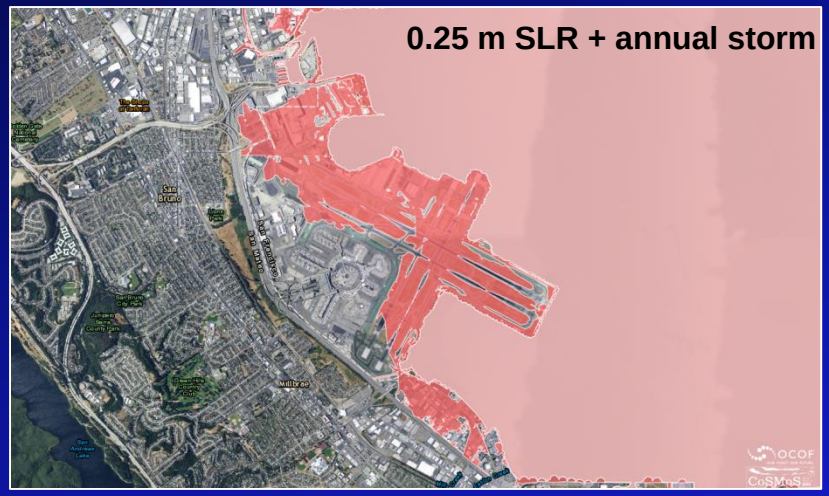
Hazards Exposure Reporting and Analytics (HERA)
www.usgs.gov/apps/hera

CoSMoS Coastal Storm Modeling System USGS

Transportation Highlights

- San Francisco, Oakland, and San Diego airports susceptible to major flooding by mid-century
- Major roadways particularly vulnerable in San Diego, Orange, L.A. and Bay Area counties
- For 1 m of SLR, ~1500 km (900 mi) of roadways could be permanently flooded, and an additional 70% under an extreme storm scenario
- Miles of roadways susceptible to coastal flooding today in a 100-year storm event could increase over ten-fold to 5,400 km (3,400 miles) by 2100
- Caltrans is currently conducting climate vulnerability assessments across the state based on CoSMoS projections



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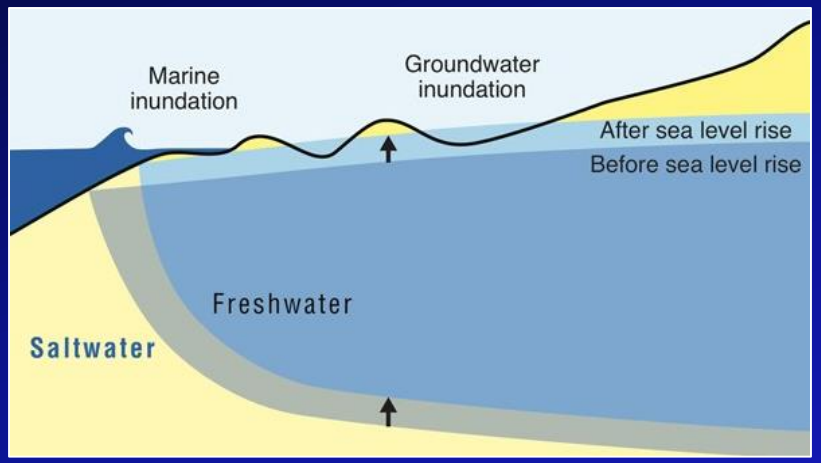
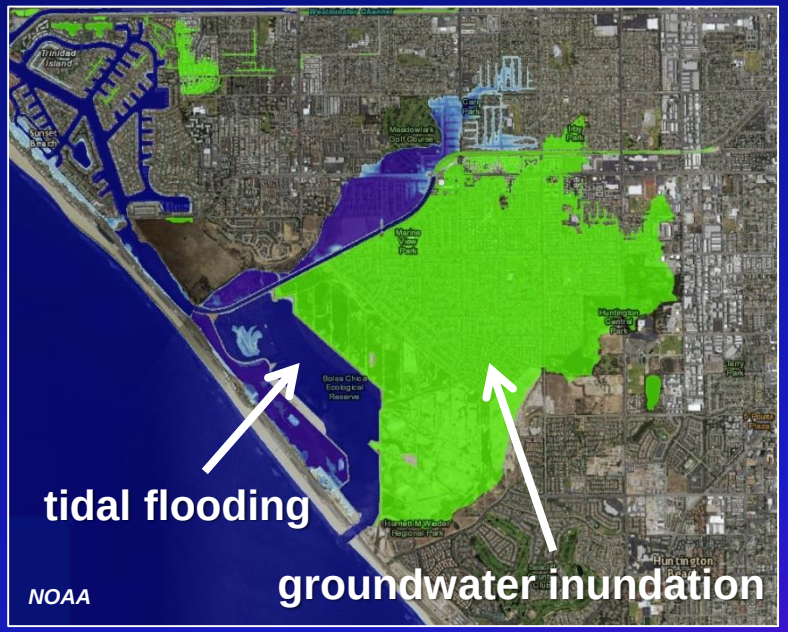
Groundwater Impacts

- **Major issues**
  - **Inundation**
  - **Shallower coastal groundwater**
  - **Saltwater intrusion**





- **Groundwater inundation**
  - **May exceed overland flooding and happen much sooner**
  - **Low-lying areas most vulnerable**

***USGS will deliver statewide maps in late 2018**

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Report Citation:

Erikson, L.H., Barnard, P.L., O'Neill, A.C., Limber, P.W., Vitousek, S., Finzi-Hart, J., Hayden, M., Jones, J., Wood, N., Fitzgibbon, M., Foxgrover, A.C. and Lovering, J., 2018. Assessing and communicating the impacts of climate change on the Southern California Coast. *California's Fourth Climate Assessment*, Report #CCCA4-CNRA-2018-013, California Natural Resources Agency, 81pp., http://www.climateassessment.ca.gov/techreports/docs/20180827-Ocean_CCCA4-CNRA-2018-013.pdf

*For more information, contact Patrick Barnard: *pbarnard@usgs.gov*

USGS CoSMoS data:

http://walrus.wr.usgs.gov/coastal_processes/cosmos/

Our Coast - Our Future tool: *www.ourcoastourfuture.org*

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

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CoSMoS USGS science for a changing world

CoSMoS End-Users

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 Harbor
- San Diego County

State

- California Coastal Commission
- California Coastal Conservancy
- California Office 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 End-Users

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)

USGS

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