

# Climate-related challenges along the U.S. West Coast

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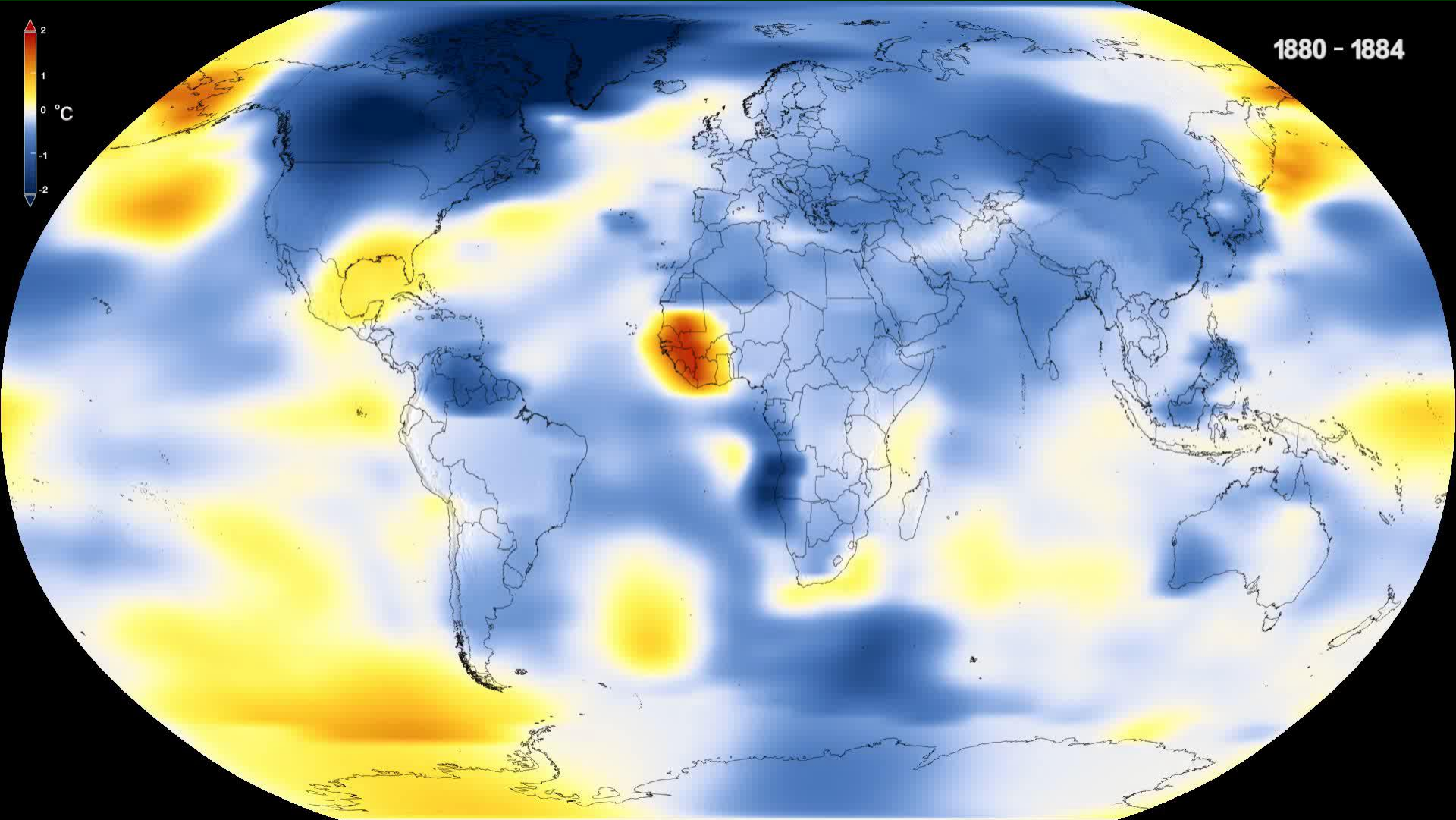
**Coastal and Marine Hazards and Resources Program**

**Pacific Coastal and Marine Science Center**

**Santa Cruz, CA**

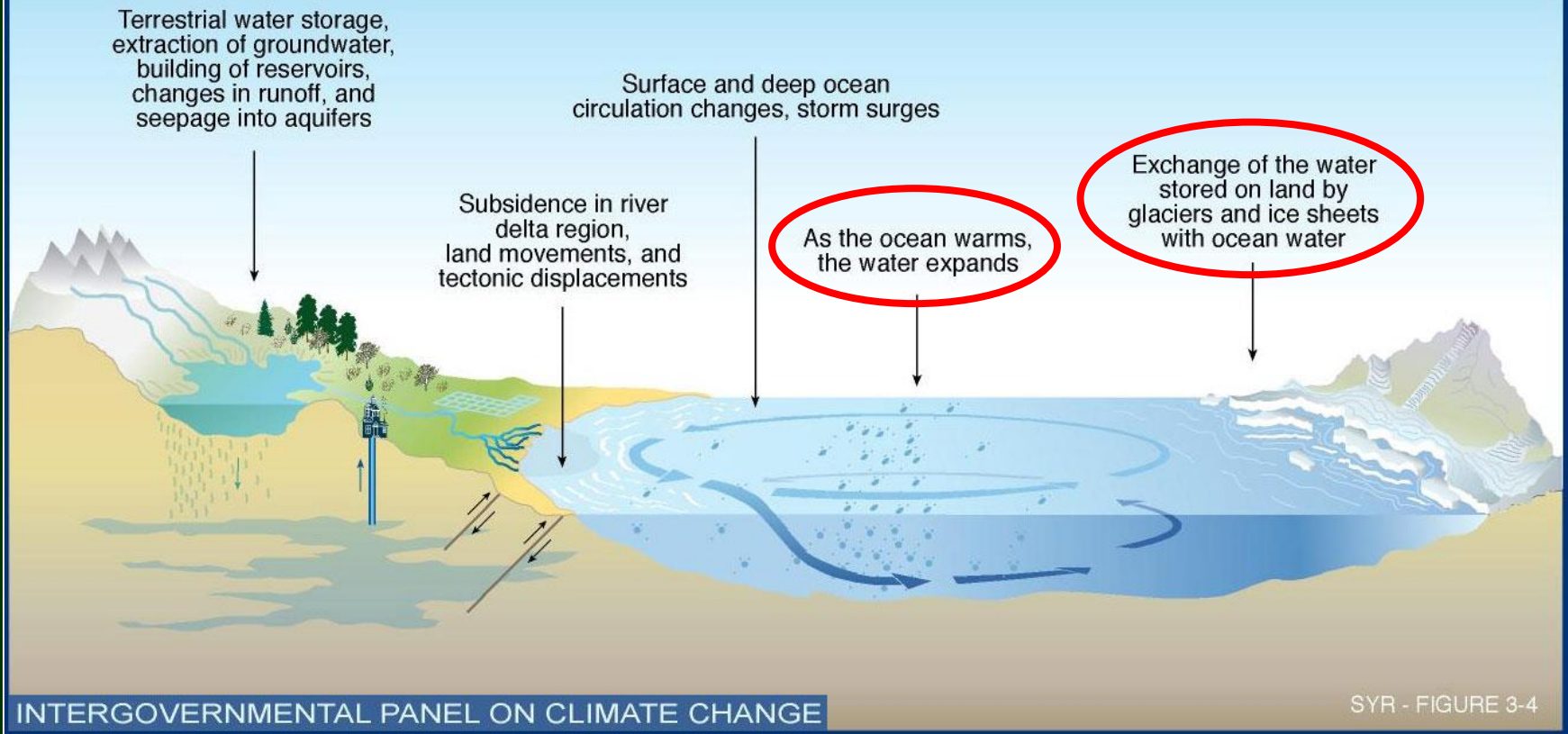
U.S. Department of the Interior  
U.S. Geological Survey

# Temperature Observations



# Sea Level Rise 101

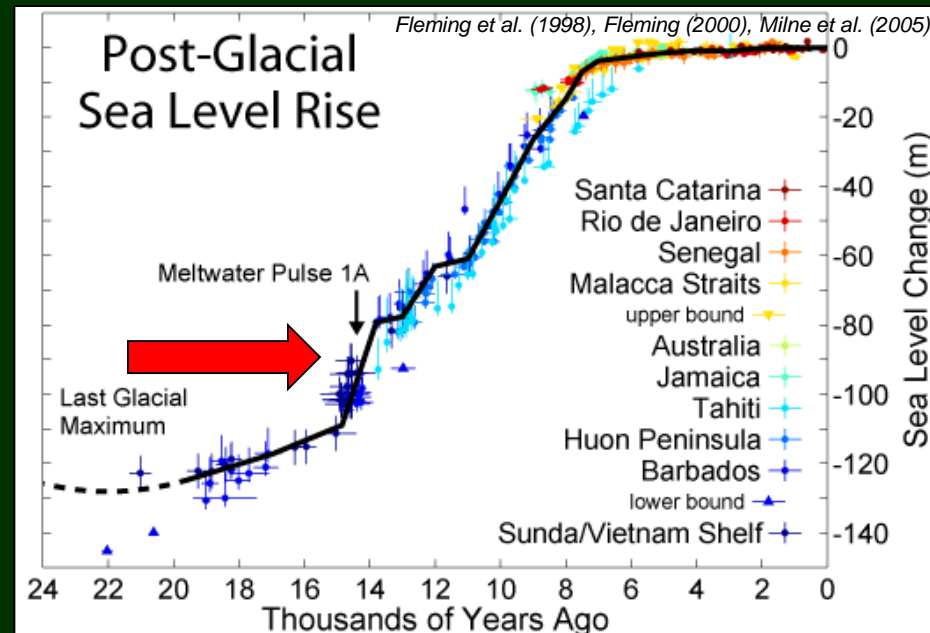
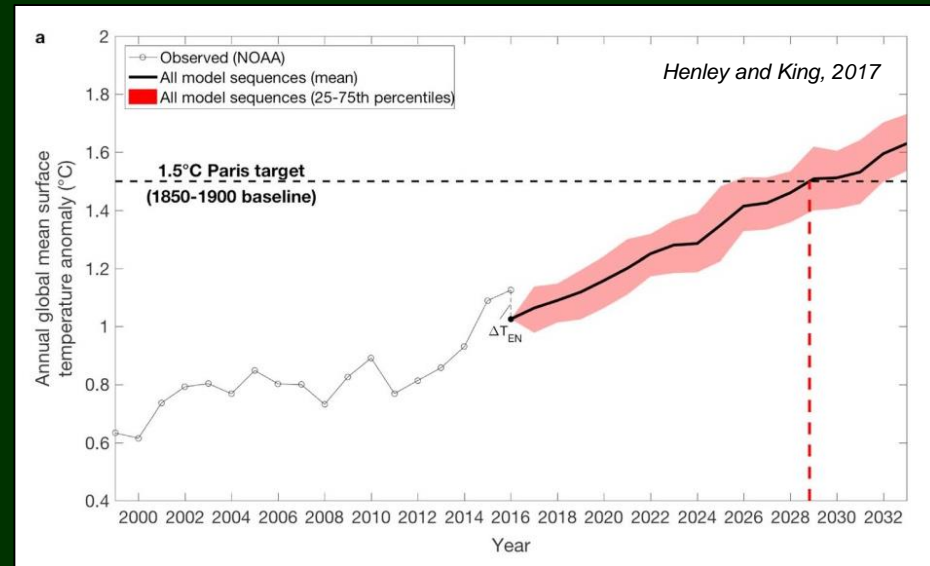
## What causes the sea level to change?



\* 230 ft (70 m) of SLR stored in ice sheets of Antarctica, 23 ft (7 m) in Greenland

# Climate Change and Sea Level Rise

- Global temperature projected to hit 1.5°C by ~2030
- 125,000 years ago global temperature was ~2°C warmer but sea level was 26 ft (8 m) higher (Kopp et al., 2009)
- 14,000 years ago sea level rose 16 ft (5 m)/century for 4 centuries
- Median SLR projection of 3 ft by 2100 (10 ft max)





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



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







Huntington Beach Pier, CA, January 1983  
(H. Lorren Au Jr., Orange County Register)







Capitola, CA, March 2014 (Sabine Dukes)



Santa Cruz, CA, January 2017 (Nick Moless)





South SF Bay, CA (Mark Taylor)



*Puget Sound, WA, December 17, 2012 (C. Mass)*

# How Big is the Problem?

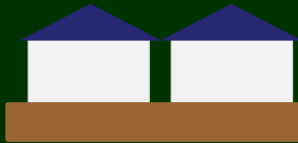
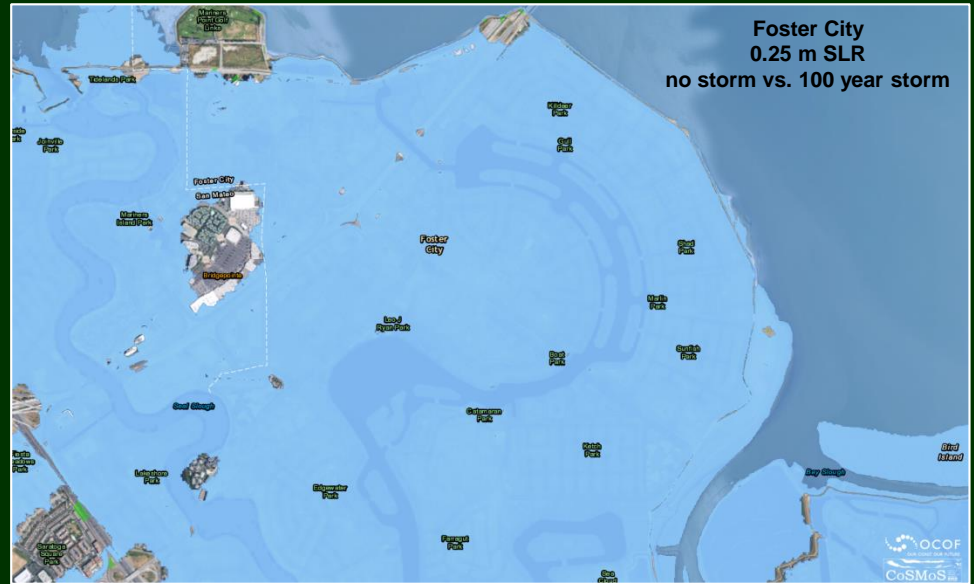
- Climate change, including sea level rise, changing wave climates, and storms will place additional stresses on coastal systems worldwide
- Over 1 billion people are expected to live in the coastal zone by 2050 (Merkens et al. 2016)
- Along the U.S. West Coast
  - 32 million people presently live in coastal counties
  - 0.5 to 1.4 million people will be exposed to daily flooding by 2100
  - When considering storms and coastal change, ~3 times more people would be at risk
  - Annual property risk could range from \$50-180 billion by 2100



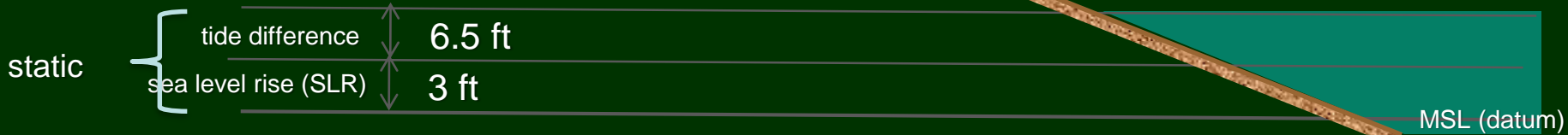
# Coastal Vulnerability Approaches

## Static

- Passive models
- Tides only
- '1<sup>st</sup> order screening tool'



“Bathtub” models under predict flooding hazards





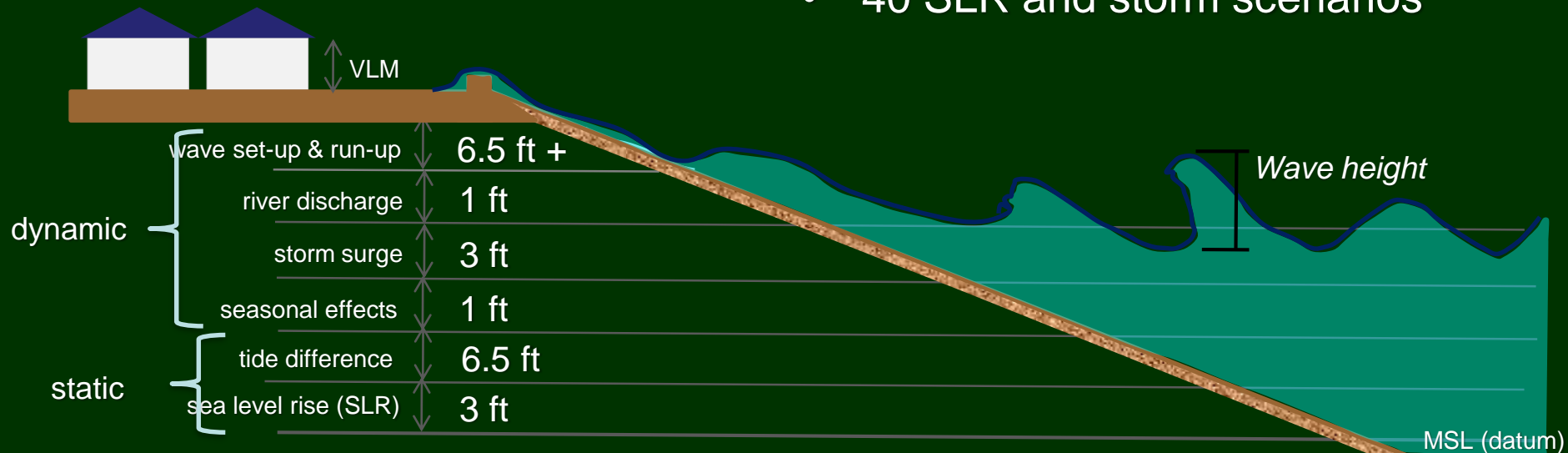
# Coastal Vulnerability Approaches

## Static

- Passive models
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## Dynamic: USGS Coastal Storm Modeling System (CoSMoS)

- All physics modeled
- Uses latest Global Climate Models
- Includes wind, waves, atmospheric pressure, shoreline change
- 40 SLR and storm scenarios



# How vulnerable are we?

200,000-600,000 people in CA could be exposed to flooding by the end of the century, in addition to \$40-150 billion in property (2-6% of GDP)...

- 500,000 employees
- 177 schools
- 87 fire and police stations
- 126 medical facilities



# CoSMoS Flooding Projections

HOME GET STARTED FLOOD MAP CASE STUDIES EVENTS ABOUT US HELP

OCOF OUR COAST OUR FUTURE  
Interactive Map  
map help  
clear  
navigate

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  
SF Bay King Tide Scenario  
 King Tide  
What are Storm Scenarios?  
What is a King Tide scenario?

4) Choose Shoreline Change (Southern California only)  
 Cliffs  Shoreline Position  
And Choose  
Management Options  
"Hold the Line"  yes  no  
Beach nourishment  yes  no

Enter an address or placename  
Alameda Park  
15 -119.6739 34.4299

Alameda Park  
Ortega Park  
Santa Barbara  
El Paseo  
Paseo Nuevo  
Mission Creek  
Sohnetti Park  
Thornbury Park  
Santa Barbara Gay College  
West Beach  
Santa Barbara Harbor  
Purshing Park  
West Beach  
Santa Barbara Zoo  
Santa Barbara Zoo  
Dwight Murphy Field  
Gabriels Park  
Palm Park  
East Beach  
West Beach  
Santa Barbara Harbor  
East Beach  
Butterfly Beach  
Montecito Country Club  
Montecito  
Santa Barbara Cemetery  
Andree Clark Bird Refuge

Pan Zoom  
Draw Report  
GIS File Report  
Known Issues  
King Tides  
Get Data  
Print Map

200 m  
1000 ft

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CoSMoS

Our Coast, Our Future tool: [www.ourcoastourfuture.org](http://www.ourcoastourfuture.org)



...but also key components of  
our energy infrastructure...



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Flooding	Waves
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[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 SF Bay King Tide Scenario

King Tide

Detail View

Enter an address or placename

15 -122.135 38.0283

Pan Zoom Draw Report GIS File Report Known Issues King Tides Get Data Print Map

Mococo

Waterfront Park

Martinez Susana Park Rieka Park

OCOF CoSMoS

Our Coast, Our Future tool: [www.ourcoastourfuture.org](http://www.ourcoastourfuture.org)

...and dozens of water treatment facilities...

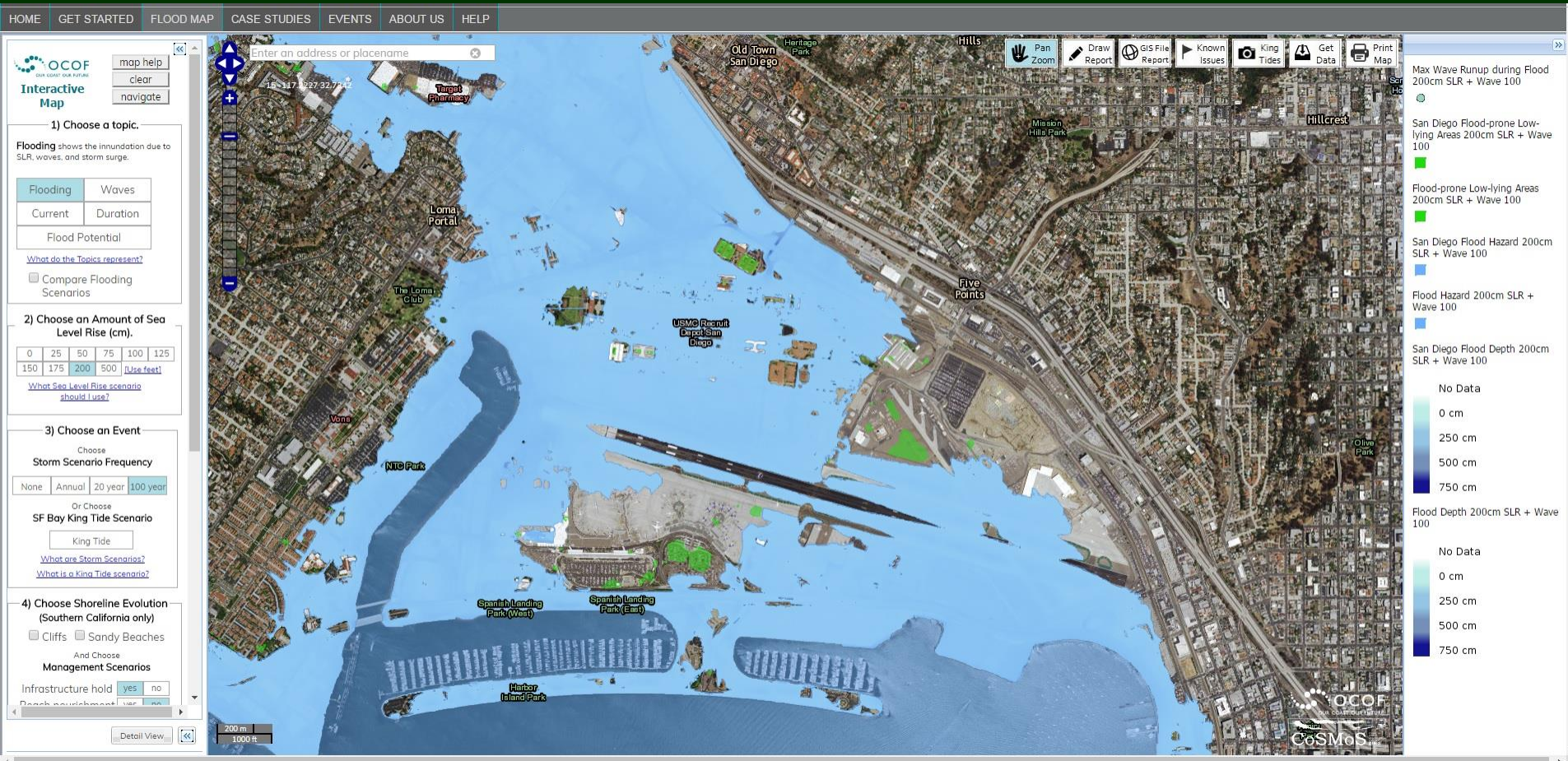


Hyperion Wastewater Treatment Plant (Doc Searls)

...3 major international airports...



# CoSMoS Flooding Projections



Our Coast, Our Future tool: [www.ourcoastourfuture.org](http://www.ourcoastourfuture.org)





...1000's of miles of roads...





...2 of the 3 largest ports  
in the country...

An aerial photograph of a large port complex, likely the Port of Los Angeles or Long Beach. The image shows a dense network of piers extending into a dark blue body of water. Numerous ships, including large container vessels and smaller cargo ships, are docked at the piers. The port area is filled with industrial structures, cranes, and storage yards. In the background, a city with a grid street pattern is visible, along with some greenery and hills. The overall scene depicts a major hub of maritime trade.

...2 of the 3 largest ports  
in the country...

...numerous DoD facilities...



# ...large expanses of tech sector...

**OCOF**  
OUR COAST OUR FUTURE  
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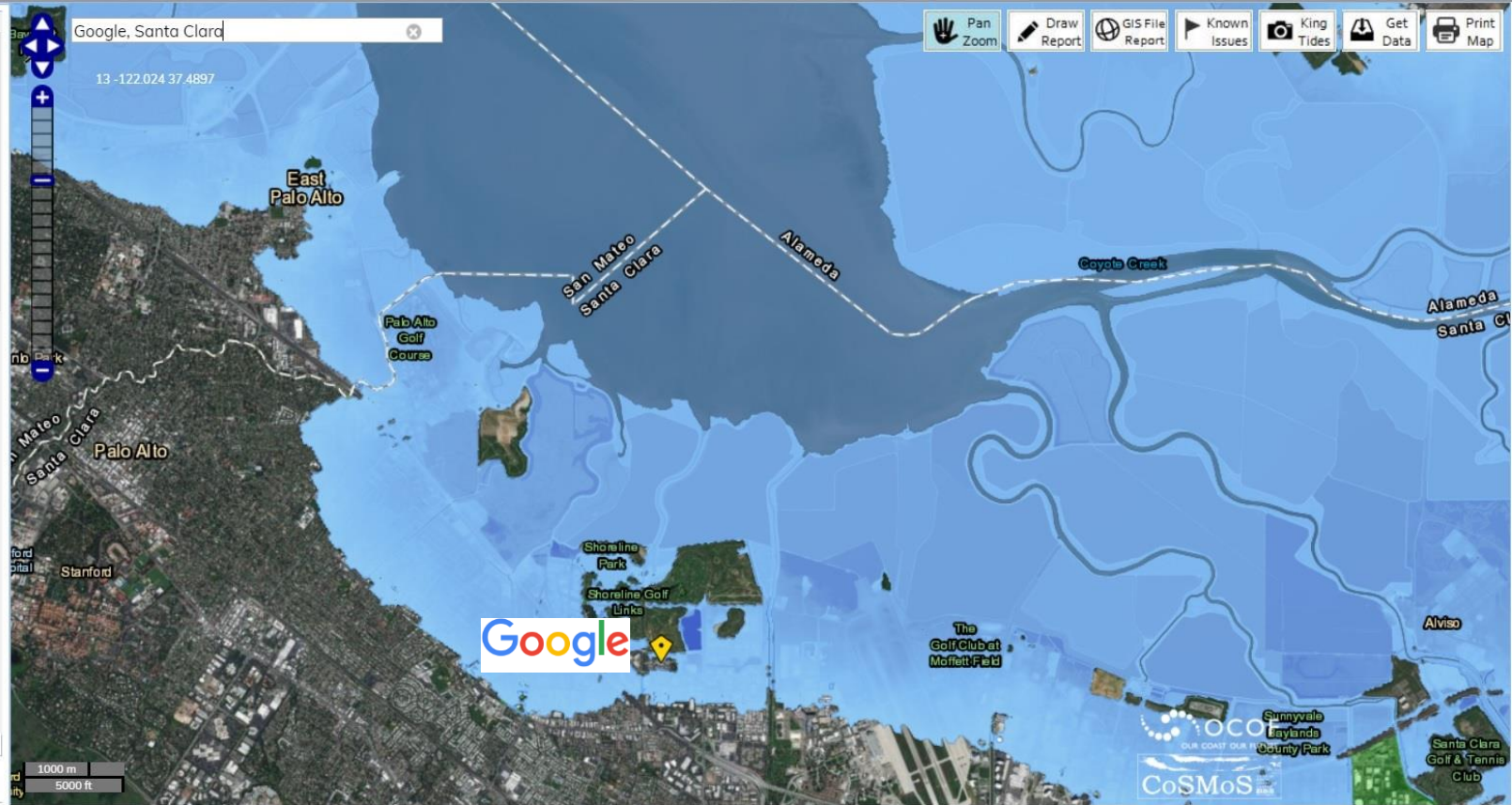
3) Choose an Event

Choose Storm Scenario Frequency

None	Annual	20 year	100 year
------	--------	---------	----------

Or Choose SF Bay King Tide Scenario

Detail View





Goleta County Beach, CA, March 9, 2016

- Rising sea levels will drive shorelines further inland, increasing physical and economic impacts



Capitola Beach, CA, January 10, 2017



Santa Cruz, CA, December 1, 2019

- In southern California, 33-67% of beaches could be lost

**> 70% loss of  
upper beach  
habitats by 2050  
+ loss of wetland  
habitats**

*-Myers et al., 2019*



*Western Snowy Plover (N. Bowdich)*



**Cliff retreat rates could double**



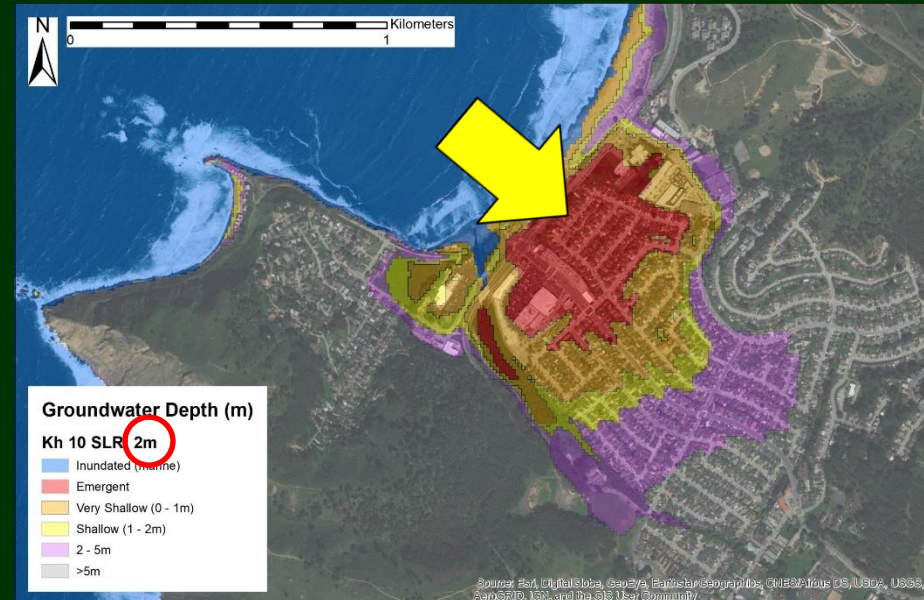
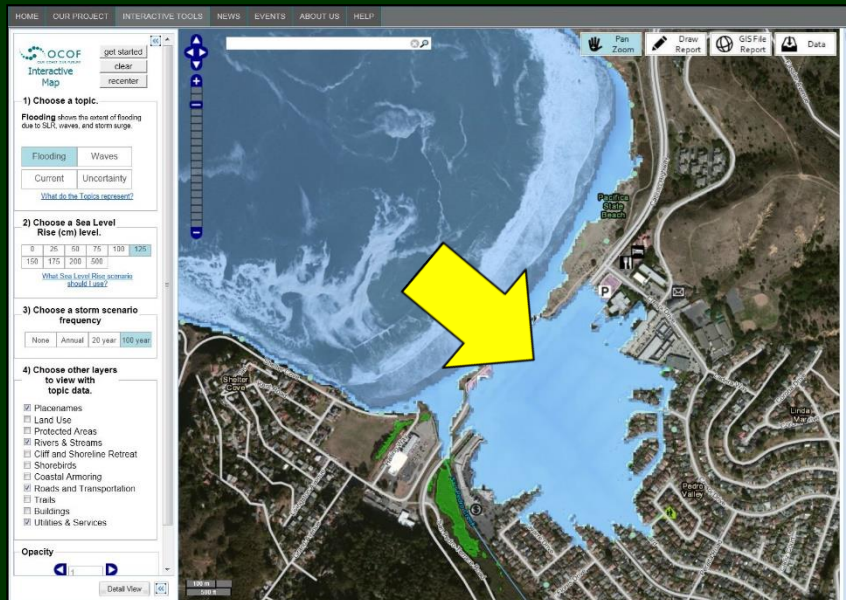
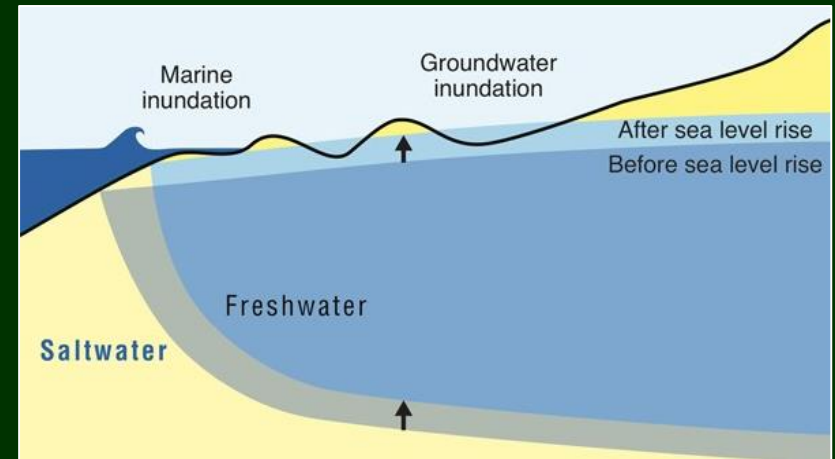
# CoSMoS Cliff Retreat Projections





# Coastal Groundwater Response to SLR

- Major issues
  - Emergence/Inundation
  - Shallower coastal groundwater
  - Saltwater intrusion, major hazard for agriculture



# Future Work

- Building out coastal hazards approach for the Pacific Northwest and SE Atlantic (incl. groundwater)
- USGS coastal hazards science will continue to inform climate policy and adaptation solutions

\*Projections show vulnerabilities with existing infrastructure

For more information, contact Patrick Barnard: [pbarnard@usgs.gov](mailto:pbarnard@usgs.gov)

CoSMoS website: [www.usgs.gov/cosmos](http://www.usgs.gov/cosmos)

Visualization tool: [www.ourcoastourfuture.org](http://www.ourcoastourfuture.org)

Socioeconomic exposure tool: [www.usgs.gov/apps/hera](http://www.usgs.gov/apps/hera)





# Who uses CoSMoS?

## Federal

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

## 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

## County

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

# Who uses CoSMoS?

## City

- **City of San Francisco**
- City of Pacifica
- **City of San Jose**
- City of Santa Cruz
- 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)

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