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science for a changing world

Projected Climate Change Impacts to the Los Angeles and Ventura County Coastline

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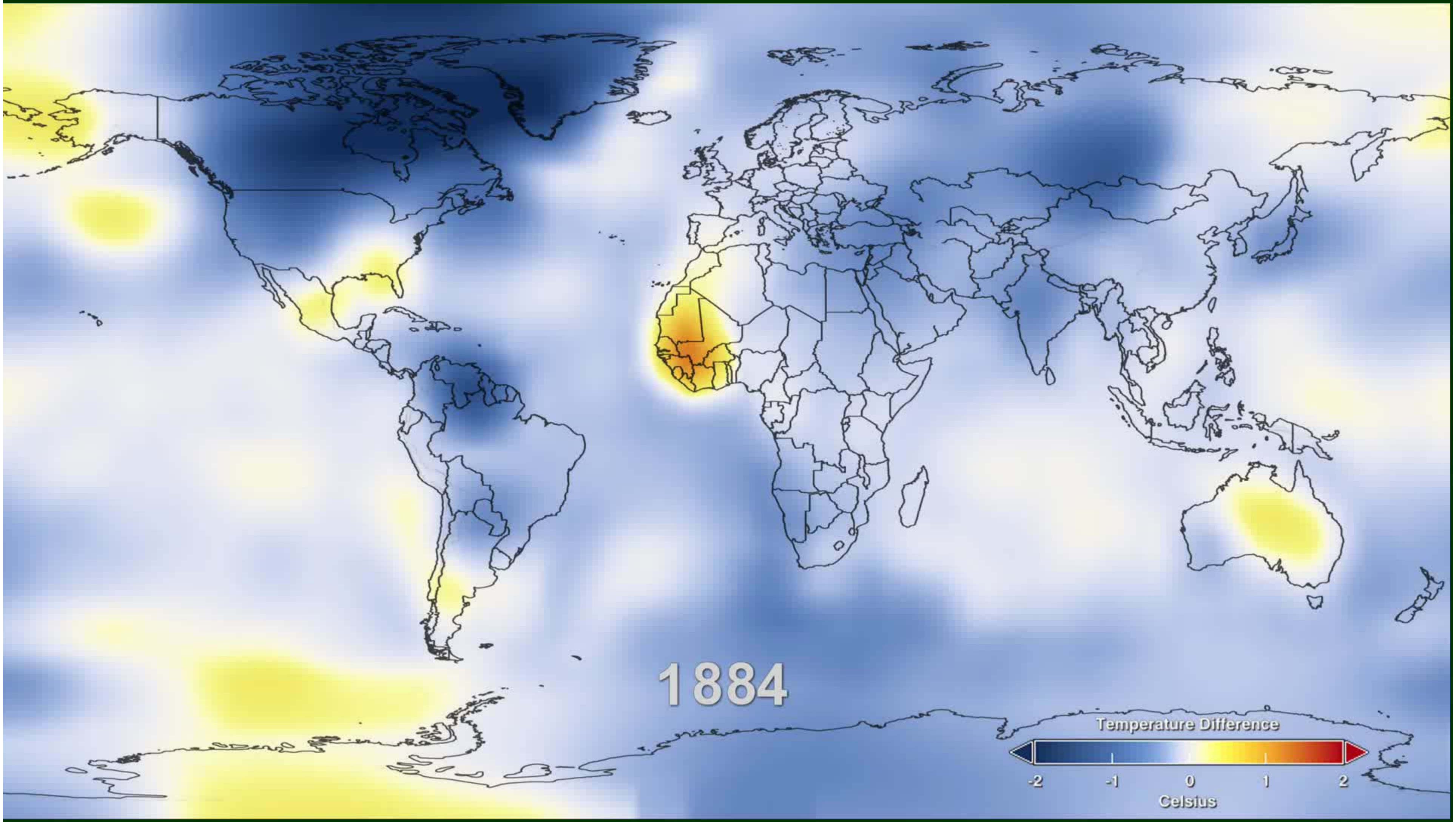
CoSMoS Coastal Storm Modeling System USGS

Santa Monica Pier, January 1983 (Paul Silhavy)

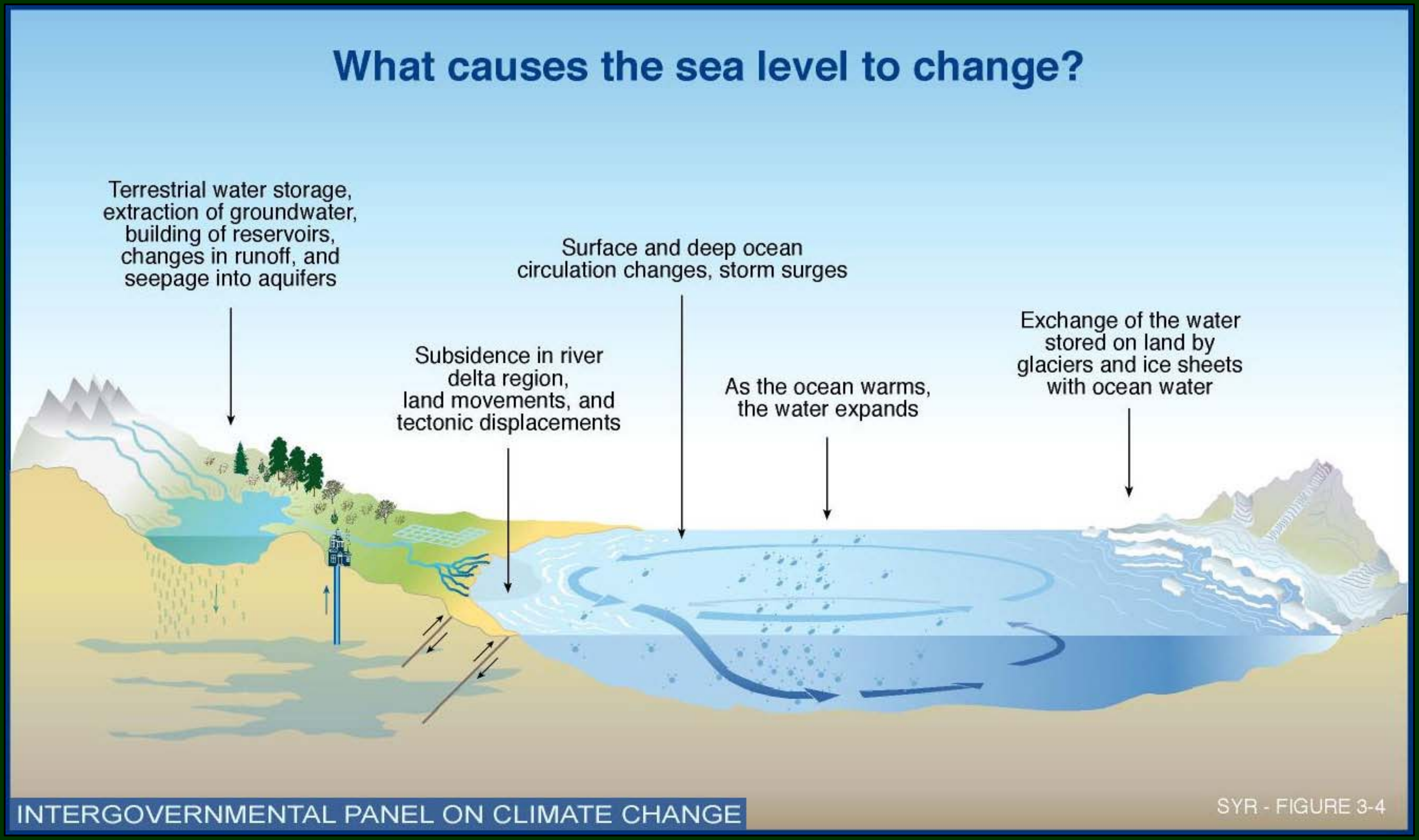
Temperature Change



NASA Goddard Institute for Space Studies

http://www.nasa.gov/multimedia/videogallery/index.html?media_id=129395671

Sea Level Rise 101



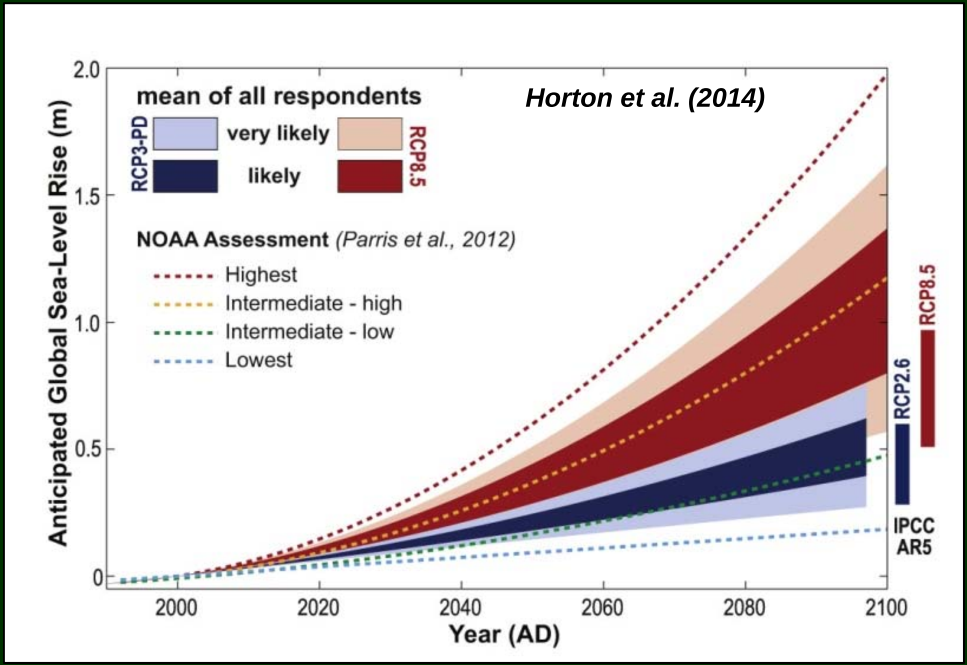
Other factors

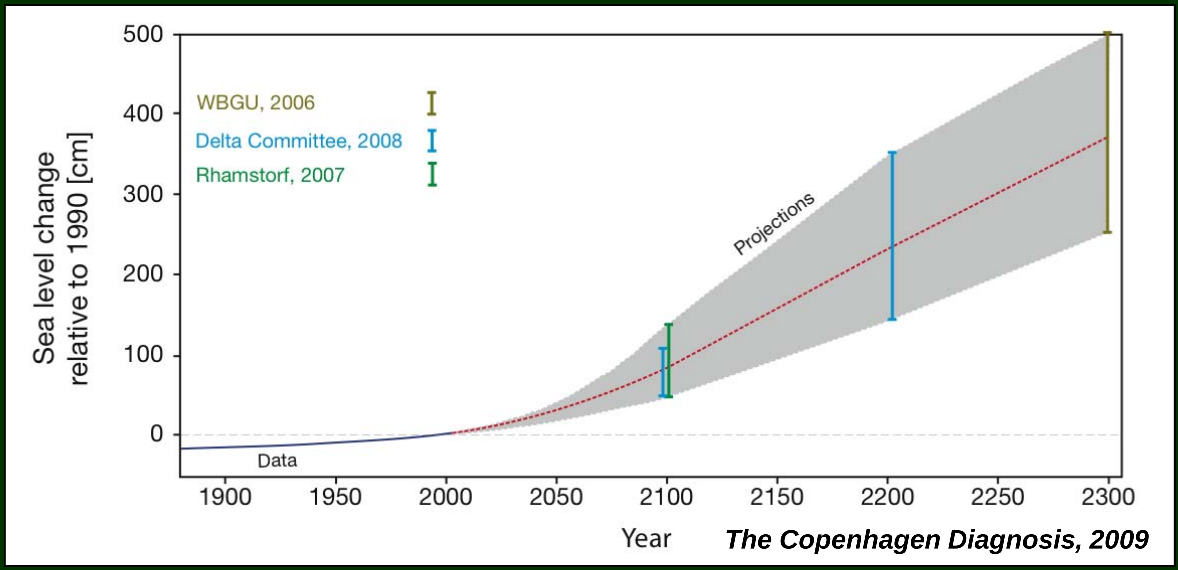
- Ocean basin configuration (geologic time scales)
- Wind patterns (hours to decades)
- Tidal (hours to decades)
- Storms (hours to days)

***Global SLR is accelerating**

- 20th century = 2 mm/yr
- 1993-present = 3 mm/yr

Sea Level Rise Beyond 2100





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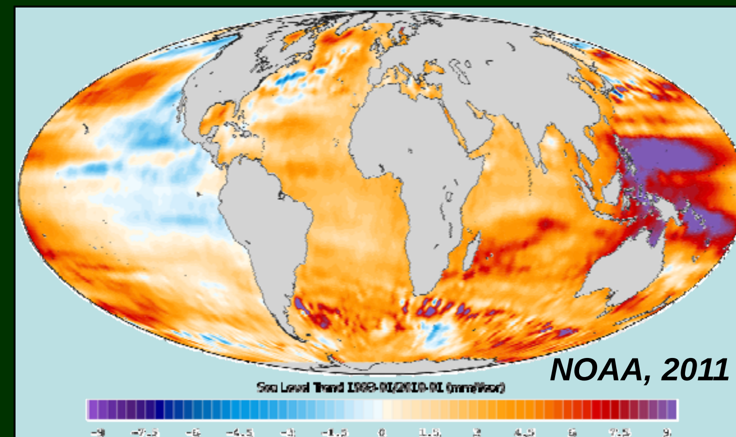
21st Century Projections for Southern California

SLR for Los Angeles (National Research Council)

-28 cm of sea level rise by 2050 (range 13-61 cm)
-93 cm of sea level rise by 2100 (range 44-167 cm)
-includes global and regional effects


NOAA, 2011

Waves

-No significant changes in wave height
-More southerly wave directions

El Niño

-More frequent extreme events
-Wave energy increase by 30%
-Water level increase by 20-30 cm
-Doubling of winter erosion

Santa Monica Pier, January 1983 (Paul Silhavy)

Net effect

-Today's 100-year coastal flooding event is projected to occur every 1-5 years by 2050 for much of California
-Greatest impacts on low-lying coastal areas (e.g., Oxnard Plain, Venice)

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Coastal Impact of Projected Climate Trends

- **Accelerated beach erosion rates**
- **Greater incidence of cliff failures**
- **Landward translation of coastal flooding and inundation**
- **More dangerous navigation conditions**
- **Beach/shore safety more often compromised**
- **Saltwater intrusion into coastal aquifers**

La Jolla, CA- Jan 2010 (A. Young)


Shore & Beach, 1989

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Societal Impacts

- **Coastal flooding from SLR alone could displace ~200 million people by 2100**
- **Nationally, $1.4 trillion of coastal property could be at risk at high tide by the end of the century**
- **500,000 people, one million jobs, and $100 billion in property are threatened by climate change along the California coast over the next century**
- **In L.A. and Ventura Counties: 30,000 people and $6 billion in property at risk (not inclu. river discharge, waves, coastal change, changes in storms, etc.)**
- **1982-83 El Niño storms caused ~$2.2 billion in storm damage to California, $1.1 billion in 1997-98**

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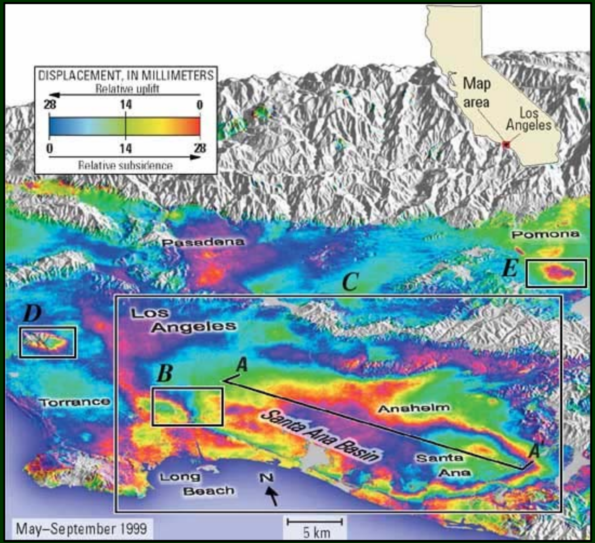
Coastal Vulnerability Considerations

•Global factors:
- Eustatic sea level

•Regional factors:
- Ocean circulation patterns
- Glacial fingerprinting
- Tectonics (large-scale)
- Isostasy

•Local factors:
- Subsidence
- Local tectonic deformation
- Fluvial discharge AND sediment supply changes
- Development and restoration

•Seasonal and storm impacts:
- Steric effects
- Waves and storm surge
- River discharge



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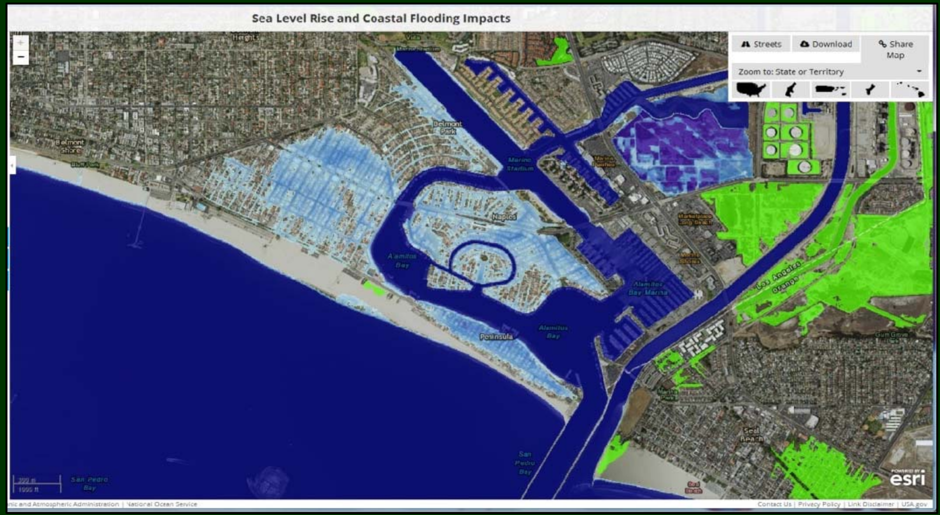
Coastal Vulnerability Approaches

- **<u>STATIC</u>: NOAA SLR Viewer**
  - –Tides only (MHHW)
  - –Excellent elevation data, datum control
  - –‘1st order screening tool’



http://www.coast.noaa.gov/slr/

- **<u>DYNAMIC</u>: CoSMoS**
  - –Tides + storms
  - –Includes wind, waves, river discharge, and vertical land movement rates
  - –Range of SLR and storm scenarios

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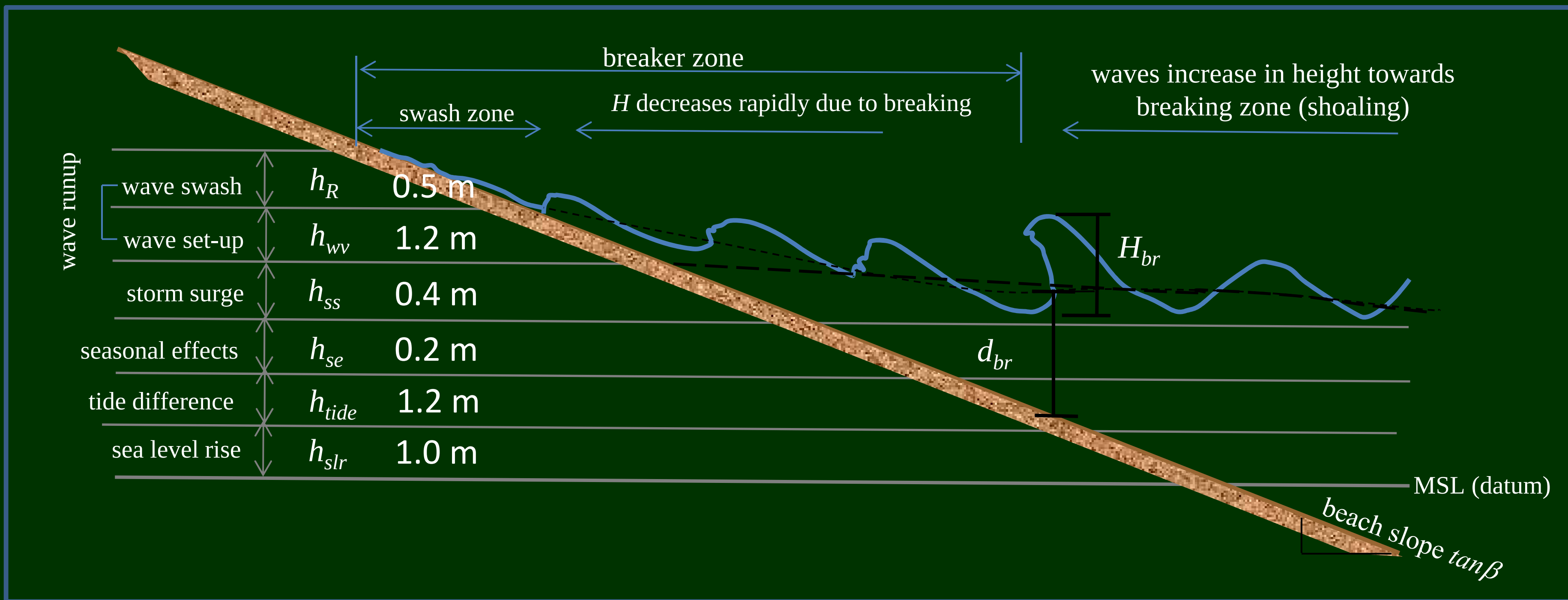
http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Overview of Processes Included in CoSMoS



flood level is the combination of

$$rSLR + tides + seasonal\ effects + storm\ surge + wave\ setup + wave\ runup + fluvial\ discharge\ backflow$$

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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

- 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)


Gary Griggs, UCSC

Brad Graverson, January 2010

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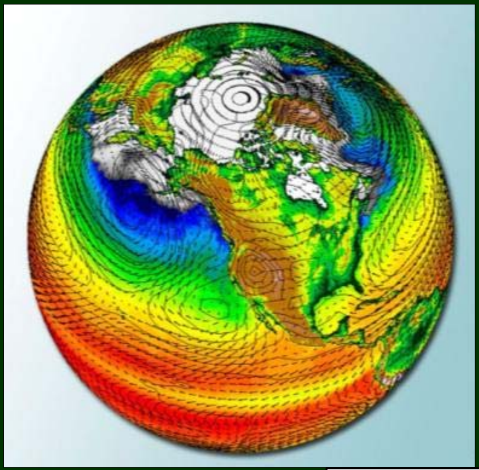
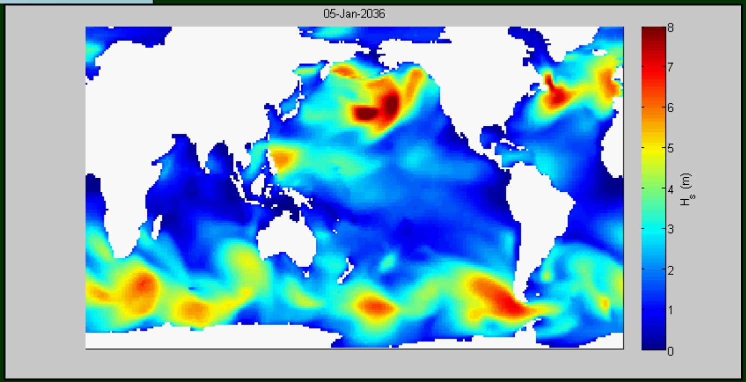
Identifying Future Risk with CoSMoS



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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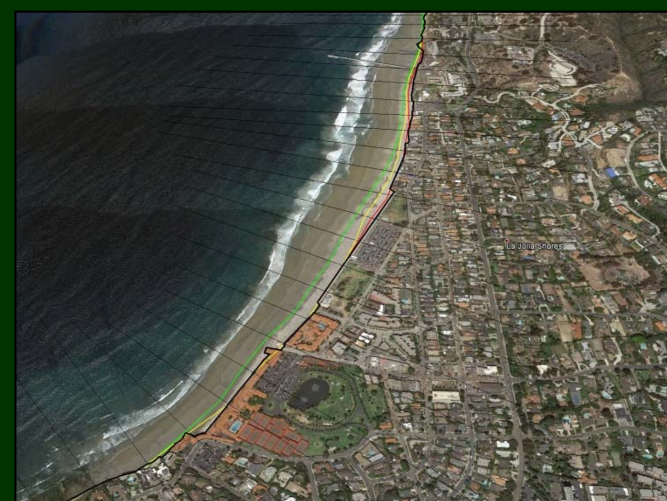
Highlights of CoSMoS 3.0

- **Long-term coastal evolution modeled, including sandy beaches and cliffs**
- **Downscaled winds from GCMs to get locally-generated seas and surge**
- **Discharge from rivers for event response**
- **100 yr storm events in combination with SLR 0 m to 2.0 m in 0.5 m increments delivered Fall 2015**
- **Products: Google Earth and GIS files of flood extent and depth, beach change, cliff retreat, waves and currents**



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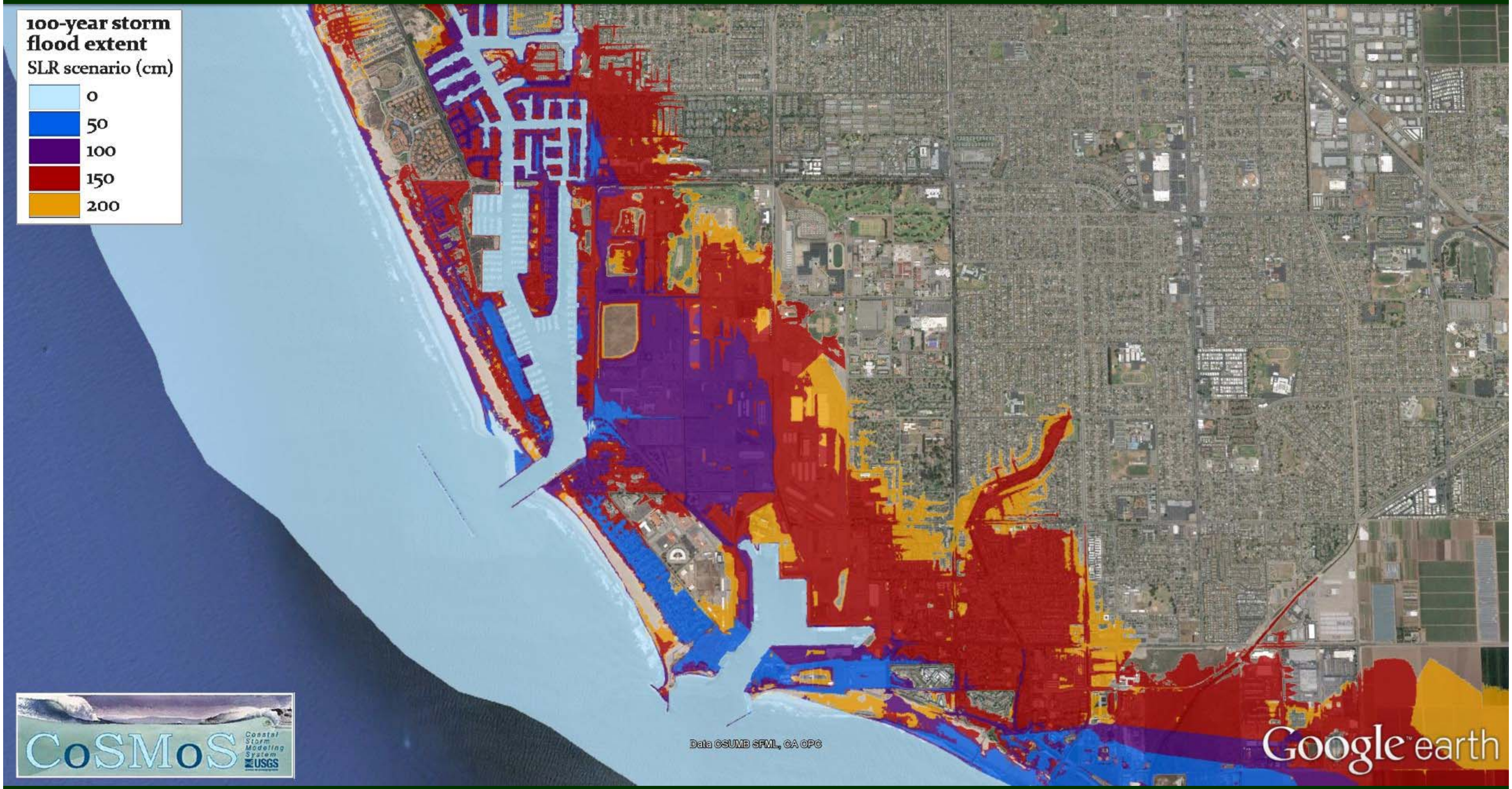
Flooding – Ventura River Mouth

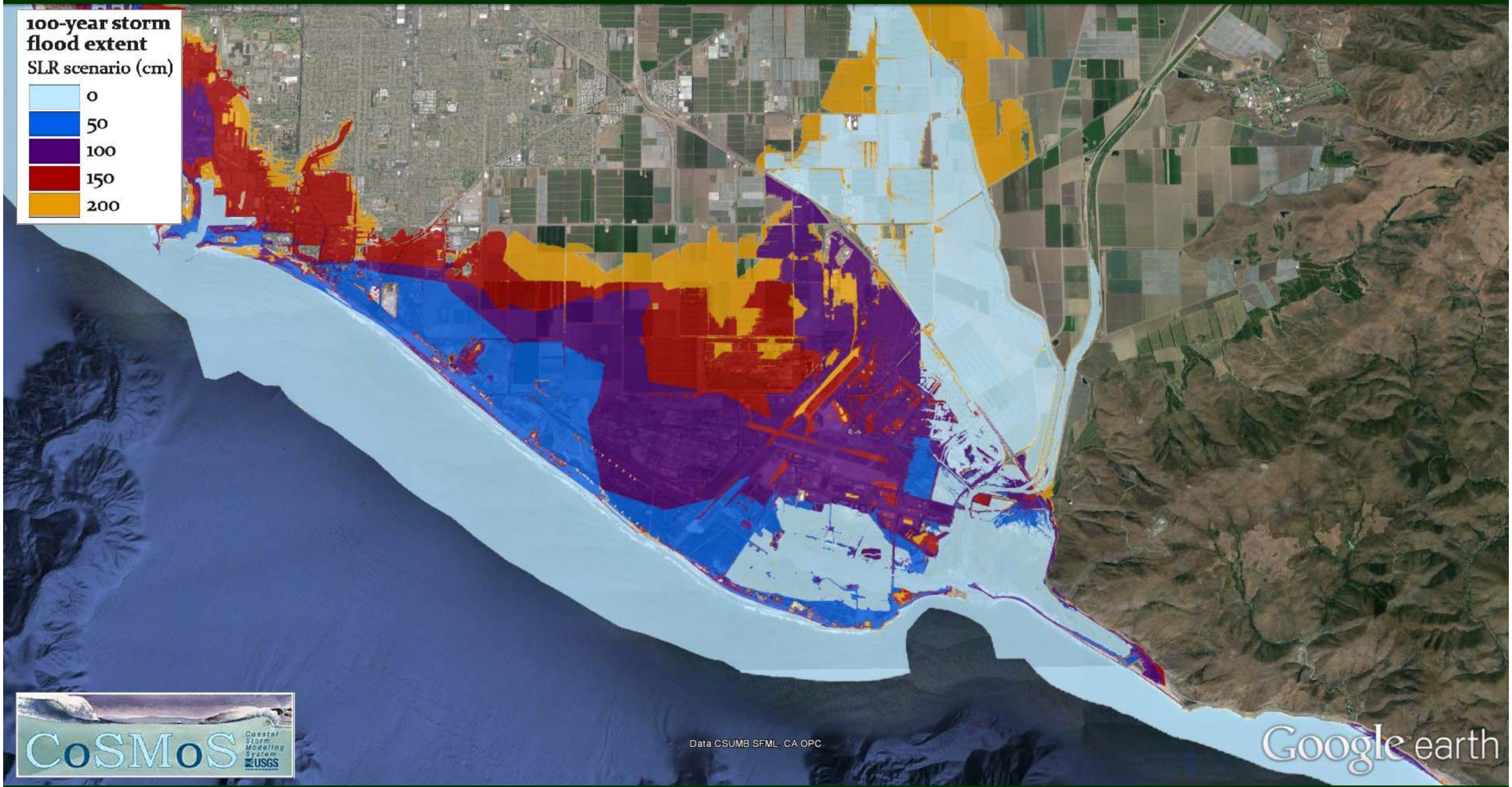
http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Flooding – Channel Islands Harbor



http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Flooding – Mugu

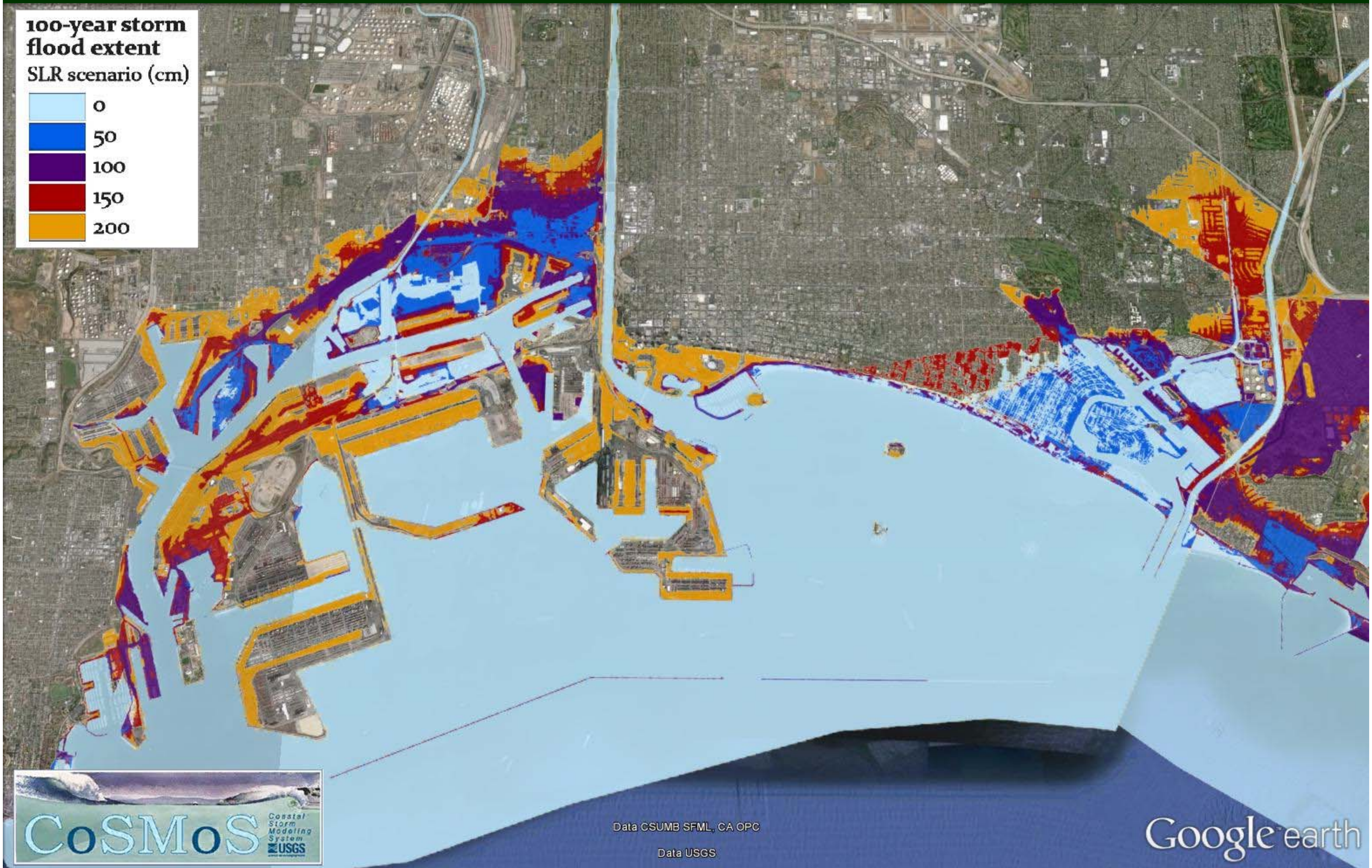


http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Flooding – Venice

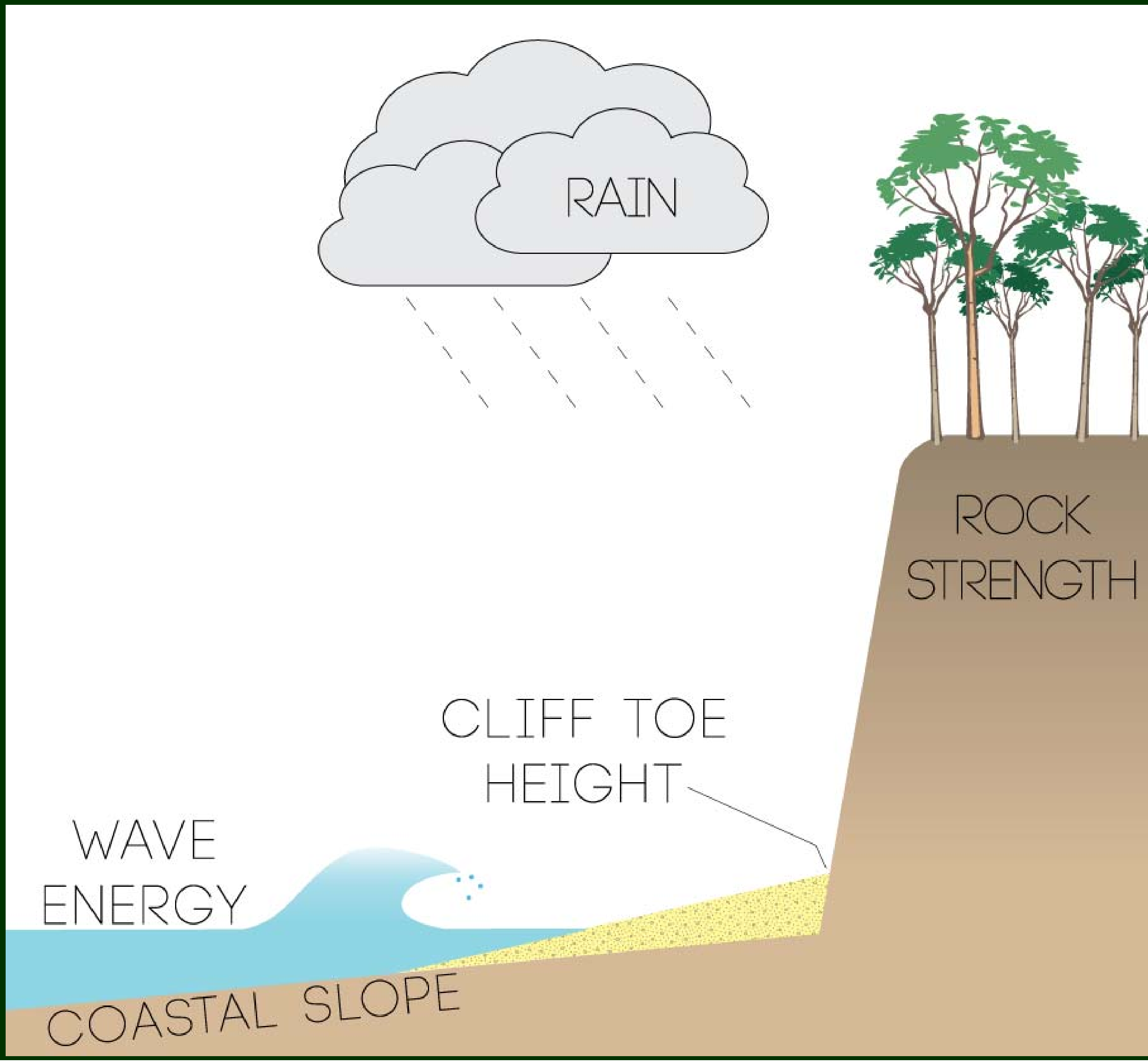
http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Flooding – Port of L.A.



http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html

Factors Driving Sea Cliff Erosion & Retreat

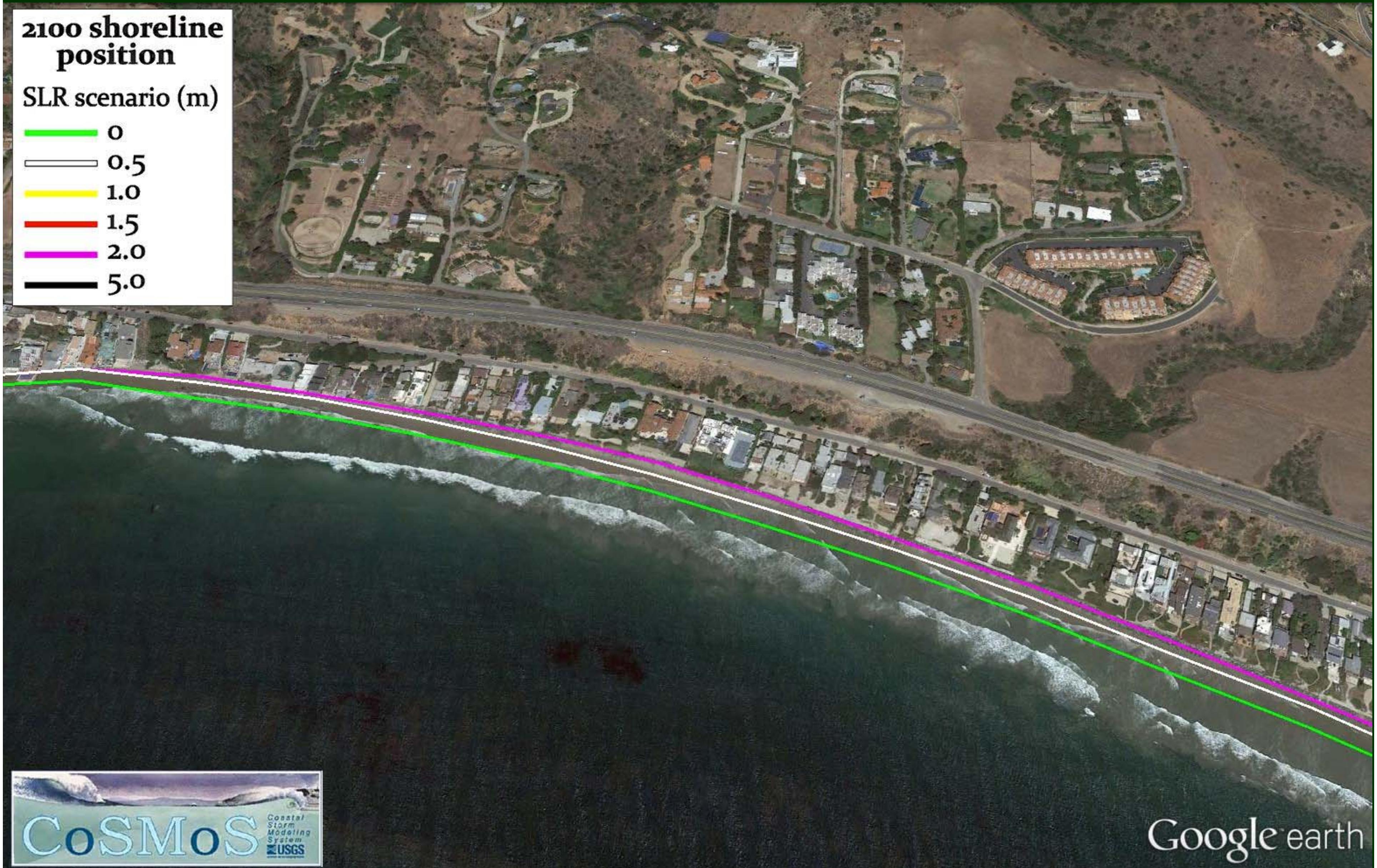


Cliff Retreat- Pt. Dume

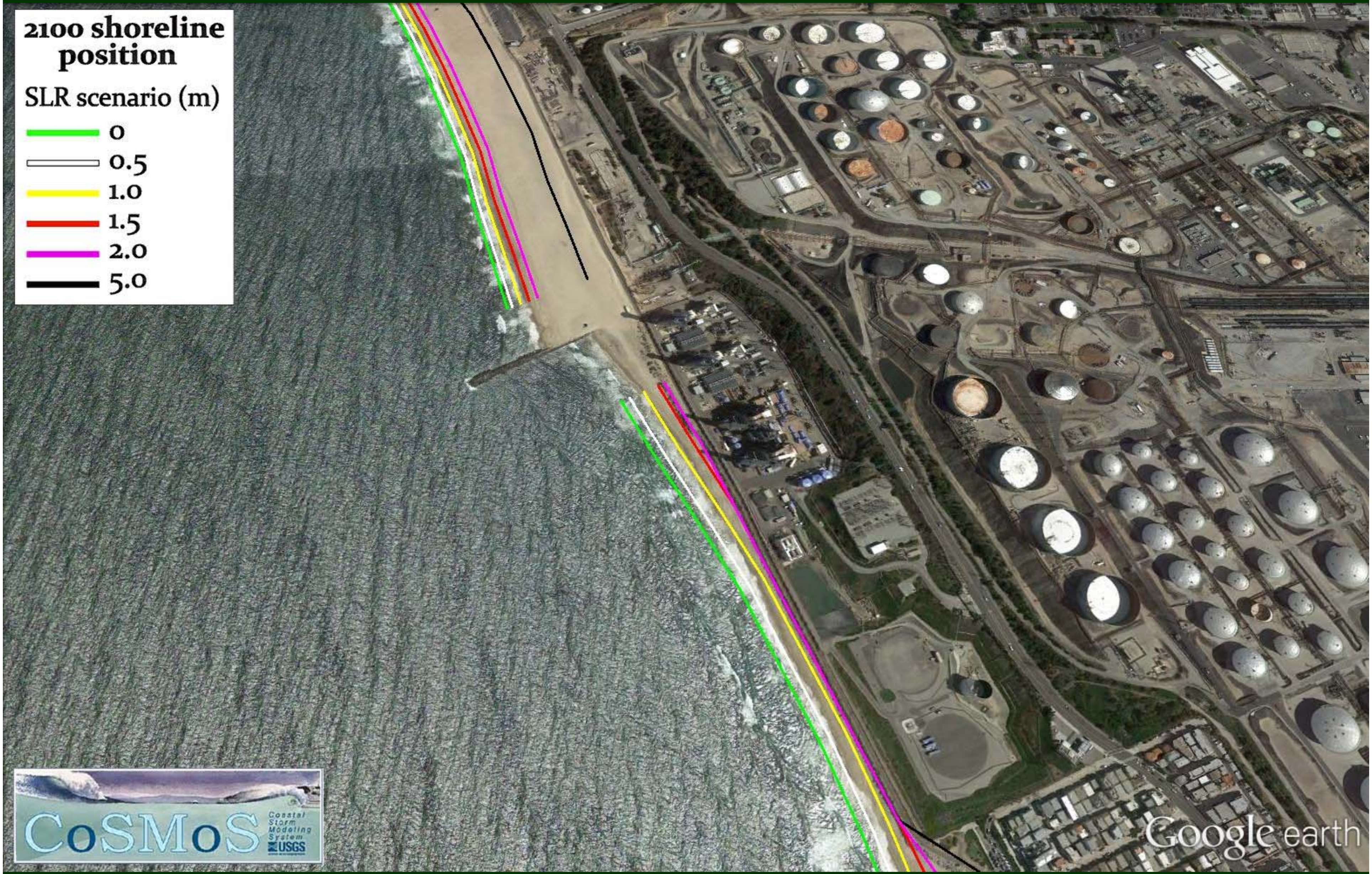
Cliff Retreat- Palos Verdes

Cliff Retreat- San Pedro

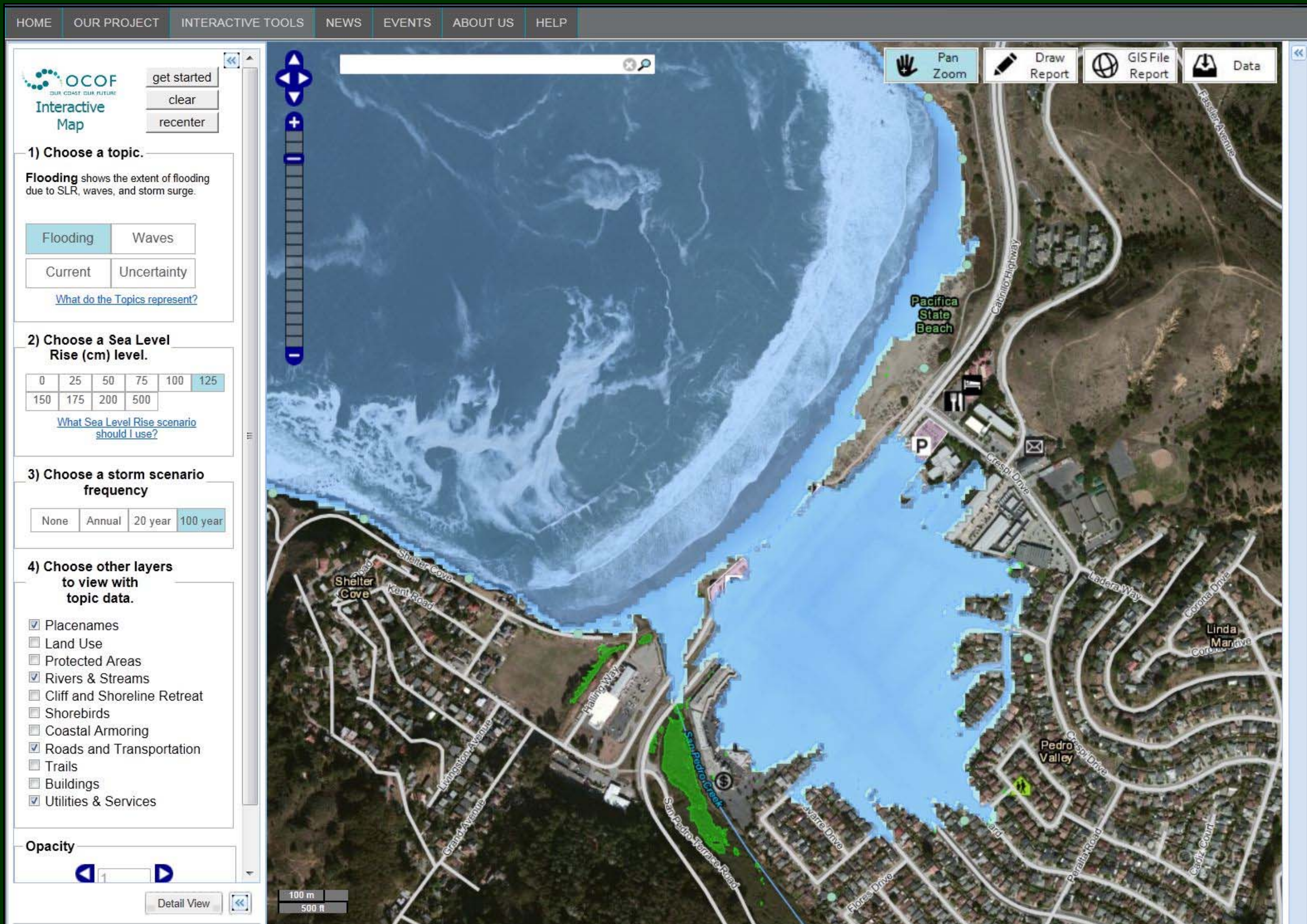
Shoreline Projections- Broad Beach



Shoreline Projections- El Segundo



Web Tool



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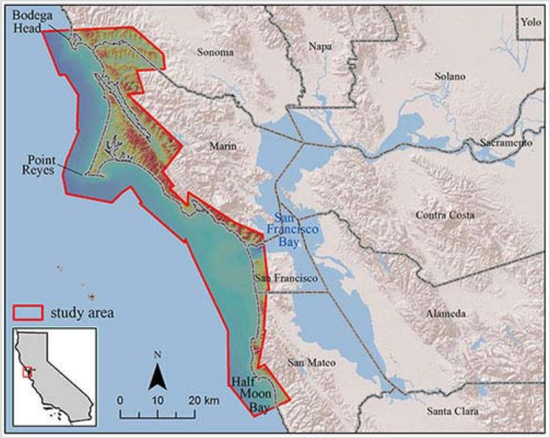
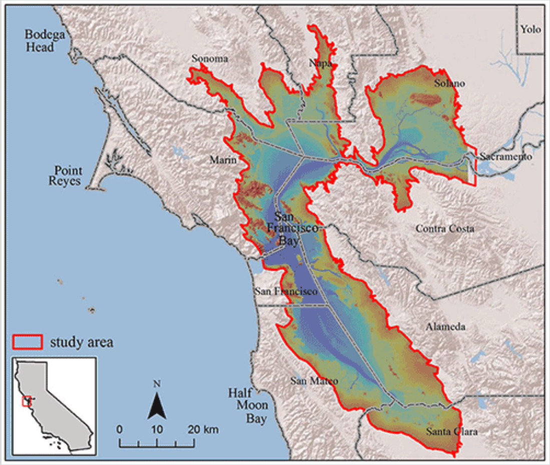
www.prbo.org/ocof **(Our Coast - Our Future)**

GIS-Based Exposure to Hazards

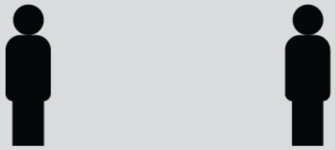
JURISDICTIONS





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:

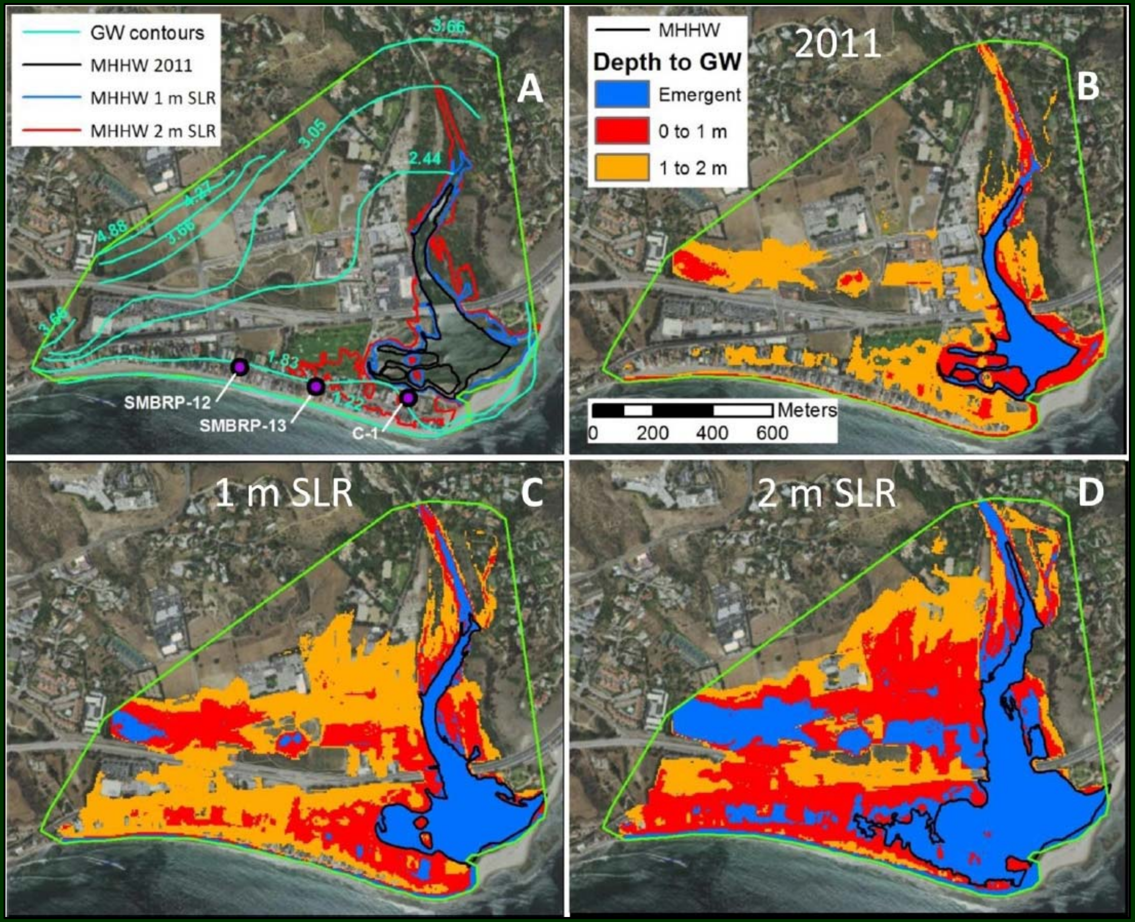
STORM FREQUENCY
None
Annual
20-year
100-year

SEA LEVEL RISE SCENARIOS
0 cm
25 cm
50 cm
75 cm
100 cm
125 cm
150 cm
175 cm
200 cm

Groundwater Impacts

- Major issues
  - Inundation
  - Shallower coastal groundwater
  - Saltwater Intrusion

- Seeking more well data and pilot sites



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What's Coming Summer 2016

- **40 scenarios of SLR + storms**
- **Long-term coastal evolution integrated into flood mapping**
- **Our Coast Our Future (OCOF) web tool**
- **Socioeconomic impacts and web tool**
- **Groundwater, hurricane impact pilots**

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

USGS CoSMoS data: *http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal3.0/index.html*

Our Coast- Our Future tool: *www.prbo.org/ocof*

Ventura Pier, December 2015
(Ricky Staub)

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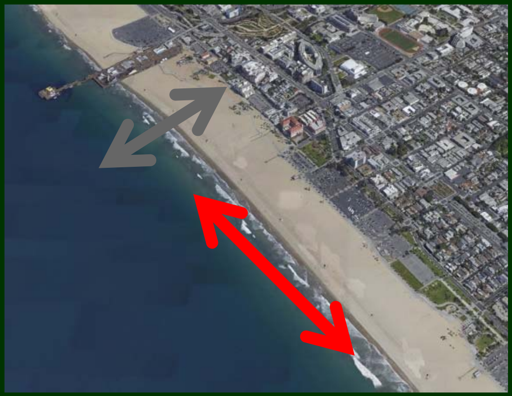
CoSMoS USGS science for a changing world

CoSMoS-COAST: Coastal One-line Assimilated Simulation Tool

- **A numerical model to simulate long-term shoreline evolution**
  - Coastline is represented by shore-perpendicular transects:

- **Two current assumptions: hold the line at urban interface and projection of historical rates**

- **Modeled processes include:**
  - Longshore sediment transport
  - Cross-shore sediment transport
  - Effects of sea-level rise
  - Sediment supply by natural & anthropogenic sources



- **Synthesized from models in scientific literature** (with several improvements)

- **Uses data assimilation to improve model skill**

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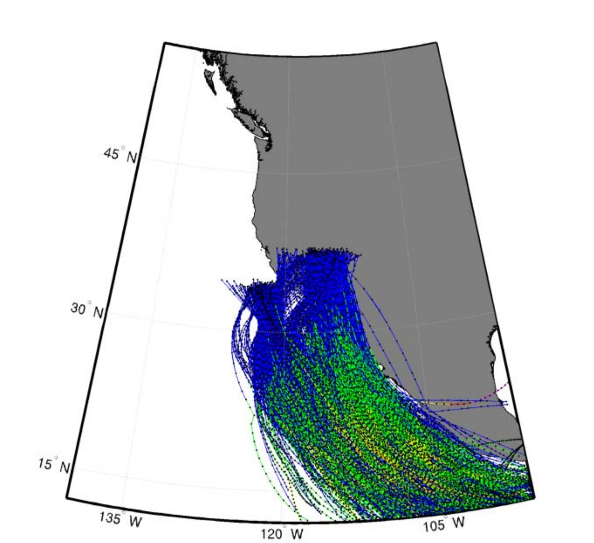
Hurricane Potential

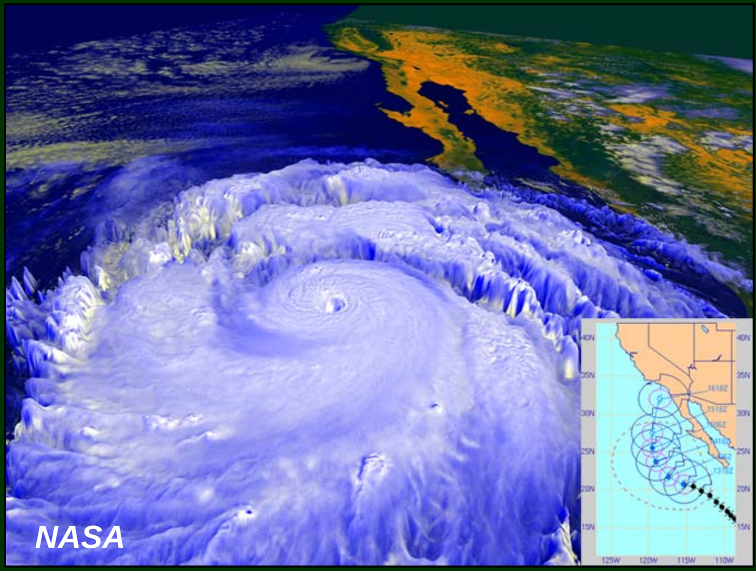
- **Hurricanes/tropical storms have the potential to significantly impact Southern California**
  - **San Diego Hurricane, October 2, 1858, produced hurricane/gale force winds from San Diego to LA**
  - **Un-named, September 25, 1939 (Long Beach), resulted in 90 deaths**
  - **Hurricane Nora, September 25–26, 1997, $100s of millions in damage**

- **Peak potential during El Niño, but overall probability of landfall is very low**

- **Research planned for SoCal (May 2016)**
  - **Will hurricane potential increase with climate change in the 21st century?**
  - **What is the probability of a hurricane making landfall?**
  - **What are the coastal hazards (e.g., coastal flooding, erosion) associated with such an event?**



F. Mendez, Universidad de Cantabria



NASA