Climate Change Impacts to the Los Angeles Shoreline

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lacurbed.com
What is the problem?

• Climate change, including sea level rise, changing wave climates, and storms will place additional stresses on coastal systems worldwide

• 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 Los Angeles County: 4,000 people and $4 billion in property at risk per Pacific Institute Report (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

www.californiacoastline.org/
Projections for Southern California

**SLR for Los Angeles (NRC, 2012)**
- 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 (e.g., wind and circulation patterns, sea level fingerprint, glacial isostatic adjustment, tectonics)

**Storms for Southern California (Bromirski et al., 2012; USGS)**
- No significant changes in wave height
- Extreme events approach from ~10-15 degrees further south

**El Niño for 21st Century (Cai et al., 2015, Barnard et al., 2015)**
- More frequent extreme events
- Doubling of winter erosion
- Wave energy increase by 30%
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
Coastal Vulnerability Approaches

**STATIC:** NOAA SLR Viewer
- Passive model, hydrological connectivity
- Tides only (MHHW)
- Excellent elevation data, datum control
- Wetland migration model, socioeconomic impacts
- ‘1st order screening tool’

**DYNAMIC:** CoSMoS
- GCM ensemble forcing
- Includes wind, waves, sediment transport, fluvial discharge, and vertical land movement rates
- Range of SLR and storm scenarios
- Flooding extent explicitly modeled, hydrological connectivity

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

Our Coast Our Future: www.prbo.org/ocof
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
CoSMoS Version Summary

CoSMoS 1.0
- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Historical storms, 2 SLRs
- Global & regional parts continue to run operationally

CoSMoS 2.0
- North-Central CA coast, 170 km, (Bodega Head to Half Moon Bay)
- 21st century winds & waves
- High resolution grids of lagoons and protected areas
- Annual, 1 yr, 20 yr, 100 yr storm events in combination with SLR 0 m to 5 m at 0.25 m increments +5 m
- Web-based tool

CoSMoS 2.1
- San Francisco Bay
- Spatial- & time-downscaled climate scenario winds
- Fluvial discharges
- Vertical land motion
- Marsh accretion
CoSMoS 2.0 - CenCal/NorCal

www.prbo.org/ocof (Our Coast - Our Future)
SoCal CoSMoS Version Differences

CoSMoS 1.0

- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Historical storms, 2 SLRs
- Global & regional parts continue to run operationally

CoSMoS 3.0 (updated SoCal)

- So Cal, 470 km coastline (Pt. Conception -> Mexico border)
- Future waves downscaled within the Pacific Basin using global climate model (GCM) winds
- Space- & time- downscaled local winds and sea level pressures
- High resolution grids of lagoons and protected areas
- Fluvial discharges
- 100 yr storm events in combination with SLR 0 m to 1.5 m in 0.5 m increments
- Shoreline change: both cliffs and sandy coast
Overview of Processes Included in CoSMoS

- wave runup
- wave swash
- wave set-up
- storm surge
- seasonal effects
- tide difference
- sea level rise

Breaker zone: $H$ decreases rapidly due to breaking
Swash zone: waves increase in height towards breaking zone (shoaling)

flood level is the combination of

\[ rSLR + tides + seasonal\; effects + storm\; surge + wave\; setup + wave\; runup + fluvial\; discharge\; backflow \]
CoSMoS 3.0 Southern California

Global
- Global conditions of future climate scenarios
- GCM winds
- WW3 wave model

Regional
- Tides, water levels, and regional forcing
- SWAN wave model
- Regionalized storm response
- 20-year storm return

Local
- High resolution hydrodynamics and waves
- Delft FLOW-WAVE

Open coast
- Fluvial discharge
- VLM Coastal change
- Results projected onto hi-res DEM

Coastal change
- 20-year storm return
CoSMoS validated with January 2010 Storm

Los Angeles tide gauge

RMS = 12 cm
$R^2 = 0.97$

Predicted and observed modeled water levels differ by 6 to 52 cm
Products- Wave and Currents

• Delft3D model results from all local SWAN and FLOW runs are used to...

To generate maps of maximum wave heights and maximum currents
Products - Flood Maps

- Delft3D model results from high resolution grids (inlets, harbors, etc.)
- Combined with open coast XBeach results
- Overlaid and differenced from the 2 m resolution DEM

To generate maps of flood extents, duration, and depth
SLR 150 cm
Venice / Marina Del Rey
L.A. Harbor
Shoreline Projections

2100 shoreline w/ sea-level rise:
- Green: 0.0 m
- Light gray: 0.5 m
- Yellow: 1.0 m
- Red: 1.5 m
- Pink: 2.0 m
- Black: 5.0 m
What’s Coming Summer 2016

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

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


Our Coast- Our Future tool: www.prbo.org/ocof
2015-2016 El Nino

How recent increases in ocean temperatures compare to strongest El Niño on record

Potential rain
California stands to get above normal amounts of rain from January to March 2016 because of El Niño.

Chance of above normal precipitation
- 33% – 39%
- 40% – 49%
- 50% – 59%
- 60% – 69%

Sources: NOAA, Climate Prediction Center @latimesgraphics

USGS
2015-2016 El Nino

Mean monthly sea level anomalies at the Los Angeles tide gauge

Mean monthly sea level anomalies at Los Angeles

- 82/83
- 92/93
- 97/98
- 09/10

MMSLA (cm)

USGS