Coastal Storm Modeling System (CoSMoS)  
CA Central Coast

Juliette Finzi Hart, Ph.D. | Director of Outreach, USGS  
Central Coast Climate Collaborative | Aug. 23, 2017
Beyond SLR…storms & tides
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
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
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
SLR = 0 to 2 m at 0.25 m increments, and 5 m

= 40 scenarios
CoSMoS Coverage
Coastal Flooding

Our Coast, Our Future tool: betaourcoastourfuture.org
Flood Duration

The Our Coast, Our Future tool: betaourcoastourfuture.org provides an interactive map for visualizing flood duration. Users can choose:

1. A topic (Flood, Duration, Waves, Current, Flooding, or Duration).
2. An amount of sea level rise (in cm).
3. An event (Storm Scenario Frequency: None, Annual, 10 year, 100 year).
4. Shoreline evolution (Cliffs, Sandy Beaches, or Infrastructure still).
5. Whether to view with other layers.

The map shows flood duration under different scenarios on the California coast. The tool allows users to explore how sea level rise and other factors impact coastal flooding duration.
Waves

Our Coast, Our Future tool: betaourcoastourfuture.org
Flood Potential (aka Uncertainty)

Our Coast, Our Future tool: betaourcoastourfuture.org
Shoreline Projections
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
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
Cliff Retreat Projections

SLR of 1 m could increase retreat rates by ~60% over historical rates.
What outputs are available?

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

4 coastal management scenarios + SLR

40 scenarios of SLR + storms
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
Socioeconomic Impacts

www.usgs.gov/apps/hera
## Sea level rise (SLR) in California

<table>
<thead>
<tr>
<th>Time Period</th>
<th>“Low”</th>
<th>“Mid”</th>
<th>“High”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 – 2030</td>
<td>2 inches</td>
<td>6 in (0.5 ft)</td>
<td>12 in (1 ft)</td>
</tr>
<tr>
<td>2000 – 2050</td>
<td>5 in (0.4 ft)</td>
<td>11 in (1 ft)</td>
<td>24 in (2 ft)</td>
</tr>
<tr>
<td>2000 – 2100</td>
<td>17 in (1.5 ft)</td>
<td>37 in (3 ft)</td>
<td>66 in (5.5 ft)</td>
</tr>
</tbody>
</table>

http://www.nap.edu/catalog.php?record_id=13389
Deterministic, Probabilistic, & Plausible, Oh My!
<table>
<thead>
<tr>
<th>Year / Percentile</th>
<th>Feet above 1991-2009 mean</th>
<th>MEDIAN</th>
<th>LIKELY RANGE</th>
<th>1-IN-20 CHANCE</th>
<th>1-IN-200 CHANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>50% probability SLR meets or exceeds...</td>
<td>0.4</td>
<td>0.3 — 0.5</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>2050</td>
<td>0.9</td>
<td>0.6 — 1.1</td>
<td>1.4</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>2100 (RCP 2.6)</td>
<td>1.6</td>
<td>1.0 — 2.4</td>
<td>3.2</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>2100 (RCP 4.5)</td>
<td>1.9</td>
<td>1.2 — 2.7</td>
<td>3.5</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>2100 (RCP 8.5)</td>
<td>2.5</td>
<td>1.6 — 3.4</td>
<td>4.4</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>2100 (H++)</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2150 (RCP 2.6)</td>
<td>2.4</td>
<td>1.3 — 3.8</td>
<td>5.5</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>2150 (RCP 4.5)</td>
<td>3.0</td>
<td>1.7 — 4.6</td>
<td>6.4</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td>2150 (RCP 8.5)</td>
<td>4.1</td>
<td>2.8 — 5.8</td>
<td>7.7</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>2150 (H++)</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
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.
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)
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

A Greater LA
CLIMATE ACTION FRAMEWORK

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/
Santa Barbara Area Coastal Ecosystem Vulnerability Assessment

Santa Barbara Area Coastal Ecosystem Vulnerability Assessment

SBA CEVA REPORT
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
thank you!

Juliette Hart
jfinzihart@usgs.gov | 1.831.460.7522