Orange County Regional SLR & Coastal Impacts Planning Workshop

Overview of CoSMoS and Sea Level Rise Models & Tools

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Overview of Presentation

- Sea Level Rise 101
- Models 101
- About the Coastal Storms Modeling System
- Overview of other local modeling efforts
- Questions and Discussion
about sea level rise
Sea Level Rise 101

- Thermal expansion
- Melting of Glaciers & Ice Sheets
- Terrestrial Water Storage
- Tectonic Activity

http://www.nap.edu/catalog.php?record_id=13389
### Table: Sea-Level Rise for the Coasts of California, Oregon, and Washington

<table>
<thead>
<tr>
<th>Time Period</th>
<th>North of Cape Mendocino</th>
<th>South of Cape Mendocino</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 - 2030</td>
<td>- 2 – 9 in.</td>
<td>2 – 12 in.</td>
</tr>
<tr>
<td>2000 - 2050</td>
<td>- 1 – 19 in.</td>
<td>5 – 24 in.</td>
</tr>
</tbody>
</table>

Coastal Storms

Flooding and Beach and Cliff Losses from Combinations of Sea Level Rise, Climate Variability, Tides, Waves and Runup

Maximum Potential Flooding Elevation

Episodic Risks

Predictable Extreme Tide

ENSO

PDO

Ocean Warming + Ice Melt

Long-Term Risks

Sea Level Today

California Today

California 2100 +

Image adapted from illustration by Dr. Bill O’Reilly (UCSD)
Hurricane Marie Impacts – Seal Beach

Images from:
NBC News & Weather Channel
Coastal Storms

“Today’s storm is tomorrow’s high tide…”

Image adapted from illustration by Dr. Bill O’Reilly (UCSD)
Expected Impacts from SLR and Storms

- Accelerated beach erosion rates
- Greater incidence of cliff failures
- Landwards translation of coastal flooding & inundation
- Dangerous navigation conditions
- Beach/shore safety compromised
- Saltwater intrusion into coastal aquifers
about models
All models are wrong; some models are useful.

- statistician George Box
What is a model?

Data → Code → Output
What is a model?

Data → Code → Output

Information that sets the boundary conditions for a model

- bathymetry and topography
- wind data
- pressure fields
- river flow rates
- grid

Slide format adapted from Dr. John Atkinson, Aracadis U.S. Inc
What is a model?

Data → Code → Output

- Mathematical equations or numerical approximation
- Xbeach
- Delft 3D
- SWAN
- ADCIRC

Slide format adapted from Dr. John Atkinson, Aracadis U.S. Inc
What is a model?

**Data**
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**Code**
- mathematical equations or numerical approximation
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**Output**

“The Model”

Slide format adapted from Dr. John Atkinson, Aracadis U.S. Inc
What is a model?

Data ➔ Code ➔ Output

- Flood projections
- Storm projections
- Uncertainty

Slide format adapted from Dr. John Atkinson, Aracadis U.S. Inc
Variations on a theme

Data → Code → Output

Data:
- Information that sets the boundary conditions for a model
  - bathymetry and topography
  - wind data
  - river flow rates

Code:
- Mathematical equations or numerical approximation
  - Xbeach
  - Delft 3D
  - SWAN
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Output:
- Flood projections
- Storm projections
- Uncertainty

Slide format adapted from Dr. John Atkinson, Aracadis U.S. Inc
Static vs. Dynamic Models

Static ("bathtub")

- A stationary model that floods based on a given elevation, no physics involved
- Instantaneous fill
- Output: topographic vulnerability
- Examples for O.C. area
  - NOAA SLR Viewer, Surging Seas, Pacific Institute

Dynamic

- Physical modeling of processes that affect water levels – tides, surge & wave-driven processes (set up and run up)
- Temporal variability
- Output: aerial extent, depth & velocity
- Examples for O.C. area
  - CoSMoS 3.0 (coming)
  - BreZo (currently available for Newport)
about CoSMoS
Coastal Storms Modeling System (CoSMoS)

- Dynamic - Physics-based numerical modeling system for assessing coastal hazards on West Coast
- Predicts coastal hazards for:
  - Full range of SLR scenarios (0 – 2 m & 5 m)
  - Annual, 10 yr, 20 yr and 100 yr storms
- Developing decision support tools to meet local adaptation planning needs
CoSMoS 1.0 – Pilot Study

- Dr. Patrick Barnard & colleagues, USGS
- Pilot Study (2010)
  - Hindcasts Jan. 2010 storm (~10 yr storm)
  - Forecasts 10 yr storm @ current, 0.5 m & 1.4 m SLR
- Outer coast focus (protected bays not explicitly modeled)
- Flooding based on maximum wave runup
CoSMoS 2.0

Global forcing using the latest climate models

Drives global and regional wave models

Scaled down to local hazard projections
Extreme Event Impacts

http://www.pointblue.org/ocof
Uncertainty

http://www.pointblue.org/ocof
CoSMoS 3.0 – Southern California

- Downscaled winds from GCMs to get locally-generated seas and surge
- Long-term coastal evolution modeled, including sandy beaches and cliffs
- Discharge from rivers for event response and long-term sediment supply
- Multi-agency collaboration featuring coastal and climate scientists from Scripps, Oregon State University & USGS
CoSMoS 3.0 Timeline

- Study is underway…
- First set of limited scenarios next September 2015
- Full suite of 40 SLR and storm scenarios June 2016
other regional OC models
An embarrassment of riches...

CA & O.C.-focused tools

- CoSMoS 3.0
- Pacific Institute SLR Report
- BreZo (Dr. Brett Sanders and Dr. Timu Gallien)

National tools

- NOAA Sea Level Rise Viewer
- Climate Central’s Surging Seas 2.0

...And likely many more to come in the future...
NOAA Sea Level Rise Viewer

- Static Model ("Modified bathtub")
- Doesn’t include storms, only tides
- Sliding scale of SLR scenarios
- Great for “1st order screening”

http://www.coast.noaa.gov/slr/
Climate Central Surging Seas

- Static Model ("Modified Bathtub")
  - Back-end data exactly the same as NOAA SLR Viewer Data

- Includes social vulnerability

- Another good "1st order screening"

http://sealevel.climatecentral.org/ssrf/california
Pacific Institute

- Modeled by PWA
- “Hybrid” Static Model
  - Empirical relationships – no physics
  - included 100-yr storm event
  - two SLR scenarios (0.5 m and 1.5 m)
- Didn’t include Scripps area
- Available on Cal-Adapt
Other Regional Efforts

- FloodRISE
  - Richard Matthew & Brett Sanders, UC Irvine

- Seal Beach Sediment Augmentation Project
  - Kirk Gilligan, US Fish & Wildlife

- Assessing SLR Vulnerability for Coastal Wetlands
  - Steve Steinberg, Southern California Coastal Water Research Project
Questions?

Other Regional Efforts

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Extra Slides
CoSMoS 2.0
CoSMoS 2.0

The DATA

- Global Climate Models provide winds, sea surface temps, pressure
CoSMoS 2.0

The CODE

- Utilizes SWAN wave model to downscale waves and Xbeach to bring waves on shore

- Total Water Levels

  - SLR, tides, waves, SLA, storm surge, river discharge
The OUTPUTS

- 40 SLR and storm scenarios, plus King Tide scenario for SF Bay using CoSMoS
- Flood depth, extent, duration
- Wave heights & velocities
BreZo & FloodRISE

- Dynamic model
- Overland flow model
- Sub-meter resolution
- Completed project for Newport Beach, includes validation data set
BreZo & CoSMoS

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Main Differences –

- DATA
  - Unstructured grid (triangular vs. rectangular)

- CODE
  - Different overland flow model (based on civil engineering)

- OUTPUT
  - Sub-meter resolution
  - Fine-scale model validation at Newport
BreZo & CoSMoS

- Dynamic model
- Overland flow model
- Sub-meter resolution
- Completed project for Newport Beach, includes validation data set

Previous collaboration between Brett, Timu & Patrick


Discussion of future collaboration

- CoSMoS provides total water levels to force BreZo