Navigating the CoSMoS: Application of CoSMoS to Local Communities
Overview

- What is CoSMoS?
- Comparing CoSMoS beach erosion projections to other models/techniques
- Comparing bluff erosion projections
- Comparing tidal/riverine interface flood risk
- Comparing resultant flood maps
CoSMoS background

- Coastal Storm Modeling System (CoSMoS) projects SLR impacts
- Developed by the USGS in multiple phases
- Outputs include:
  - Inundation
  - Maximum wave runup
  - Long-term shoreline erosion (beach and bluff)
  - Erosion uncertainty (accounts for storm event erosion)
CoSMoS background

• **Scenarios**
  - **Storms**
    • 100-year storm (1% annual chance) – similar to FEMA
    • 20-year storm (5% annual chance)
    • 1-year storm (100% annual chance)
    • No storm event (tidal scenario)
  - **Sea-Level Rise**
    • 0
    • 0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.75, 2 meters
    • 0.93 meters (NRC mid-range projection, erosion only)
    • 5 meters
  - **Management**
    • Hold the line- maintain barriers
    • Let it go- allow natural erosion

• **Outputs available for each (although not all combinations are available for each scenario)**
Comparing CoSMoS to Other Types of Beach Erosion Projections – Del Mar, CA

- Project: Local Coastal Plan Amendment for Sea-Level Rise
- CoSMoS wasn’t available during project study
- ESA conducted a Costal Hazards, Vulnerability, and Risk Assessment (CHVRA) (ESA 2016)
- Later, compared CHVRA to CoSMoS 3.0 Phase 2 (USGS 2017)
Beach Erosion Assessments

1. Del Mar CHVRA (ESA 2016)
   - Bruun Rule
   - Average beach width with winter/summer range

2. CoSMoS 3.0 Phase 2 shoreline projections (USGS 2017)
   - Process-based models including Bruun Rule term
   - Beach width on January 1 of each simulation year
Del Mar (CHVRA) Beach Erosion (ESA 2016)
CoSMoS Beach Erosion (USGS 2017)
Comparison of CHVRA and CoSMoS

Excluding CoSMoS output years where beach width on Jan 1 is wider than prior years.
CoSMoS Beach Erosion Conclusions

• Del Mar CHVRA and CoSMoS generally agree because both are primarily based on the same approach (Bruun Rule)

• When using CoSMoS, it’s important to note the output of beach widths in on January 1
  – Beach width dependent on when storms occur
  – Erosion doesn’t occur linearly over time
Comparing CoSMoS to Other Types of Bluff Erosion Projections – Santa Barbara, CA

- Project: City of Santa Barbara Local Coastal Program Update

- Local study of bluff erosion had already been conducted: Santa Barbara County Coastal Resilience Study

- Campbell Geo Inc. compared Coastal Resilience Study to CoSMoS 3.0 Phase 2 (USGS 2017)
Bluff Erosion Assessments

1. Santa Barbara County Coastal Resilience Study (ESA 2015)
   - Coastal erosion and shoreline response model
   - Sensitive to the increase in wave runup (e.g., total water level)

2. CoSMoS 3.0 Phase 2 shoreline projections (USGS 2017)
   - Transect-based cliff recession models- ensemble of models
   - Sensitive to the historic erosion rate used
Comparing CoSMoS to Other Types of Bluff Erosion Projections – Del Mar, CA

- Project: Site-specific study in Del Mar, CA
- Site-specific geotech study had already been conducted
- Compared site-specific study to CoSMoS 3.0 Phase 2 (USGS 2017)
CoSMoS Bluff Erosion Conclusions

• CoSMoS is sensitive to historic erosion rate
• If better, site-specific historic erosion rates are available, can use CoSMoS to scale historic rate for SLR

• Example:
  - CoSMoS uses historic rate of 0.40 ft/yr and determines a future rate of 1.02 ft/yr in 2100 (or 2.55x greater rate in 2100)
  - Site specific study shows historic rate is actually 0.17 ft/yr
  - Using CoSMoS to scale (2.55x), determine future erosion rate of 0.43 ft/yr in 2100

• Also note, CoSMoS relies on an ensemble of models to consider variability across models
Comparing CoSMoS to Other Types of Riverine/Tidal Flooding Projections – Oceanside, CA

- Project: City of Oceanside Local Coastal Program Update
- San Luis Rey River
- Loma Alta Creek
- Buena Vista Creek
- Compared to CoSMoS 3.0 Phase 2 (USGS 2017) and FEMA
Comparing CoSMoS and FEMA – San Luis Rey River

- **CoSMoS 3.0 Phase 2 (USGS 2017)**
  - 1%, 5%, 100% chance coastal storm with estimated coincident river discharge (e.g., 1% coastal storm with 5% river flood)
  - Does not include 1% coastal storm + 1% river flood

- **FEMA FIRM**
  - 1% chance coastal flood and 1% chance river flood
  - Does not include SLR

- **ESA 2018**
  - Use FEMA 1% chance river flood
  - Assume generally steep slopes
  - Where slopes were flatter, mapped FEMA 1% chance river flood + SLR on LiDAR
CoSMoS Riverine/Tidal Flooding Conclusions

- CoSMoS is considering a realistic scenario for combining coastal and fluvial flooding
- However, for flood hazard maps, CoSMoS riverine flood mapping is less than the 100-year storm event
Comparing CoSMoS to Other Types of Flood Mapping Projections – Del Mar, CA

- Project: Local Coastal Plan Amendment for Sea-Level Rise
- CoSMoS wasn’t available during project study
- ESA conducted a Costal Hazards, Vulnerability, and Risk Assessment (CHVRA) (ESA 2016)
- Later, compared CHVRA to CoSMoS 3.0 Phase 2 (USGS 2017)
Coastal Flood Hazard Assessments

1. Del Mar CHVRA (ESA 2016)
   - Hazard zones created based on:
     • 1983 storm: “extreme coastal flooding”
     • 2016 events: “significant coastal flooding”
   - Projected increase in occurrence with SLR

2. CoSMoS 3.0 Phase 2 (USGS 2017)
   - 1%, 5%, 100% chance coastal storm with estimated coincident river discharge (e.g., 1% coastal storm with 5% river flood)
   - Mapped SWL + wave setup
   - Maximum wave runup point data

3. FEMA Flood Insurance Rate Map (FEMA 2017)
   - 1% chance coastal flood and 1% chance river flood
   - Map high wave velocity (VE) zones and inundation (A) zones
## Del Mar CHVRA

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<th>Annual Chance of Occurrence</th>
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<tr>
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<td>High 50%</td>
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### Coastal Flooding

**Significant (2016)**
- Low 1%
- Mod 5%
- Mod 15%
- High 50%
- High 100%

**Extreme (1983)**
- Low 1%
- Mod 5%
- Mod 15%
- High 50%
- High 100%

Accounts for beach erosion
Del Mar CHVRA – FEMA Comparison

Comparison of
- FEMA 1% chance
- Del Mar CHVRA
  - Significant Coastal Flood Hazard (10%)
  - Extreme coastal event (<1% chance)
    - Wave hazard
    - Flood hazard
- CoSMoS
  - Maximum wave runup for 1% chance coastal storm, no SLR
CoSMoS Flood Mapping Conclusions

• Del Mar CHVRA generally agrees with CoSMoS

• FEMA maps are conservative (low) for wave overtopping, but different methodologies, events, and purpose
Last Thoughts on Using CoSMoS

- CoSMoS is a very powerful tool based on solid science

- CoSMoS carries weight with the public and stakeholders since it is a USGS model

- However, it is important to understand what CoSMoS assumes and what the results mean when applying the model for a project analysis
Questions?

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July 13, 2016 bluff collapse at 10th Street