Projecting wetland habitat evolution in intermittently open estuaries with SLR

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Restore America’s Estuaries
December 10th, 11-12:30pm
Outline

• One important knowledge gap is how intermittently-open lagoons of Southern California, will be affected by sea-level rise

• Summary of tidal marsh processes that influence the structure and functions

• Modeling to demonstrate future changes under lagoon closure frequency
Los Penasquitos Lagoon
Northern San Diego county
Vegetated tidal wetlands

Tidal wetland vegetation typically extends from about MTL to above MHHW – the upper half of the intertidal zone.

Tidal wetlands can ‘keep pace’ with sea-level rise through elevation building processes called accretion.

Tidal wetlands can also migrate inland - transgression.
Research Questions

Does the frequency of opening/closing of lagoons affect long-term sea-level rise vulnerability?

How does lagoon closure affect wetland processes and accretion?
What do we know about estuary closure?

  - Offshore wind and wave action
  - Geomorphology (catchment size, erodibility of material)
  - Fluvial flow rate
  - Sediment concentration

- Closure leads to environmental responses:
  - Increased water levels in the lagoon
  - Changing salinity inside lagoon (hypo or hypersaline depending on evaporation and flow)
  - Changing water quality (algal blooms & low oxygen)
Knowledge Gaps

• Closure frequency is uncertain with climate change
• How does closure frequency affect the ecology?
  • Decreased biodiversity in benthic and fish communities (Pollard 1994; Hodgkin & Hesp 1998)
  • Algal communities shift (Perez-Ruzafa et al. 2007)

• Wetland processes
  • Macrophyte responses are unknown
  • Closure frequency effects on marsh migration
  • How closure frequency impacts accretion and wetland elevation and ability to keep pace with sea-level rise
Permanently Open

Intermittently Closed

plant vectors from IAN image library (Tracey Saxby, Dieter Tracey)
Numerical Modeling Methods

- **WARMER Processes** (Swanson et al. 2014)
  - Mineral & organic deposition, compaction, decomposition, sea-level rise

- **Mouth closure scenarios:**
  - Annual closure probability: 0, 25, 50, 75, 100%
  - Closure length: Mean=28 days (SD=19)
  - Berm Height: Mean=130 cm, MSL (SD=25)
  - Linear SLR: 2, 4, 6, 8, 10 mm/yr
  - SSC: constant 25 mg/L
  - Initial marsh elevation: 90 cm, MSL
  - 10 Monte Carlo runs
Preliminary Results

• More frequent closure-increases the marsh accretion rate by trapping incoming sediment

• Rate of SLR has minor affect on accretion rates with increasing closure
Exploration: Biomass Response

- Assumption: plant productivity is reduced with closure
  - Longer flooding duration (increased plant stress)
  - Less flooding frequency (less soil flushing)
- Biomass production coefficient – function of the ratio between inundation duration:frequency

**Strong Response**
- Decreases immediately with closure

**Weak Response**
- Decreases after 100 days
No biomass response to closure

Weak biomass response

Strong biomass response
• Frequency of closure impacts wetland accretion processes

• Increase frequency of closure increases marsh platform elevation if a freshwater source contributes suspended sediment. Increasing resiliency to sea-level rise.

• Closures decreases plant production and increase plant decomposition reducing marsh elevations.

• We can use this to inform the regional vulnerability analysis for sea-level rise.

• Modeling can be used to answer management agency specific questions about lagoon closure impacts.
Thank you

Funders:
NOAA EESLR SCOOS grant
California Coastal Conservancy

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