Geomorphologic Response of Estuaries to Sea Level Rise and Climate Change

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Explore Geomorphic Response of Estuaries to Climate Change and Sea Level Rise

• Sediment supply and demand
  - Historical data and numerical models

• Limitations of simple models
  - Bruun rule

• Change in hydrodynamics and sediment transport
  - Numerical models
Examples and modeling presented in this talk will focus on San Pablo and Suisun Bays, two sub-embayments of the San Francisco Estuary.
San Pablo Bay- A prime example of the effects of changing sediment supply

Change from depositional to erosional system
Intertidal mudflat area responded to changes in sediment supply to San Pablo Bay.
Mudflats widened where sediment was abundant

Jaffe et al., 2007
Bruun Rule - A simple model

Pilkey and Cooper, 2004
Conceptual Application of Bruun Rule to San Pablo Bay

1856
Comparison of Actual and Bruun Rule Deposition and Erosion

1856 - 1983

Change (m)
- Deposition
- No Change

5 mi
5 km

Deposition
Erosion
No Change

Miles
CASCaDE’s Geomorphology Models

**Outputs**
- Depth distribution
- Turbidity
- Habitat distribution

**BDWM/CALSIM**
- Delta inflows
- Magnitude
- Timing

**ROMS/DELFT3D**
- Hydrodynamics
- Sediment transport
- Geomorphology

**SEDIMENTATION/GEOMORPHOLOGY**
- ROMS, Delft, Geomorph

**WATERSHED**
- Hydrology - BDWM, HST; Operations - CALSIM II
- Delta inflows
- Upstream inflows and T & S
- Daily weather, Martinez tide levels
Increase in tidal amplitude with 1 m SLR

10% increase in tidal amplitude up-estuary

Delft-3D Model

Mick van der Wegen
Decrease in tidal bottom shear stress

Delft-3D Model

Mick van der Wegen
**Sea-level rise:**
- Increase in water depth reduces wave-induced shear stress
- Less erosion, less redistribution

**Warming:**
- Minor changes in redistribution

**Decreased sediment supply:**
- Erosion everywhere except fringes
Summary- Geomorphic Response of Estuaries to Sea Level Rise and Climate Change

- Sediment supply and demand
  - Historical data and numerical models
    - Sediment supply extremely important
    - SLR will increase sediment demand
- Limitations of simple models
  - Bruun rule
    - Does not predict changes in San Pablo Bay
    - Limited by being 2D, not a closed system
- Changes in hydrodynamics and sediment transport
  - Numerical models
    - SLR increases tidal amplitude
    - SLR decreases average tidal bottom shear stress in San Pablo Bay
    - SLR decreases wind wave bottom shear stress in Suisun Bay, induces deposition in shallows