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The State of the Coast - Shorelines in Motion

Jon K. Miller

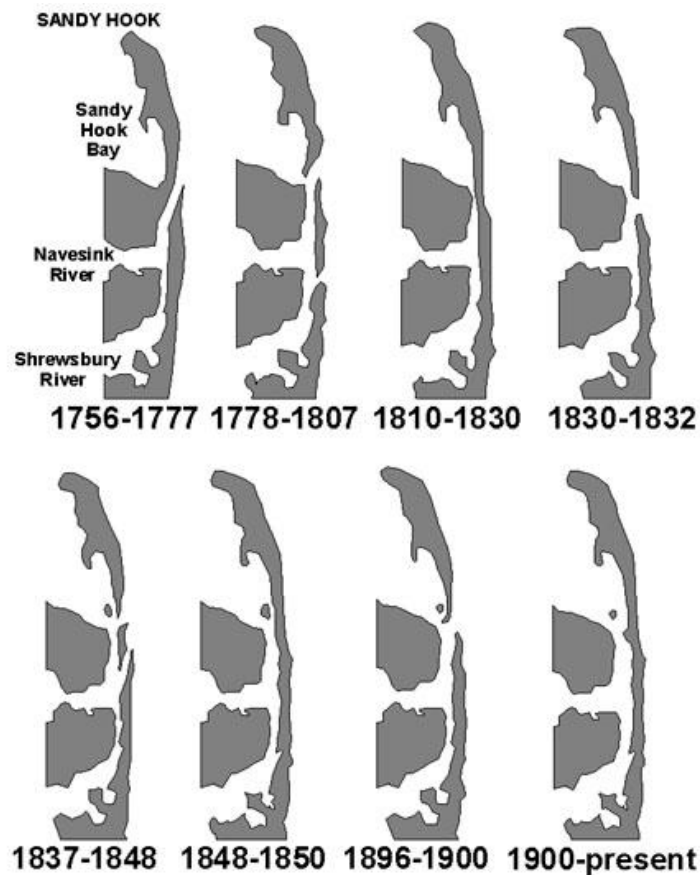
*Research Associate Professor
Director NJCPTAS
NJSG Coastal Processes Specialist*



Dynamic Coastal Landscape

Scales of change

- Seconds – wave by wave
- Hours – tides & storms (Hurricanes)
- Days – storms (Nor'easters)
- Years – sea level rise, changes in sediment supply (natural and/or anthropogenic)



South Cape May (?)



Longport



39°18'21.51"N 74°31'58.07"W
© 2009 Tele Atlas



Beaches and Dunes



NJ Shoreline Evolution

- Coastline of NJ changes on many scales:
 - Long-term
 - Seasonal
 - Episodic
- To manage these costal changes, we have altered the coast through:
 - Shore protection structures
 - Inlet stabilization
 - Beach nourishment and sand management



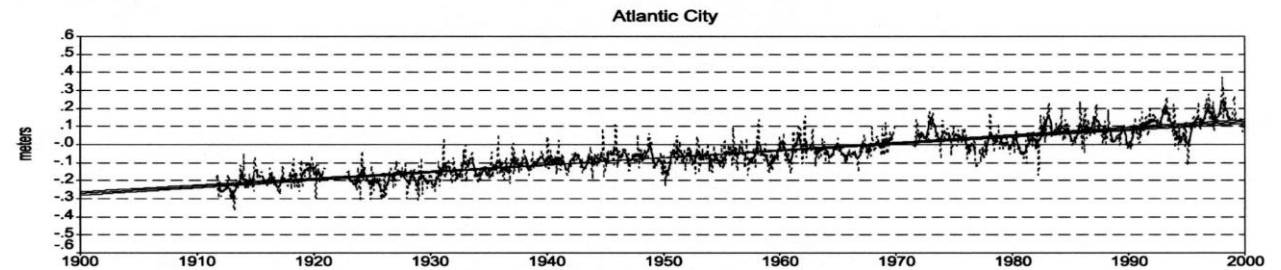
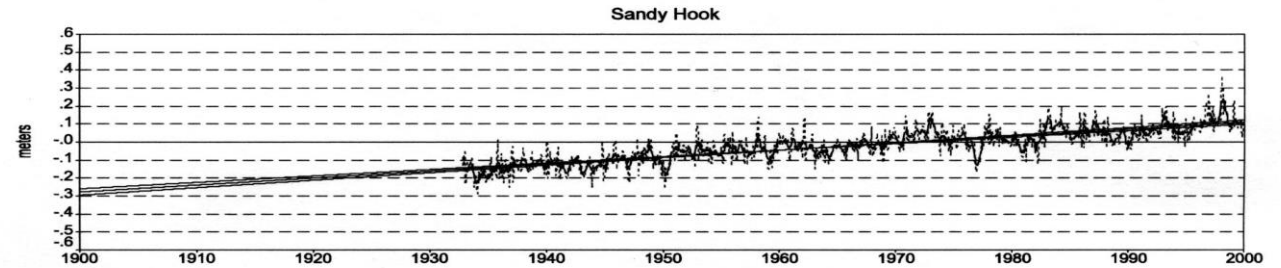
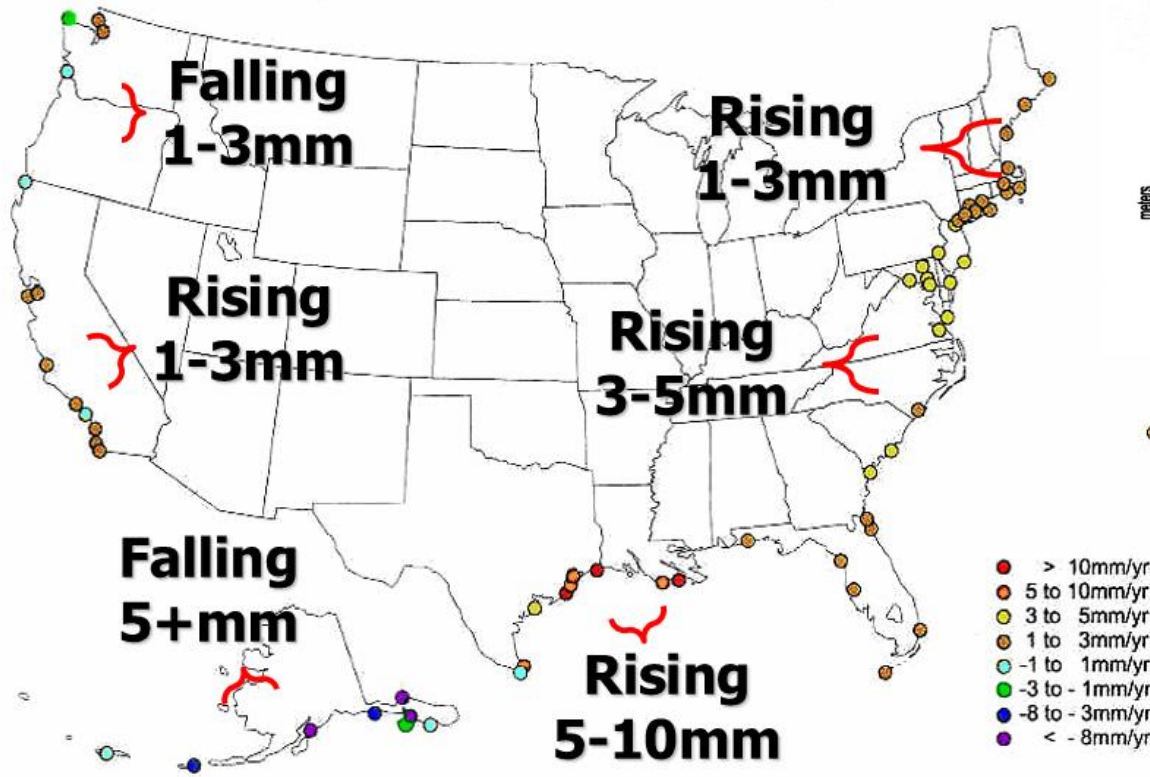


Long-term Coastal Changes



LONG TERM SEA LEVEL TRENDS FOR THE UNITED STATES

(Accepted Global Sea Level Rise is 2mm/yr)



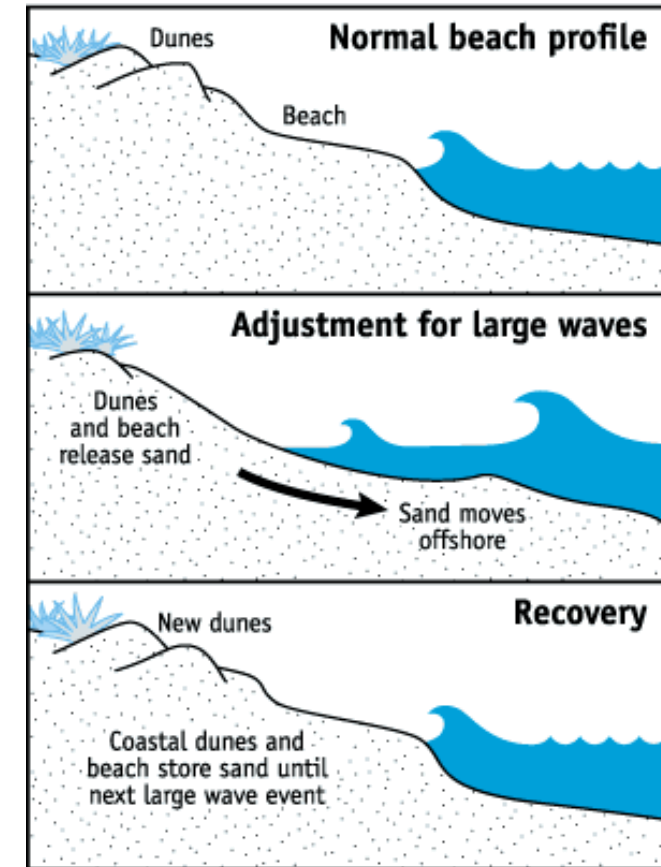
For typical NJ beaches 1' of SLR translates into a 50 ft recession in beach width



Seasonal Coastal Changes

- The cross-shore extent of the beach undergoes erosion and accretion on a seasonal basis
 - In the summer and fall, small waves transport sand up onto the beach
 - In the winter and spring, large storm waves erode sand
 - Transition provides natural protection for the beach.
 - Shoreline can change 100 ft or more

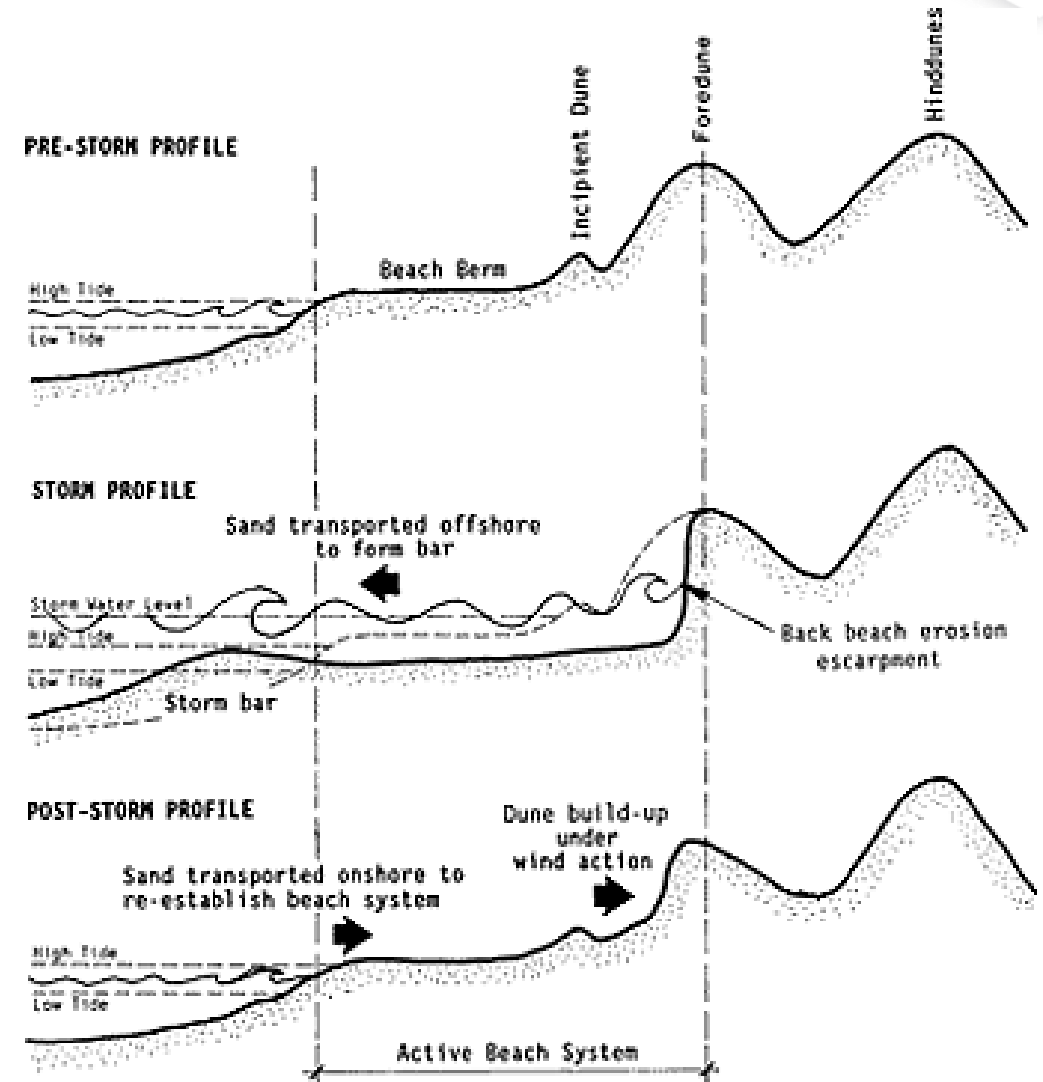
Seasonal beach profile adjustments





Episodic Shoreline Change

- New Jersey Coast is impacted by two types of Coastal Storms:
 - Hurricanes
 - Northeasters
- Main Drivers
 - Maximum Water Level
 - Storm Waves
 - Storm Duration



Name that storm



1944 Hurricane



1962 Ash Wednesday Storm



1984 Nor'easter



December 1992 Nor'easter

Name that storm



2017 Winter Storm Jonas



Superstorm Sandy

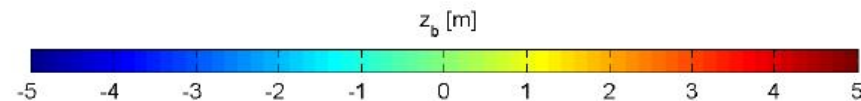
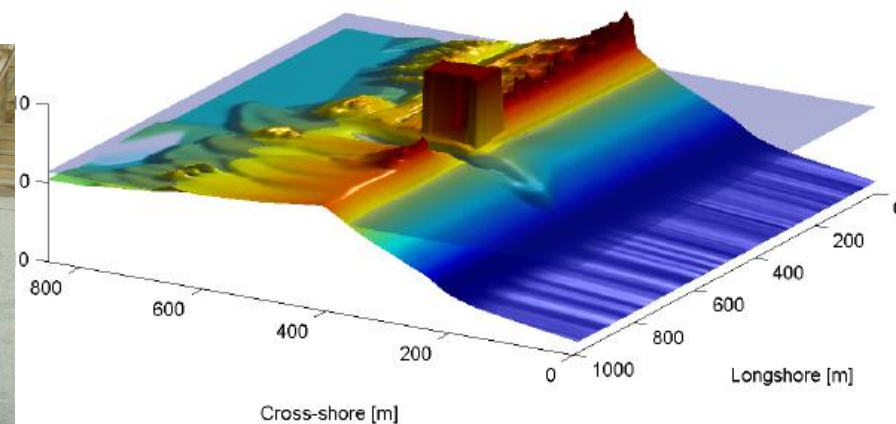
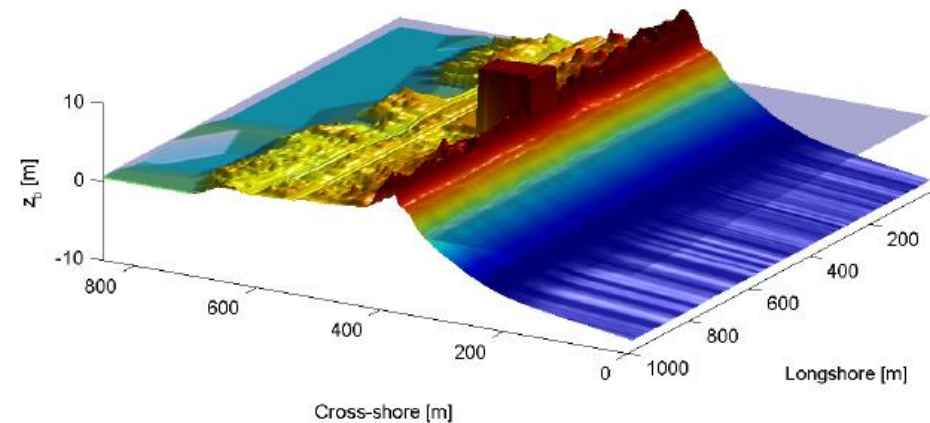


2009 Veterans Day Storm



2018 Four'easter

Technologies for Understanding the Response of Beach/Dune Systems





Beach/Dune Status Update

What we know

- Damage/erosion is related to water levels, wave heights, and storm duration
- Wide beaches and large dunes reduce damage during storms
- Freeboard reduces damage during storms
- Bulkheads, seawalls, revetments reduce damage to landward structures during storms

What we don't know

- How well hybrid coastal protection systems perform
- Details of flow/waves over land
- Details of structure response
- How long will existing coastal management approaches be effective
- Feedbacks
- Thresholds



Interior Shorelines

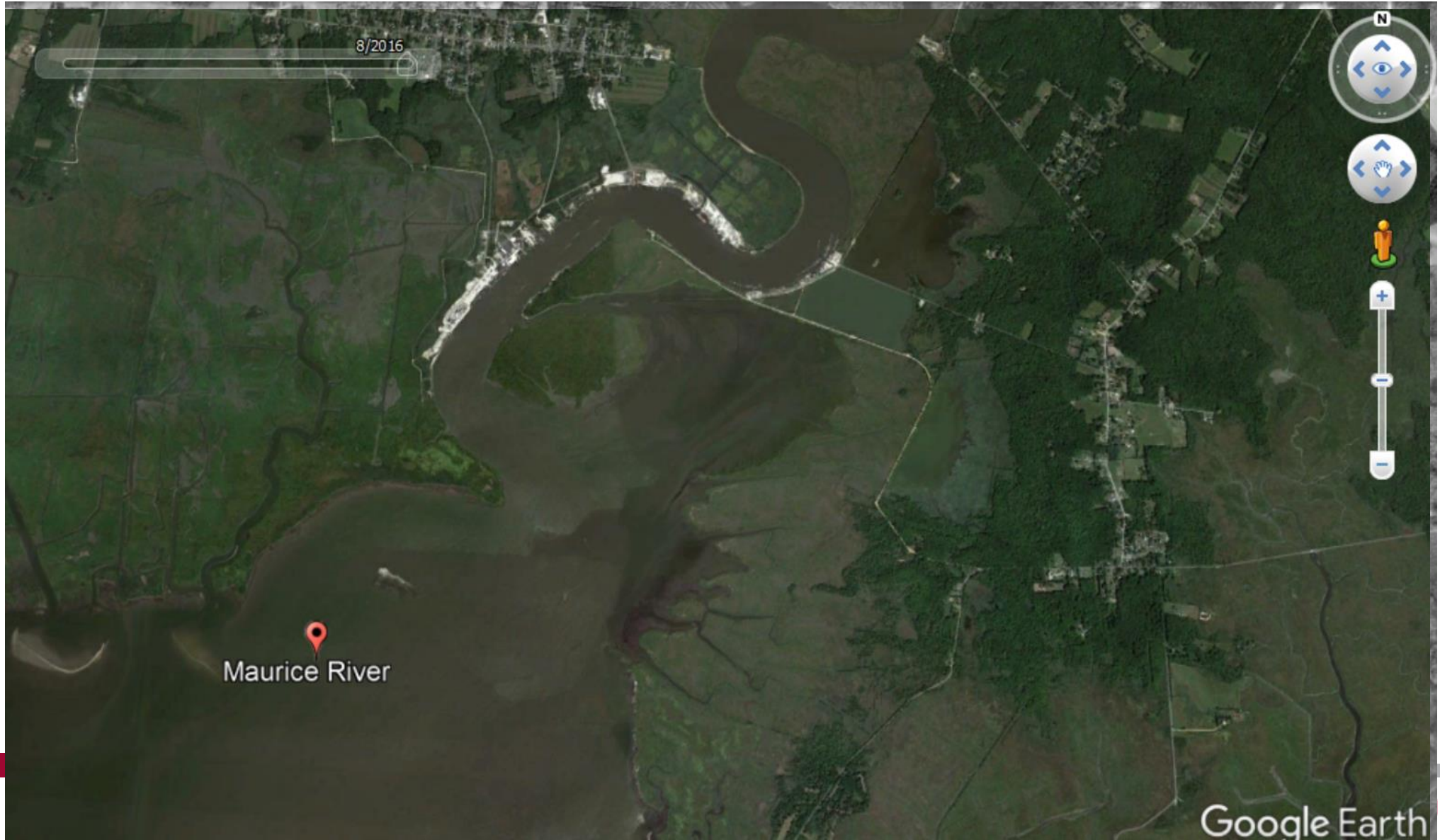


Interior Shorelines

- Historically much less attention
- Suffer many of the same impacts
- Will be the first to feel the influence of sea level rise
- Multiple scales and a large range in wind, wave, tide and current forcing
- Wakes and ice



Still Dynamic?





Living Shorelines

Low"er" Energy Approaches

- Common structural materials include vegetation, shell, coir logs, coir mats

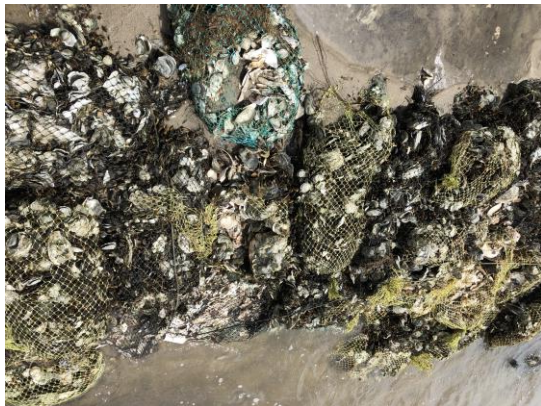




Living Shorelines

Moderate "er" Energy Approaches

- Common structural materials include concrete blocks and smaller stone



Living Shorelines

High"er" Energy Approaches

- Common structural materials include gabion baskets, geotubes, large rock





Interior Shoreline Status Update

What we know

- Historically natural systems have provided protection to the upland
- Living shorelines can reduce wave energy
- Higher energy sites require more “structure”
- Living shorelines projects take time to take hold – maintenance may be required
- Marshes have a limited ability to adapt to rising sea levels

What we don't know

- How do we quantify ecological benefit
- What is the impact of wakes/ice
- How transferable is living shorelines design guidance
- How successful will the projects be at adapting to sea level rise
- How do biologic processes affect engineering performance
- What is the collective impact of multiple small projects



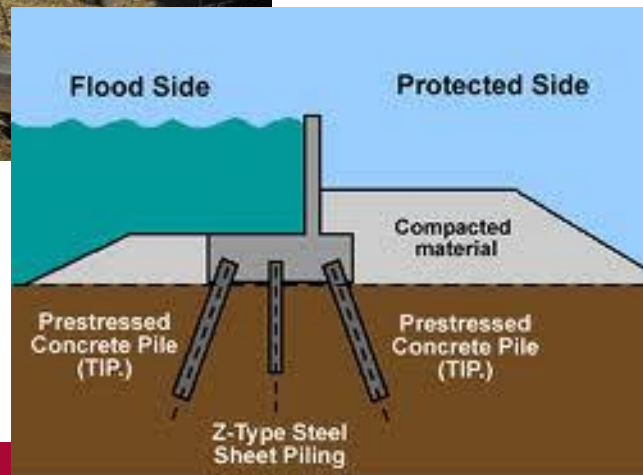
Urban Shorelines



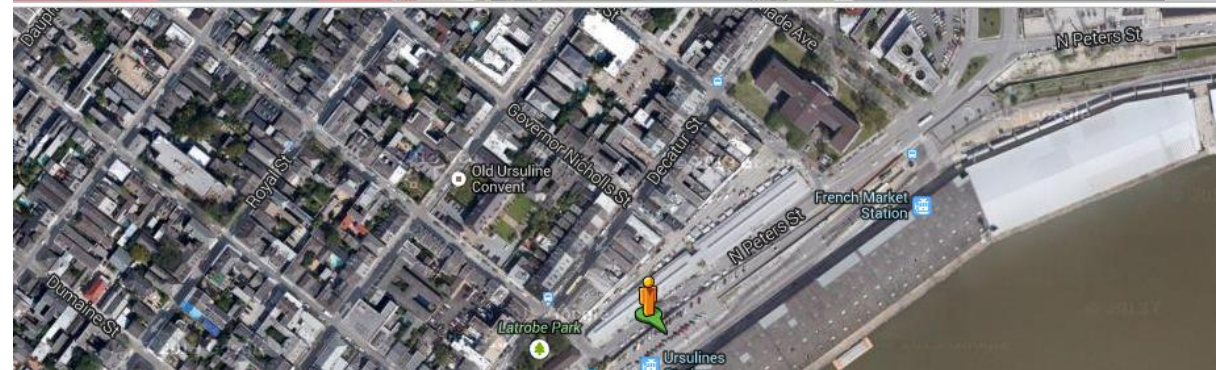


Traditional Approach

Separate People from the Water



T-Wall supported on a pile foundation



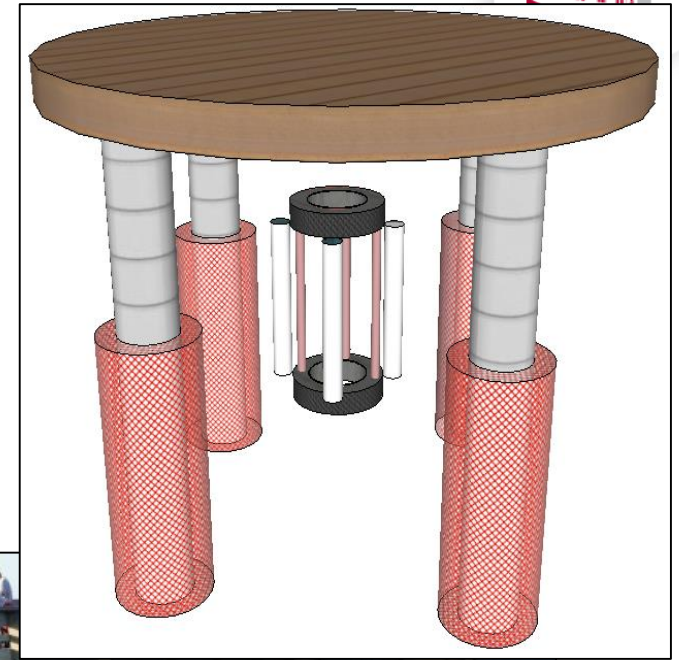
Modern Approach

Encourage Interaction with the Water



Modern Approach

Incorporate Ecological Considerations



Modern Approach

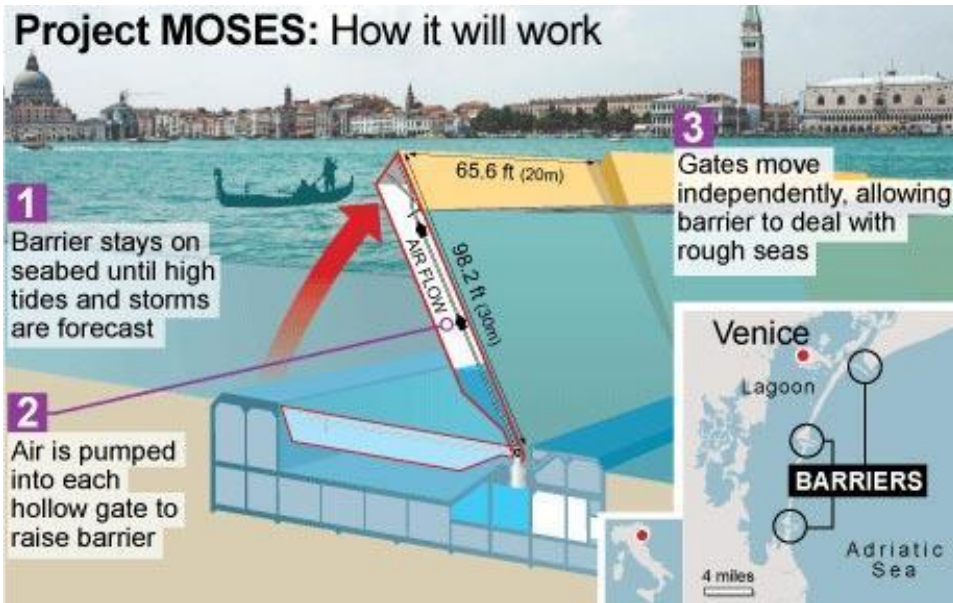
Live with the Water





Modern Approach

Large-scale Engineering
(possibly)





Urban Shoreline Status Update

What we know

- Small shoreline modifications can have a large ecological impact
- Generally speaking...
 - Vertical is bad – sloping is good
 - Straight is bad – curvy is good
 - Rugosity is good
- Large scale interventions have the potential for unforeseen large-scale impacts

What we don't know

- How do we quantify ecological benefit
- How do urban eco-shorelines perform over the long term
- Quantification of cumulative impacts
- Fine scale hydrodynamics associated with overland flow
- What are the potential impacts (good & bad) of large scale interventions



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Thank You

Jon K. Miller
(201) 216-8591
jmiller@stevens.edu
@NJBeachProf
www.stevenscoastal.com

