

Civil, Environmental, and Infrastructure Engineering VOLGENAU SCHOOL OF ENGINEERING

Wetlands as a nature-based coastal defense

A numerical modeling and field data integration approach to quantify storm surge attenuation for the Mid-Atlantic region

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Background

- Wave attenuation by vegetation has been explored:
 - Field studies
 - Lab simulations

- Dissipation of surge energy via vegetation resistance
- Vegetation roughness impedes wind flow
- Dampening of wind-driven surface stresses

Effective attenuation depends on: micro-topography, geomorphology, vegetation characteristics , storm parameters, spatial scales

elg. Resio & Westerink (2008)



Study Region: Virginia Chesapeake Bay

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Objective

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• Can a regional scale model be used for quantification of storm surge attenuation by wetlands?



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REGIONAL SCALE



PROCESS SCALE



Methods

- Regional scale model: ADCIRC+SWAN
 - Sensitivity analysis in semi-idealized conditions
- Local scale model: ADCIRC subdomains
 - Sensitivity analysis in realistic conditions at marsh field sties
 - Resolution, delineation of marsh geometries
 - Spatial representation of surface roughness
- Field work mobilization/deployments
- Calibrate with field data: topo, vegetation, hydrodynamic

- Against hydrodynamic data gathered during storms



Regional Model set-up

Mesh: adapted from FEMA R3



~ 1.5 million node unstructured mesh

Storm Forcing: NHC Best Track





Semi-idealized analysis Spatial scales for attenuation

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Local Scale: Marsh Field Sites

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OCEANS 15

FEMA Region 3 mesh at marsh scale





Eastern Shore of Virginia National Wildlife Refuge



ADCIRC Subdomains



Eastern Shore of Virginia National Wildlife Refuge



Hurricane Arthur Subdomain Run



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- Hurricane Arthur (asymmetric vortex wind model)
- Full run: 3.75 hrs, 400 cores
- Sub run: 1.25 hrs in serial

Storm Surge Syposium, November 2015



Wetting and Drying Test





H0 = 0.01 m



Field Work

Quadrat, caliper, meter tape

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Bushnell/Gopro

'Pre-Joaquin' Deployment, October 2015

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Impressions so far

- Capacity of wetlands to provide storm surge attenuation in the Chesapeake Bay region is highly dependent on storm characteristics, wetlands configuration and geomorphology.
- However, at the same spatial scale -> high degree of scatter in attenuation.
- Combining modeling and field measurements will provide a more robust framework to understand the potential of storm surge attenuation by wetlands.



Future Work

- Perform sensitivity tests iteratively improving:
 - 1. Resolution \rightarrow DEM and field surveys
 - 2. Spatial definition of surface roughness → vegetation surveys, NLCD, NWI, etc.
- Testing ADCIRC's bottom friction formulations
- Calibration with field data based on sensitivity experiment results.





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Extreme Science and Engineering Discovery Environment

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Questions?

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