Coast to Cosmos Lecture Series

Attenuation of Hurricane-Generated Waves in Flooded Wetlands: Field Observations and Numerical Modeling

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Abstract:

In the past decade, interest in wave attenuation by vegetation has increased considerably as coastal engineers and scientists search for sustainable, nature-based solutions to mitigate the impacts of climate change and natural hazards. It is well known that vegetation in wetlands can effectively reduce the flow speed, modify turbulence structure, attenuate wave energy, and affect sediment dynamics. Restoring coastal wetlands and reducing flood risks require improved understanding and better predictive capability of wave and surge attenuation over inundated coastal landscapes with vegetation. Recent field studies on wave attenuation by salt marshes under tropical cyclone conditions have shed light on the vegetation effects on wave spectra and wave height distributions. Most of the existing storm surge and wave models, however, utilize the conventional quadratic law for bed shear stresses. An empirical, constant bottom friction coefficient has been used to represent the increase in the flow resistance due to vegetation, which may not be applicable to storm surges and hurricane-generated waves over marsh grass and mangroves.

During a hurricane event, salt marshes remain emergent at the beginning and ending of the water surge while become completely submerged at the peak of the surge. For flows over flooded wetlands, the vegetation drag coefficient strongly depends on the vegetation properties (vegetation spacing, stem diameter, plant height and flexural rigidity, etc.) as well as the flow depth and speed associated with the storm surge and wind waves. Hurricane Isaac (2012) made landfall in southeastern Louisiana. Although it was only a Category 1 hurricane, the large size of the storm, the slow forward speed, and the shallow water depth of the Mississippi River delta and its estuaries result in a surge height equivalent to a Category 3 hurricane making landfall on an open coast. Large waves were observed in the Gulf of Mexico and small waves were measured in flooded wetlands.

I will present recent advances in field observations and multi-scale numerical modeling of wave attenuation by wetland vegetation. Two field data collection campaigns during Tropical Storm Lee (2011) and Hurricane Issac (2012) will be described and the data will be presented. Numerical modeling results ranging from vegetation-resolved large eddy simulations under idealized conditions to incorporating vegetation-induced drag forces into conservation laws of momentum and energy for engineering applications will be shown. Effects of vegetation flexibility on wave attenuation will be discussed.

Speaker's Bio:

Dr. Qin Jim Chen is CSRS Distinguished Professor in Coastal Engineering and Professor of Civil and Environmental Engineering at Louisiana State University (LSU). He specializes in the development and application of numerical models for coastal hydrodynamics, wave-structure interaction and deltaic processes. His research includes field observations and applications of high performance computing technologies. Dr. Chen serves as a focus area head in the Center for Computation and Technology, an associate director of the Coastal Studies Institute, and the coordinator of Water Resources and Coastal Engineering at LSU.