High-Resolution Prediction of Coastal Compound Flooding under Future Relative Sea Level Rise

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STUDY OBJECTIVES

Many locations along the U.S. East and Gulf Coasts have experienced compound flooding, defined as combination of storm tide, fluvial, and precipitation-driven flooding.

In this study, we develop a hydrodynamic model to study the effects of relative sea level rise (RSLR) on compound flooding at street to community scales in Norfolk City located in Hampton Roads, VA.

This model is evaluated for the 2011 tropical cyclone Irene which caused massive flooding on the U.S. East Coast.

BACKGROUND

Hampton Roads region is experiencing a high and increasing rate of flooding as well as the highest rate of RSLR in the U.S. East Coast

Compound flooding is nonlinear and thus simulating the impacts of each source (i.e., tide, surge, river, and rainfall) separately and adding them up would lead to large errors.

HYDRODYNAMIC MODEL

Delft-3D Flow Flexible Mesh (depth-averaged 2D)

The offshore portion of the model domain extends 1500km toward the Atlantic Ocean and beyond the continental shelf and covers ~2000km of the U.S. East Coastline

The grid contains ~1653000 cells, covering an area of 2.95 million km2. The model domain has grids with lengths ranging from 20m (high resolution) in Norfolk City to 25km in offshore areas.

Figure 1, Model domain includes coastline of several states of the U.S. East Coast, Chesapeake Bay and Delaware Bay.

The model is forced with M2, S2, N2, K2, K1, O1, P1, and Q1 tidal constituents at the ocean open boundary, with amplitudes and phases obtained from the OTIS package.

BATHYMETRY AND TOPOGRAPHIC

(A) The general bathymetric chart of the oceans gridded data set with 15arc-second resolution, (B) High-resolution (1/3 arc-second) bathymetric digital elevation model of the Chesapeake Bay and (C) Virginia Beach. (D) 3-ft ground resolution LiDAR data of Norfolk and surrounding counties of Chesapeake, Hampton, Newport News, Portsmouth, Suffolk and Virginia beach

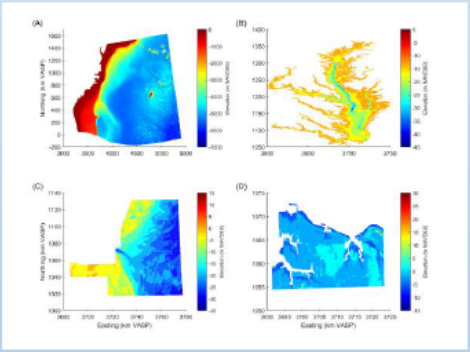

Figure 2; Elevation of topography and bathymetry incorporated into the model domain.

All datasets were converted to North American Datum of 1983 HARN (NAD83 HARN) and North American Vertical Datum of 1988 (NAVD88) and were projected to Virginia State Plane South coordinate system.

RESULTS AND FUTURE WORK

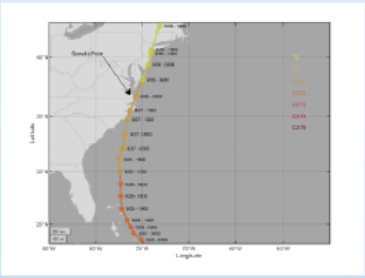

Figure 3; Hurricane Irene 2011 track within the model domain.

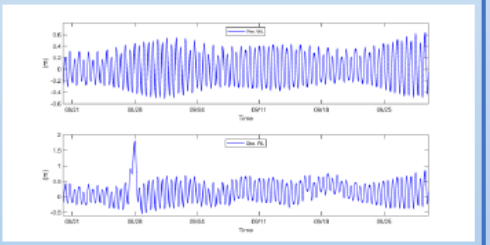

Figure 4; The measured and predicted water level at Sewells Point, VA.

A series of parametric tropical cyclones to be applied to the verified model.

Rainfall will be incorporated into the model to investigate the effect of compound flooding.