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Implications of Beach and Dune Topography on Storm Surge Dynamics on the Florida Panhandle

IMPLICATIONS OF BEACH AND DUNE TOPOGRAPHY ON STORM SURGE DYNAMICS ON THE FLORIDA PANHANDLE

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The elevation and gradient of coastal beach and dune topography can have a significant impact on coastal storm surge and waves. For instance, the presence of elevated beaches and dunes can induce wave breaking and attenuate maximum wave heights. Dunes can physically prevent water from passing inland when the surge depth is below that of the dune crest. However, even when dune overtopping occurs, the presence of the dune will still affect the timing and duration of inundation and may limit the depth of flooding and height of waves behind the dune. The degree that dune heights and beach profile affect flooding is also partly a function of the intensity of the storm. Larger storms that generate very high surge may be minimally affected if the dunes are a small portion of the total flow depth. Smaller storms that generate surges of similar height as the dunes may be greatly affected.

Many sandy beaches and dunes are highly mobile during storm events. Data suggest that each storm event has the potential to re-work the near-shore landscape. This implies that for a specific coastal location, the surge and wave characteristics may change over time in response to the shifting landscape. When computer simulations are used to predict surge and wave dynamics for a particular region, it is important to carefully implement representative coastal topography. For instance, this can be quite important when validating a computer model to historic data which corresponds to a historic landscape that is not adequately represented by the most recent topographic data sets. Alternatively, existing topographic data sets can become obsolete if storm events have reshaped the beach to a degree that the data no longer reflects the actual landscape. When flood risk analysis is performed, the quantified risk may be misleading as the near-shore topography evolves naturally overtime. Consequently, it is of interest to monitor changes to the near-shore landscape and to understand how these mobile landscapes impact local surge and wave dynamics.

A recently constructed storm surge model of the Florida Panhandle coastal region is used to explore the sensitivity of extent and depth of flooding to coastal topography. Historic gauge data and high water mark (HWM) data for several historical hurricane events are used to evaluate the accuracy of the computed surge and to explore how the solutions are modified using different beach profiles and dune heights. Results for a test using Hurricane Ivan are presented below. To test the effect of dune height on the storm surge, the dune height was lowered 1.5 meter (m) near the entrance to Pensacola Bay to approximate the magnitude of erosion that has been observed during storm events to dunes on Santa Rosa Peninsula (EPA-FL, 2004). The results in Figure 1 and Figure 2 show that the lowered dune height results in a modest 0.5 ft surge increase throughout the bay. The time series reveals that the arrival time of the surge is slightly advanced with the lowered dune once the surge exceeds 1.5m, but the duration of deep inundation is

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reduced. Additional tests have revealed the degree of sensitivity to the 1.5m dune lowering is inversely proportional to storm strength.

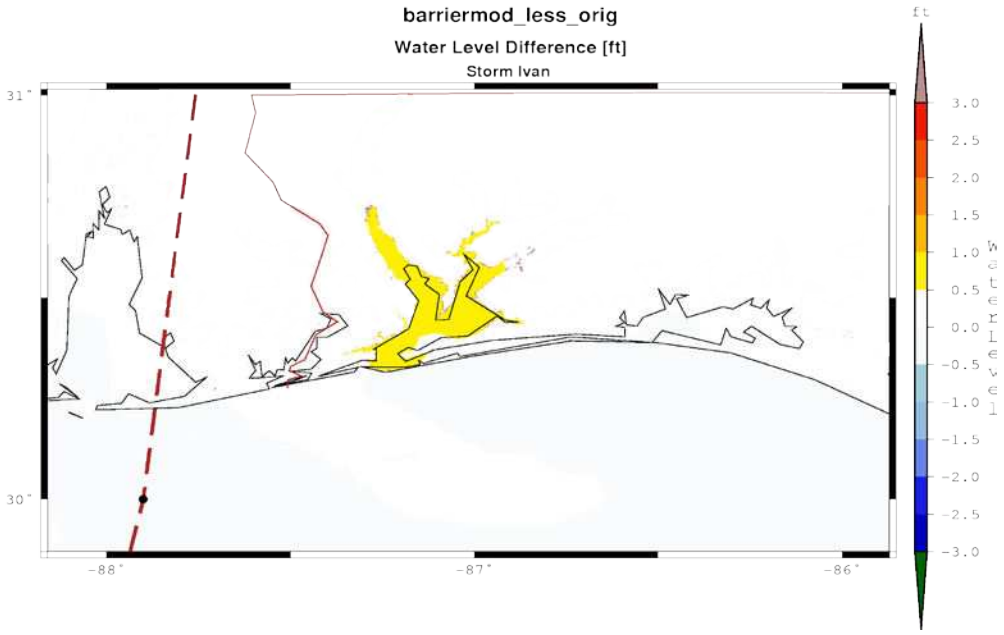

Figure 1 Impact on peak surge of dune erosion south of Pensacola Bay.

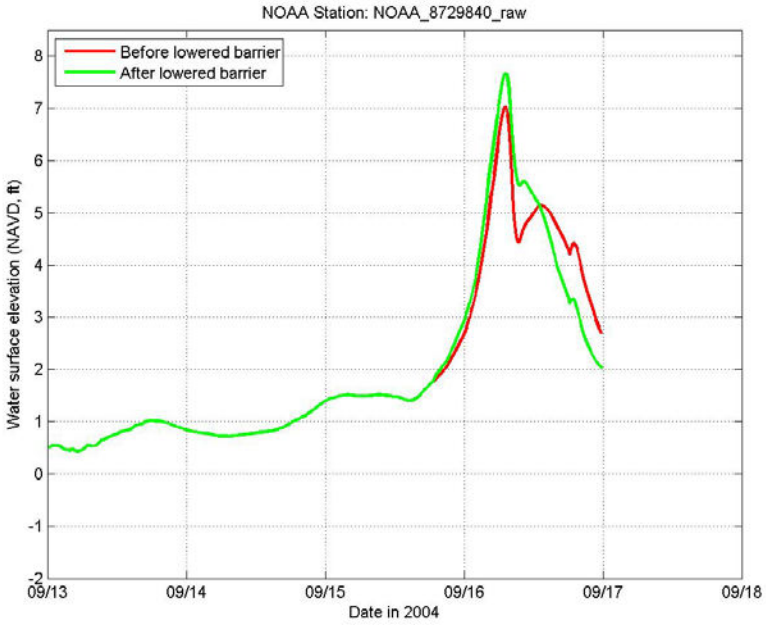

Figure 2 Hydrographs in Pensacola bay for two simulations with identical wind forcing, but different dune heights.

REFERENCES

"Hurricane Ivan, Beach and Dune Erosion and Structural Damage Assessment". 2004, Bureau of Beaches and Coastal Systems Division, Division of Water Resource Management, Department of Environmental Protection, State of Florida.