EESLR 2015· Understanding and predicting changes in coastal marsh ecosystem services: realizing the combined effects of sea-level rise, tides, and storm surge on marshes and their capacity to protect shorelines

Institution: University of North Carolina at Chapel Hill Institute of Marine Sciences
Investigators: C.M. Voss, J. Rosman, R.A. Luettich, C.H. Peterson
Total cost: $ 598,885.
Budget period: 3 yrs
Project Summary: Rising sea levels and changes in exposure to storms are aspects of global climate change that challenge the resilience of coastal ecosystems and human communities. Protecting coastal populations and preventing the loss of ecosystem services provided by marsh habitat represents a crucial challenge. Flooding risk and attendant damages to natural resources on estuarine shores depend upon local sea levels along with storm surge, tidal phase and/or meteorological state, and wave conditions. This project will use 8 years of as yet unpublished continuous water-level data at two locations within the North Carolina (NC) Sentinel Site Cooperative (SSC), one on Bogue Sound with water level variations dominated by tides and the other on southern Pamlico Sound with water level variations dominated by wind. This research will quantify the contribution of different forcing mechanisms, including tides and wind, to water level variations at these sites. Harmonic analysis will be used to isolate variations due to tide. The role of meteorological forcing will be investigated using a database of existing storm surge simulations that have employed ADCIRC. These efforts will focus on 5 tropical storms and the 5 extratropical storms that impacted NC in those 8 years. In addition, this project will combine a marsh transgression model with a marsh wave attenuation model to predict changes in shoreline protection associated with rising sea levels and changes in storm intensity. This marsh wave attenuation model will be developed from basic physical principles and field measurements at 10 marsh sites within the NC SSC boundary. Marshes at these sites are composed of two structurally different alternative dominant marsh macrophytes, *S. alterniflora* and *J. roemerianus*, which are expected to have different wave attenuation properties. Opportunistic storm sampling at selected sites will be used to test predictions of the model. Using this model, marsh wave attenuation capacity at the 10 sites under present day conditions and future scenarios will be examined. Future scenarios will explore effects of increases in sea-levels, storm intensity, and storm frequency on marsh habitat in a factorial design. For each scenario, this research will examine how wave attenuation capacity varies across a range of storm surge and incident wave conditions. For each site, the marsh position, extent, and plant community will be adjusted for sea-level rise using a digital elevation model. Field measurements of site topography and plant distribution will be used to predict the extent and condition of marsh habitat over 1-50 years, recognizing limitations to landward transgression based on barriers including steep slopes. Wave attenuation capacity will then be computed for these new marsh distributions across the range of expected storm surge (water level) and wave conditions. Marsh habitat changes will also be translated into changes in the delivery of other macrophyte-related ecosystem services: trophic contribution and hydrologic processing. By comparing the resilience and ecosystem service capacities of the two marsh dominants, managers can target the best species or mixed species pattern for restoration projects. The project will also identify barriers to up-slope transgression that could be removed to improve marsh resilience in the face of sea level rise, and provide guidance for coastal property owners on the value of marsh habitat in protecting their shoreline properties. Finally, the King Tides Project will be implemented in NC with other outreach efforts to increase public awareness about coastal inundation issues and the value of natural assets.