

Executive Summary Outline

Cullowhee Coastal Conference on Tropical Storm Hazard Assessment

An expert panel was convened in July 2007 to discuss the state-of-the-art of assessing and mapping coastal hazards. The panel consisted of 20 coastal scientists and engineers from academia, the public sector, and the private sector. The goal of the meeting was to build a cross-disciplinary, consensus slate of recommendations for how coastal storm hazards should be quantified and mapped. The panel examined only the scientific aspects of our current understanding of coastal hazard assessment, and did not address issues of planning, risk assessment, or coastal management. The workshop focused on the impacts of tropical storms on the southeastern coast of the United States. Participants developed recommendations to improve the accuracy and utility of coastal hazards mapping and to guide future data collection efforts to improve the accuracy of current (and future) methods. The First Cullowhee Coastal Conference aimed to identify areas of consensus and discordance among practitioners of coastal storm hazard assessment and hazard mapping. Recommendations were sought regarding the types of data and techniques needed to fill the gap in our present understanding of coastal storm response to landfalling tropical cyclones in the southeastern U.S.

The panel agreed that both extrinsic and intrinsic factors determine tropical storm hazards and coastal impacts at any given location. Both factors must be considered when establishing the vulnerability of any particular coastal segment.

1) Site **Extrinsic Factors:** Extrinsic factors establish the likelihood that any particular site will experience a tropical storm in any given year. Extrinsic factors are currently being researched by groups (such as Yan et al., 2006 and Ebersole et al., 2007) that examine the probabilistic occurrence of hurricane impacts and landfalls, respectively.

2) Site **Intrinsic Factors:** The physical setting of a coastal segment affects the intensity of storm processes. For example, low-elevation areas without sand dunes are more likely to experience intense overwash and inundation than areas of higher elevation and large protective dunes. An example of intrinsic factor hazard assessment is the methodology outlined in Sallenger (2000), which partitions storm effects into four impact regimes.

It is the conclusion of this panel that both extrinsic and intrinsic factors must be considered when establishing the vulnerability of any particular coastal segment. Ideally, these factors should be integrated within a probabilistic framework, taking uncertainties into account.

Data needs: A critical aspect of the panel's discussion centered on identifying the data needed to better characterize physical processes of storms as potential hazards. The panel focused primarily on assessing **storm surge, waves, and inundation**. Wind hazards and inland precipitation were considered to be adequately characterized at present and, thus, were not examined.

It was agreed that currently there is significant uncertainty in the assessments of surge, offshore and inland wave characteristics, and inundation levels from landfalling tropical cyclones because there are insufficient data available to assess the accuracy of current models. This is true for all model systems currently employed (e.g. SLOSH, ADCIRC, POM-ROMS-FVCON-HYCOM System) and is particularly true for complex, inland water bodies and over areas of open marsh. The panel draws this conclusion based on the significant lack of storm surge field data available for model calibration and verification. To fill this gap, the panel recommends the following:

I. Goal: A joint regional goal to improve coastal hazard mapping and assessment should be established amongst relevant federal and state agencies together with participation by scientists and engineers from academia, the public sector, and the private sector.

II. Impetus: The motivation behind the establishment of this goal is the realization by the panel members that existing numerical models of tropical storm hazards have not been adequately calibrated, verified, or sufficiently constrained by data due to a lack of direct *in situ* observations.

III. Actions: In order to meet the goal of improved hazard mapping, the following set of actions were recommended:

A. A major effort by the relevant federal agencies to improve the real-time, synoptic data collection of important storm impact characteristics such as storm surge water levels, onshore inundation, offshore and inland wave characteristics and changes in coastal morphology and elevation.

B. The development of a national storm surge level database that can be used for hazard mapping, model calibration and verification, and testing the results of the storm surge and inundation hazard prediction.

C. Continuing efforts to map nearshore bathymetry and onshore topography in as much detail as feasible to improve the accuracy of all aspects of hazard assessment mapping.

D. There are significant uncertainties in the extrinsic factors as a result of the limited duration of historical storm data sets and the incompleteness of this data set prior to 1950. The problem is further complicated by climate change. It is important to re-analyze and develop a better understanding of the historical record in order to reduce, or at least be able to quantify, these uncertainties. In the future, numerical hurricane models may also yield some useful insights on these issues.

IV. Products: Implementation of the preceding recommended action items would dramatically improve our understanding of coastal storm processes and hazards, and facilitate better predictive capabilities for coastal planning and management. Distinct derivative products would include:

1. High fidelity databases of *in situ* measurements of physical processes with pronounced improvement in spatial and temporal resolution
2. Publicly accessible distinct quantitative model outputs illustrating spatial hazard patterns and probability maps for hazard vulnerability.

References Cited

Bruce A. Ebersole, D. T. Resio, and J. J. Westerink, 2007. A Community Approach to Improved Prediction and Characterization of Coastal Storm Hazards. *Marine Technology Society Journal*. Vol. 40, no. 4.

Sallenger, A. H., Jr. 2000. "Storm impact scale for barrier islands." *Journal of Coastal Research*, 16(3), p. 890–895.

Yan, T., L. Pietrafesa, S. Bao, 2006. . Frequency of Occurrence of Land falls of Hurricanes. Reviewed Proceedings: *27th Conference on Hurricanes and Tropical Meteorology, April 23-28, Monterey, CA*.

Storm surge models:

ADCIRC: Advanced Circulation Model for Oceanic, Coastal, and Estuarine Waters, developed by R. Luettich and J. Westerink.

SLOSH: Sea, Lake, and Overland Surges from Hurricanes, developed by the National Weather Service and the National Hurricane Center.

POM-ROMS-FVCON-HYCOM: Princeton Ocean Model-Regional Ocean Model System-Finite Volume Conserving-Hybrid Circulation-Ocean Model System, developed by M. Peng, S. Bao and L. Pietrafesa