US Army Corps of Engineers®
Engineer Research and Development Center

Ongoing Research

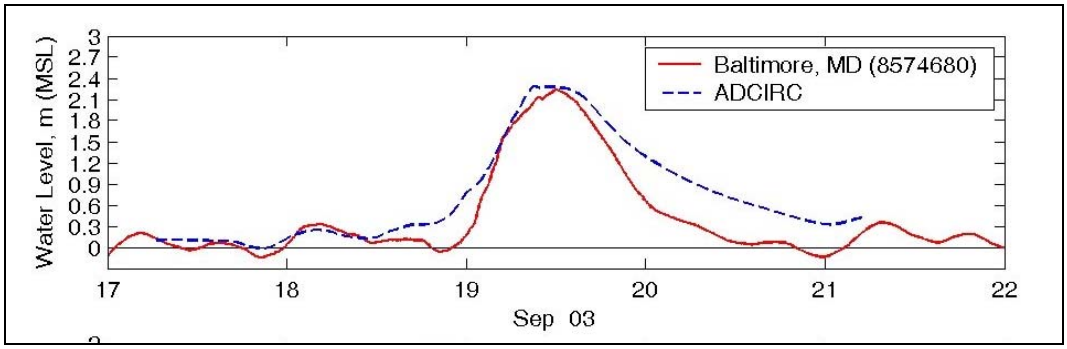
Storm Surge Frequency-of-Occurrence Analysis for Chesapeake Bay

Problem

More people are living and working in coastal towns, with the result that losses due to flooding are increasingly more common and severe. The Federal Emergency Management Agency (FEMA) has published Flood Insurance Studies (FIS) for numerous communities along the Chesapeake Bay and its tributaries to promote sound floodplain management. For many Bay communities, these flood-risk analyses have depended on data published in Boon et al. (1978), which summarizes storm surge estimates for the area. Since its publication, however, 28 extratropical and 11 tropical storms, including Hurricane Isabel, have impacted the Bay. Given the intensity of Hurricane Isabel and the vast area that was flooded, concern exists that the flood hazard areas designated in the existing FIS are obsolete and that new flood analyses should be performed.

Description

The U.S. Army Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL) recently completed a life-cycle analysis of construction projects for Mid Bay and Poplar Islands, Chesapeake Bay, Maryland, sponsored by the U.S. Army Corps of Engineers District, Baltimore. As part of this study, 95 tropical and extratropical storms were numerically simulated (Lin et al. 2005), developing a database of model-generated water-surface elevations throughout Chesapeake Bay.



Comparison of model-generated and measured water levels at Baltimore, Maryland, during Hurricane Isabel, September 2003.

Frequency-occurrence relationships will require combining the time-series of storm surge with multiple time-series of astronomical tide elevations to account for the independence in phasing between the hurricane making landfall and tide elevation. This approach permits peak storm surge to occur at any time during a tidal cycle. Consequently, time-series of water-surface elevations are required at each location where stage-frequency relationships are desired. This research will perform a 90-day simulation with the calibrated ADCIRC model developed by Lin et al. (2005). Water-surface elevation constituent amplitudes and phases will be computed with the harmonic analysis module contained in ADCIRC over the latter 75 days of the simulation.

Constituent amplitudes and phases will be used to synthesize multiple time-series of water-surface elevations. Linear superposition of time-series of storm surge and water-surface elevations will provide time-series of surge plus tide elevations. The peak water-surface elevation will be extracted for processing in the frequency-of-occurrence analysis using the Empirical Simulation Technique (EST) statistical method, which simulates life-cycle sequences of cyclic, but non-deterministic multi-parameter systems, such as storms and their

corresponding environmental impacts (Scheffner and Borgman 1993). This procedure generates a large population of life-cycle databases that are post-processed to compute mean value frequency relationships with standard deviation error estimates. Two frequency-of-occurrence relationships will be generated, one for tropical storms and the other for northeasters. These two relationships will be combined into one using the procedures described in Scheffner et al. (1999).

References

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Expected Products

The research will develop an updated grid of the Chesapeake Bay for use in this and subsequent modeling efforts. Datasets developed by the ADCIRC model during the study will include multiple time-series of water-surface elevations, surge plus tide elevations, and peak water surface elevations. Datasets developed by the EST portion of the study will include maximum water surface elevations expected to result from tropical storms and northeasters. Frequency-of-occurrence relationships will be developed for tropical storms, northeasters, and the combined scenario.

Potential Users

Corps Districts; FEMA Region III; the states of Maryland and Virginia; and Federal, state, and local agencies concerned with storm surge levels in the Chesapeake Bay will be the main beneficiaries of this research.

Projected Benefits

The results of this research will help FEMA determine whether new and more rigorous flood insurance studies are warranted. Federal, state, and local agencies with interests in floodplain management, emergency operations, ecosystem restoration, navigation, and regulatory functions also will benefit from the knowledge generated by this research.

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