DESIGN HURRICANE STORM SURGE PILOT STUDY

BACKGROUND

Storm surge prediction models are used to forecast inland flooding for hurricanes. They are useful for coastal hydraulics, in addition to emergency/evacuation planning and other purposes such as assessing building codes and predicting the environmental impacts of storms. By predicting hydraulic conditions at bridges and roads, the models provide key information for proper design. The greater the accuracy of the predictions, the more useful the models. Two ways to improve storm surge models that had not been tested include (1) determining if combining wave action models with water elevation projections would improve the storm surge modeling procedures and (2) assessing how tidal inlet-bay systems affect coastal storm surge modeling.

OBJECTIVES

The purpose of this study was to examine several aspects of the processes by which storm surges are predicted, including (1) how two-way coupling impacts storm surge elevations and wave models, and (2) how tidal inlet-bay systems affect storm surge hydrographs on the open coast in the vicinity of the inlet during hurricanes.

The objectives of this study were as follows:

- Develop one- and two-way computer code and procedures for coupling the hydraulics model, ADCIRC, and the wave model, SWAN.*
- Using the one- and two-way coupling code, perform numerical experiments with idealized and real geometries with steady, uniform, and unsteady hurricane wind fields with
    - different bed slopes
    - different frequencies of information exchange between models
- Analyze the results of the numerical experiments to determine the differences in water elevations and wave parameters for the one- and two-way coupling.
- Determine the impact of tidal inlet-bay systems on storm surge hydrographs on the open coast in the vicinity of the inlet.

* Shallow water wave (computer) models, such as SWAN, output wave induce radiation stresses that can be input to depth-averaged hydraulics models, such as ADCIRC, to produce a more accurate estimation of the water elevation. The time dependent water elevations from ADCIRC can then be input to SWAN to produce more accurate wave predictions. In this report, one-way coupling refers to periodically inputting the radiation stresses from the wave model to the hydraulics model. Two-way coupling refers to the procedure of periodically inputting radiation stresses from the wave model to the hydraulics model and periodically inputting water elevations from the hydraulics model to the wave model. The time interval for the information exchange need not be the same; in fact, the frequency of water elevation exchange can be lower than the wave radiation stress exchange. Most storm surge predictions/hindcasts to date that include waves have only used one-way coupling (radiation stress from wave model input to hydraulics model).

FINDINGS AND CONCLUSIONS

For most storm surge applications one-way coupling at intervals of approximately 3 hours appears to be adequate. If approximate wave conditions are needed, then the procedure described in the report should be used:

1. Run the wave model with ambient water levels and save the radiation stresses at each time step.
2. Input the radiation stresses and wind field to the surge model, and obtain water levels throughout the domain at each time step.
3. Using the storm surge generated water elevations, re-compute the waves throughout the model domain at each time step.

If more accurate results are required, then two-way coupling may be required. For two-way coupling, wave-to-surge and surge-to-wave, the information exchange interval should be approximately 3 hours or less.

With regard to the impact an inlet-bay system may have on model predictions, this study indicated that unless the inlet-bay system is very large, the impact on open coast storm surges is not significant from a practical, storm surge modeling point of view.

BENEFITS

The information obtained through this study will be useful to anyone who conducts hurricane storm surge hindcasts, as it provides guidance regarding when to use one- and two-way coupling of surge and wave models. The results of this study are also useful to those modeling storm surge and waves in bays, harbors, and waterways with seaward mesh boundaries that extend just beyond the inlet.

The models will be useful for predicting and planning for storm surges in a variety of ways, which include but are not limited to bridge and building design considerations and emergency/evacuation planning, which translate into improved safety and economic benefits.

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