MODELING COASTAL STORMS; PAST, PRESENT AND FUTURE

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A consortium of universities and other partners, led by Texas A&M University at Galveston, is investigating the feasibility of a coastal barrier to greatly reduce coastal flooding in the Houston/Galveston region caused by hurricane-induced storm surge. In support of the feasibility study, Jackson State University and the U.S. Army Engineer Research and Development Center's Coastal and Hydraulics Laboratory are collaborating to quantify storm surge suppression and reduction in inundation that can be achieved with the Ike Dike concept, which is a long coastal spine (dike and/or wall system) and gates at the tidal passes. This presentation summarizes key findings regarding the Ike Dike's flood mitigation benefits, which are based on results from highly detailed, coupled storm surge and wave models.

Past modeling involved a "bracketing" set of 25 different hurricanes, each of which was simulated for both the existing condition, which reflects a post-Hurricane Ike (2008) condition, and a with-Ike-Dike condition. The with-dike condition was a long coastal spine which extended from Freeport, TX to a location near High Island, TX, having a crest elevation of 17 ft, the same elevation as the Galveston seawall. All model simulations were made for the 2008 sea level, which is considered to be present-day sea level. Twenty-one, high-intensity hurricanes were simulated, each having a very low 900-mb minimum central pressure, each taking a different track and having a different landfall location, and each approaching from one of three directions. The other four storms had varying intensities, central pressures of 900 mb, 930 mb, 960 mb, 975 mb, but were all on a "direct- hit" path approaching from the south-southeast. The direct-hit path involved landfall at the City of Galveston and a storm that tracked inland along the western shoreline of Galveston Bay. The bracketing set enabled understanding of the following: 1) how hurricane storm surge is generated in the region, particularly in those key areas along the western shoreline of Galveston Bay that have the greatest potential for economic damage and losses, 2) how the peak surge varies spatially for a particular storm, and 3) how storm track influences surge development and peak surge. The four "direct-hit" storms were selected to assess how storm surge varied as a function of intensity.

Present modeling involves simulations for the same existing condition and a longer with-dike condition, in which the 17-ft Ike Dike concept was extended to Sabine Pass, TX, in order to avoid the significant contribution to storm surge in Galveston Bay caused by flanking of the northeast terminus of the dike. Present modeling involves storm surge simulations for Hurricane Ike and for three "proxy" storms. The proxy storms were selected, from among those considered in the recent FEMA Risk MAP Project, to best approximate peak water surface elevations associated with the 10-yr, 100-yr and 500-yr average recurrence intervals along the western side of Galveston Bay. Examination of proxy storms enables an initial probabilistic assessment of economic damages and losses. The proxy-storm approach was adopted as balance between level of effort, technical rigor, and resources available to perform the modeling and analysis.

The influence of sea level rise on storm surge is examined in the present modeling. A projected relative sea level rise of +2.4 feet (an estimate for the year 2085 using an assumed intermediate rate of global sea level rise) is adopted as a future sea level scenario in a simplified sensitivity study, which also involves the 2008 present-day sea level scenario.

Surge suppression and reduction in the extent of inundation achieved with the coastal spine, and residual risk, are being examined in various sub-regions of the broader Houston-Galveston area, as are possibilities for secondary lines of defense to further reduce residual risk. Some results are presented. The Ike Dike concept is extremely effective in eliminating coastal flooding in most areas that lie behind it for lesser-intensity hurricanes, and even for a storm like Hurricane Ike. For major hurricanes, surge suppression achieved with the Ike Dike concept is 7 to 9 feet on average, which greatly reduces the likelihood of inundation in all areas. The 17-ft Ike Dike reduces the likelihood of inundation to a very low probability at nearly all the heavy industrialized sites and in a number of residential areas. Because of the storm surge dynamics within

Galveston Bay, even with the dike in place, there is residual risk, particularly in the lowest-lying areas. Sea level rise increases residual risk.

Peak storm surge results from the model simulations are being used as input to assess the reduction in economic damages/losses achieved with the Ike Dike concept. The economic analysis is being led by Texas A&M University at Galveston.

Future plans for the storm surge modeling are presented.