Research Project Name: Present and future hazard scenario database for coastal infrastructural resilience and maintenance planning

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Description: This project seeks to characterize present and future flooding impacts for coastal communities by using a database of historical and synthetic storms to force a suite of hydrodynamic and wave models for a coastal community. Projections of wave, surge, and flooding will be particularly focused on areas near critical infrastructure components (e.g., roads critical for evacuation and recovery; bridge piers, etc.). Synthetic storms have many of the same trends as the historical storms but have random starting and ending locations along established tracks, along with a distribution of hurricane parameters along these tracks. Wind fields from the hurricanes can be calculated from the parameters, and since the parameters have a probability of occurrence associated with them, surge probability and susceptibility can be determined. In addition, upland discharge values will be added to represent flooding from rainfall and riverine sources. The overall product will be a set of maps delineating flooding risk and susceptibility. For selected infrastructural components of particular concern, a phase-resolved wave model, driven by flooding and wave events from hurricanes, can be used to simulate the time-dependent forces from hurricane-driven waves and help pinpoint potentially damaging conditions within hurricane events. Finally, the results will be used to evaluate the impact of flooding on evacuation and traffic flow.

US DOT Priorities: The expected outcomes from this work include identification of infrastructural elements at high risk of failure, whether by impact damage or undercutting and scour by erosion, as well as the development of a usable database of future climate scenarios for flooding and surge risk evaluation and evacuation planning for a given region. This would address Priority Area D since it deals specifically with issues impacting durability of infrastructure.

There are four innovative aspects to this proposed work. One is the use of a physically realistic, well validated model (Delft3D) for replicating both the hurricane surge (its typical use) and inland flooding from rivers and rainfall (a new, innovative application). This latter application was developed recently through a Healthy Gulf Coasts program project supported by the National Academies. Typically, models like SLOSH (a fast, approximate surge model) would be used for surge predictions. However, using a pre-calculation approach for surge response allows the use of accurate, though computationally intensive, models such as Delft3D, leading to more reliable predictions of surge and accurate delineation of critical areas of chronic flooding. The second is the use of the TCWise synthetic hurricane database, which increases the robustness of probabilistic estimates of flood levels and helps determine flooding susceptibility for a given area. The third is the selective use of coupling the Delft3D hydrodynamic model with a phase-resolved wave model (FUNWAVE) to look at highly transient wave and surge conditions on infrastructural components. While Delft3D will resolve surge and the appropriate scale, waves

riding atop surges are averaged, so the peak wave elevations are not predicted. Coupling with FUNWAVE will allow these peak wave elevations to impact local infrastructure in order to determine the likelihood of damage. Finally, the forecasting of potential hurricane impacts on traffic and evacuation is a new application of modeling technology to solve a critical problem impacting a community's durability and recovery.

Outputs: The primary result of this work will be the establishment of flooding susceptibility maps for a given coastal community. These maps will provide information on flooding probability and risk and can be used to help plan infrastructure maintenance actions and distribute resources. These maps can also be tailored for various specific applications (e.g., tracking trends in traffic, evaluating evacuation routes) and can be extended with information from phase-resolving models to highlight damage probability on critical infrastructural components.

We have involved city engineers and planners from three Texas coastal communities in this proposed work: Galveston, Port Arthur, and Texas City.

Outcomes/Impacts: The outputs and products from the work are described above. The impact of this project will involve maintenance and repair protocols and scheduling for city planners and engineers. An improved, verified depiction of critical areas of surge, waves, and flooding will better estimate potential repair and maintenance budgets.

Final Research Report: URL to final Report will be provided upon completion.