COASTAL TEXAS: MODELING NATURE BASED BEACH PROFILE RESPONSE TO EXTREME STORM EVENTS

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INTRODUCTION

The upper Texas coastline is receding rapidly, on the order of 5 feet per year and in excess of 20 feet per year in some regions (HDR 2014). The Coastal Texas Study was developed in response to shoreline recession, in a coordinated effort with local sponsor the Texas General Land Office (GLO) to develop solutions to improve Texas coastal resilience. Severe storm events are capable of exacerbating shoreline recession, and causing billions of dollars of damage. This study specifically addresses the feasibility of nature-based improvements to the dune-beach system along Galveston Island and Bolivar Peninsula. The numerical model SBEACH (Storm-Induced BEAch Change) was used to simulate the cross-shore response of representative existing beach profiles and alternative configurations relative to historic extreme storm events. Evaluation of alternatives was based on storm-induced performance and sediment budget requirements in an effort to identify improvements that optimize resilience of the coastline and protection to its inhabitants.

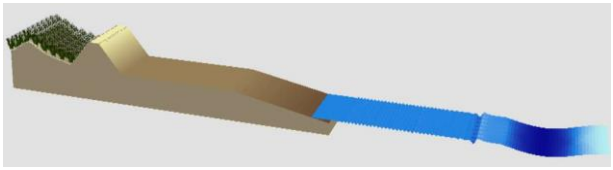

Figure 1 – 3D representation of single dune configuration

BACKGROUND

From west to east, the study site includes approximately 19 miles Galveston Island beachfront, from San Luis Pass to the western end of the seawall, and 26 miles of Bolivar Peninsula shoreline, from Fort Travis to High Island. Four contiguous, morphologically similar reaches of shoreline were identified within the study site, from which representative cross-shore profiles were developed to characterize the beach morphology of each respective reach. Met-ocean and water level time-series data was collected for recent extreme storm events including Hurricane Ike.

SBEACH MODEL

SBEACH is an empirically based numerical model that uses an explicit finite-difference scheme to simulate the storm-induced response of beach profiles in the cross-shore direction. Model results were utilized for comparison of pre and post-storm existing and alternative design profiles. Alternative profile configurations modeled include varying quantities, dimensions, and shapes of dune-berm systems. The primary performance evaluation criteria was based on upland damage hazard mitigation, (landward of the primary dune) relative to sediment budget estimates (initial + re-nourishment volume requirements). A detailed risk analysis is outside the scope of this study, however the duration of overtopping and/or profile inundation was central to assessing the potential for damage to upland property. Additional consideration was given to dune resilience due to the time required to establish and the criticality of its condition. Model results yielded post-Ike volume changes at approximately -5.98 to -6.81 cubic yards per linear foot of shoreline in Galveston and -9.02 to -12.23 cubic yards per linear foot in Bolivar for existing conditions profiles. These results were validated within the range of actual post-Ike volume change estimates per a Texas GLO funded HDR study that reports impact from Ike at rates up to -14.1 for West Galveston and -26.9 for Bolivar (HDR 2014).

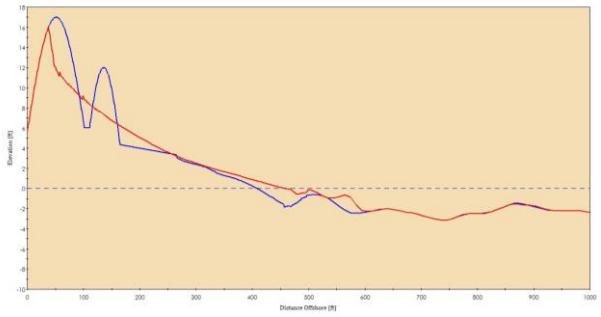

Figure 2 – Pre and post-Ike dual dune design profiles

RESULTS

Increased dune elevation had the most notable performance impact during Hurricane Ike simulations, while berm elevation and width controlled impact to the primary dune during other storm simulations. A dune crest elevation of +17' NAVD88 was the threshold elevation required to effectively eliminate overtopping and profile inundation during the Ike simulation. Further, the dual dune configuration provided optimal results per evaluation criteria by effectively eliminating damage to the primary dune during simulations other than Ike. Sediment requirements for initial construction range between 100 and 160 cubic yards per foot depending on existing beach conditions, for a total of approximately 50-million cubic yards for the entire study site. Post-Ike nourishment requirements in the foreshore region of Galveston are 7.14 to 8.82 cubic yards per linear foot and Bolivar are 13.08 to13.81 cubic yards per linear foot.

REFERENCES

HDR (2014): Beach and Shoreline Changes Along the Upper Texas Coast: Recovery from Hurricane Ike, HDR Engineering Inc., Project Number 166742 pp. 2-61.