A COMPREHENSIVE EVALUATION OF FLOOD HAZARDS FOR SABINE TO GALVESTON, TX, USA REGION

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INTRODUCTION

The Sabine Pass to Galveston Bay, TX Pre-Construction, Engineering and Design (PED): Hurricane Coastal Storm Surge and Wave Hazard Assessment (S2G) includes flood hazard assessment for over 100 km of levee/floodwall/gate coastal storm risk management systems (CSRM). Figure 1 shows the 3 different CSRM systems being evaluated in the S2G PED. The CSRM systems consist of levees, floodwalls, composite systems, gates and pumps, among other things. This paper summarizes this large flood risk study.

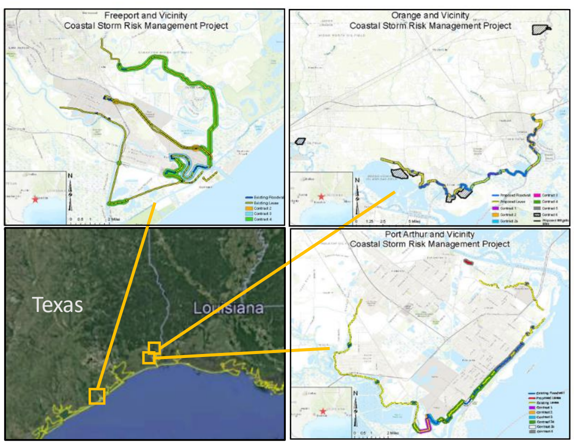

Figure 1. Maps showing 3 CSRM in S2G PED

APPROACH

Coastal flood physics are complex and so flood risk assessment often employs a large number of simplifications. These include linear superposition of water level components, linear combination of waves and water levels, wave height H=K*depth (K=0.78 is often used), no consideration of wave spectral transformation (high to low frequency), insufficient storm population, insufficient model validation, not characterizing multivariate probabilistic relationships, and not characterizing epistemic uncertainty. It is still common to assume that risk can be adequately quantified using a single return interval "event". The result of these simplifications is computed risk levels that can be very different from reality. In this study, we were fortunate to have the computational resources and expertise to compute both physics and statistics at high fidelity in order to compute accurate system response estimates and evaluate common simplifications. The approach resolved practical approaches to flood risk assessment.

For the study reported herein, the focus of the flood hazard assessment was to compute coupled water level and wave response near the structures, runup $R_{2\%}$, and overtopping rate q, combined hydrostatic and hydrodynamic pressure distributions on walls, overtopping nappe characteristics and other pertinent responses stochastically. Water levels included surge, wave effects, tides, and relative sea level rise. Since this is the PED phase, the focus is on design of the CSRM systems. Optimal synthetic tropical cyclone (TC) suites were generated from joint probability models of TC parameters. The storms were modelled with coupled surge and wave models. Nearshore modelling included both phase-averaged and phase resolving wave models. Joint statistical analysis of forcing parameters, including epistemic uncertainty, was conducted to compute hazards. Design was based on varied confidence levels and thus reflected uncertainty. The approach brought high-fidelity components together to produce accurate probabilistic coastal flood hazard assessment.

Figure 2 shows two examples of the overtopping response hazard (left) for CSRM analysis location. Here the increased crest elevation of the with-project geometry reduced combined wave and steady flow overtopping hazard from the without-project geometry. The right side of Figure 2 shows example analysis location cross sections. Overtopping limit states corresponding to the start of leeside erosion damage were used to compute an optimized crest elevation.

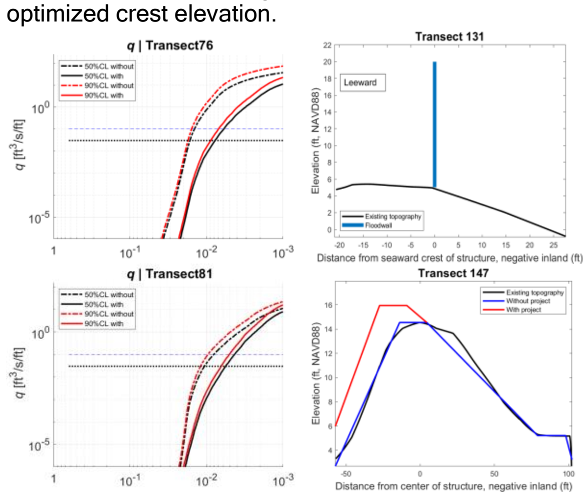

Figure 2. Examples of two overtopping response hazards (left) and example of floodwall (top right) and levee (bottom right) analysis location cross sections.