ASSESSMENT OF THE EVOLUTION OF STORM SURGE IN COASTAL LOUISIANA

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INTRODUCTION

The Louisiana coastal landscape comprises an intricate system of fragmented wetlands, natural ridges, man-made navigation canals, flood protection and oil and gas infrastructure. Louisiana lost approximately 1,883 square miles (4,877 sq km) of coastal wetlands from 1932 to 2010 including 300 square miles (777 sq km) lost between 2004 and 2008 due to Hurricanes Katrina, Rita, Gustav and Ike (Couvillion et al., 2011). A projected additional 2,250 square miles (5,827 sq km) of coastal wetlands will be lost over the next 50 years if no preventative actions are taken (Coastal Protection and Restoration Authority of Louisiana, 2017). Storm surge models representing historical eras of the Louisiana coastal landscape can be developed to investigate the response of hurricane storm surge (e.g. peak water levels, inundation volume and time) to land loss and vegetative changes. Land:Water (L:W) isopleths (Gagliano et al., 1970; Twilley et al., 2016; Siverd et al., 2018) have been calculated along the Louisiana coast from Sabine Lake to the Pearl River. These isopleths were utilized to develop a simplified coastal landscape (bathymetry, topography, bottom roughness) representing circa2010. Similar methods are employed with the objective of developing storm surge models that represent the coastal landscape for past eras (circa1890, c.1930, c.1970).

STORM SURGE MODEL SIMPLIFICATION

L:W isopleths derived for the year 2010 include: 1%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 99%. These L:W isopleths were applied to a storm surge model featuring a high resolution representation of the coastal Louisiana landscape (Coastal Protection and Restoration Authority of Louisiana, 2017) to create 36 variations with simplified landscapes. A L:W isopleth permutation of 99% - 90% - 40% - 1% (Fig. 1) with three distinct coastal zones labeled “High” (99% - 90%, i.e. high wetland), “Intermediate” (90% - 40%, i.e. wetland) and “Submersed” (40% - 1%, i.e. region between open water and wetland) was found to best represent simulated storm surge that most closely reproduces the high resolution storm surge model output. The simplified model mesh was produced using the average elevation of all nodes of the high resolution model within each respective zone with 0.47m, 0.27m, and -0.98m (with respect to NAVD88) and by assigning Manning’s n values of 0.070, 0.045, and 0.025 for High, Intermediate, and Submersed, respectively. This permutation yields mean absolute maximum water surface elevation differences of 0.042 m, 0.044 m, and 0.035 m and mean percent errors in volume inundated (95 percentile) of 3.4%, 11.4%, and 10.2% for Hurricanes Rita, Gustav and Katrina, respectively, across all inundated coastal Louisiana hydrologic unit code 12 (HUC12) sub-watersheds (Siverd et al., 2018).

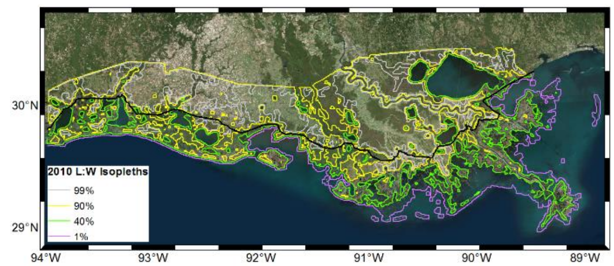

Figure 1 - 2010 Land to Water (L:W) Isopleths with Intracoastal Waterway (black line)

TEMPORAL STORM SURGE EVOLUTION

The goal of the next step in this research is to temporally examine the evolution of storm surge along coastal Louisiana. The L:W isopleths determined to best represent the Louisiana coast as a result of the method devised to develop the simple storm surge model for c.2010 (i.e. 99% - 90% - 40% - 1%) are applied in the development of surge models for historical eras c.1890, c.1930, c.1970 and c.2010. The ADvanced CIRCulation (ADCIRC) code is tightly coupled with the Simulating WAves Nearshore (SWAN) wave model and used to perform storm surge simulations for the models representing historical eras (Luettich and Westerink, 2004; Dietrich et al. 2011). HUC12 sub-watersheds provide geographical bounds to quantify mean maximum water surface elevations (WSEs), volume of inundation, and inundation time. HUC12 sub-watersheds also provide a means to compare/contrast these quantified surge parameters on a HUC12-by-HUC12 basis for the c.1890, c.1930, c.1970 and c.2010 eras. Results will demonstrate how storm surge has evolved in coastal Louisiana from 1890 to 2010, provide insight into important characteristics of the land form and vegetation that attenuate surge, and assist to inform policy makers of regions with temporally accelerating storm surge heights.

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