MODELING THE EFFECT OF LAND-BUILDING PROJECTS ON STORM SURGE AND HURRICANE WAVES IN COASTAL LOUISIANA

Kelin Hu, Louisiana State University, khu@lsu.edu
Qin Chen, Northeastern University, q.chen@northeastern.edu
Ehab Meselhe, The Water Institute of the Gulf, emeselhe@thewaterinstitute.org

INTRODUCTION

Wetland loss on the hurricane-prone Louisiana coast continues at an alarmingly high rate. Coastal Louisiana is at risk of losing between 2118 and 4677 km^2 of land over the next 50 years (Couvillion et al., 2013). To combat the devastating wetland loss, the Louisiana 2017 Coastal Master Plan (CMP) called for sediment diversions along the lower Mississippi River to enhance sediment supplies to coastal wetlands and build more wetlands. The Louisiana Coastal Protection and Restoration Authority (CPRA) plans to spend $2 billion on the Mid-Breton and Mid-Barataria sediment diversion projects. In this study, numerical experiments were conducted to quantify the effect of land-building projects on storm surge and hurricane waves in Barataria and Breton Basins of Louisiana.

METHODS

The coupled flow-wave Delft3D model was applied to study the effect of land-building projects in this area. Vegetation was considered as rigid cylinders in both flow and wave modules. An asymmetric parametric hurricane wind model integrated with background winds was employed to generate surface wind fields. The projected bathymetry and vegetation data with land-building operations in the next 50 years (every 10 years from 2020 to 2070) was provided by the Water Institute of the Gulf. In addition, the data for 'Future without Projects' (FWOP) was achieved as well for comparisons. Based on these data, cases with projects and FWOP cases for a specific year can be set up for numerical experiments. Taken Hurricane Isaac (2012) as an example, the Delft3D model was first validated using water level and wave observations during the hurricane event. After that, numerical experiments were carried out to study the effect of land-building projects on storm surge and hurricane waves by comparing model results between cases with projects and FWOP cases in different years from 2020 to 2070.

RESULTS

The modeled water levels, significant wave heights and peak wave periods agreed fairly well with observations during Hurricane Isaac, which validates good model performance in coastal Louisiana during a hurricane event. Figure 1 shows the effect of land building on water levels and wave heights by an Isaac-like hurricane in 2070. In Barataria Basin, the project reduced about 0.5 m of either storm surge or hurricane waves in the construction area, while caused increases of surge (0.3 m) and waves (0.1 m) to the south of the project due to the blockage of the elevated topography. In Breton Basin, the project effect on storm surge was not obvious due to the semi-enclosed geometry of the basin, while waves were reduced by 0.3 m around the construction area.

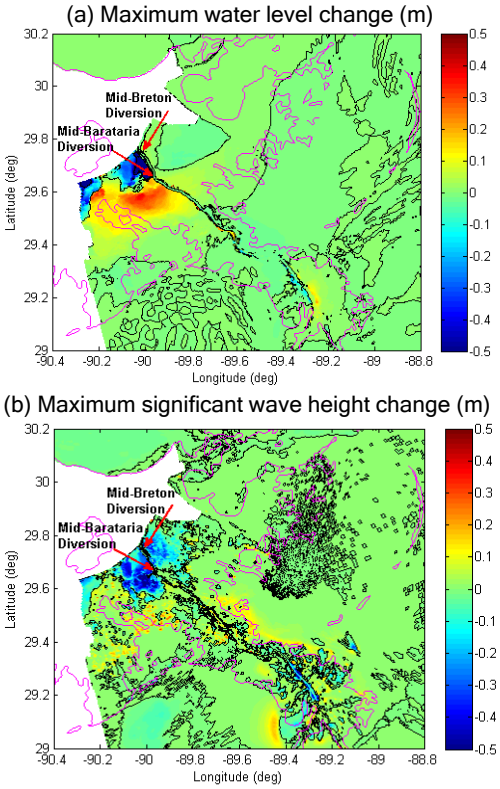

Figure 1 - Differences in maximum water level (a) and significant wave height (b) by an Isaac-like hurricane between the case with projects and the FWOP case in 2070. Black lines denote contours with the value of zero.

CONCLUSIONS

The project in Barataria Basin reduced both surge and waves in construction areas, while to the south of the project, surge and waves increased. The project in Breton Basin reduced waves nearby, but had little effect on surge. Model results also indicated the importance of other factors, such as delta morphology, vegetation and sea level rise (SLR). It should be noted that hurricane parameters, such as track, intensity, forward speed/duration, affect the surge and wave reduction by wetlands, which is being focused on in our study.

REFERENCES

Couvillion, Steyer, Wang, Beck, Rybczyk (2013): Forecasting the effects of coastal protection and restoration projects on wetland morphology in coastal Louisiana under multiple environmental uncertainty scenarios, Journal of Coastal Research, CERF, Special Issue No. 67, pp. 29-50.