HEC-RAS BASED COMPOUND FLOOD ANALYSIS FOR PROJECT PLANNING AND DESIGN

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THE PROBLEM

US Army Corps of Engineers (USACE) Coastal Storm Risk Management (CSRM) projects along the Gulf and Atlantic Coasts are often designed using coastal hazard models that neglect rainfall, riverine inflows and other important physics necessary for accurate flood risk estimation. In transition zone areas that are subject to compound flood effects, using models that neglect rainfall and river contributions may lead to under-designed levee and floodwall elevations that do not meet the project's intended level of risk reduction. Without the proper characterization of total water level statistics, CSRM designers often pick more unlikely and perhaps overly conservative design scenarios (ie 100 year storm surge plus 100 year rainfall plus 100 year riverine flood). The neglect of compound flood physics influences important calculations typically involved in coastal project planning such as annual expected damages, project costs, benefit cost ratios, making it difficult to plan and select optimal infrastructure.

The interior drainage design of CSRM projects, if not properly designed, can increase flood levels for certain scenarios or drastically increase project cost if overbuilt. A model that can accurately predict flooding from all hazards and provide true total water levels statistics is needed to design and evaluate project alternatives, especially as relative sea level rise and climate non-stationarity increase coastal loading to inland areas.

RECENT ADVANCEMENTS

The US Army Corps Hydraulic Engineering Center's River Analysis System (HEC-RAS) is a state-of-art hydraulic modeling software used for multi-hazard flood inundation mapping for project planning and design. Recent advances, listed here, have made it possible to bridge the gaps described above.

- HEC-RAS version 6.0 and subsequent releases, new features have included gridded wind and rainfall forcing, spatially varying hydrologic infiltration, and, storm surge and riverine inflows.
- Hindcasting of Hurricane Katrina, Isaac and Ida in Louisiana and Hurricane Ike in Texas have proven the ability of RAS to predict storm surge while also including the inland and transition zone flooding. See Figure 1.
- The HEC-RAS hurricane simulations are currently facilitated by a one-way coupling scheme which uses USACE Advanced Circulation Model (ADCIRC) based winds and stage boundaries.
- HEC-RAS models have been used for interior drainage analysis and design of major Corps projects including West Shore Lake Pontchartrain (WSLP) in Louisiana and Sabine to Galveston (S2G) in Texas.

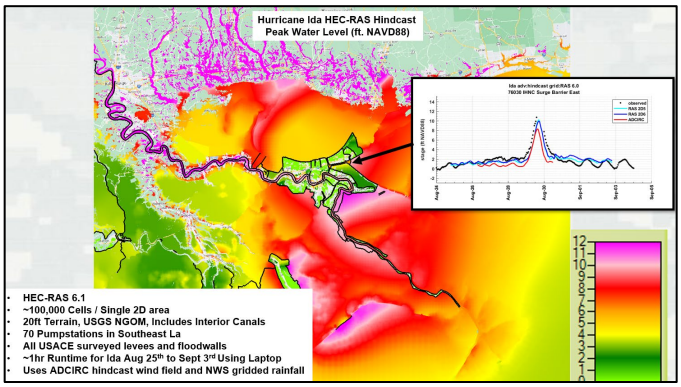

Figure 1 - HEC-RAS 6.1 hindcast of Hurricane Ida using USACE MVN district wide model

THE FUTURE

USACE has developed a large scale coastal HEC-RAS model than includes the entire coastal and inland watersheds of South Louisiana. This model is internally known as the South Louisiana Master Model (SLaMM). The model has been used for inundation mapping during Hurricane Ida (2021) and other storms impacting the region, as well as planning studies for district projects. The model included gridded rainfall and wind forcing, allowing realistic simulations of hurricane storm surge and the compounding effects of rainfall and riverine inflows. A similar model has been proposed for the area of Texas covering the USACE Sabine to Galveston Project.

HEC software developers plan to continue to add physics to the HEC-RAS code such as pressure and wave forcing which would help facilitate hurricane simulations. Pressure is extremely important parameter to include for hurricane simulations, as the drop in pressure at the eye of the most intense tropical cyclones can result in 3ft or more rise in the water surface.

Large scale flood risk assessments such as the Texas GLO or Louisiana LWI plan to use HEC-RAS to model a large suite of synthetic storm events with the extension of the JPM-OS code to include rainfall and antecedent hydrologic conditions.
Simulation of the full suite of synthetic tropical cyclone events, riverine floods and rainfall events, would provide true total water level statistics accounting for all sources of flooding. These outputs are used to help design and plan large scale flood risk reduction projects.