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CORE MPO Dynamic Flood Modeling Tools (FMT) for Optimized CORE MPO Planning of Infrastructure Systems

Task 2.1 Deliverable
SWMM Report for MPC Study

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<u>SWMM Model Description and Setup</u>

The hydrological model used to produce the hydrographs and measure the water level depth at each node was built in EPA’s (Environmental Protection Agency) SWMM (Storm Water Management Model). This model is used worldwide for planning, analysis, and design related to stormwater runoff and other drainage systems. The Curve Number (CN) method was selected as the rainfall excess technique. The developed SWMM model for this study simulates a compound flood event by combining pluvial and coastal flooding in a single simulation. For the pluvial component, two different rainfall events were selected based on the city of Savannah's 10- and 25-year storm events. The 10-year rainfall event has a total accumulation of 6.51 inches, while the 25-year event has 8.1 inches. The rainfall event temporal distribution was based on a SCS (Soil Conservation Survey) Curve Type III, which assumes that the highest rainfall intensity occurs halfway through the 24 hour rain event (See Figure 1A).

For coastal processes, the astronomical tides conditions were implemented at the outfall of each pipe that drains into the Savannah River or other coastal waterways. The tidal curve selected represents a simplified condition of the observed mean conditions at the Ft. Pulaski tidal gauge. Thus, high tide occurs every 12 hours with a peak value of 3.85 ft above mean sea level (amsl), while low tide has a minimum value of -3.85 ft amsl every 12 hours (Figure 1B). To consider climate change conditions, the intermediate scenario of sea-level rise (an increase of 1.18 feet) was considered for the 2050 projection for the US southeast coast. Thus, the future climate coastal conditions included the mean tidal conditions plus the sea-level rise projections.

The total simulation time was 48 hours; the rainfall only fell within the first 24 hours. The tidal conditions were applied throughout the entire simulation. A total of 4 different simulations were performed for each model that represented all the possible combinations between pluvial and coastal conditions. Due to the lack of data, a “reverse engineering” approach was used to simplify the stormwater system. Thus, the main stormwater lines were considered in the SWMM model. However, the pipe diameter used on these main lines had an equivalent flow area to the complete system, which ensures that the modeled system simulates the appropriate system capacity.

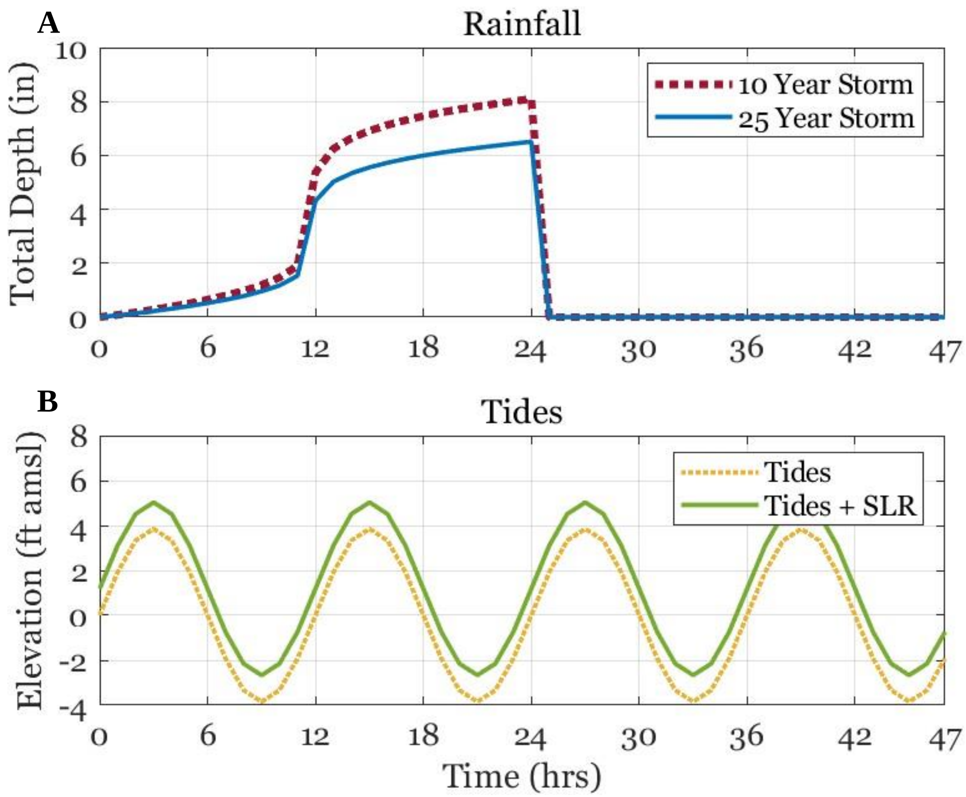

Figure 1. Rainfall events (A) and tidal conditions (B) used in the SWMM models as flood drivers.

Data Source

To mimic real-world conditions in the model, various data sources were used throughout the model. NOAA Atlas 14 data was used for the rainfall intensity in the Savannah Chatham County Area, which collected data from the Savannah International Airport Station (Station number 09-7847). The storm event simulated in the SWMM models was a 24-hour storm, meaning precipitation depths with a partial duration of 24 hours were selected. NOAA's 2022 Sea Level Rise Technical Report was used to gather the sea-level rise projections for the tidal curve, including future conditions. The tidal curve was based on a tidal resynthesis analysis for this region's entire tidal constituent sets in a tidal period (~14 days). The data was downloaded from the NOAA's Ft. Pulaski gauge station. The mean tidal amplitude was selected for the simplified tidal boundary condition. Thus, the selected tidal curve is simple but representative of real-world conditions.

Land use/land cover (LULC) data for these models was gathered from the US Geological Survey's Conterminous US Land Cover Projections (CONUS) model. The model is a comprehensive overview of LULC of the US dating from 1992 to future predictions in 2100. The model has different versions based on the International Panel on Climate Change's (IPCC)

Special Report on Emissions Scenarios. Scenario A1B was selected for this study, and the CONUS Land Cover file with scenario A1B was used. Initially, multiple SWMM models were planned to be made, which will have different LULC projections based on the year. Models for 2022, 2050, and 2100 were planned to be made for each of the 6 drainage basins. However, when LULC data was collected for Fells St and Bilbo, there was no notable change in land use for 2050 and 2100 compared to 2022. This negligible change in land use also carried over to every other basin. This is because every basin is already heavily urbanized and developed. Therefore, we only developed the SWMM models for a LULC of 2022.

Soil coverage for each basin was calculated using the Web Soil Survey. Using the survey, the Hydrologic Soil Group for areas within a basin could be determined and translated into the model. Many times, one area would contain multiple soil types. In this case, the soil group that was least infiltrative (typically soil type D) was assigned to each area to test the stormwater infrastructure under the worst possible conditions.

Rainfall: https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=ga
Tides: https://tidesandcurrents.noaa.gov/stationhome.html?id=8670870
Sea-level Rise: https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report-sections.html

Land Use/Curve Numbers:
https://www.sciencebase.gov/catalog/item/5b96c2f9e4b0702d0e826f6d
https://www.mrlc.gov/data/legends/national-land-cover-database-class-legend-and-description

Soil: https://websoilsurvey.nrcs.usda.gov/app/

Using the SWMM model

The individual conditions within the model can be changed to produce four different simulation results for the hydrographs. The conditions that can be altered in this simulation are the tidal curve and rainfall event. The alterations to the rain gauge can be made by locating the Edit menu on the toolbar, then selecting a group edit. Next, the subcatchment property within the group edit can be changed to the desired rainfall output. The alterations to the tidal curves must be made by individual outlet nodes. Once locating the outlet node properties within the Hydraulics tab of the Project Menu, select the individual outlet node and change the "Tidal Curve" to the desired output. These changes will allow for the simulation results to be modified per run. To acquire simulation results, the specific conditions must be changed to match the desired outcome, then the "Run Simulation" icon will output results. The scenarios that have been demonstrated in the hydrographs are a 10-year storm with sea level rise, 25-year storm with sea level rise, 10-year storm without sea level rise, and 25-year storm without sea level rise.

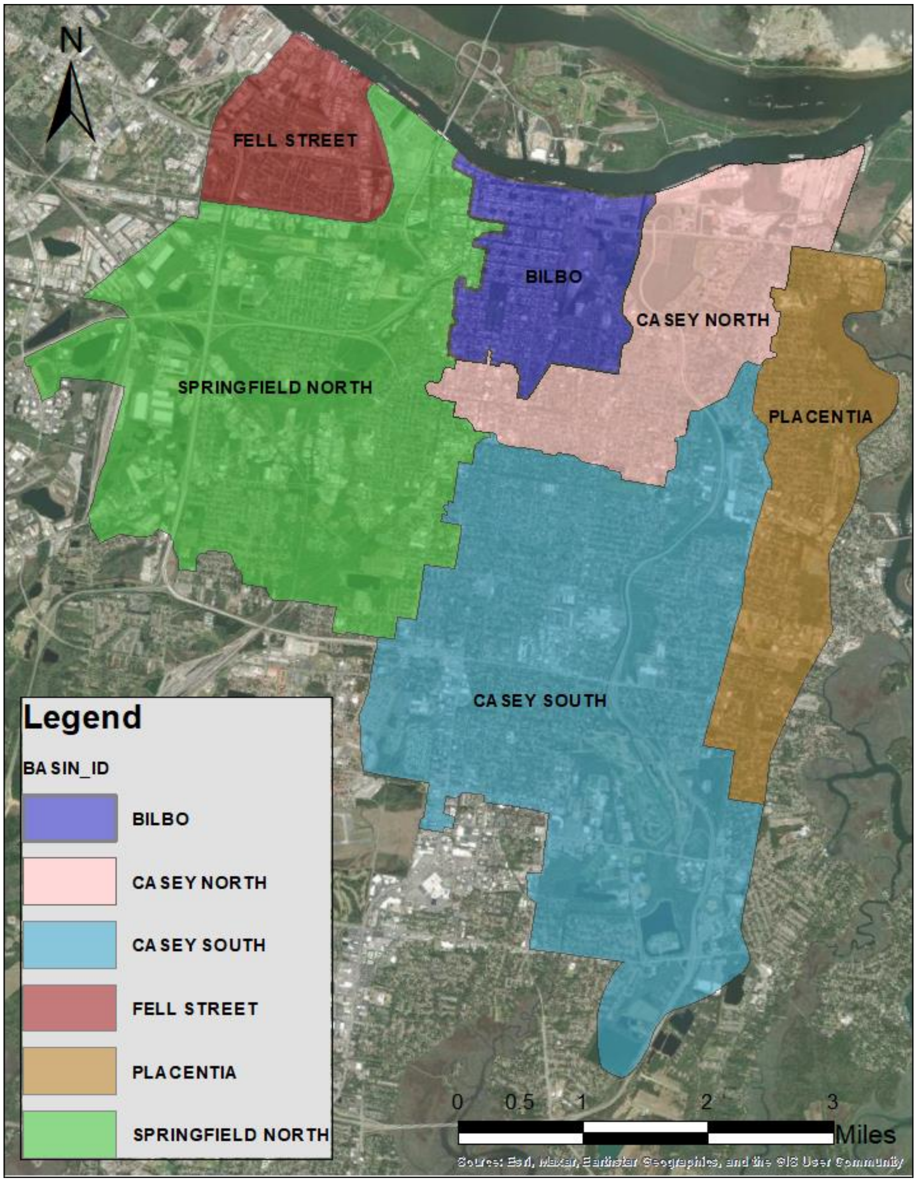

Figure 2. Coverage of the SWWM model and the sub-basins.