Naimaster, Ashley; Bender, Christopher; Miller, William

Automated Mesh Development Tools for Central Florida Storm Surge Study

AUTOMATED MESH DEVELOPMENT TOOLS FOR CENTRAL FLORIDA STORM SURGE STUDY

Ashley Naimaster[1], Christopher Bender[2], and William Miller, Jr.[3]

The Federal Emergency Management Agency (FEMA) commissioned the Central Florida Storm Surge Study (CENFL_SSS) as part of the recent effort to update coastal Flood Insurance Rate Maps. The study will simulate hurricane-induced coastal flooding with the tightly coupled SWAN+ADCIRC model. The SWAN+ADCIRC model inputs meteorological, tidal, and river inflow forcing to calculate depth-averaged currents, water levels, and waves.

Successful simulation of coastal storm surge physics requires a quality model mesh. For coastal flooding studies, the model mesh should identify and capture hydraulically important features that could conduct or impede storm surge flow. The mesh should also employ sufficient resolution to discretize the wetting and drying front.

The CENFL_SSS team developed three GIS-based tools to aid in developing a high-quality model mesh. The automated mesh development tools leverage the high-density elevation data now frequently available for coastal storm surge studies, and they allow for a consistently applied methodology during the model mesh development phase.

The first tool applies ArcHydro watershed delineation software to identify topographic features that may conduct or impede storm surge flow. The ArcHydro tool automatically digitizes these features as breaklines. ArcHydro also allows the user to detail the size of the watersheds. Steps for running this tool include

- Run the 5 m LiDAR through a low-pass filter
- Resample the LiDAR data to a 10 – 25 m cell size
- Run ArcHydro with the desired watershed size
- Smooth and edit output to produce breaklines that permit high-quality mesh elements.

The next tool draws from multiple input datasets to develop a resolution dataset covering the model domain. This tool creates a georeferenced file showing spatially variable resolution data, in the form of target nodal spacing values. Several factors influence resolution: elevation, population density, and proximity to the coast. LiDAR (5 m), land use data (30 m), and a digitized shoreline polyline provide data for evaluating the factors. The CENFL_SSS team developed an algorithm to evaluate the factors on a 1000 m structured grid covering the model domain. This algorithm yields a target nodal spacing value for each cell in the structured grid. Adjacent grid cells containing similar target nodal spacing values form polygons defining different resolution zones. The centroids and edge intersections of these polygons constitute locations where the nodal spacing values fully describe the desired resolution changes over the model domain.

[1] Taylor Engineering, Inc. 1675 Palm Beach Lakes Blvd., Suite 210, West Palm Beach, FL, 33401, USA (anaimaster@taylorengineering.com)
[2] Taylor Engineering, Inc. 10151 Deerwood Park Blvd., Bldg. 300, Suite 300, Jacksonville, FL, 32256, USA (cbender@taylorengineering.com)
[3] [3] Taylor Engineering, Inc. 10151 Deerwood Park Blvd., Bldg. 300, Suite 300, Jacksonville, FL, 32256, USA (bmiller@taylorengineering.com)

As noted, the first tool develops breaklines that represent topographic features. These breaklines may contain the minimum number of vertices necessary to preserve their shapes. However, because vertices along breaklines force nodal placement and connectivity within the model mesh, a breakline may require additional or adjusted vertices to establish mesh triangulation. To project the resolution data onto the breaklines, the third tool uses output from the previous two tools to redistribute vertices optimally (Fig. 1). Steps involved to implement this tool include

- Interpolate resolution data onto end points of breaklines
- Convert breaklines from shapefile to ASCII format
- Run Fortran script to redistribute vertices along breaklines
- Convert breaklines from ASCII back to shapefile format

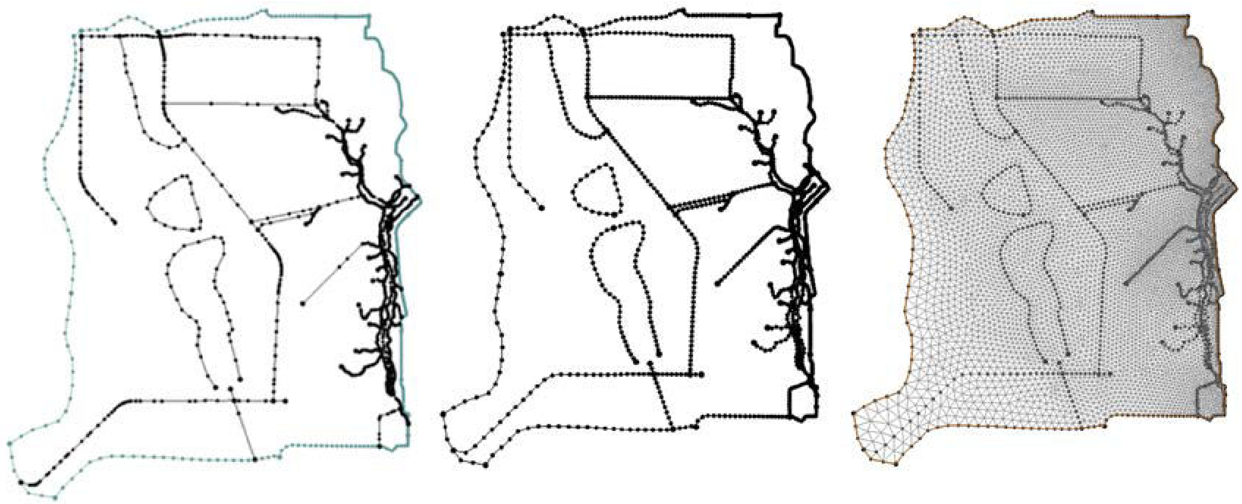

Figure 1 Extracted breaklines, redistributed breaklines, and mesh triangulation.

While the tools automate processes in mesh generation, they require user input at several intermediate steps. The CENFL_SSS team completed many trials to establish guidelines for various input parameters, including LiDAR resample grid cell size, desired ArcHydro watershed size, algorithm to determine nodal spacing values, and weighting schemes to interpolate nodal spacing values onto breaklines. These guidelines encourage high-quality model mesh elements for coastal surge studies, with the additional benefit of a consistently applied methodology.