THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

Resolving the Bathymetry of Rivers in eastern North Carolina for Flood Modeling

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UNC COLLEGE OF ARTS AND SCIENCES

Earth, Marine and Environmental Sciences

My dissertation research focused on characterizing the role of compound processes on tropical cyclone flood hazards.

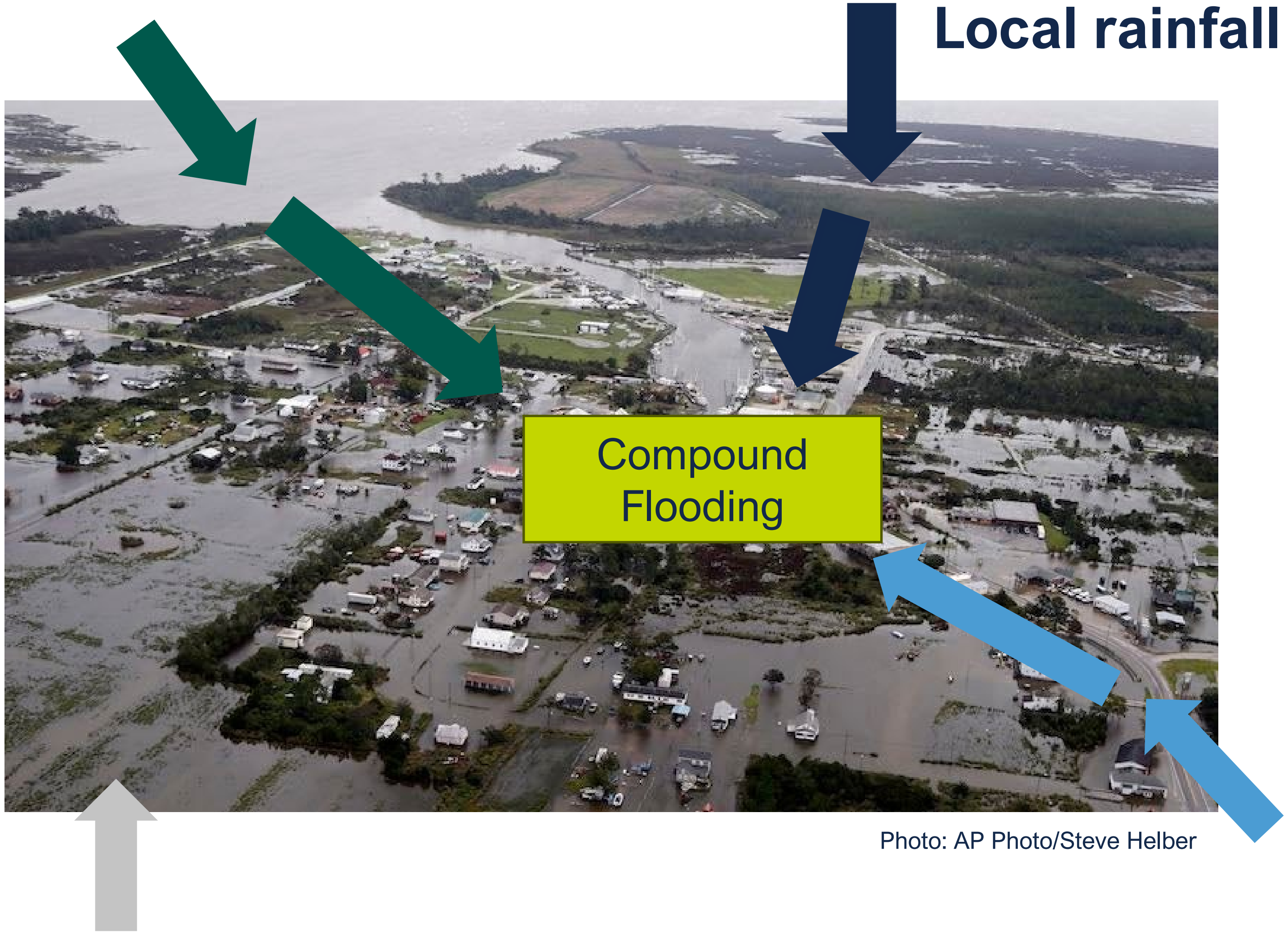
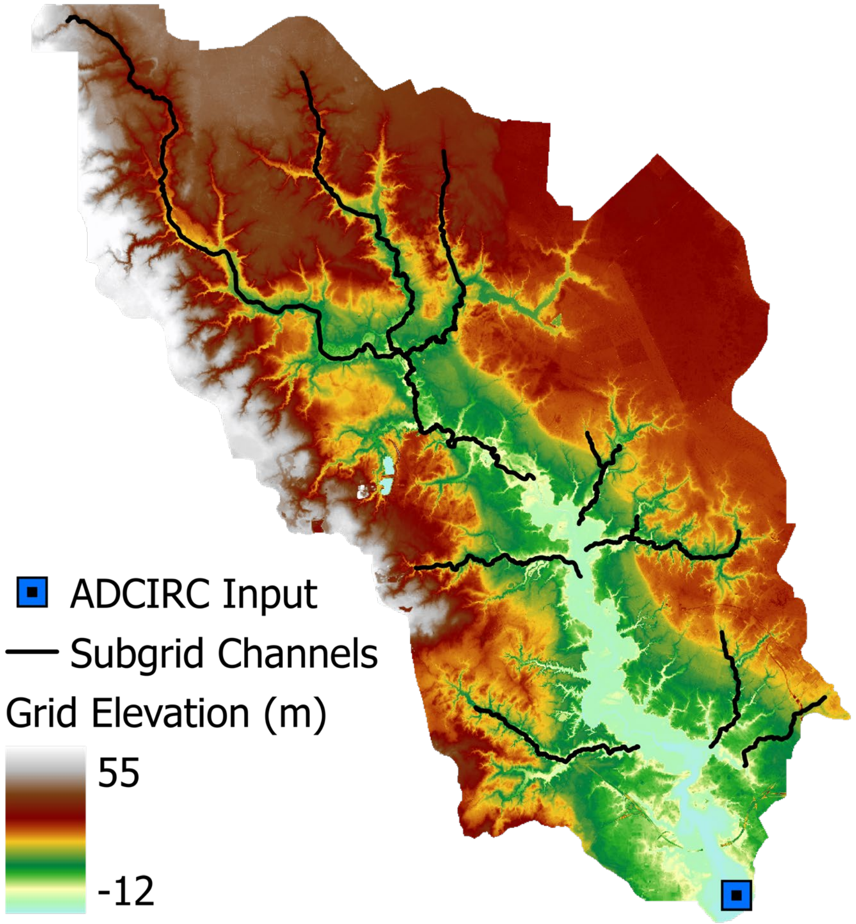
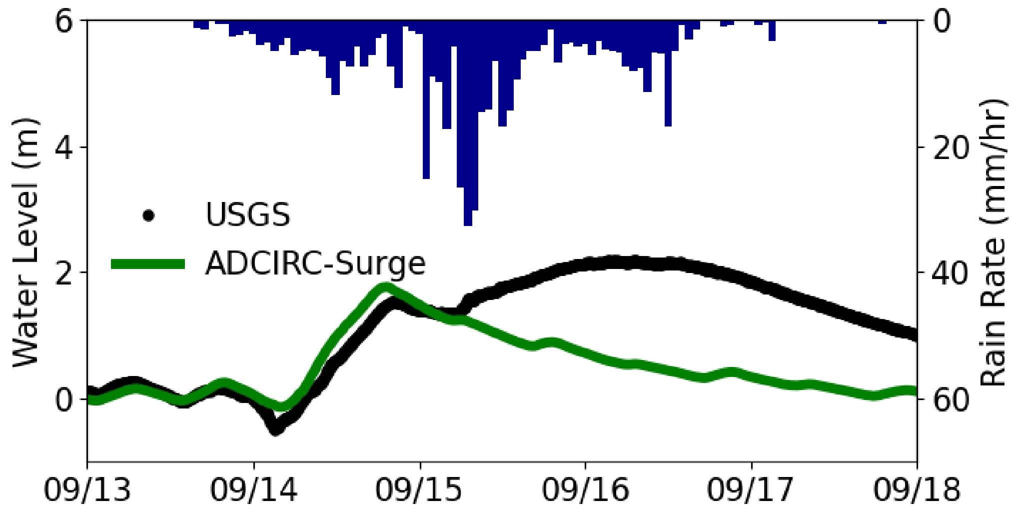
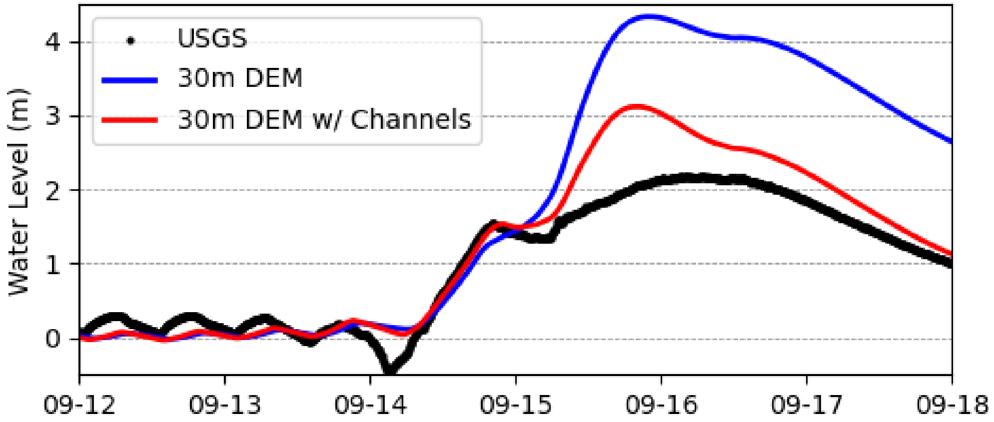


Photo: AP Photo/Steve Helber

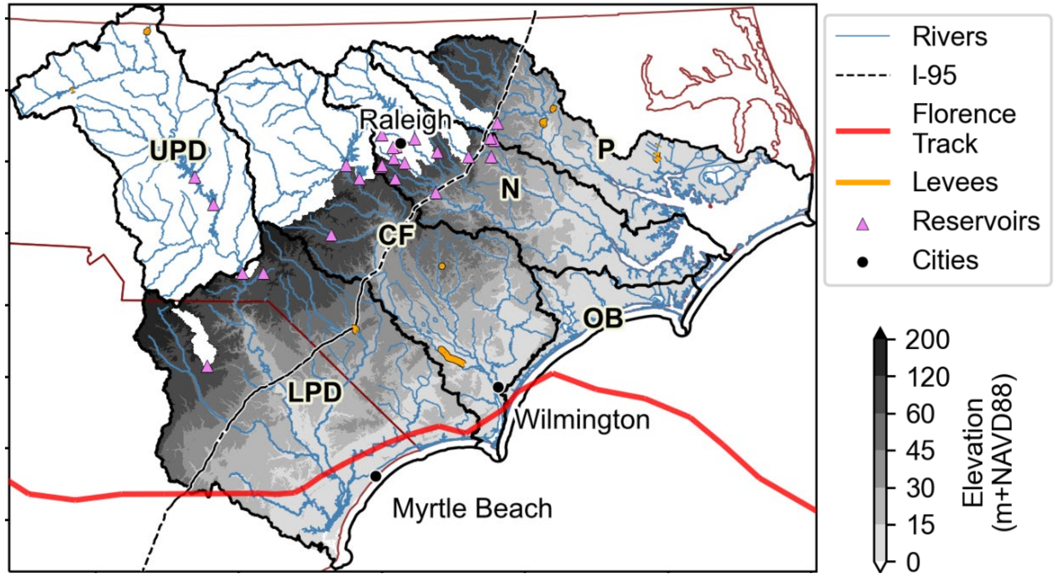
Representing channels in the flood model improves total water level predictions for Hurricane Florence… but getting the data for is a challenge.







I constructed and validated a large-scale, hydrodynamic model of the eastern Carolinas to simulate flooding from real and synthetic TCs in different climates.



Grimley et al. (2025) WRR

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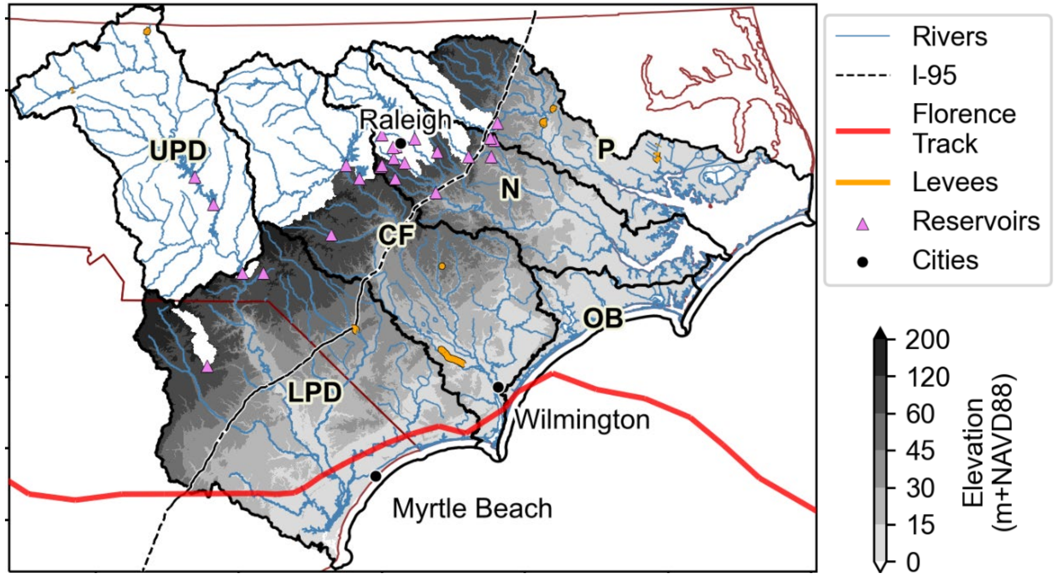

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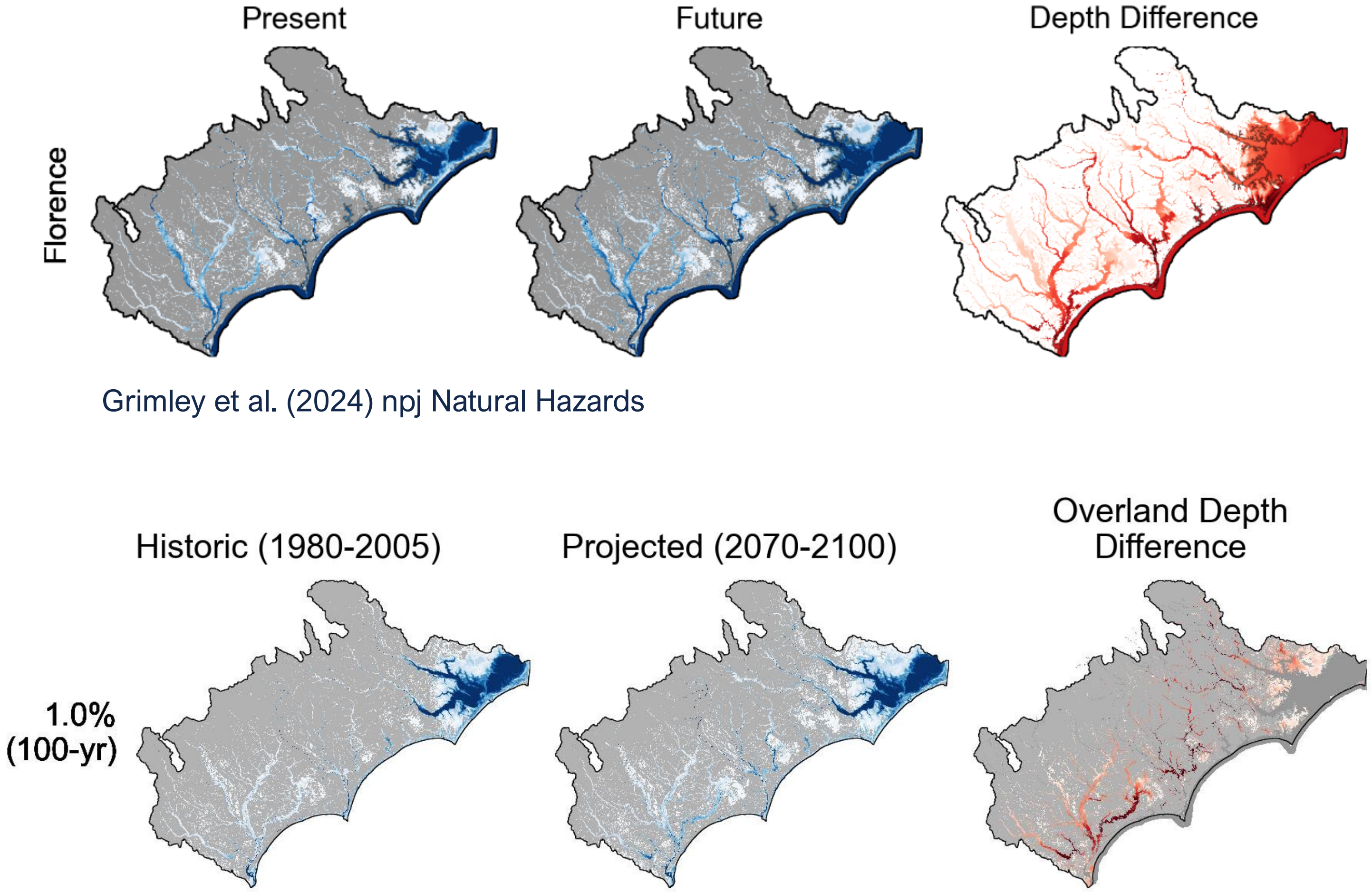
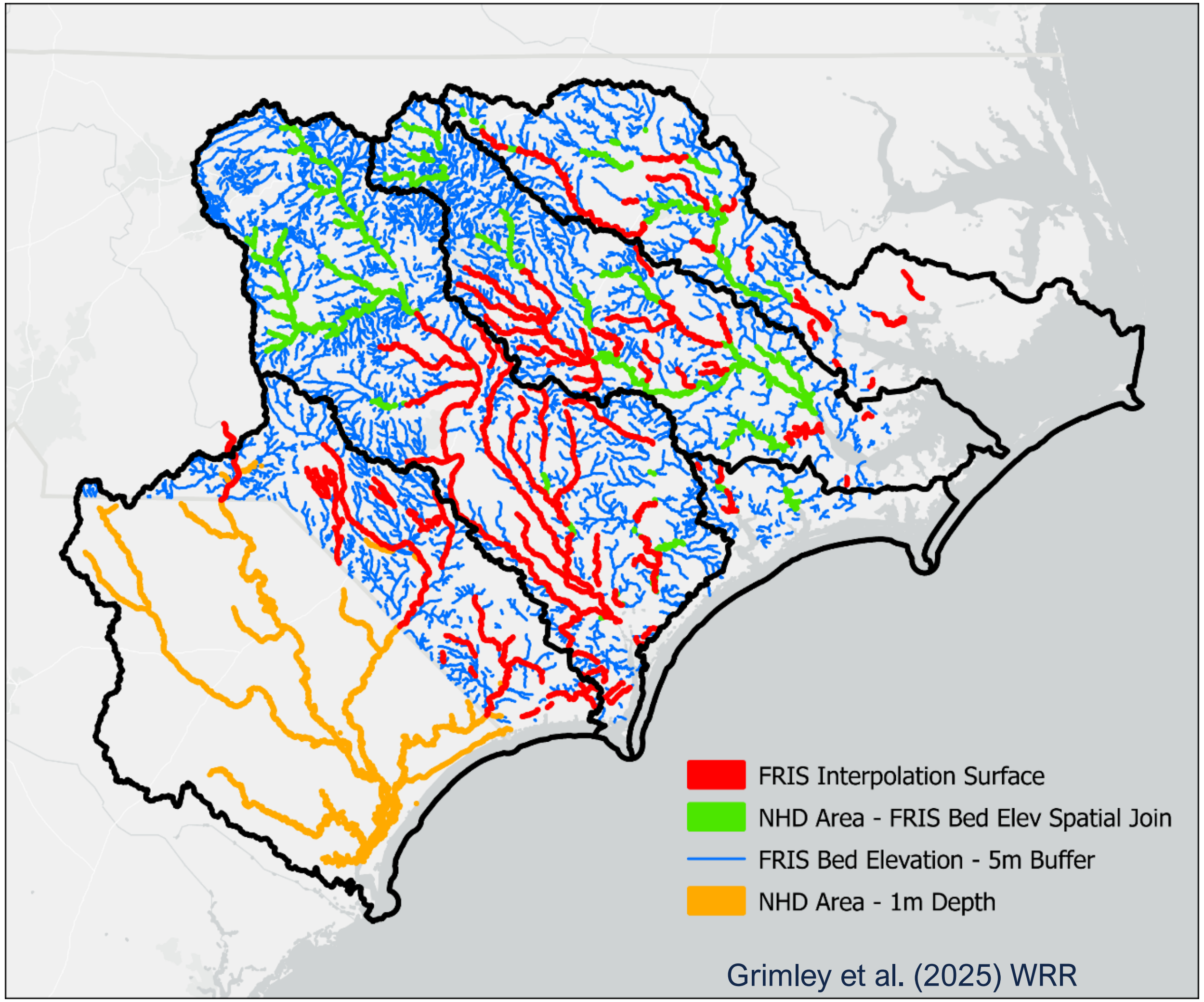


Grimley et al. (2024) npj Natural Hazards

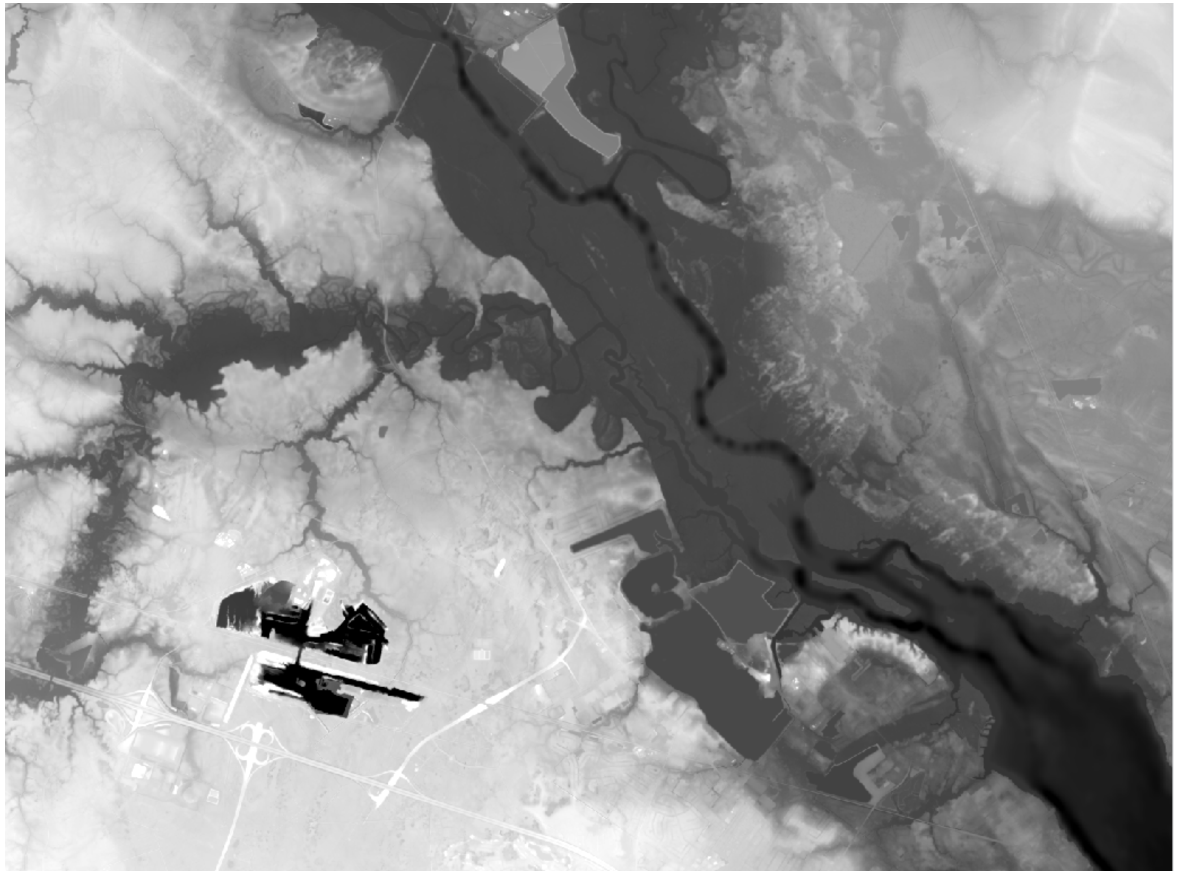
Grimley et al. (2025) Earth's Future, in prep

The model elevation is based off a DEM that includes channel information extracted from 1D HEC-RAS models used for floodplain mapping.

Grimley, L., A. Sebastian (2025). *Topobathymetric Digital Elevation Models (DEM) for Flood Modeling in the Carolinas*. DesignSafe-CI. https://doi.org/10.17603/ds2-mzc8-s589

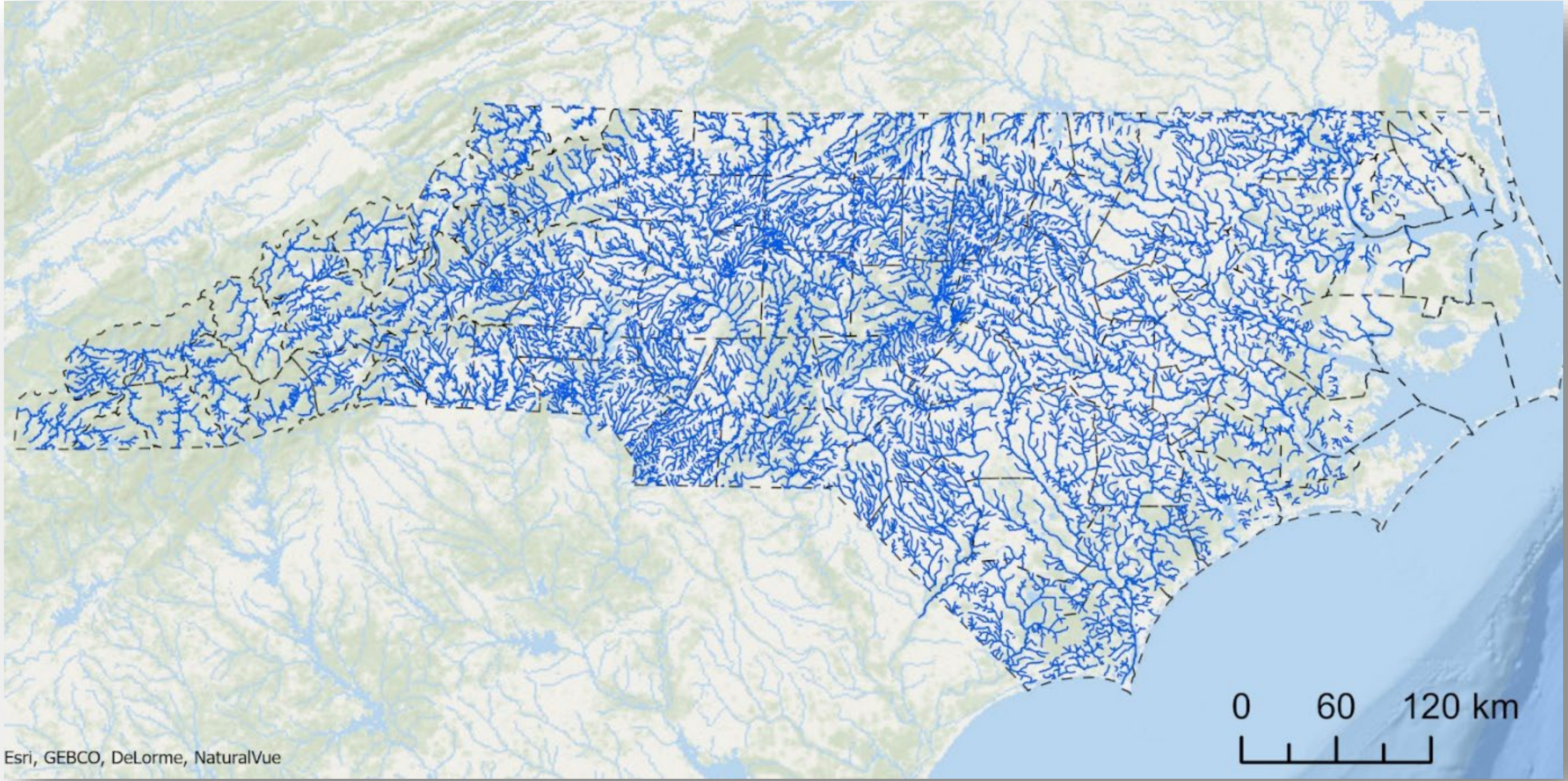


We use the HEC-RAS data to represent channels in different ways in the model DEM.

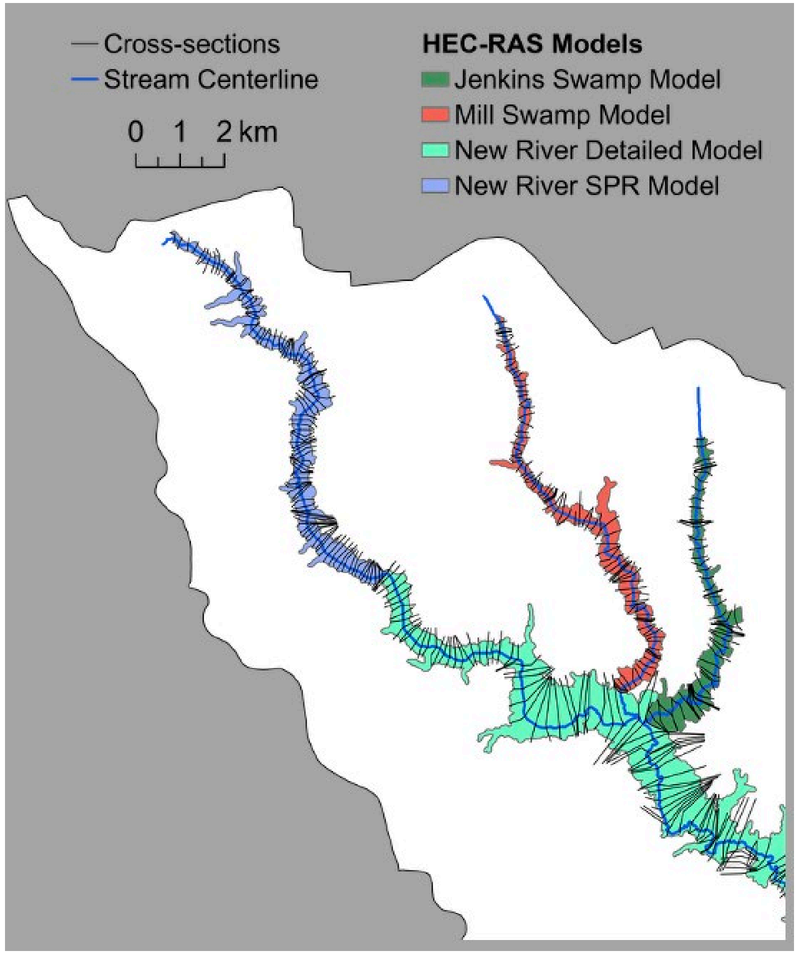


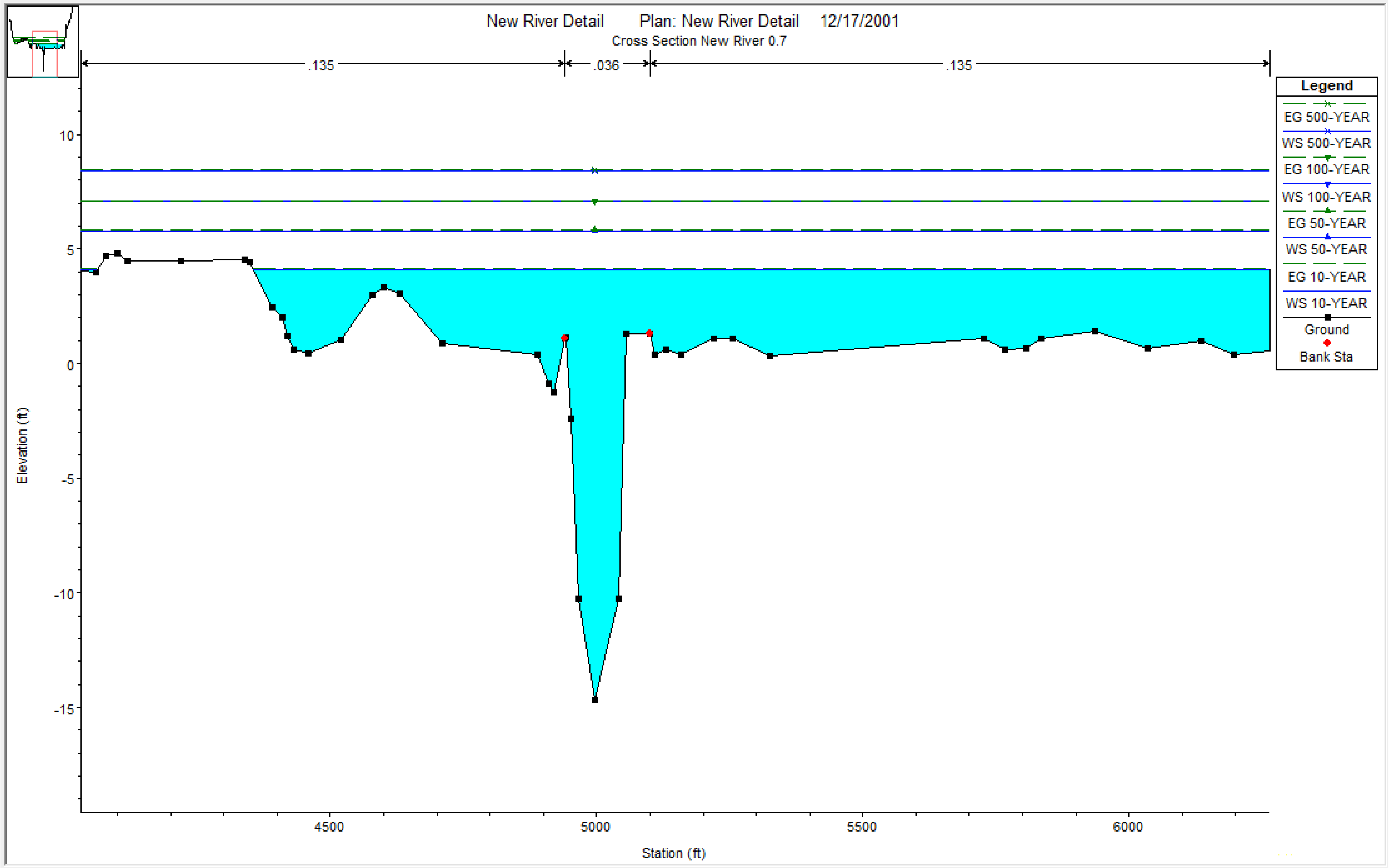
There are over 39,000 mapped streams in NC each with a separate HEC-RAS model (archived by the state) amounting to hundreds of thousands of river cross-sections.

Built on a tributary-by-tributary basis using surveyed cross-sections



The elevation data along each HEC-RAS cross-section is a combination of field surveys and LiDAR based products.

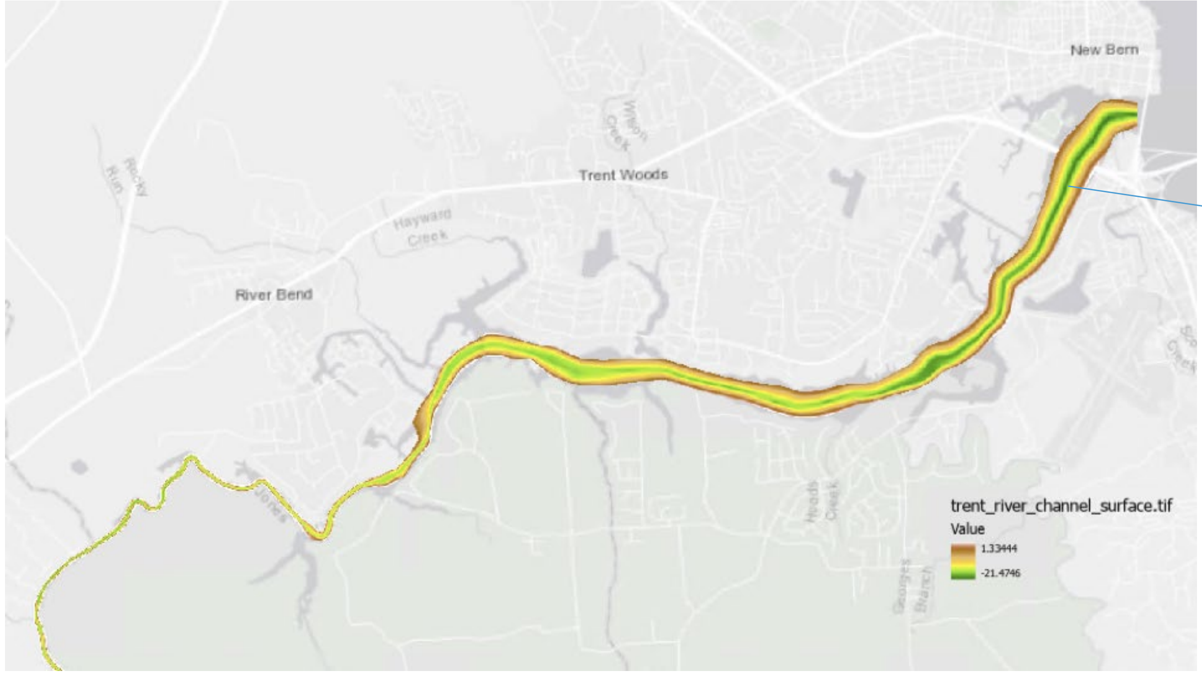


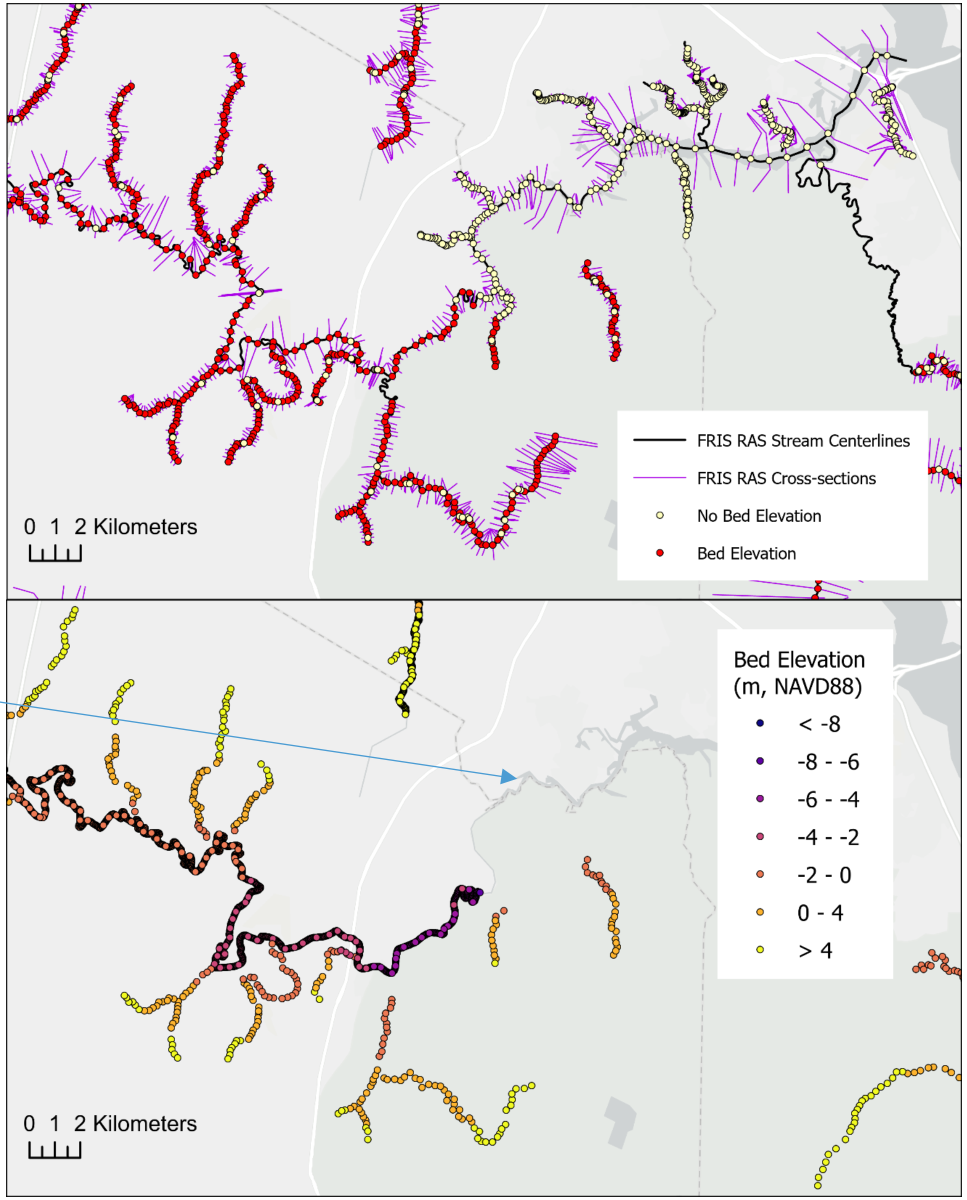


There are two ways I used to access the HEC-RAS channel information.

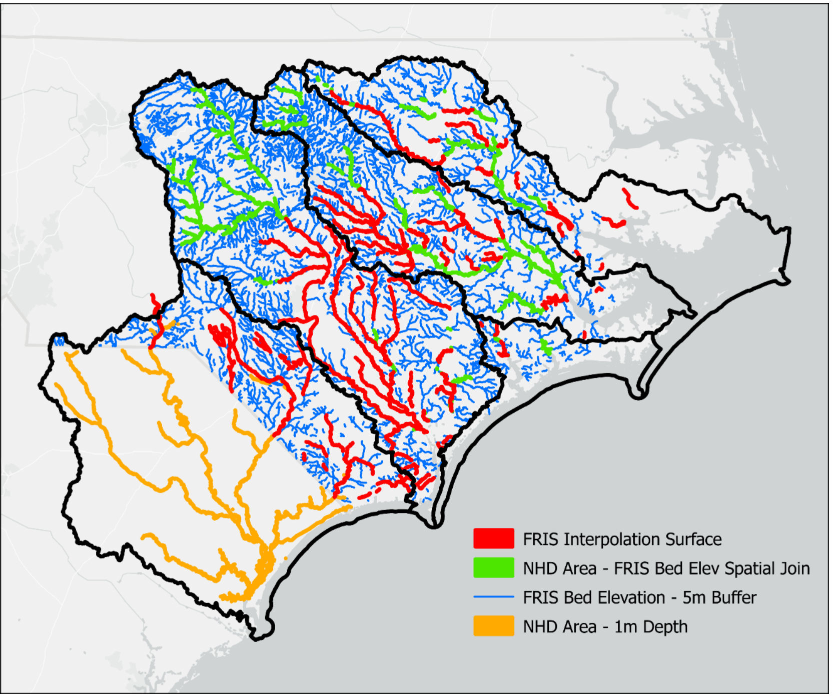
- Geometry files (txt) with all station and elevation data

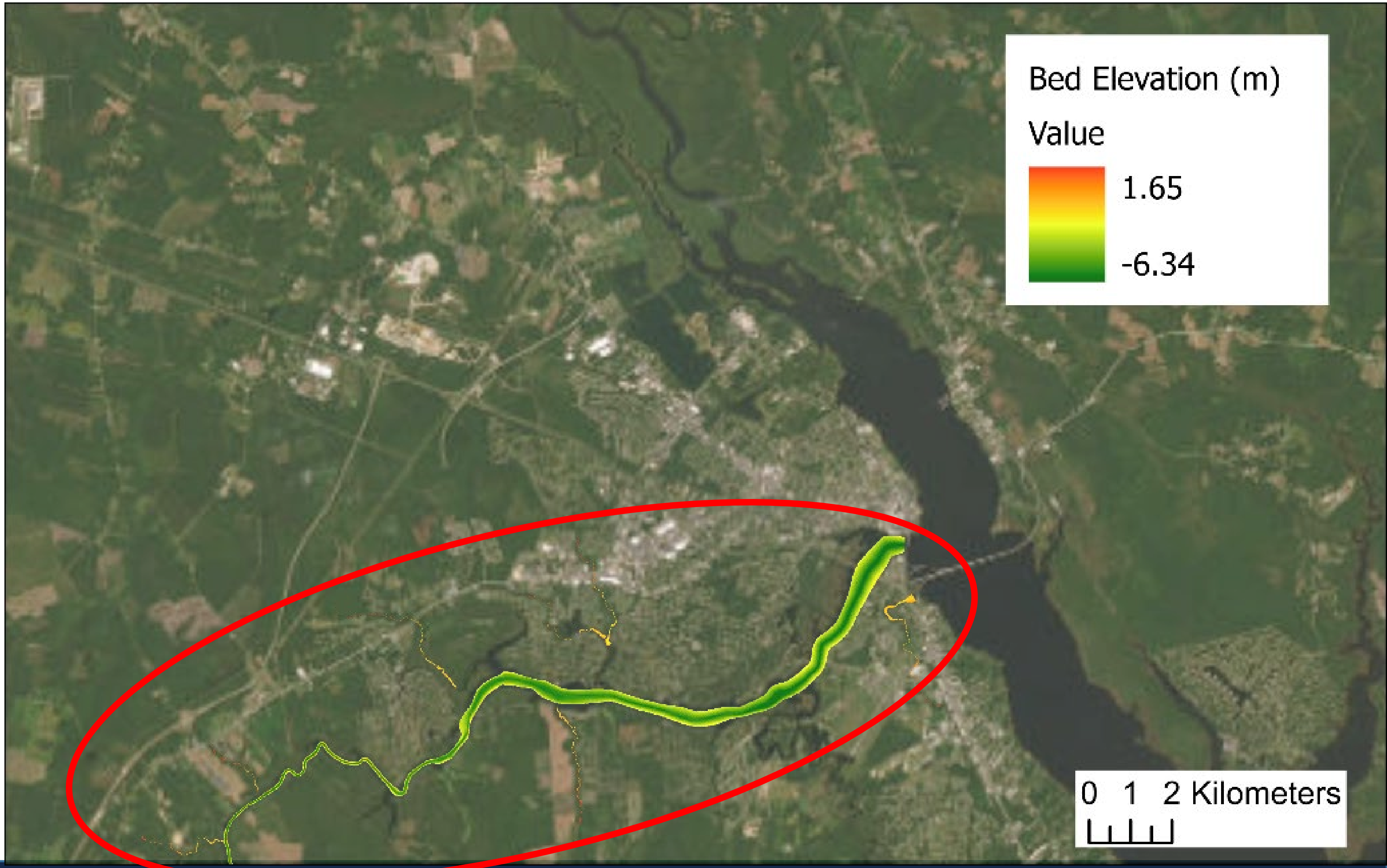
- A stream centerline shapefile and a cross-section shapefile (from the state) that has the minimum bed elevation stored as an attribute (but only for some rivers).



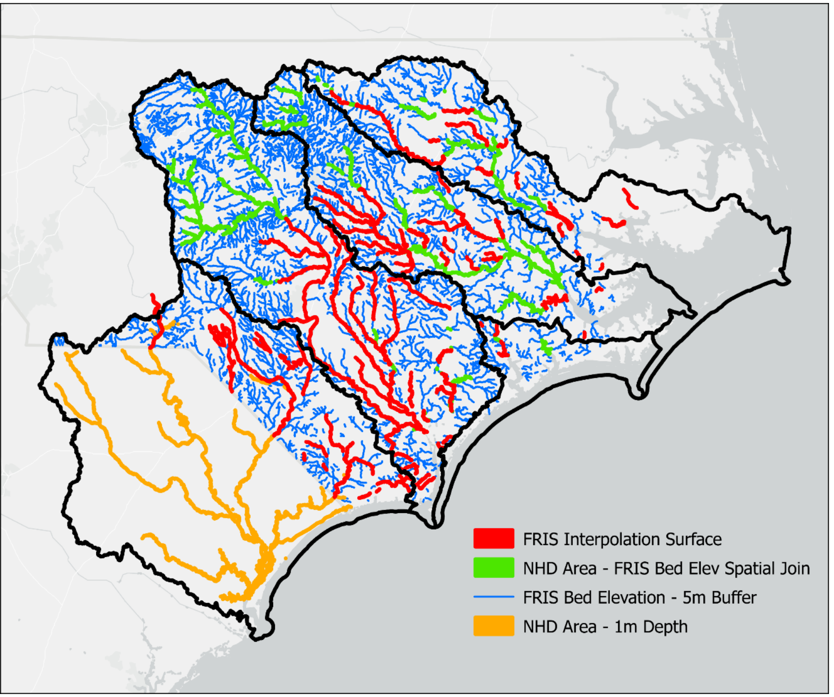


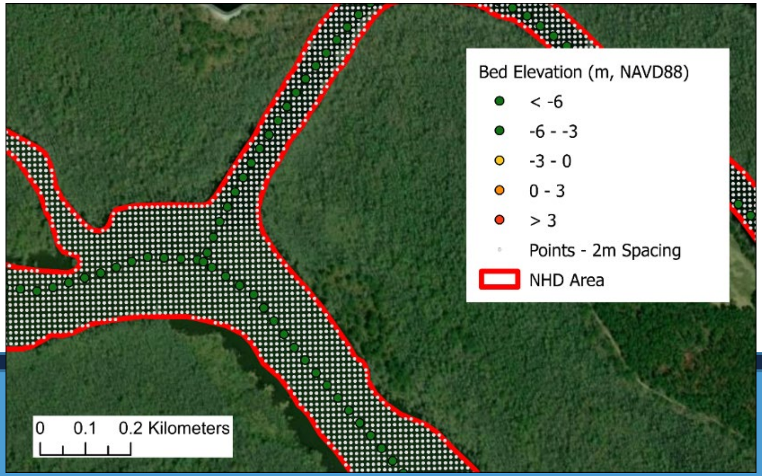
I use the HEC-RAS interpolation surface output directly from RAS mapper.

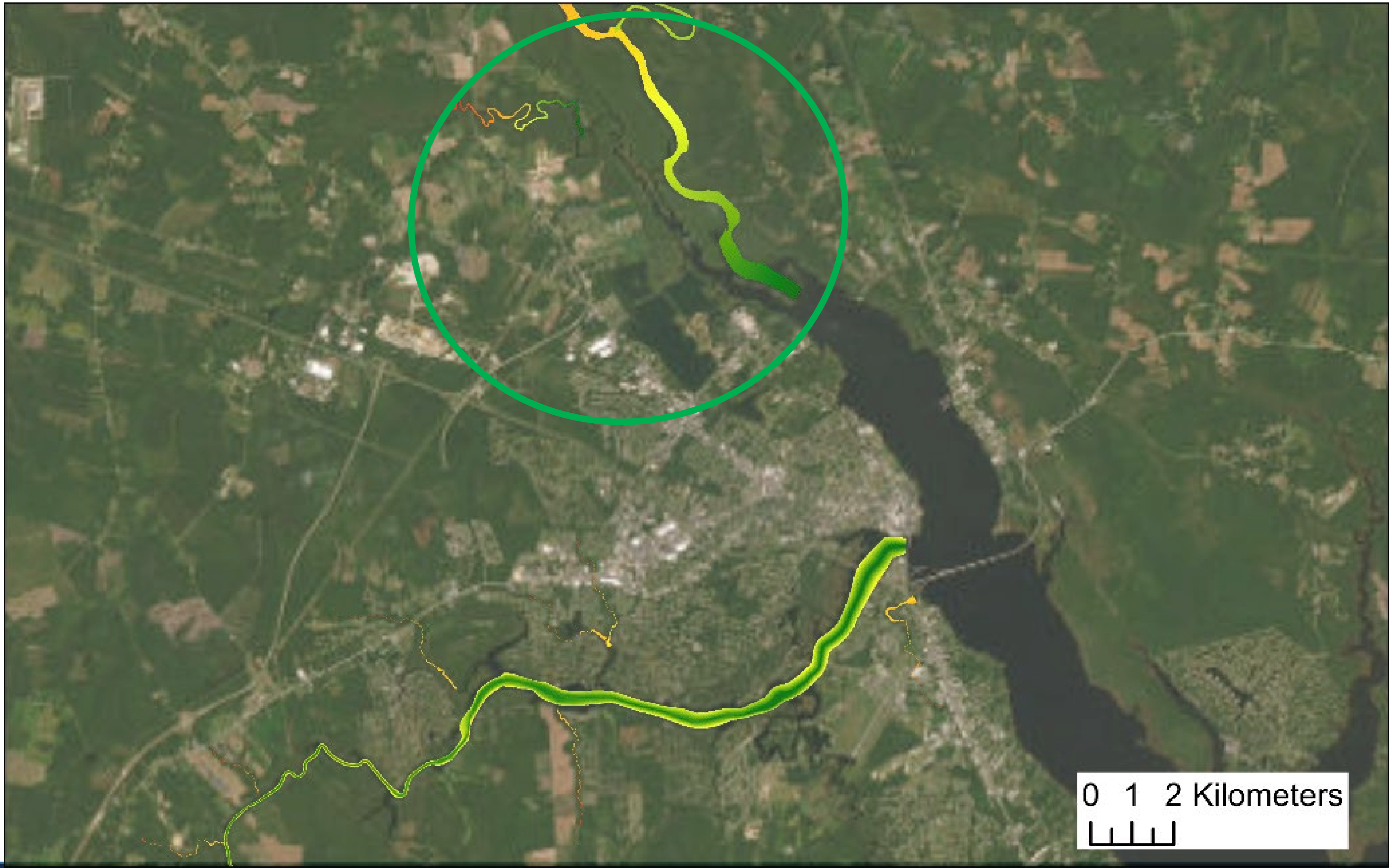




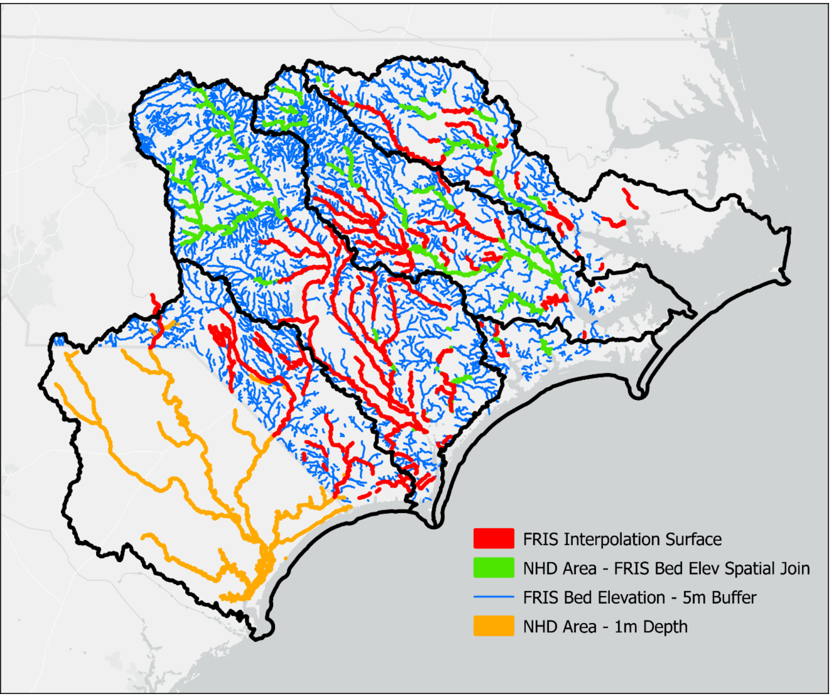
Otherwise, I use a point dataset of minimum bed elevation at each cross-section to create the NHD Area rasters.

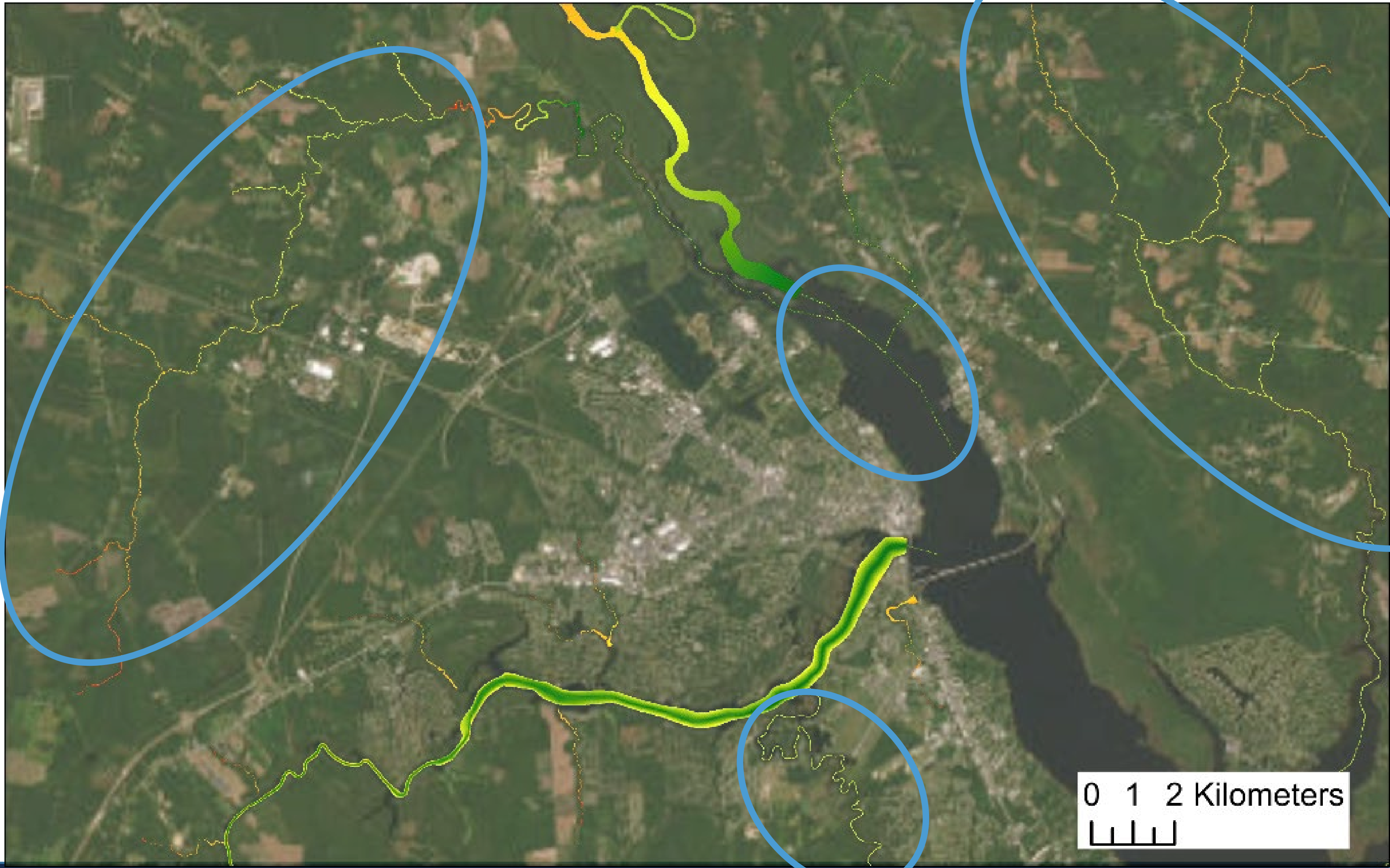




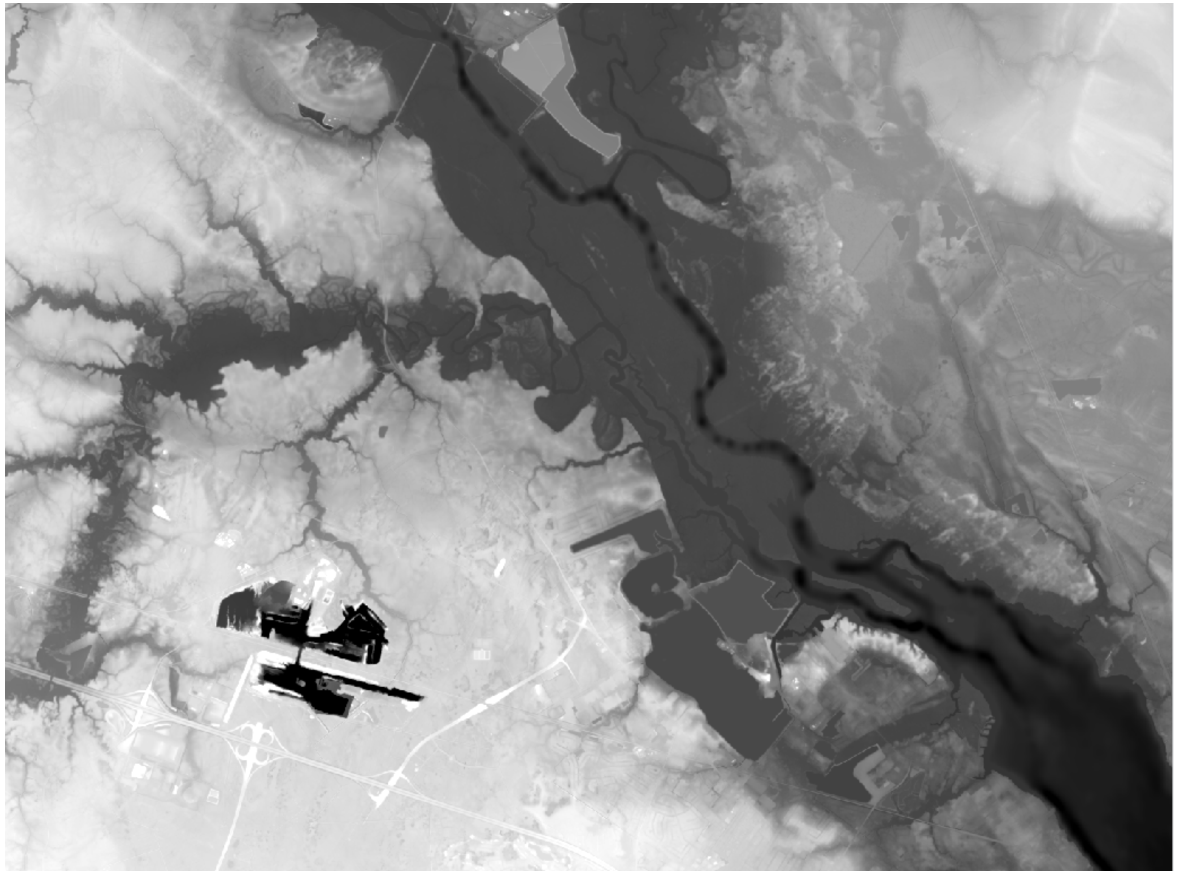


When there is no NHD Area shape, I just rasterize the 5 m bed elevation point data.

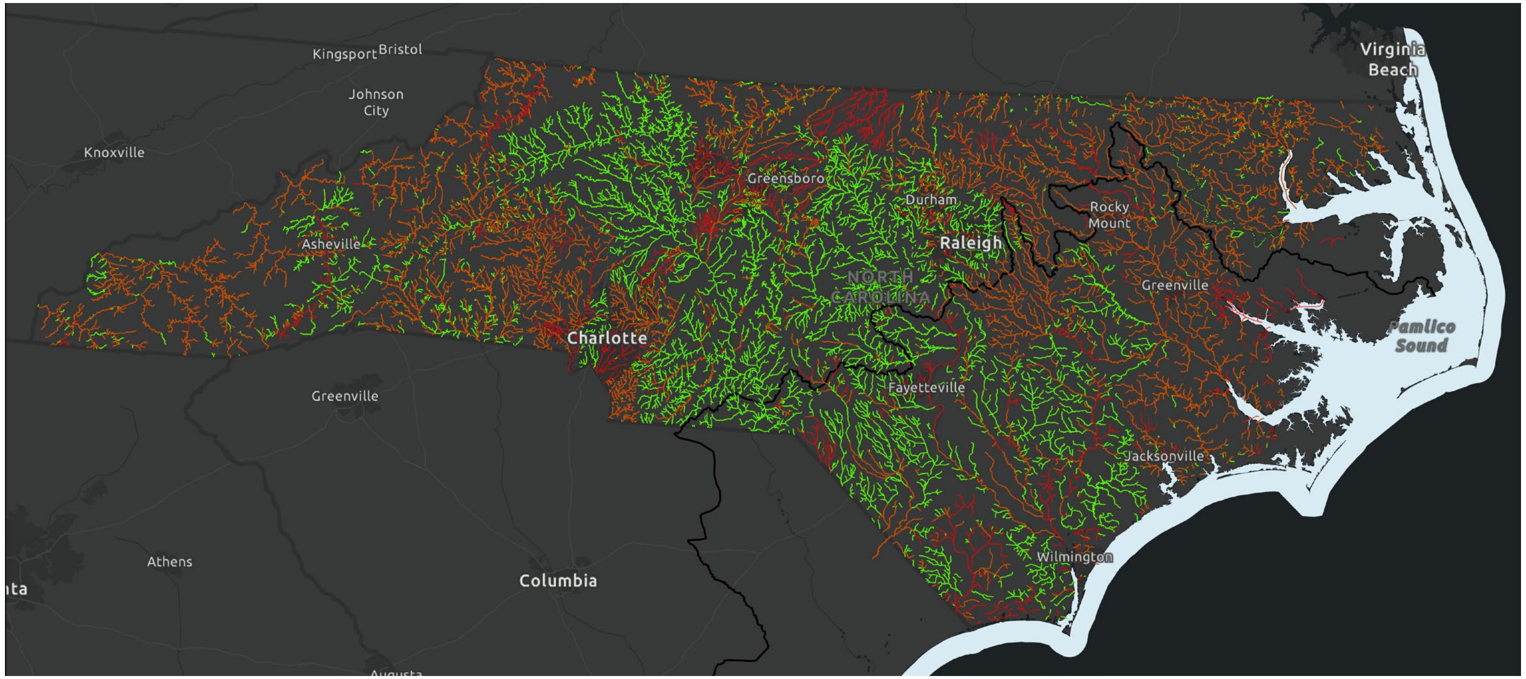




We merge these bathy rasters with the overland DEMs (e.g., CoNED, NED, state LiDAR, CUDEM) at a 5 m resolution with limited smoothing.



In addition to improving flood models, we can leverage the data in the HEC-RAS models in other ways.

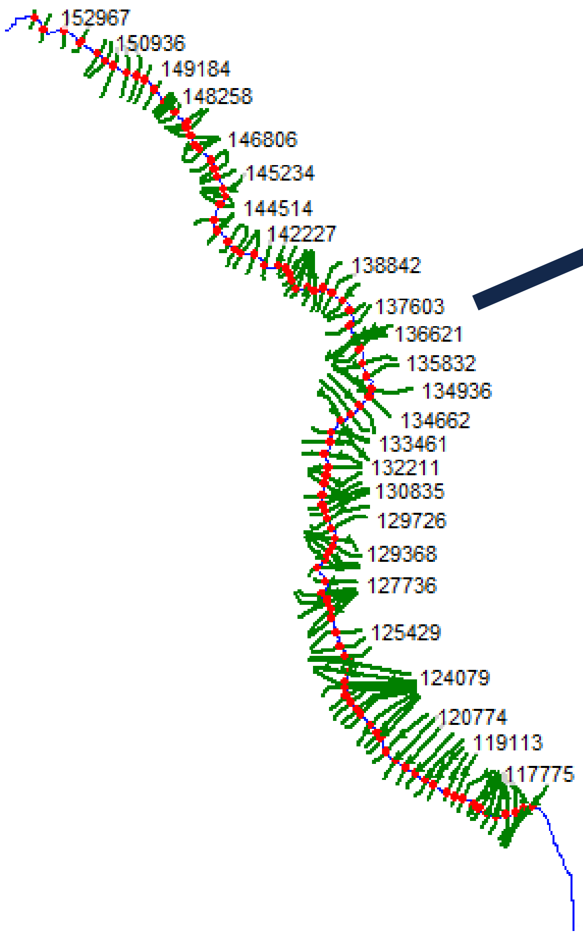


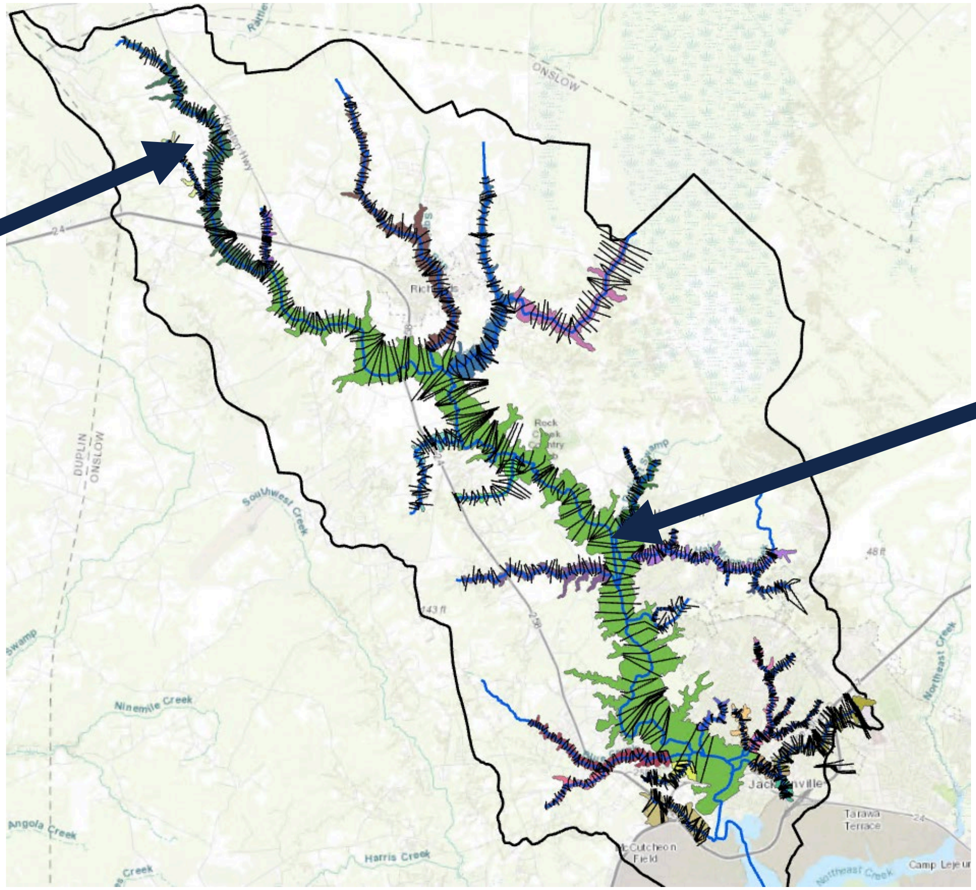
- Is the data accurate and what about sedimentation? we compared to field measurements
- How does it compare to empirical models (e.g., power-law)?
- How do we use channel information as input to flood models? (e.g., minimum bed elevation vs. effective capacity for rectangular channels)

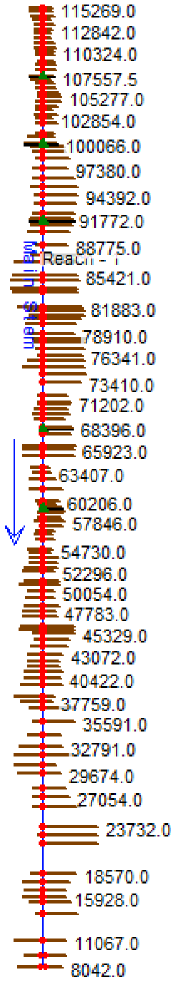
These models are also available in other states!

Grimley, L (2025). *Topobathymetric Digital Elevation Model (DEM) for Flood Modeling in Harris County, TX*. DesignSafe-CI. https://doi.org/10.17603/ds2-21k1-sj54

Older versions of HEC-RAS did not retain the coordinates of the stream centerline and cross-sections in the geometry file… but they do exist as shapefiles.

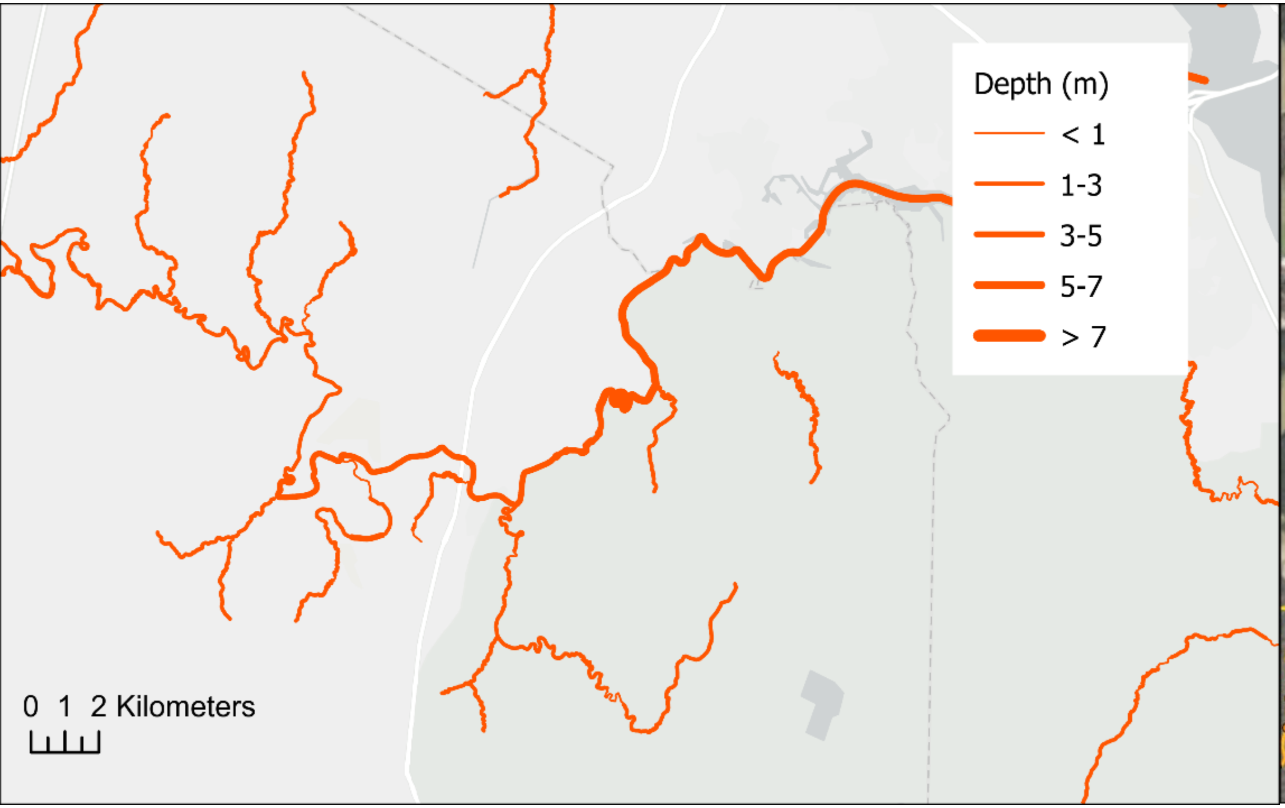


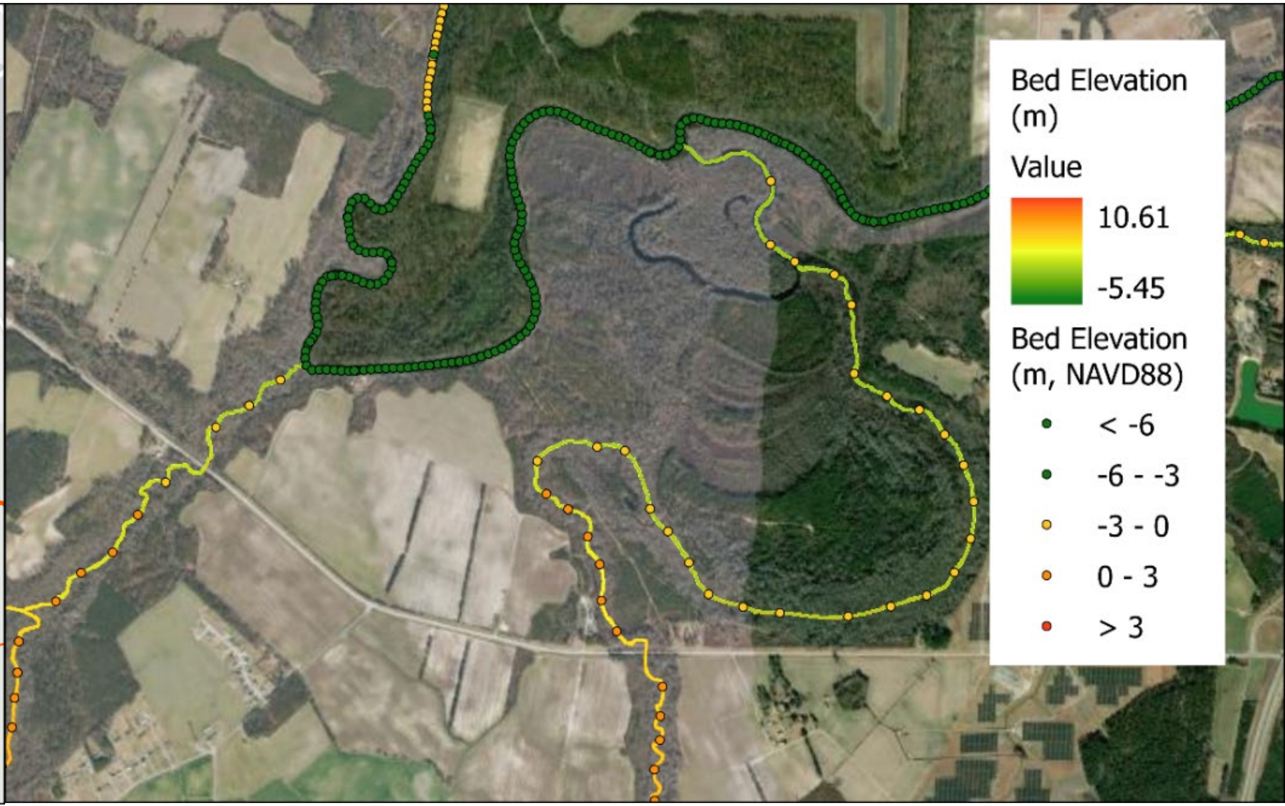




Stream segments are assigned a channel depth from the minimum bed elevation data based on the nearest point.

Next, I generated points with 5 m spacing along the segments.





I generated points with 2 m spacing in the NHD Area polygon. Then I spatially join each point to the nearest bed elevations points (5 m spacing along the centerline). We create a 2 m raster using bilinear interpolation.