Apr 14th, 1:00 PM - 3:00 PM

Bathymetric digital elevation model for the Tennessee River

Caleb Mathias
University of Tennessee at Chattanooga

Azad Hossain
University of Tennessee at Chattanooga

Bathymetric Digital Elevation Model for the Tennessee River

Caleb Mathias, Azad Hossain
Department of Biology, Geology, and Environmental Science
Contact: azad-hossain@utc.edu

RESEARCH DIALOGUES 2020

UNIVERSITY OF TENNESSEE CHATTANOOGA

Motivation

This project arose from a need for bathymetric data of the Tennessee River within southeast Tennessee as no publicly digitized data for river bathymetry could be found.

Summary

A seamless digital elevation model (DEM) of Chattanooga, TN containing the Tennessee River bathymetry was needed for a hydrodynamic modeling project. Geospatial bathymetric data for the Tennessee River was not available in digital form. Depth contour maps downloadable as a PDF files were the only readily available data. A strategy was thus developed to create a GIS of the contour maps and "burn in" this bathymetry data into USGS DEMs which lack information on river depth. Two PDFs were digitized pertained to "Nickajack Lake" and "Chickamauga Lake." Each PDF contained multiple pages of maps that split up bathymetric data for different sections of the river. Each page was georeferenced using the software ERDAS Imagine. Georeferenced maps were imported into ArcGIS Pro and contour lines were traced as point shapefiles with stored depth data. A polygon of the Tennessee River was created covering the extent of the point depth data to be used as a mask for geoprocessing. Depth point data were converted to raster through the Topo to Raster spatial interpolation tool for burning into the DEM. The Raster Calculator tool was then used to stitch the DEMs together. The resulting raster seamlessly combines the Tennessee River bathymetry data with the original USGS DEM and can be used for hydrodynamic modeling (Fig. 1).

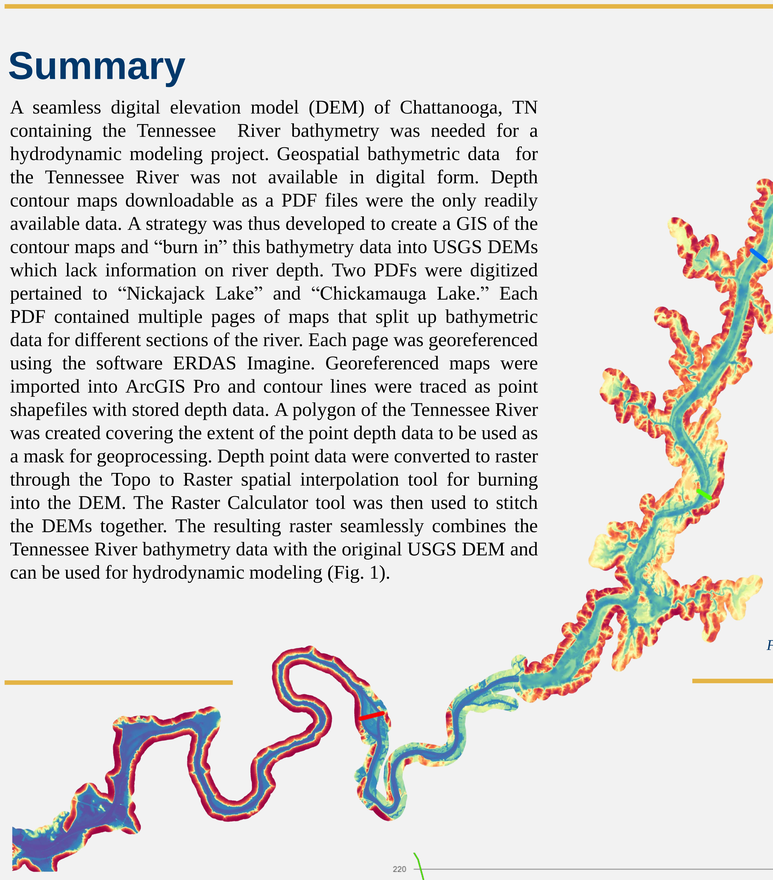

Fig. 1: Bathymetrically complete DEM of the Tennessee River in SE TN

Results

Elevation profiles comparing the old USGS DEM with the new bathymetrically seamless DEM were created (Fig. 2). Training and test data were created in order to validate the data. The training data were used to create the seamless bathymetric DEM. The testing data were then used to obtain the bathymetric raster's predicted depths validated against the source depth. These values were exported as a table to Microsoft Excel to calculate root mean square error which was found to be 1.057.

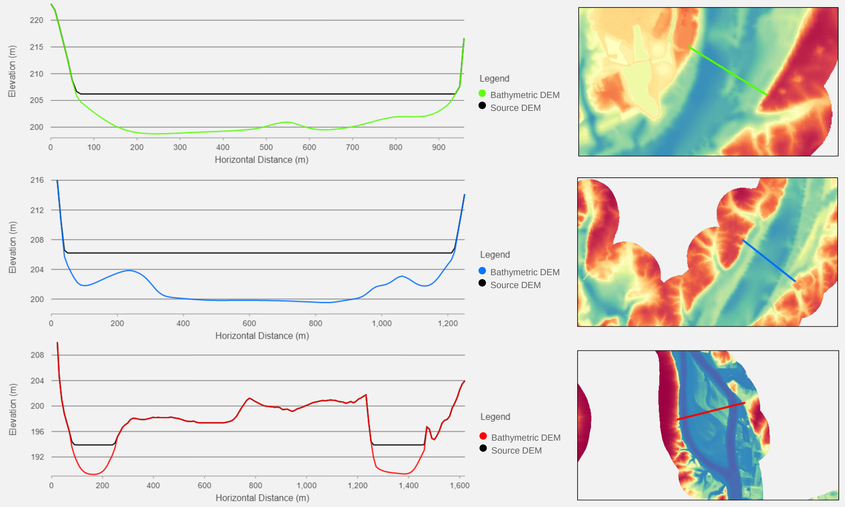

Fig. 2: Profiles comparing original and updated DEM depths.

Methodology

The source for bathymetric data was found from Sportsman's Connection who have published bathymetric data for the Tennessee River via digital PDFs. Two PDFs were digitized pertaining to Nickajack Lake and Chickamauga Lake. These sections were georeferenced and imported into ArcGIS Pro. The bathymetric lines were traced with point shapefiles storing depth data. A polygon shapefile was created covering the extent of the point depth data and used as a mask for the geoprocessing tool used to interpolate depth point data to raster to be burned into the DEM (Fig. 3). A ⅓ arc second USGS DEM for the SE TN region was downloaded from USGS. Due to the source depth unit being in feet, the depth values of the generated raster was converted to meters. The interpolation generated values below 0, which would create unintended artificial additions to elevation when subtracted from the USGS DEM. Code (1) was used to convert values below 0 to 0. This new DEM then needed to be subtracted from the original USGS DEM using Code (2). The next step was to seamlessly burn the subtracted DEM into the original USGS DEM. Code (3) was used to insert bathymetric raster data into the desired USGS DEM. This generates a new raster dataset that combines the new bathymetric DEM and the original USGS DEM. Fig. 4 illustrates the complete process involved in the methodology.

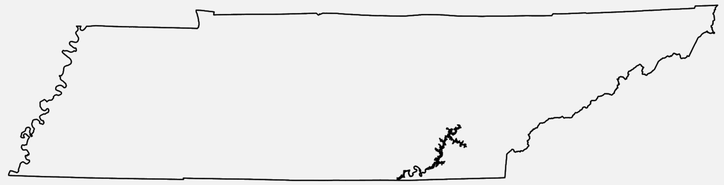

Fig. 3: Extent of study area within Tennessee

(1) *Con("Negative River Values" <0,0,"Negative River Values") == Corrected River Depth Raster*

(2) *"Source DEM" - "Corrected River Depth Raster" == Bathymetry Raster*

(3) *Con(IsNull("Bathymetry Raster"),"Source DEM", "Bathymetry Raster","Value = 1") == Seamless Bathymetric DEM*

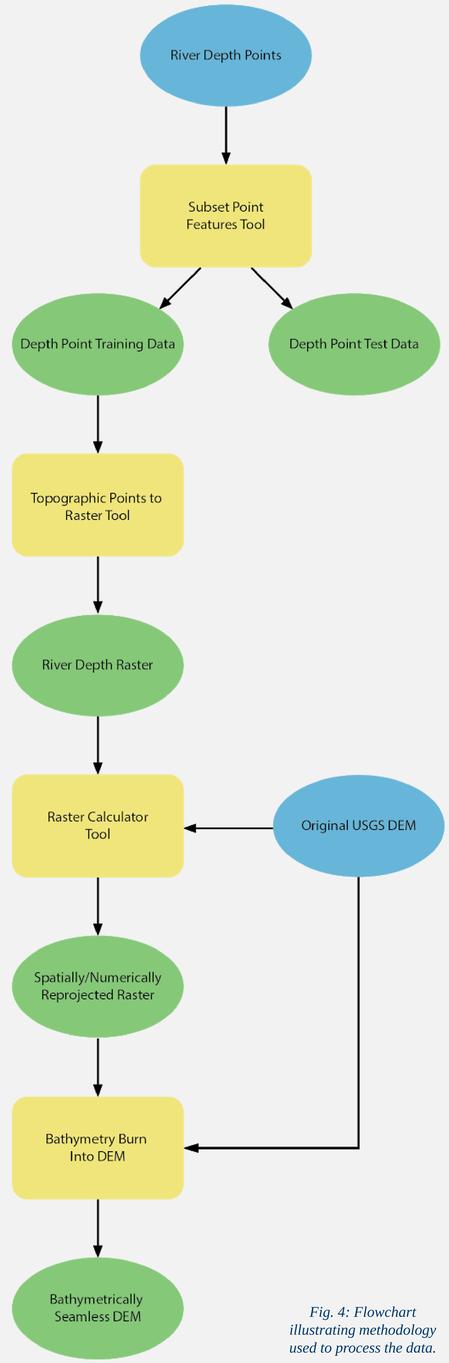

Fig. 4: Flowchart illustrating methodology used to process the data.

Conclusions

Due to the highly variable nature of Tennessee River morphology and depth, these values should not be taken as absolute and used only for general hydrodynamic modeling purposes. Many of the pages from the PDFs were found to be inconsistent with current landforms, e.g. no indication of a dam that exists on the river today; therefore, the point data are not entirely accurate when compared to the source as adjustments had to be made to incorporate differences and errors from georeferencing.

Acknowledgements

This project was funded by the THEC Center for Excellence in Applied Computational Science & Engineering (CEACSE) at the University of Tennessee at Chattanooga. Thanks are due to Rick Blanton for helping with geoprocessing. Sportsman's Connection, USGS, U.S. Army Corps of Engineers, and the TVA provided the data for the project.