Exploring Depth to Bedrock Estimation

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Background

The geologic Depth To Bedrock (DTB) is an important aspect of soil and lithologic science that has no widely used and agreed upon non-invasive estimation practice. This research project attempts to estimate DTB using readily available Digital Elevation Model (DEM) data and pre-existing core logs as validation.

Approach

Depth to bedrock (DTB) within this poster is defined as the vertical distance from Earth's surface to the geologic bedrock layers directly below.

This projct aims to estimate DTB using DEM-derived parameters, based off of the previous methodology of Catani et al. (2010) and Xiao et al. (2023). These parameters were determined by analyzing the correlation between soil depth and various geomorphic features of landscapes.

This methodology was applied to McLean County, Kentucky alongside a control DTB map created using the Kentucky Geological Survey's coal borehole database.

Using the DEM parameters and the borehole interpolation, we tested a generalized regression in order to derive a stand-alone DTB map.

Methods

- Extract area elevation, profile curvature, and slope angle.
- Adjust outliers of profile curvature.
- Normalize each to create parameters.
- Multiply parameters by an existing DTB base or flat raster layer.

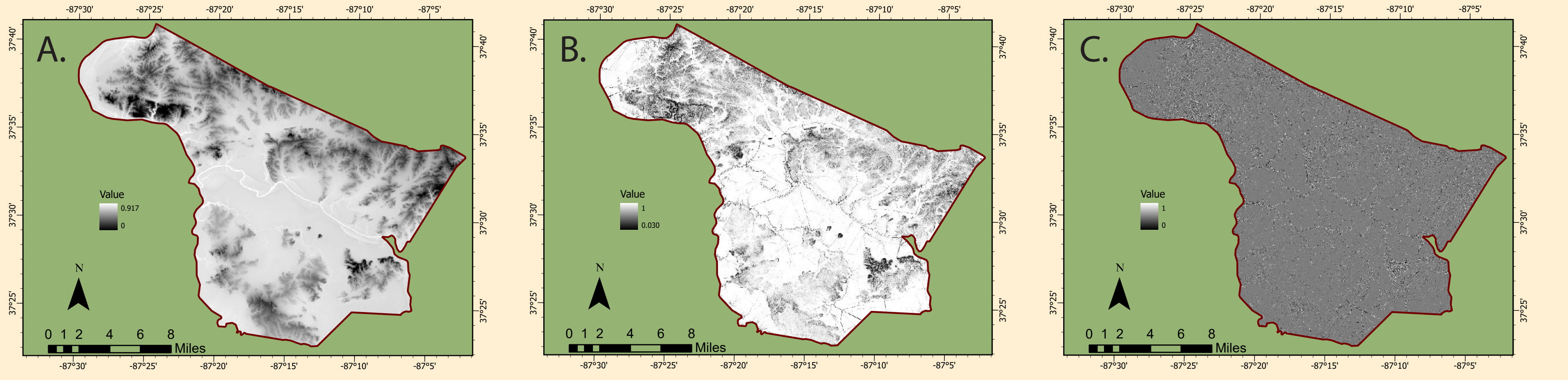

Figure 1.
A. Normalized elevation parameter map
B. Normalized slope angle parameter map
C. Normalized curvature parameter map

- Run regression modelling to
- determine importance of each
- parameter and test accuracy.
- Test new parameters, such as river distance, bedrock lithology, topographic roughness index, and geomorphons to raise r^2 value and try to improve reliability.

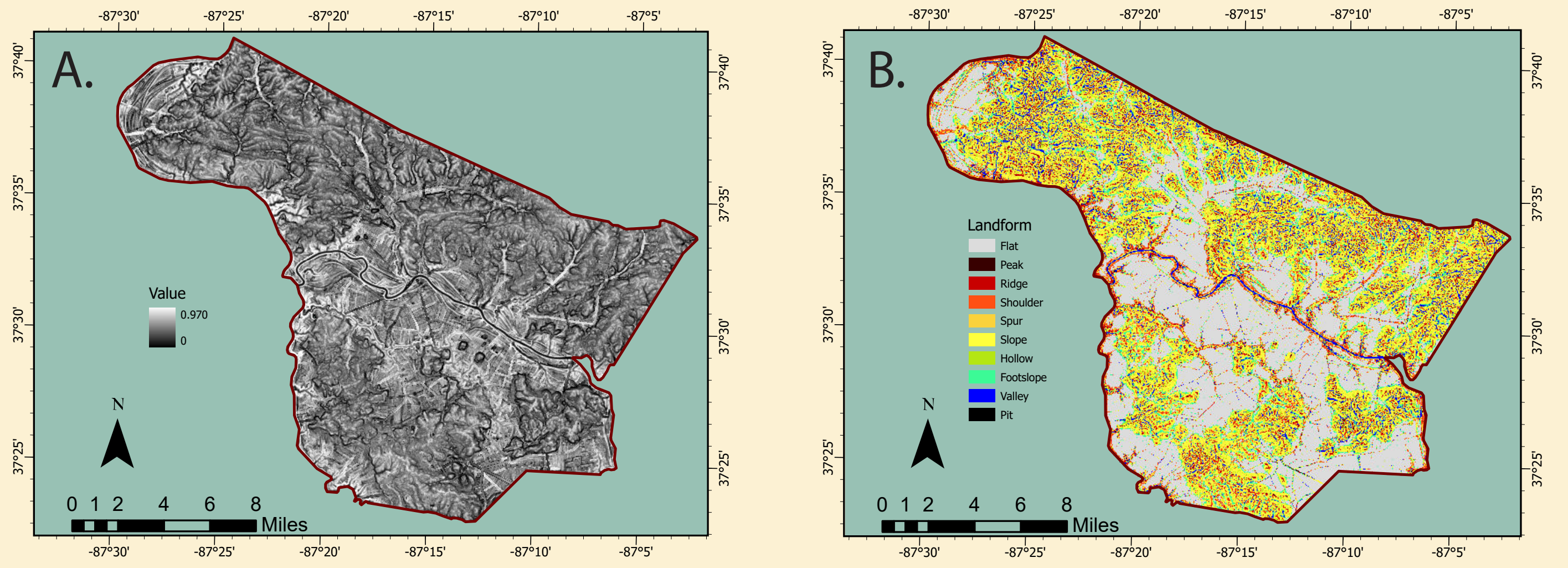

Figure 2.
A. Terrain Roughness Index map
B. Geomorphon map

- Run parameters that are deemed important and reliable (roughness, geomorphons).
- Create DTB maps with calculated intercept and coefficients.

$$\mathrm{Elevation}(-0.327) + \mathrm{Profile\ Curvature}(1.58) + \mathrm{Slope}(1.25) + \mathrm{Roughness}(52.63) + \mathrm{Geomorphons}(-1.60) + 156.34$$

Equation 1. Generalized regression parameter coefficients and intercept equation.

Results

The initial DTB map created with the DEM parameters had a strong correlation with the control map created from the borehole data. While not numerically accurate, it showed a definite relationship between the parameters and the actual depth value.

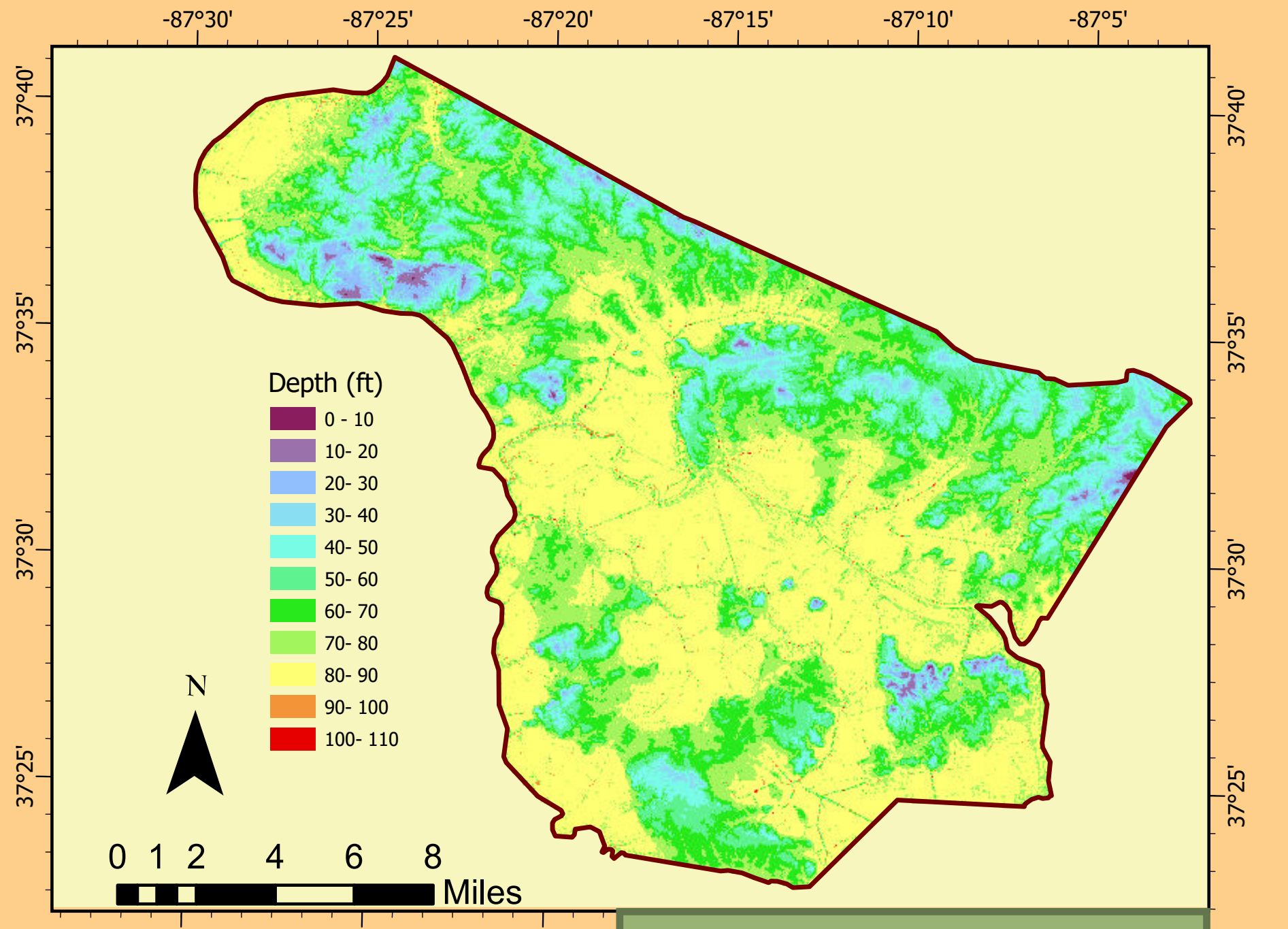

Figure 5.
DTB map made with the GIS parameters found in Fig. 1.

For the regression modelling, five inputs were used and an r^2 of 0.38 was acquired. It seems to represent low values with good accuracy.

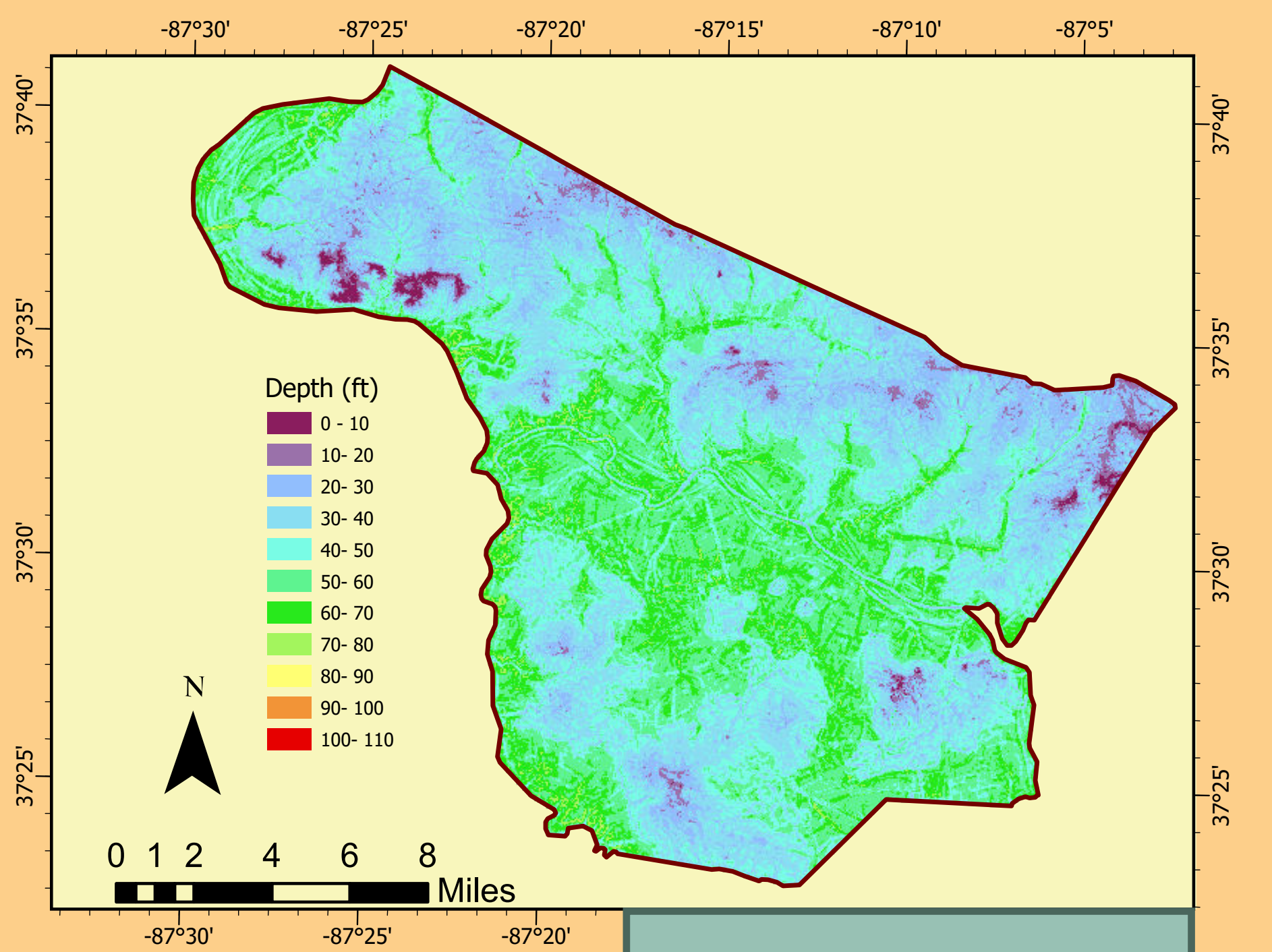

Figure 6.
Generalized regression DTB map, made with Eq. 1.

Control Map

- Find coal boreholes or other known accurate DTB data for study area.
- Filter through to determine most likely actual depth for each borehole based on location, bedrock lithology, and adjcent borehole values.
- Establish a data table with values and locations to create a control DTB map.

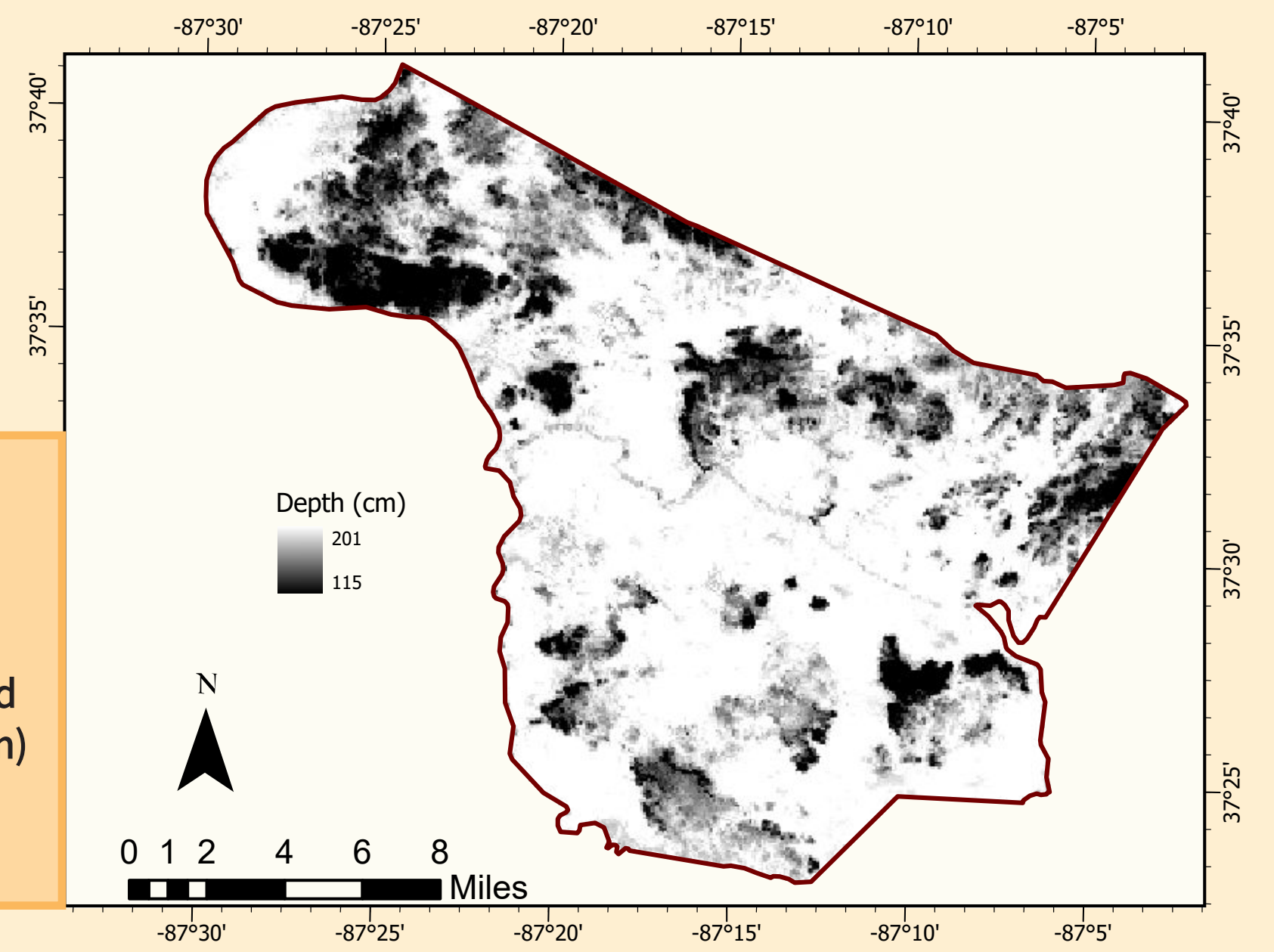

Figure 3.

The Soil Landscapes of the United States (100m) DTB map.

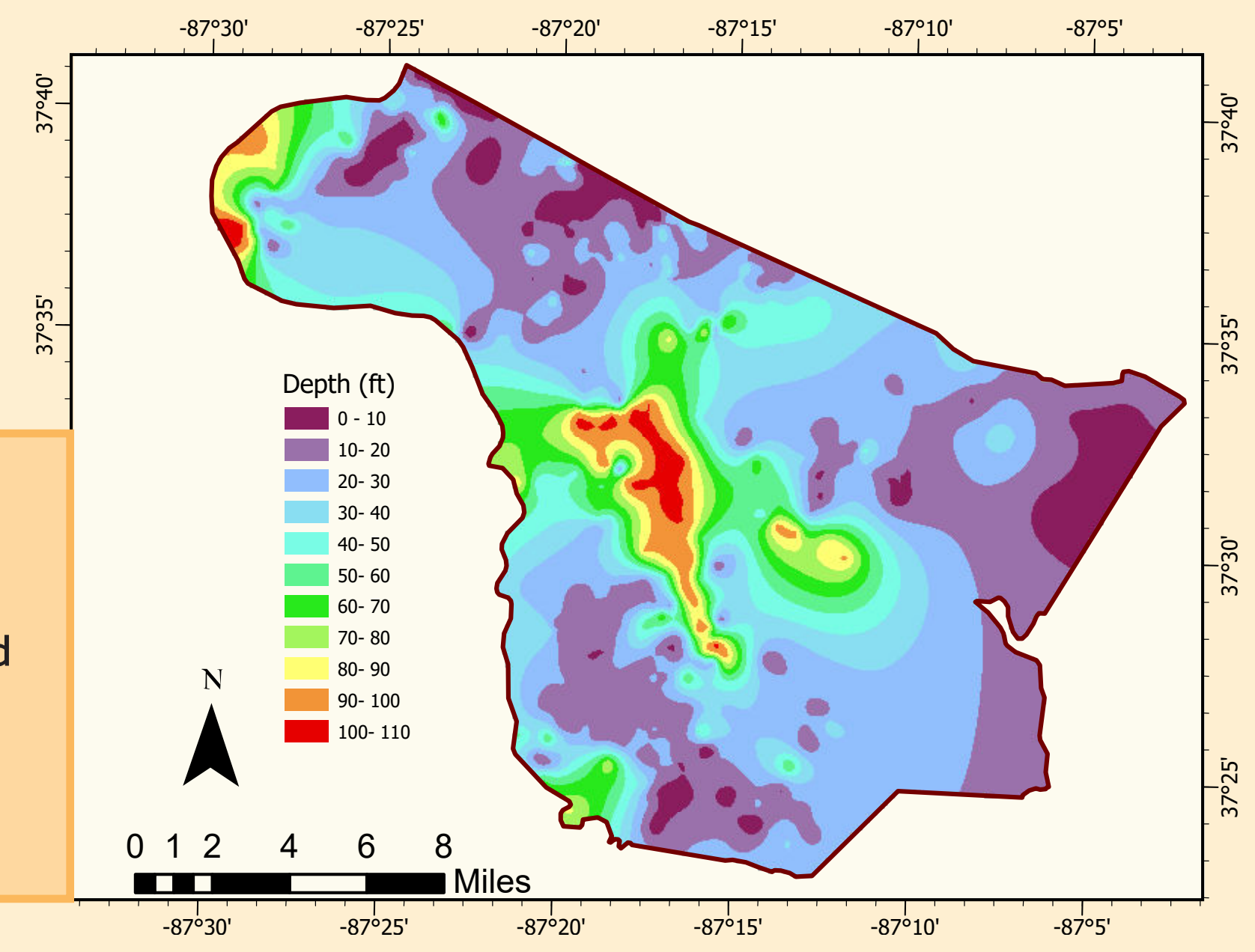

Figure 4.

A DTB map interpolated from coal borehole strip logs.

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Works Cited

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