Methods for developing soil functional property maps for scaling to regional estimates

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INTRODUCTION

As part of the transdisciplinary approach taken by the CSCAP group, digital modelers and mappers are working to produce regional (Midwestern) predictions to better understand and evaluate the climatic and economic impact of corn-based systems.

Baseline measurements of greenhouse gases, carbon, nitrogen, water use and other metrics are being collected at more than 20 sites across the Midwest for corn-soybean rotations, under a variety of management practices. This field level data will be used to define and quantify local soil process, as a function of soil properties, and utilized to predict region wide processes and understand their agricultural implications in a world of changing climates.

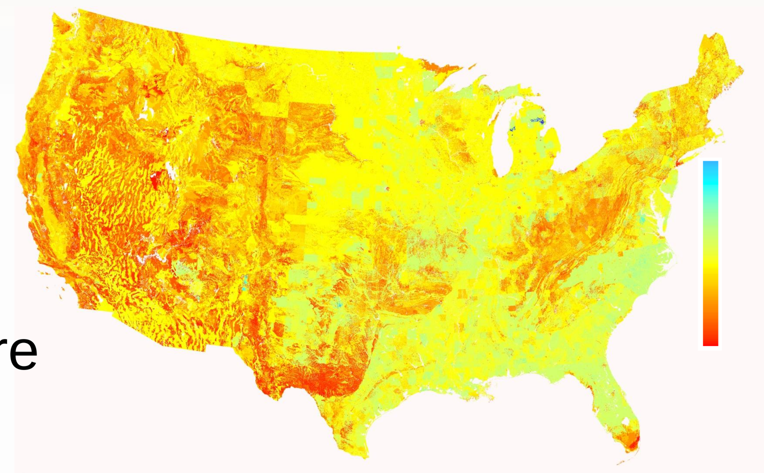

Figure 1: Soil Depth.

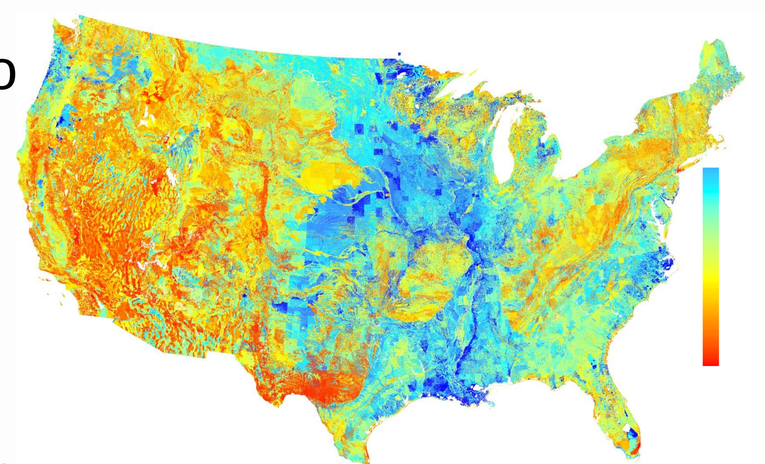

Figure 2: Available Water Holding Capacity.

METHODS

Figure 3: SEPAC site.

Field Site

Initial field scale modeling and analysis took place for the cover crop field at the Southeastern Purdue Agricultural Center(SEPAC) located in Jennings County, IN. The soil landscape is characterized by the Cincinnati-Rossmoyne-Grayford and Clermont-Avonburg associations. These soils are formed in deep loess over pre-Wisonsin age glacial till. Soils are poorly drained on the broad flat surfaces and well drained on side slopes.

METHODS

The Terrain Attribute Soil Mapping approach (TASM) works to improve upon the USDA/National Soil Survey maps by creating continuous raster-based estimates of soil properties as opposed to the discrete, polygon range estimates, provided by the soil survey.

The open source GIS, SAGA, was used to derive terrain attributes from a 10m site DEM (Figure 4). Rules were determined to define the relationships between terrain attributes and soil classes , and then formalized through a serious of if/then statements in the soil mapping software, SoLiM, from which a new, continuous, soil class map was generated.

A continuous property map of soil depth was generated using discrete, soil survey range estimates and validated with soil cores taken from the 13 GPS point locations, show in Figure 4.

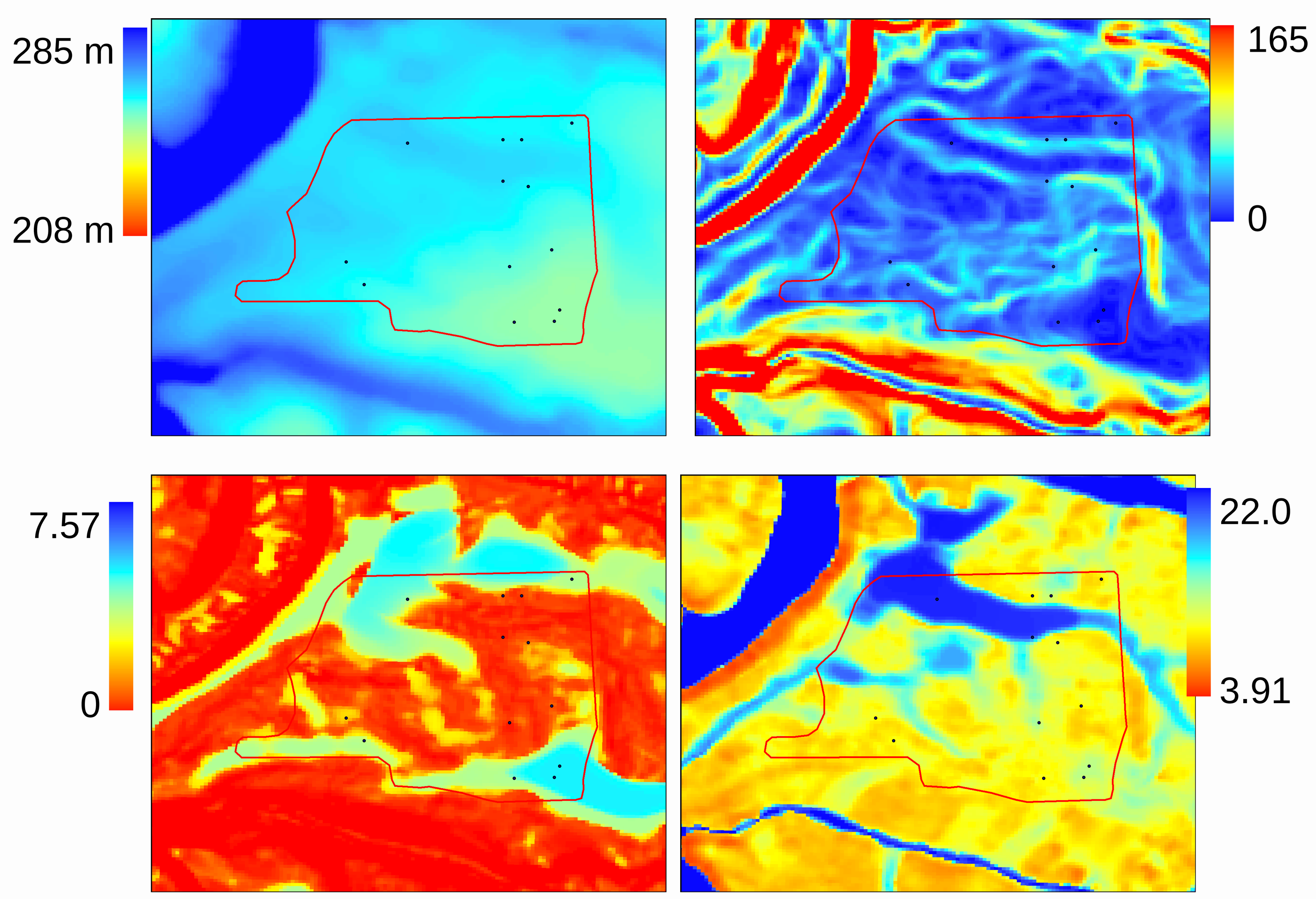

Figure 4: SAGA derived terrain attributes. (a) 10 m DEM of SEPAC site. (b) Slope Percent. (c) Multi-resolution ridge top flatness. (d) SAGA Topographic wetness index.

RESULTS & DISCUSSION

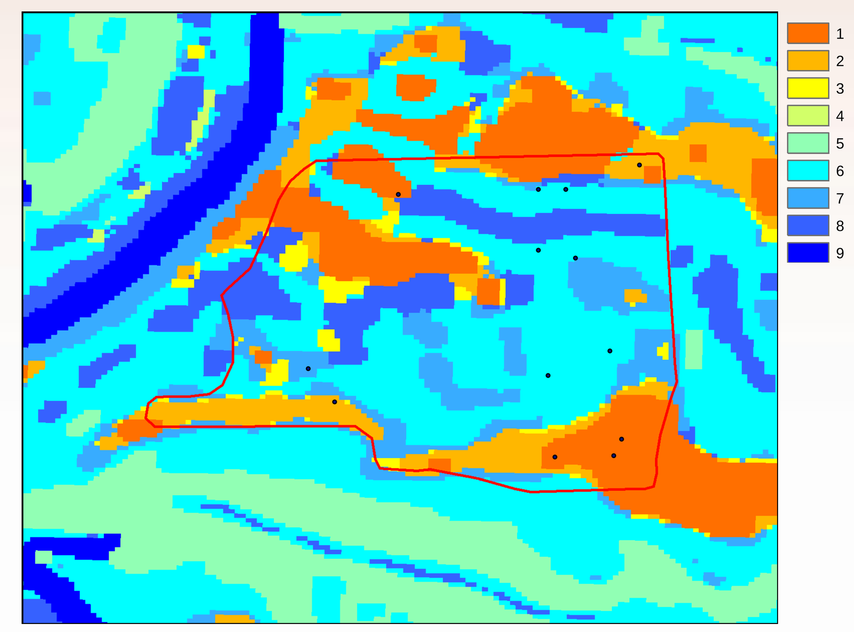

Figure 5: TASM soil class map.

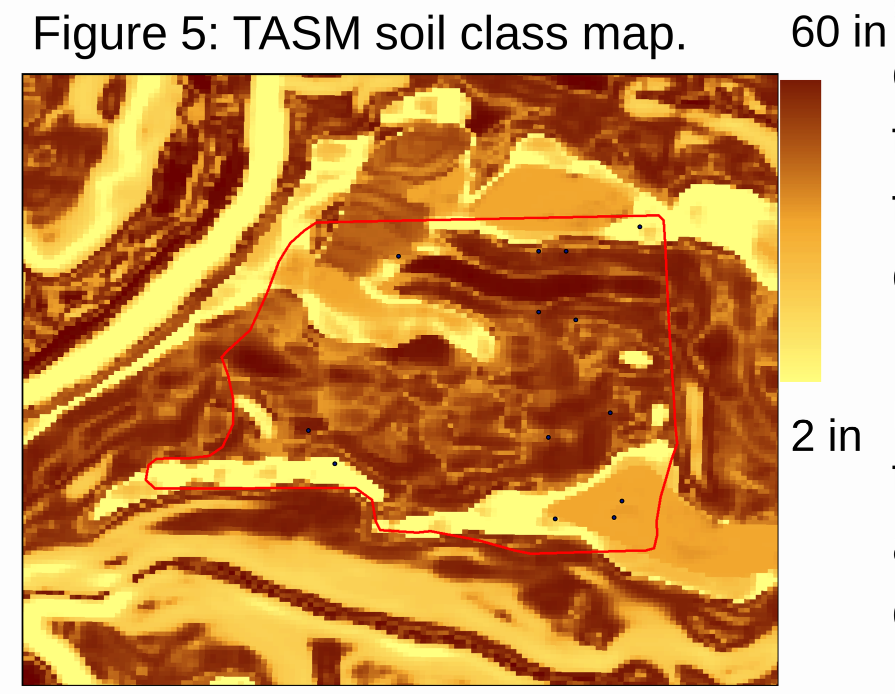

Figure 6: Continuous soil depth.

The TASM soil map (Figure 5) is continuous because each pixel has an associated probability of belonging to a class, with probability decreasing from 1 to 0 as distance increases from the centroid of the class. The continuous depth estimates (Figure 6) are based on soil class membership. When there is 100%membership, the soil property would equal the assigned properties. As the membership decreases, the soil property estimate is adjusted to reflect the change across the landscape.

CONCLUSION

With the current availability of digital soil information, the ability to develop techniques for regional scaling is greatly improved. The Terrain Attribute Soil Mapping (TASM) approach is a labor intensive, knowledge-based approach rooted in the five state factor model for predicting soil variability and has been demonstrated to be useful in previous studies . With the understanding of soil property -corn responses gained at the field scale, the TASM method may be useful for upscaling the responses to provide quantitative regional predictions. Further research will focus on developing improved methods for soil property estimates and increased efficiency. Similar soil mapping procedures may be implemented for the other CSCAP sites.

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