Field scale mapping for soil classification and property prediction

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INTRODUCTION

Corn, soybeans, and their associated agricultural products are vital to U.S. food security, energy independence, and economic growth. In the face of changing climates and potential resource depletion, providing adequate, sustainable production for ever growing domestic and international markets may become increasingly difficult.

Soil, its properties, and fertility are fundamental to crop production. Understanding soil variability and its impact on crop performance and greenhouse gas dynamics will be crucial to developing best management practices and interpreting field level yield variability.

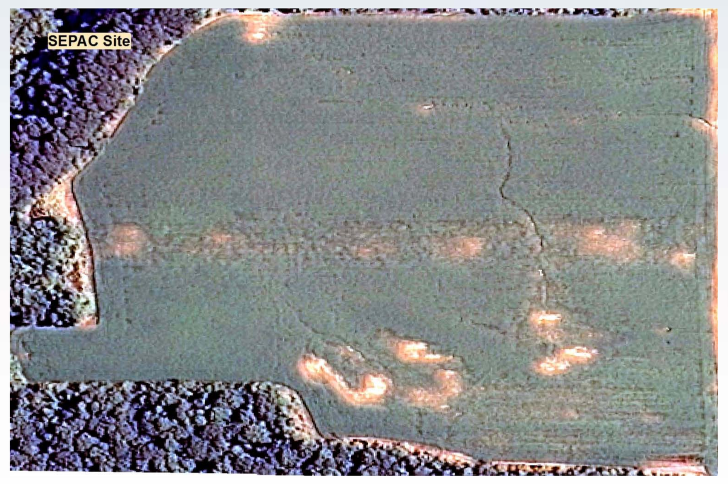

Figure 1: SEPAC site.

Digital mapping was implemented at the Southeastern Purdue Agricultural Center (SEPAC) site to generate a soil class map related to the functionality of the soils. From these "functional classes", a continuous property map was created, predicting the depth to a water limiting paleosol layer. These types of functional class and property maps may be used, in combination with field trial data, to inform management decisions and feed various systems.

MATERIALS & METHODS

Field Site

Field scale digital soil mapping and analysis took place for the cover crop field at the located in Jennings County, IN. The soil landscape was formed in deep loess over pre-Wisconsin age glacial till. Soils are poorly drained on the broad flat surfaces and well drained on side slopes.

Initial Reconnaissance

Initial reconnaissance is preformed in the field to locate the centroid/central concept of the soil classes related to soil function. This involves using "expert knowledge" to identify various topographic "zone", in the field, which have similar water relations and therefore provide similar function. These zones will be represented as classes. Sampling is then preformed at the central concept of each landscape position to identify the driving soil features related to soil function.

MATERIALS & METHODS

Digital Methods

Terrain attributes are derived from a digital elevation model (DEM) using the open source, SAGA GIS and attribute values of each class centroid are determined to define the various zone.

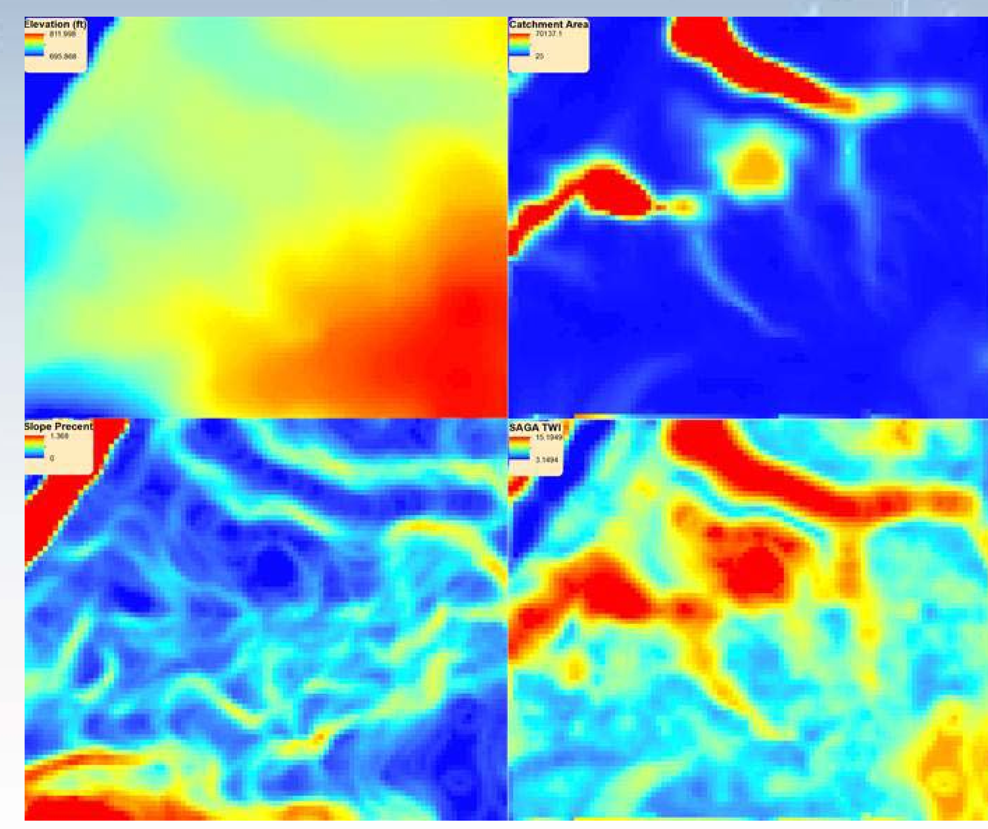
Figure 2: SAGA derived terrain attributes.

These "threshold" values are input into the Soil-land Inference Model (SoLIM) to generate a fuzzy membership class map. From these fuzzy classes, a depth to paleosol map was generated by assigning a depth value at the class centroid location and weighting it by its fuzzy membership in all 5 classes.

Validation

Field sampling of texture, redoxomorphic features, depth to fragipan and depth to paleosol were performed at 20 points selected using a Latin hyper cube sampling design, for the purpose of model validation. A comparison of yield amongst the classes was preformed using normalized yield monitor data from 2011.

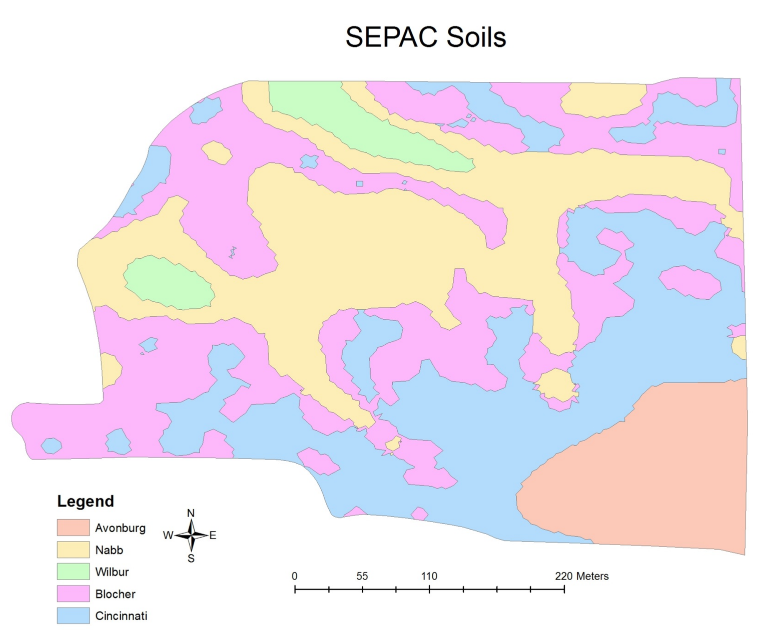

Figure 3: Predicted fuzzy class map.

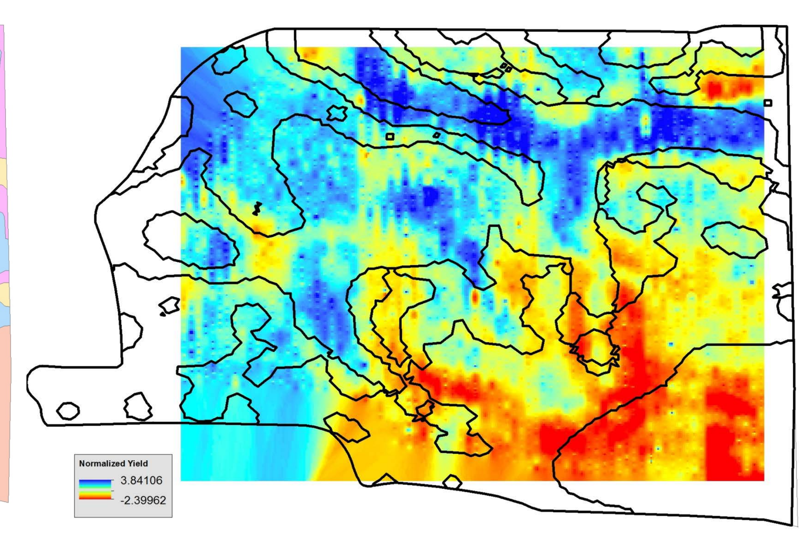
Figure 4: Normalized yield.

RESULTS & DISCUSSION

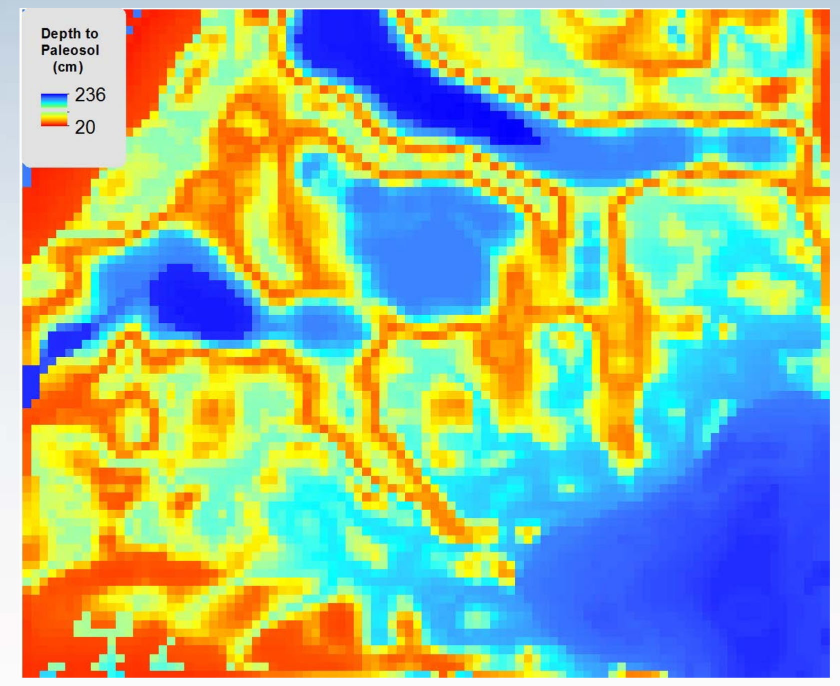

Figure 5: Predicted depth to paleosol map.

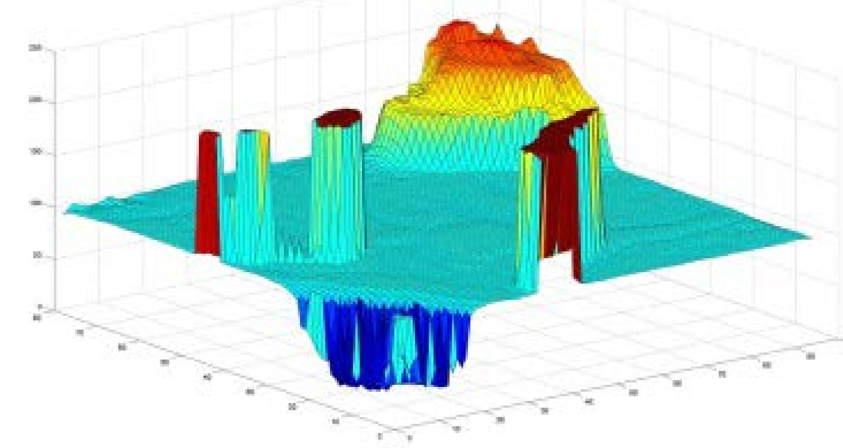
Figure 6: 3D depth to paleosol.

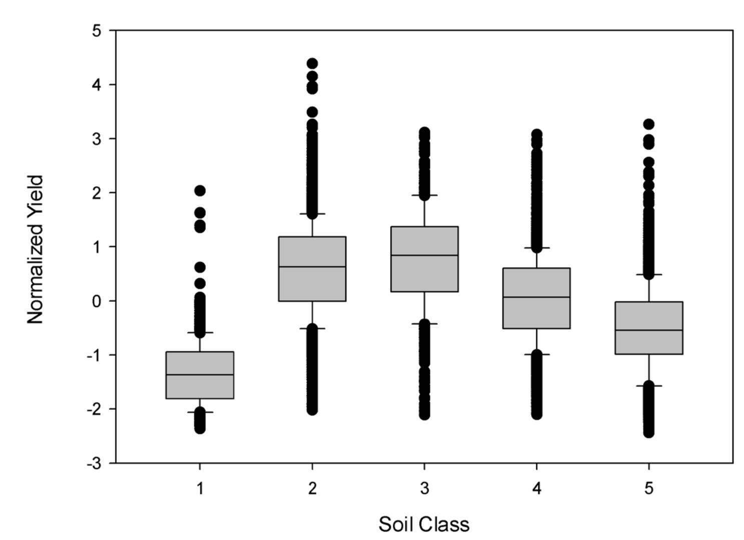

Figure 7: box plots of normalized yield by soil class.

Shown in figure 3, five soil classes were predicted using the terrain attributes; Topographic Wetness Index (TWI), Modified Catchment Area, elevation above sea level, and slope (Figure 2). Each class was related to a soil series for classification purposes. From these classes, a depth to paleosol map was generated ranging from 20 to 236 cm in depth. Validation, in the form of a rank t-test, found all five classes to be significantly different in terms of corn and soybean yield, determined by yield monitor data (Figure 7). This shows that functionally similar soil classes, in terms of yield variability can be determined and mapped using a fuzzy membership, terrain attribute, knowledge based approach.

CONCLUSION

The method proved to be useful for field scale mapping and prediction of functionally similar soil classes. In future research, this methods can be easily scalable using currently available soil surveys and terrain attributes, enabling the prediction of soil function on field to regional scales.

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