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Spatial Modeling of Soil Properties in Catchments with Prairie Strips

Purpose

Native prairie vegetation strips on contours (STRIPS) are a relatively new conservation strategy which bring a host of ecosystem services. They also add a degree of complexity to what would otherwise be a simplified landscape. Despite the bloom of research on the functionality of the management practice, no studies have examined the spatial nature of STRIPS' impacts to soil properties.

This study analyzes the impact of the presence of the prairie strips on surrounding soil properties. Data mining techniques were used to select covariates from large pools to support estimation or organic matter concentration and pH. The best performing models were used to produce maps of SOC, pH, and their respective prediction error.

Questions

Do prairie strips alter the spatial distribution of soil properties?

- What are the new spatial patterns created by their presence?

Methods

Digital soil map models were built from data collected in the Basswood field located in Neal Smith Wildlife Refuge, Jasper County, Iowa. Samples were strategically collected with respect to topographic and hydrologic variables from paired catchments to support spatial modeling.

Target variables were measured from 147 locations at 0-10cm depth in the summer of 2017 during R3-R4 in the soybean's growth stage.

The Cubist datamining algorithm selected parameters from the provided pool of digital elevation model derivatives and built rule-based, multivariate linear models. For each target variable different predictors were selected.

Potential Variable Pool

Predictor	Software	Analysis scale
Elevation (LiDAR, bare earth)	n/a	2m
Topographic Position Index (TPI)	Arc GIS	6-502m
Relative Elevation	ArcGIS toolbox	6-502m
Planform Curvature	GRASS	6-702m
Profile Curvature	GRASS	6-702m
Longitudinal Curvature	GRASS	6-702m
Crossectional Curvature	GRASS	6-702m
Minimum Curvature	GRASS	6-702m
Slope Gradient	GRASS	6-702m
Northness	Transformed from aspect (GRASS)	6-502m
Eastness	Transformed from aspect (GRASS)	6-502m
Area Solar Radiation	ArcGIS toolbox	6-502m

Results

Models of organic matter trained solely on samples from STRIPS catchments predict higher organic matter content around the measured areas. Binned sample data, plotted in figure 1a, show slightly greater with higher variability than the control. This pattern is visually reflected in the spatial models [figures 2b & 2c].

Models of pH trained with sample data from STRIPS-containing-catchments predict higher pH within the STRIPS area. Binned sample data, plotted in figure 1b, show significantly higher pH than that of the control. The sample data also shows a different pattern moving from above to inside to below [the STRIPS area]. The pattern is visually reflected in spatial models [figures 2d & 2f].

Binned sample data

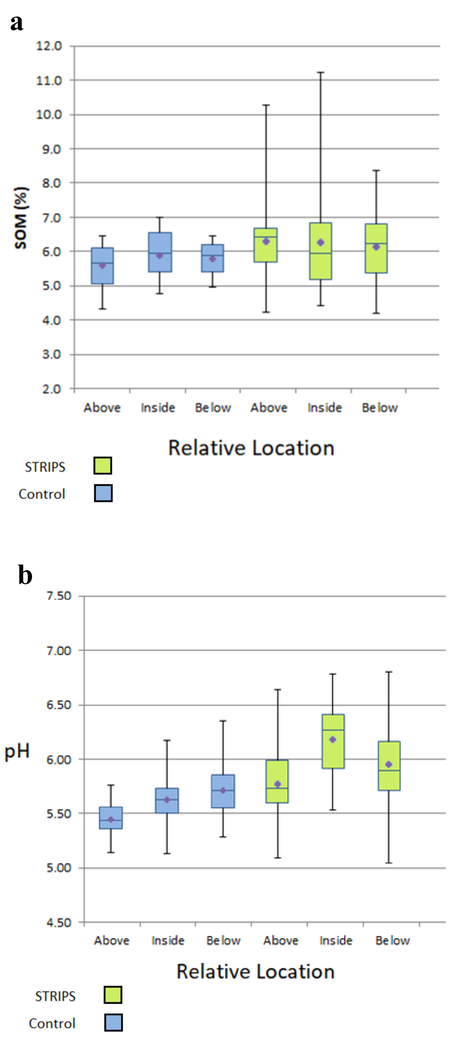

Figure 1: Box plots of binned values of organic matter concentration (a) and pH (b). Measurements of organic matter centered around the strips are slightly higher but not significantly different than the control. Measurements of pH centered around the strips are significantly ($p < 0.05$) different in magnitude and exhibit a different spatial pattern.

Resulting Maps

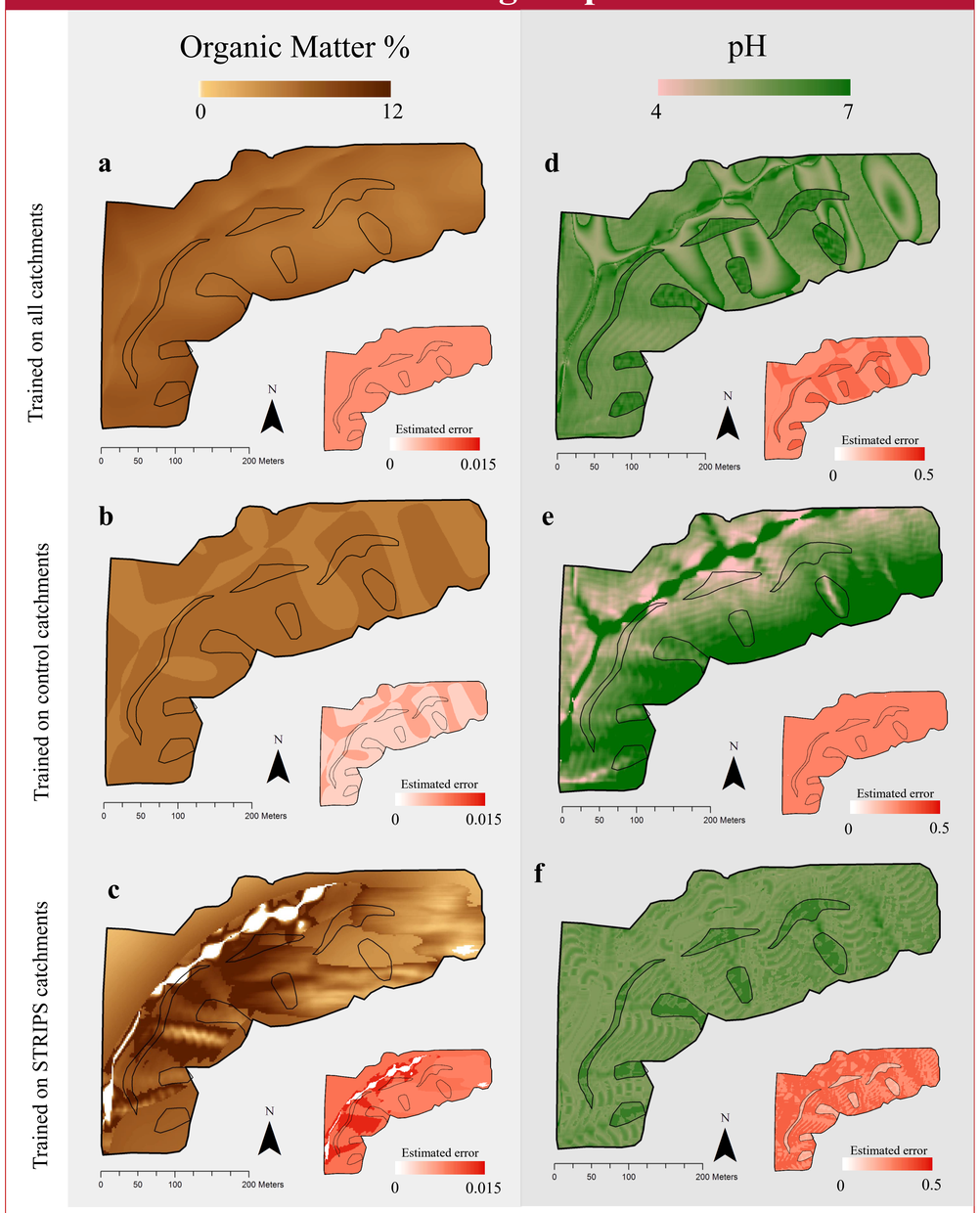

Figure 2: a) OM gradients occurring with aspect and topographic position. b) OM concentrations are dependent on catena position. c) Models aspect and slope to predict OM concentrations; d) Models exhibit a dual pattern. The strips area exhibits high pH concentrations. The second division targeted south-facing aspect. e) Models exhibit a simple gradient with higher pH values in the upper hillslope positions and increase down the hill. f) Models exhibit a hump-like pattern, where the samples within the STRIPS have higher pH than the area around them, both above and below.

Conclusions

Prairie strips, perennial vegetation installed on contours, change the spatial distributions of soil properties. Soil organic matter concentrations were slightly in samples around the strips. Measured pH was significantly higher around the strips. Models created using data specific to catchments with strips exhibit different spatial patterns than those created without strips. The locations of samples can dramatically alter the way an area is modeled.

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