GIS Mapping of Soil Properties by Different Interpolation Methods at Walter C. Agricultural Research Center, Nacogdoches, Texas

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Introduction

Advancement in precision agriculture focuses primarily on arable crops with limited study on forage due to low economic value and high field variability.

An important aspect of precision agriculture is generating site specific soil map. Using inappropriate interpolation methods can provide misleading spatial information resulting in potentially poor managerial decisions.

Interpolation techniques such as inverse distance weighting (IDW), kriging, and spline have been extensively used in constructing soil fertility maps.

Very few study have been conducted to generate soil map of forage fields because of forage land limitations.

The objective of this study is to (i) construct soil map of selected soil properties from forage land using different interpolation techniques and (ii) evaluate the relationship between the accuracy of prediction between interpolation techniques.

Materials and Methods

The study was conducted at Walter C. Todd Agricultural Research Center (WCTARC), Nacogdoches, Texas with an area of approximately 198 hectares.

One hundred and three soil samples were collected and analyzed for soil pH, Mehlich III extractable phosphorous and potassium using a grid sampling method with a grid area of 2 hectares.

Geographic positioning system points of each sampling point were recorded. Five to ten sub-samples were collected from the soil surface to a depth of about 15 cm inches within a 20 meters radius and bulked to form a composite sample. Sampling configuration is shown in figure 1.

Soil maps were constructed using three interpolation methods, inverse distance weighted, ordinary kriging, and completely regularize spline.

The prediction accuracy of maps was assessed using cross-validation while the relationships between measured and predicted soil properties were evaluated using linear regression.

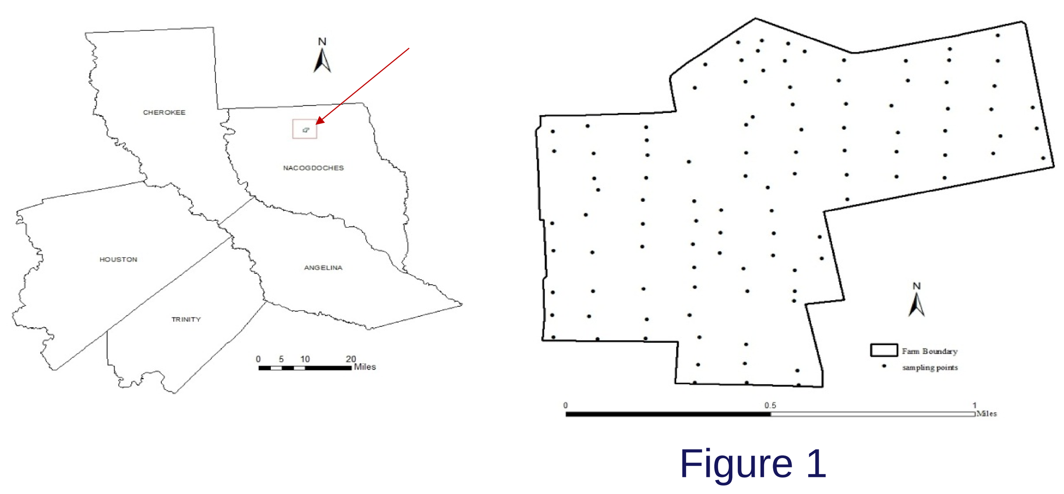

Figure 1

Results and Discussion

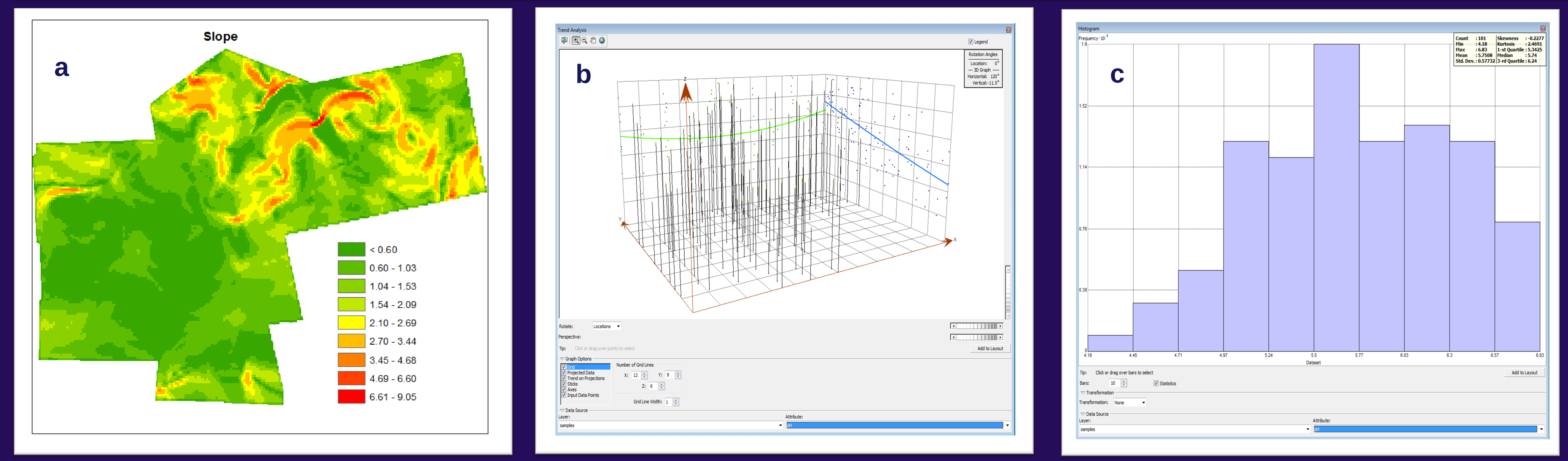

Figure 2. (a) Slope (b). Trend analysis (c). Histogram for soil pH sampled from WCTARC (Exploratory data analysis)

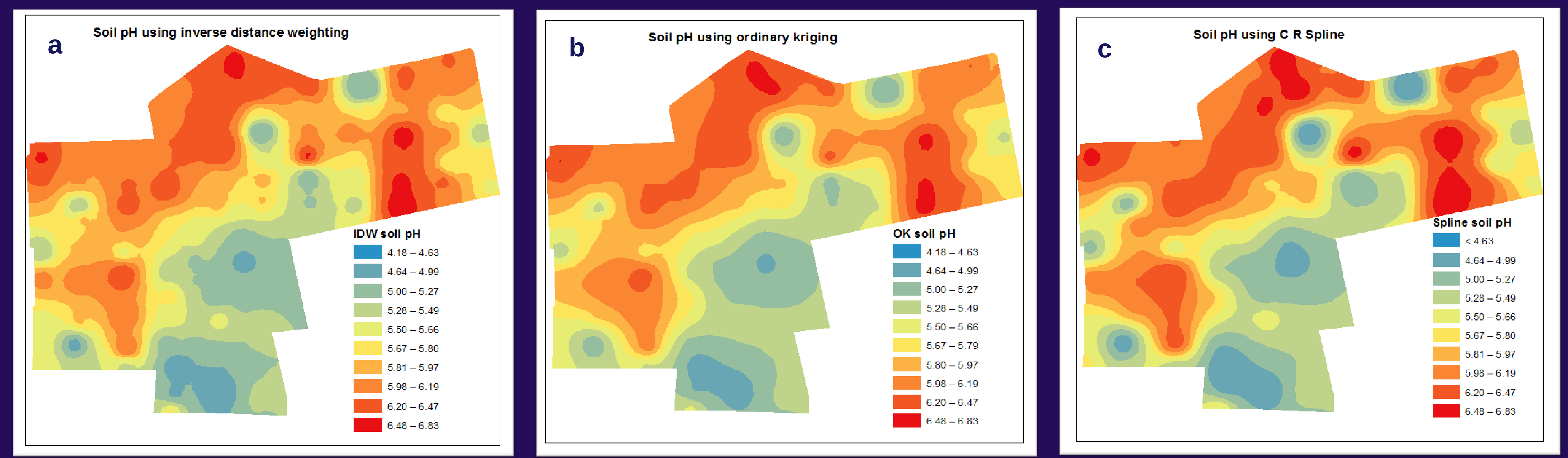

Figure 2. Soil pH map of WCTARC generated from (a). Inverse Distance Weighting (b). Ordinary Kriging and (c). Completely Regularized Spline interpolation techniques.

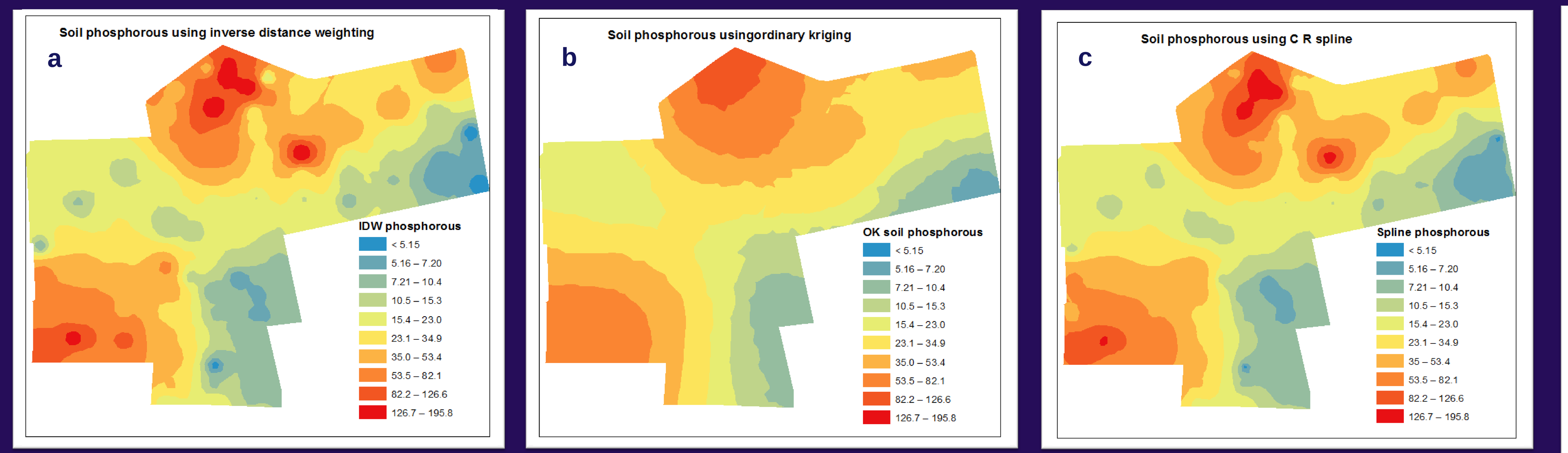

Figure 3. Soil phosphorous map of WCTARC generated from (a). Inverse Distance Weighting (b). Ordinary Kriging and (c). Completely Regularized Spline interpolation techniques.

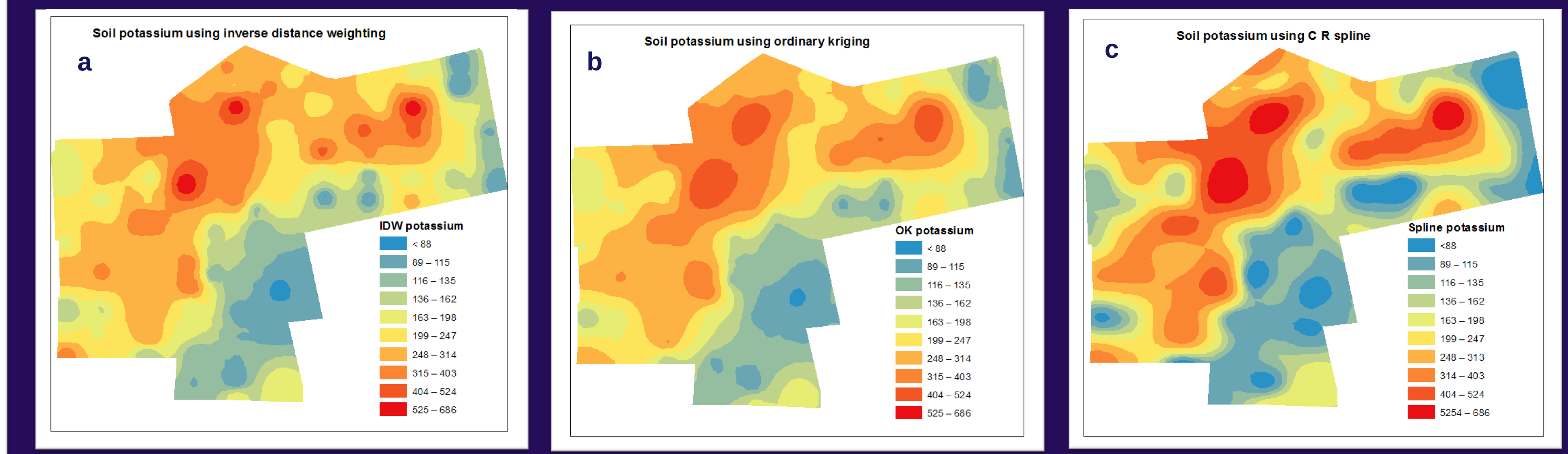

Figure 4. Soil potassium map of WCTARC generated from (a). Inverse Distance Weighting (b). Ordinary Kriging and (c). Completely Regularized Spline interpolation techniques.

Table 1. Root mean square error of soil properties for interpolated technique

Soil Property	IDW	SK	CR Spline
	Spatial Interpolation Methods		
	Mean Root Square Error		
Soil pH	0.46	0.45	0.45
P (ppm)^2	36.4	34.9	34.8
K (ppm)^2	112.0	106.0	102.0

Table 2. R^2 of measured and predicted soil properties by interpolated technique

Soil Property	IDW	SK	CR Spline
	Spatial Interpolation Methods		
	R^2		
Soil pH	0.41	0.45	0.45
P	0.33	0.37	0.38
K	0.26	0.33	0.39

Trend analysis showed that soil properties did not have a trend or a trend too weak to be identified and hence was impossible to detect any spatial structure (Figure 2b).

Histogram shows that data was normally distributed (Figure 2c).

Applied interpolation methods for the soil properties gave similar RMSE in terms of accuracy, without any of them being clearly better than the other except IDW map generated for K (Table 1).

Modest correlation between measured and predicted soil properties particularly soil pH (Table 1).

The predictions were generally lower for ordinary kriging method compared to the other techniques.

Regardless of spatial interpolation method, the pattern of distribution of potassium was similar to soil pH.

Conclusions and Recommendations

Spatial interpolation methods used in this study were not superior to each other in interpolating soil properties.

Moderate correlation provides evidence that spatial interpolation has the tendency to predict soil property such as soil pH.

Classifying and interpolating sampling points into groups based on soil type and terrain might help improve map accuracy as well as correlation between measure and predicted soil properties.

Further study must be conducted to evaluate the effect of the coefficient of variation on the accuracy of interpolation.

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