THEME 1

# Using Remote Sensing and GIS techniques for predicting soil organic carbon in Southern Iraq

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## INTRODUCTION

Soil organic matter is a major source of nitrogen used by crop at any given time. Ninety-five to ninety-nine percent of the potentially available nitrogen in the soil is in organic forms, either in plant and animal residues, in the relatively stable soil organic matter, or in living soil organisms, mainly microbes such as bacteria. Data on field soil total organic carbon and nitrogen content is important for determining existing C : N ratios to guide optimal rates of nitrogen fertilizer application. Because laboratory measurement of C is expensive and time-consuming, the total number of samples that can be analysed is limited and therefore hinders the characterization of soils and their spatial variation at broader scales (Bouma, 2001; Mermut and Eswaren, 2001; Salehi, et al., 2003) . Hence, there is a need for reasonable landscape and regional-scale estimations of C based on limited numbers of samples distributed across an area of interest which can be done by using remote sensing and GIS techniques (Zhu, 2000).

## OBJECTIVES

The present study aimed to develop remote sensing and GIS based methods to predict and map the spatial distribution content of soil organic carbon for soils in the study area in Sothern Iraq.

## METHODOLOGY

Laboratory analysis for the target soil properties for the selected 35 sites in the study area (Fig.3) including soil organic carbon, and other physical and chemical soil properties were done using common laboratory analysis methods. LANDSAT OLI images of the study area, obtained from the USGS EROS Centre, were used to calculate a range of indices from the distributed spectral values for evaluation; including SAVI, EVI, and GDVI. Statistical correlations were applied between soil organic carbon, measured soil properties and indices to determine the best-performing models for prediction. The best fitting models are represented by the following equation :

$$\mathbf{SOC} = \mathbf{32.588} + \mathbf{8.495}\ \mathbf{ln(SAVI)} - \mathbf{57.965(SAVI)} \quad \mathbf{R^2 = 0.92}$$

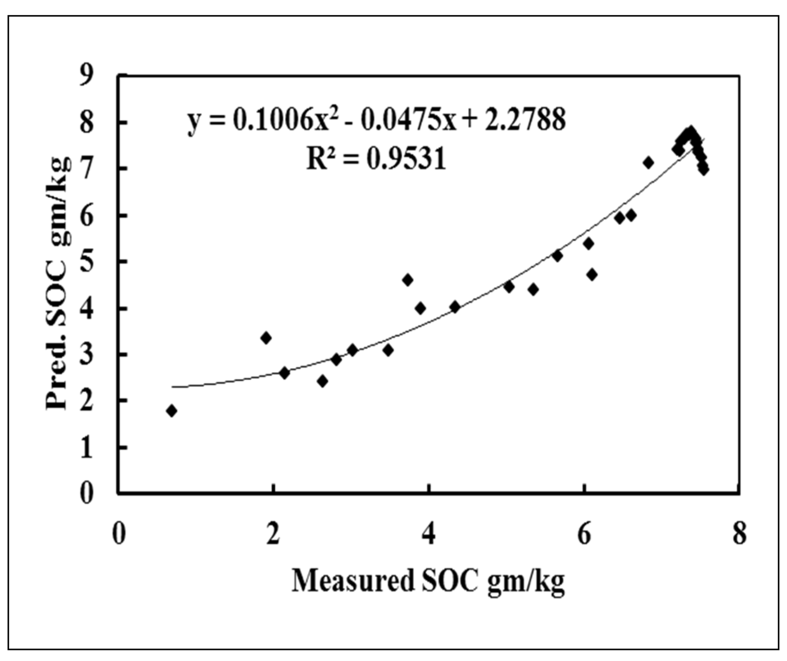


**Fig. 1:** Relationship between the predicted and measured SOC

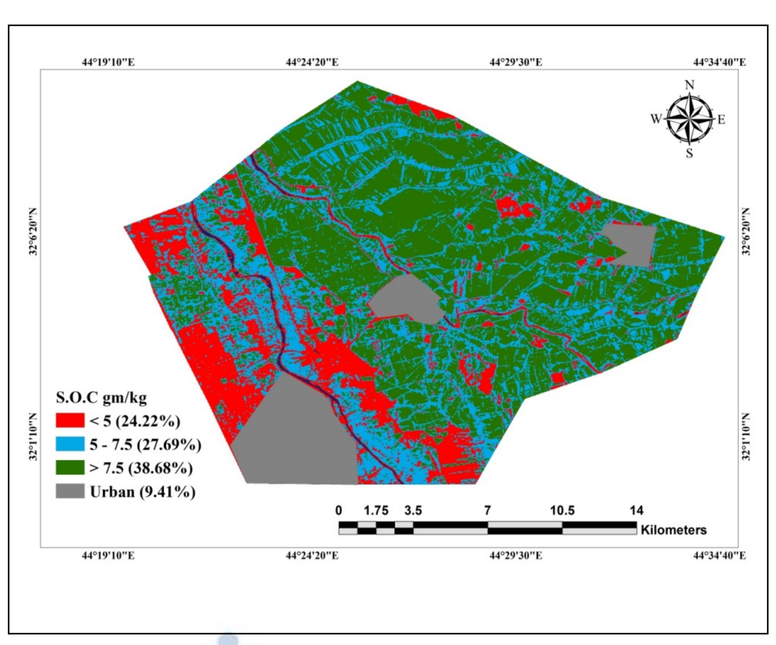


**Fig. 2:** Spatial distribution for SOC classes in the study area

## MAIN RESULTS

The content of OC in the study soils are very low, ranging from 0.69 to 7.55 gm/kg with mean value of 5.79 gm/kg. The results show very strong correlation between the measured content of SOC and the predicted with $R^2 = 0.9531$ ($p < 0.01$) (Fig.1).

The regional map of SOC spatial distribution in the surface soil horizon of the study area was developed using the best fitting model (Equation 1), as shown in Figure 2.

Three classes for SOC were recognized in the study area. Class 3 (> 7.5 gm/kg SOC) was the most dominant and occupied 38.68% of the total study area. These areas were the most productive agriculturally and also had low salinity levels.

Class 1 (< 5 gm/kg SOC) covered 24.22% of the study area and was associated with high salinity levels, and was in topographic lows in proximity to the Tigris river, with poor drainage.

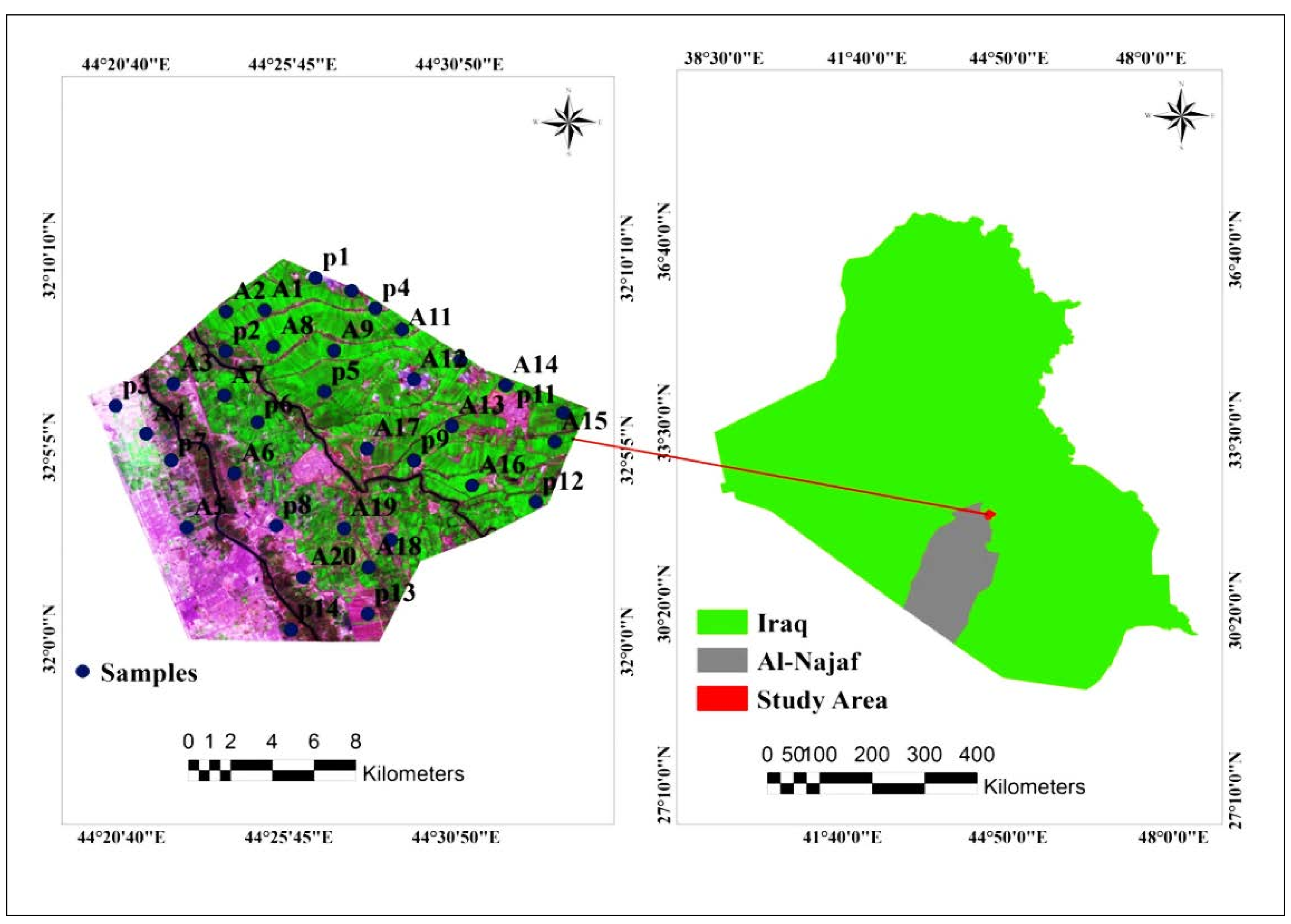


**Fig. 3:** location of the study area

## CONCLUSIONS

The modelled variations corresponded well with the expected factors affecting C in soils, which were land cover, parent material and soil salinity. Total SOC showed strong negative correlation with salinity ($R^2 > 0.9$, $p < 0.01$). We demonstrate the successful approach of using statistical correlation models derived from spectral indices processed from LANDSAT multispectral indices for a region of interest to predict spatial variations of SOC, while maintaining 'ground-truth' accuracy by laboratory analysis of samples collected from the field. The results of this study can be used to develop statistical models which are best fitting to develop the general map for spatial distribution of SOC in Iraqi soils.

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