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MAPPING OF SOIL ORGANIC CARBON USING GEO-SPATIAL TECHNIQUES

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Abstract – *Towards the need for sustainable development, the remote sensing techniques in the Visible-Near Infrared–Shortwave Infrared (VNIR–SWIR, 400–2500 nm) regions are efficient data source for mapping of the spatial variability of soil organic carbon (SOC).*

Soil Organic Carbon (SOC) is a useful representative of soil fertility and an essential parameter in soil. Soil texture is also used to calculate soil's ability to retain water for plant growth.

In this study, an evaluation of the prediction ability of models assessing SOC using real remote sensing data is performed. The data from currently operating sensors, including satellite data from Sentinel-2 is used. The study was conducted on a study plot (290 kmsq) in the Bewar Block region of Mainpuri District. The adopted methods included field sampling and predictive modeling using satellite multispectral Sentinel-2. The Land use /Land cover of the project area was classified using the LISS IV image of 2017-2018. Ground truth information collected during field trips of project area were used to assess the accuracy of the classification results. Furthermore, the performance of a soil reflectance composite image from Sentinel-2 data is analyzed. The agricultural based system recorded the highest values, the form based system and waste land recorded low values of SOC content.

Key Words: Soil Organic Carbon; Remote Sensing; Sentinel-2; Fertility; Spatial Variability.

1. Introduction

Globally, soil is one of the most important terrestrial carbon (C) stocks being two or three times the size of atmospheric Carbon-di-oxide, and a small change in soil Carbon can trigger changes in atmospheric greenhouse gas concentrations. Soil is one of the most important terrestrial carbon (C) stores in agro ecosystems.

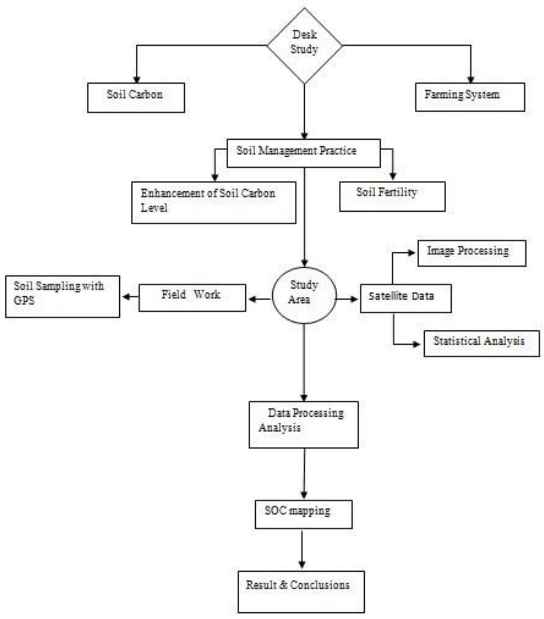
The United Nation frame work convention on climate change (UNFCCC) defined “Climate Change” as a change which is attributed directly or indirectly to human activity that alters the composition of global atmosphere. Agriculture is inherently sensitive to climate change and is one of the most vulnerable sectors. Climate change directly affects agriculture productions and productivity efficiency by fast decomposition of soil organic matter.

Decreasing organic matter claim effect on farming activities, reduced crop yield, shortage of water and biomass for animal due to low rainfall and frequent dry spell. The decreasing soil organic carbon (SOC) content in agriculture soils is generally considered a major threat to the sustainability of soil cultivation. Therefore, implementing adoption strategies by farmers becomes indispensable in order to minimize the effect of climate change in their own way. Agriculture sector has the potential capable to minimize the climate effect, no other human managed realm on the same capacity.

Objective

The main objective of this study is to describe the soil organic carbon (SOC) content (%) (with pH and Electrical Conductivity) within different farming system and other land use types and discuss the land use management option that could enhance SOC content (%) within the project area

Flow Chart of Research Methodology



SOIL ORGANIC CARBON (SOC) DETERMINATION

The organic carbon estimates in the soil samples from the top layer (0-20 cm) and bottom layer (20-50 cm) was determined using the wet combustion method **(Walkely- Black, 1973).** The modified version of method has been used by several researchers **(Dutta et al, 2010, GOI et, al, 2010).**

SOIL pH

The soil water ratio method adopted for the determination of hydrogen ion activity or pH of soil sample **(Adigun et.al2008).**

Electrical Conductivity of Soil

Soil electrical conductivity is an indirect measurement that correlates very well with several soil physical and chemical properties. Electrical conductivity is the ability of a material to conduct (transmit) an electrical current and it is commonly expressed in units of milliSiemens per meter (mS/m).

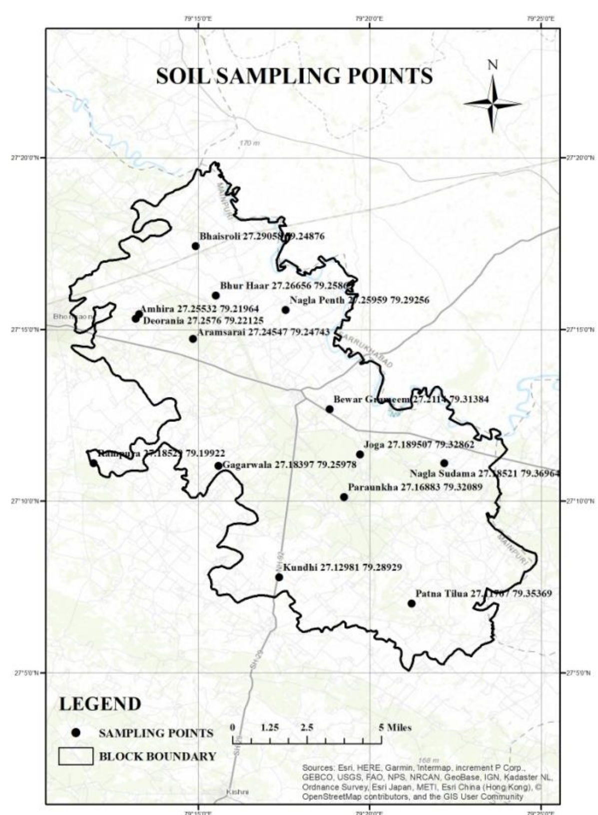
Data Used

A multispectral Sentinal-2 image (2019-2020) is obtained for the study.

Study Area

This study is conducted in Bewar block of Mainpuri district of Uttar Pradesh. The areas located between 27.22^{0}N to79.29°E.

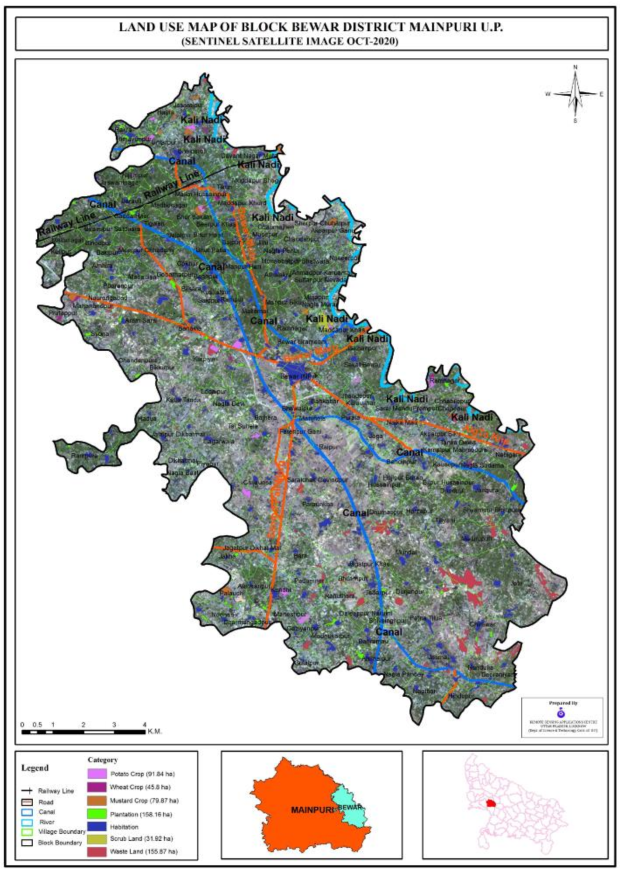
Ground sampling and soil measurements Samples were collected from selected locations, regarding field size; the selected sample size had sufficient coverage of the study area. The position of each sampling point was recorded by a Mobile mapper with GPS with accuracy of 1 m. Grid sampling method was applied for soil sampling of SOC determination under different land use pattern of the project area . Soil conditions of the plot were investigated with 10- 20cm deep soil auger boreholes. The soil samples were taken at 0–20 cm depth, air-dried, ground and sieved (≤2 mm) and thoroughly mixed before analyzing (ISO 11464:2006). SOC was measured as total oxidized carbon using wet oxidation (ISO 14235:1998). Additionally, soil particle size distribution was obtained by the pipette method (ISO 11277:2009).



Map-1

3. Land Use and SOIL Unit type

In all the Samples or in project area namely Bewar Block of Mainpuri District which includes total 14 numbers of villages observations were made and the total area was 290kmsq.These observations were separated in to four land use types namely crop land, waste land, Forest land and Agro forestry. Out of the total area sampled, the distribution of each land use type was obtained. Farm based system (Tree plantation, mixed field, crop land) formed a large portion (216.85ha) of the field sampled in comparison of wasteland (155ha) in all project area. This is an indicator that agriculture is the main occupation of the people in the project area.



(SOURCE-RSAC, UP)

Map-2: Land Use Map

Representation bar chart of soil parameters

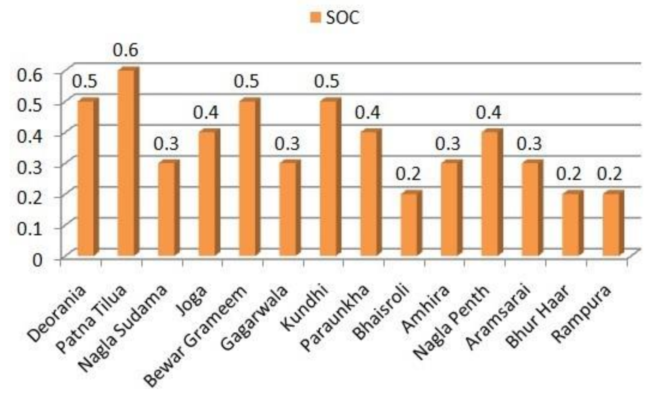


Chart-1: SOC value

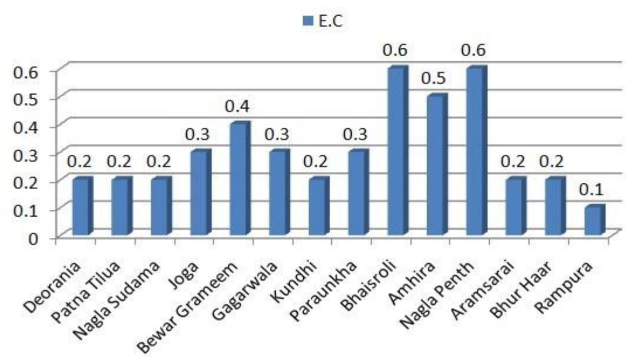


Chart-2: EC value

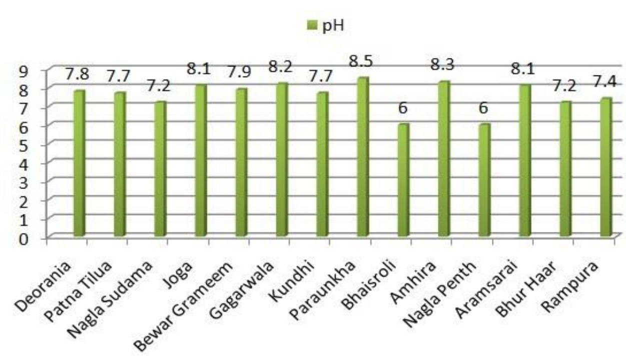


Chart-3: pH value

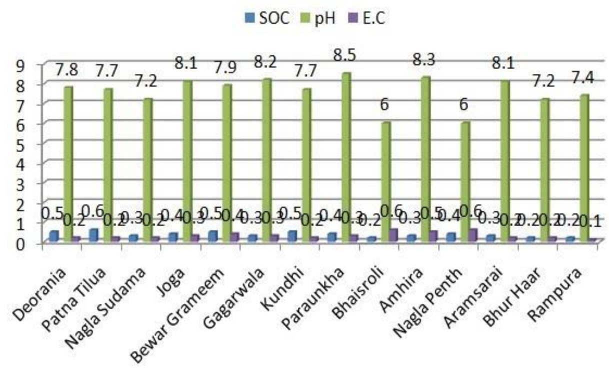
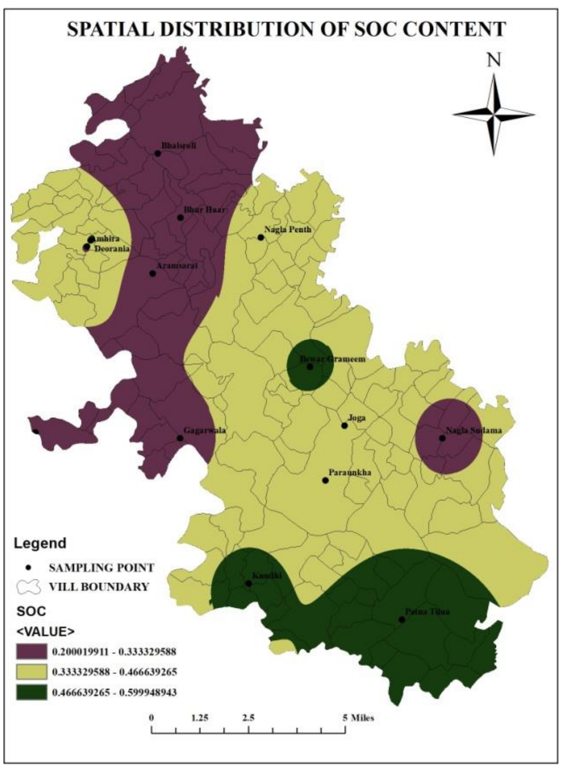


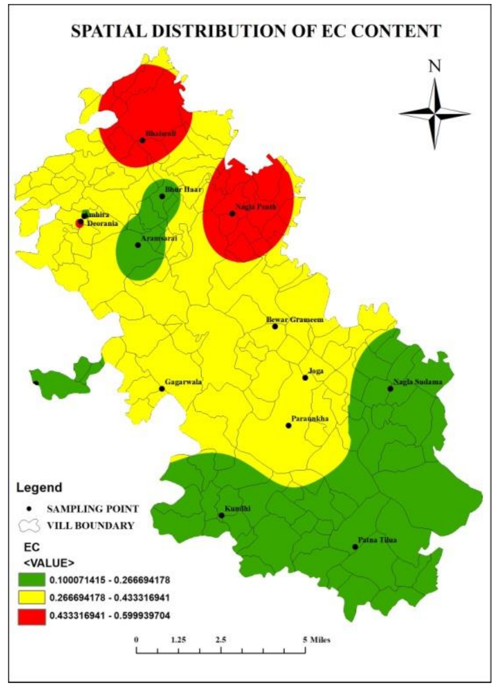
Chart-4: Combined Parameters

4. SPATIAL DISTRIBUTION OF SOIL PARAMETERS

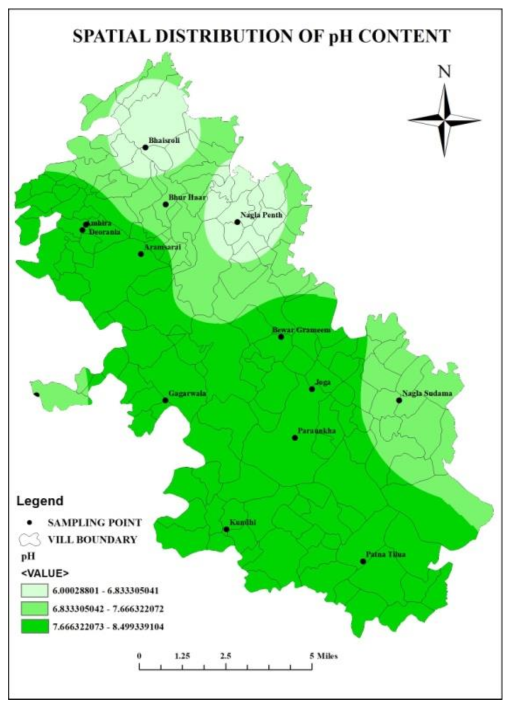
The spatial distribution of SOC, pH & Electrical Conductivity content after the spatial interpolation process shown by IDW interpolation method



Map-3: SOC Distribution



Map-4: Electrical Conductivity Distribution



Map-5: pH Distribution

5. CONCLUSIONS

The type of land uses identified in the Bewar block are- Cropland (217.51ha %), wasteland (155.87ha %), Agro forestry (190.08ha %). The agricultural based system recorded the highest values, the form based system and waste land recorded low values of SOC content. Therefore in the carbon distribution map, the agricultural based systems showed the high colour intensity while the waste land and crop land showed low colour intensity

The fallowing options are considered viable option to increase SOC in the study area-

Promotion of residue retention on crop land and farmer must avoid moving/ burning the residues but store and use their as mulch.

Introduction of alley cropping or other form of agro forestry practices. Deliberately introduction of cover Crops a waste land like Medicinal and aromatic crops can be grown to restore erosion a further degradation. Guided use of inorganic fertilizers. Awareness creation on the benefits of such practices in term of improving yields, Soil fertilely and role of SOC in contributing to climate change mitigation as well as the potential financial benefits.

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