ESTIMATION AND MAPPING SOIL ORGANIC CARBON IN PADDY GROWING SOILS OF MONARAGALA DISTRICT, SRI LANKA

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INTRODUCTION

Since the industrial revolution, the concentration of CO_2 in the atmosphere is increasing year on year as the burning fossil fuels, disrupting the global carbon cycle, leading to a planetary warming impact.CO_2 is considered as the controlling factor of global warming. Carbon sequestration can be defined as the capture and secure storage of carbon that would otherwise be emitted into or retained in the atmosphere. As productive croplands, paddy fields are also reported to have higher soil organic carbon storage and sequestration compared to drier croplands and great potential for sequestration of soil carbon has been found in rice paddy fields (Liu *et al.*, 2006).Soil Organic Matter (SOM) accumulation is enhanced in rice cropping under waterlogged conditions (Lal, 2002). Sri Lanka is one of the countries that consume rice as the staple food daily and land cultivated under paddy covers approximately 34 % of the cultivated lands. Therefore, there is an excellent potential in storing and maintain carbon in the paddy growing areas of Sri Lanka.The current study was conducted to estimate the current status of SOC stocks and develop a digital map showing the spatial distribution of soil organic carbon, mainly concerning the different Agro ecological regions in the paddy growing soils of Monaragala district of Sri Lanka.

METHODOLOGY

This study was carried out in paddy growing soils in Monaragala district; a major paddy growing district between the central highlands and the lowlands towards the south, East and North-east in the Uva Province of Sri Lanka. Monaragala district has intermediate and dry climatic conditions scattered in the entire area of the district. The dry zone comprises five agro ecological regions (AERs), namely, DL1, DL2, DL3, DL4, and DL5, and they all occur in the low country dry zone. The intermediate zone- up country is made up of IU1, IU2 and IU3. The intermediate zone – mid country is made up of IM1, IM2, IM3 and the intermediate zone- low country is made up of IL1, IL2, and IL3.This study was adopted conditional Latin hypercube sampling (cLHS) design to determine sampling locations and 35 main soil sampling sites were allocated optically across the landscape using cLHS (Figure 1).

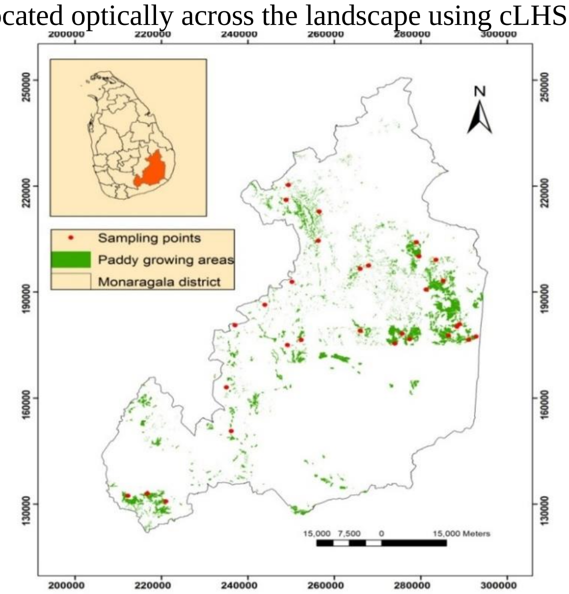

Figure 2: Locations of soil samples collected District depicted on rice distribution

The paddy growing soil types mainly distributed in Monaragala district are hydromorphic association of reddish brown earth and low humic gley soils, reddish brown earths and immature brown loam soil and Alluvial soils (Figure 2).

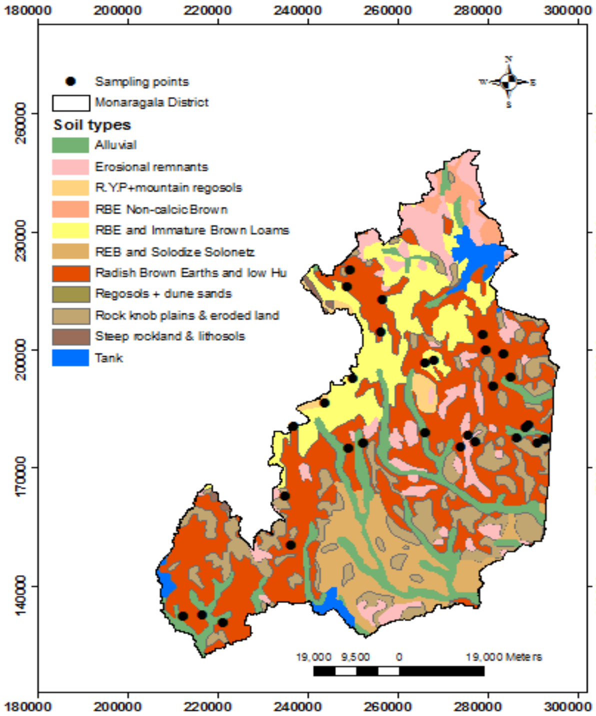

Figure 2: Soil map of Monaragala district

(Source: Natural Resources Management Centre, Department of Agriculture)

The data was collected during the period from December 2019 to January 2020 in Maha season and the vegetative stage of the paddy. At each sampling site, three composited soil samples were collected at top soil layer (0 -15 cm) depth by using a soil auger. Additional undisturbed soil samples were taken as representing each soil type and analyzed for soil bulk density. The bulk density values were calculated as a ratio of dry soil weight and internal volume of the core (Blake and Hartge, 1986).

Fresh soil samples were prepared by removing all visible organic debris, plant roots and stones followed by sieving using a 2 mm sieve in order to prepare homogeneous soil samples. Then, the remaining fresh soils were air dried at room temperature, ground to a powder and finally sieved to have fine powder that is less than 0.2 mm in particle size. Total carbon content was estimated by dry combustion method using CHN elemental analyzer. Soil carbon stocks (Mg ha^{-1}) were calculated for the respective soil types. A digital carbon map was prepared using Regression kriging interpolation technique in the Arc GIS environment. The standard error of the sample means was calculated and used to determine the significant difference of soil carbon stocks in different paddy growing soil types.

RESULTS & DISCUSSION

- **Major Soil Types and Soil Organic Carbon Stocks**

According to the results, the mean SOC stock was varied from 15.2 Mg ha^{-1} to 55.6 Mg ha^{-1} with a mean value of 31.1 Mg ha^{-1} for top soil layer in the Monaragala district. The Reddish-Brown Earths (RBE) & Immature Brown Loam soil (39.3 Mg ha^{-1}) and Alluvial soil (37.2 Mg ha^{-1}) were showed higher carbon contents. On the other hand, the Reddish - Brown Earths (RBE) soil and Low Humic Gley soil (LHG) (29.4 Mg ha^{-1}) and Miscellaneous land units comprising of erosional remnants with eroded and shallow soils (26.7 Mg ha^{-1}) were showed lower carbon content in paddy growing soils in Monaragala district (Figure 3).

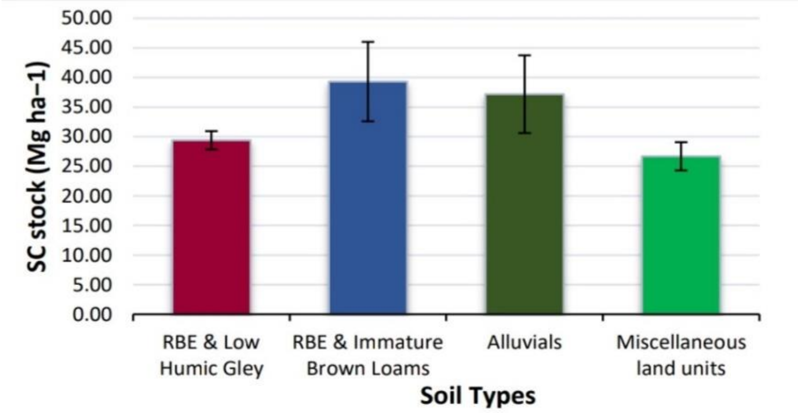

Figure 3: SOC stocks in different soil types in Monaragala district

- **The Spatial Distribution of Soil Carbon**

According to predicted values of soil organic carbon, soil carbon content varied from 1.2% to 2.1% with mean value of 1.6 %, which showed a coefficient of variation of 15%. The highest soil carbon content stocks (1.7% - 2.1%) were observed in south-west and western side, whereas lowest soil carbon contents (1.2% - 1.5%) were observed in the eastern side and center of the Monaragala district. Medium level of soil carbon content can be observed in North – west side and southern side in Monaragala District of Sri Lanka (Figure 4).

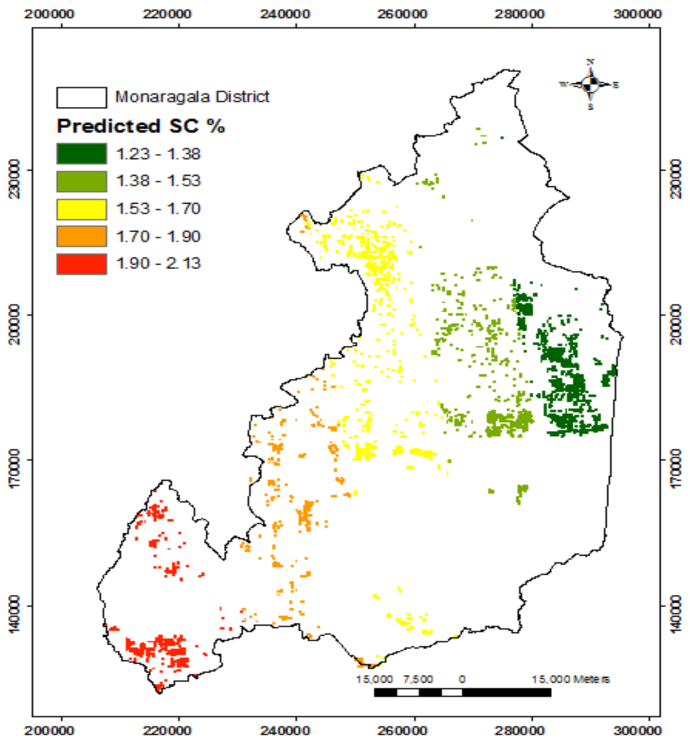

Figure 4: Predicted SOC stock map in paddy growing soils in Monaragala District

The spatial distribution of soil carbon with the overlapped agro ecological regions in the paddy growing soils in Monaragala district, Sri Lanka was shown in Figure 5. The highest soil carbon content (1.9% - 2.1%) was observed in the Sevanagala DS division in DL1b agro ecological sub region and slightly highest soil carbon content (1.7% - 1.9%) was observed in the Wellawaya DS division in DL1a agro ecological sub regions of Monaragala district. These agro ecological sub regions are characterized by two detectable peaks in the rainfall distribution and it supports the growth of plants in both Yala seasons for paddy growing. The moderate distribution of soil carbon content (1.5%- 1.7%) was observed in Medagama DS division in IL1c sub region and Badalkumbura DS division in IM2b agro ecological sub region. IL1c and IM2b sub regions are resemble a bi-modal rainfall distribution since second inter monsoon and north east monsoon rains. Whereas very low soil carbon content (1.2%- 1.4%) was observed in the Siyambalanduwa DS division in DL1b agro ecological sub region and low soil carbon content (1.2%- 1.5%) was observed in the Monaragala DS division in IL1c agro ecological sub region.

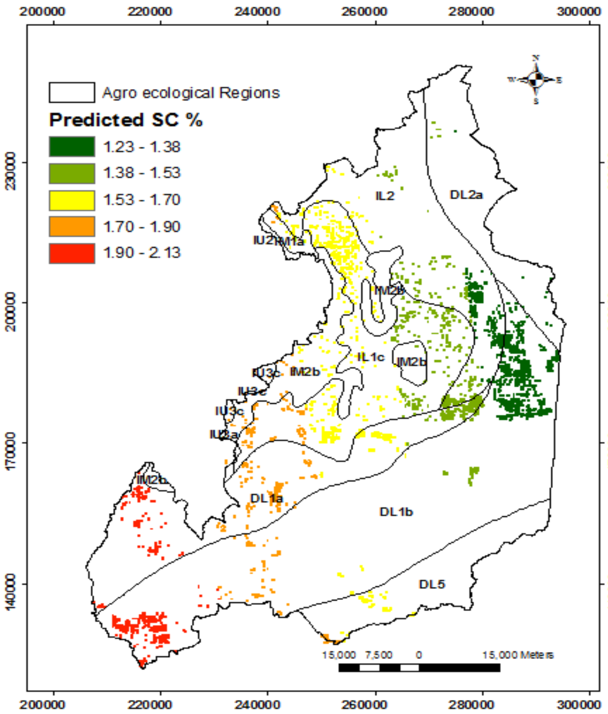

Figure 5: The spatial distribution of soil carbon with the overlapped AERs in Monaragala district

CONCLUSION

The current study predicted and interpreted the spatial distribution of soil carbon contents of the paddy soils of Monaragala district, Sri Lanka, concerning the different paddy growing soil types and the climatic conditions prevailing in the area. According to the survey conducted from December 2019 to January 2020 (within Maha season), all the results were presented. According to predicted values, soil carbon content varied from 1.2% to 2.1% with a mean value of 1.6% ± 0.24, which showed a coefficient of variation of 15%, among the different paddy growing soil types, Reddish Brown Earths (RBE) and Immature Brown Loam soil and Alluvial soils showed high carbon content than the other soil types. According to the agro ecological zones, DL1b and DL1a, agro ecological sub-regions showed a high SOC distribution in paddy soils of the Monaragala district. The estimated average Soil Organic Carbon (SOC) stock value is 31.1 Mg ha^{-1}.

Moreover, the regional level information generated from this study will be very much useful for the establishment of national carbon accounting system and future Carbon trading programs.

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