Proceedings of 15th Agricultural Research Symposium (2016) 505-508

Mapping of Soil Organic Carbon in Different Soil Types in Trincomalee District of Sri Lanka

M.H. DANANJAYA[1], H.M.I.K. HERATH[2], B. GAJANAYAKE[1], D.M.D.I. WIJEBANDARA[2] and K.P.A. PATHIRANA[2]

[1]*Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), 60170, Sri Lanka*

[2]*Coconut Research Institute, Lunuwila, 61150, Sri Lanka*

ABSTRACT

Abundance of soil carbon can have positive impacts on physical, chemical and biological properties of soil and vital for agricultural sustainability. This study aims to quantify and map soil organic carbon (SOC) levels in different soil types in the Trincomalee district of Sri Lanka. As a part of the soil survey for characterizing and land suitability assessment for coconut, 41981 ha of potential agricultural land area in Trincomalee district was systematically sampled at 0-23 cm depth for soil organic carbon analysis based on the area covered by different soil series. Soil organic carbon was analyzed using Walkley and Black method. The analyzed data were combined with detailed soil survey data to produce map of soil organic carbon using geographic information system. Results indicate that all soils in the area were low in organic carbon content ranging from 0.1-1.1%. The highest SOC content of 1.1% was reported in Pulmudai Soil Series and Wellamaichenai Soil Series while the lowest SOC level (0.1%) was recorded in Valaltoddam soil series of Regosols. The SOC map of the area indicates the soil types along the coast line have lower soil carbon content compared with the soils towards inland areas. The high variability of SOC in soil series within one great soil group shows the importance of characterizing soil organic carbon at soil series level.

KEYWORDS: Carbon sequestration, Soil fertility, Soil mapping, Soil organic matter

INTRODUCTION

Soils are the heart of the Earth's critical zone, the thin outer veneer between the top of the tree canopy and the bottom of groundwater aquifers that humans rely on for most of their resources (US NRC, 2001). Soils are formed over thousands of years by breaking down rocks and colonized by plants and soil biota, leading to the formation of soil organic matter (SOM). While SOM is primarily carbon, it also contains nutrients essential for plant growth namely nitrogen, phosphorus, sulphur and micronutrients.

Organisms in the soil food web decompose SOM and make these nutrients available (Brussaard *et al.*, 2007). The rate of SOM decomposition and turnover mainly depends upon the interplay between soil biota, temperature, moisture and a soil's chemical and physical composition (Taylor *et al.*, 2009).

Soil carbon which plays a key role in soil fertility, exists in both organic and inorganic forms. Soil inorganic carbon is derived from bedrock or formed when CO_2 is trapped in mineral form (e.g. as calcium carbonate). Soil organic carbon is the main constituent of soil organic matter. Soil organic matter is formed by the biological, chemical and physical decay of organic materials that enter the soil system from sources, above ground or below ground. The sequestration of atmospheric CO_2 in soil is an effective way to reduce global warming (IPPC, 2007). Abundance of soil carbon can have positive impacts on soil physical, chemical and biological properties (Dexter *et al.*, 2008). A depreciation of soil carbon will create negative consequences in relation to the soil health and productivity (Karunarathne *et al.*, 2014). Forests and tree plantation crops are particularly important as carbon reservoirs because trees hold much more carbon per unit area than other types of vegetation (Lasco *et al.*, 2002; Lamade and Bouillet, 2005).

Soil carbon sink is a major problem in most agricultural soils. Its constraint is particularly important in tropical agricultural soils.

Perennial tree crops like coconut with 50-60 years of economic lifespan, has a potential to act as a carbon sink (Jayasekara and Jayasekara, 1995; Mialet-Serra *et al.*, 2005; Ranasinghe and Silva, 2007; Roupsard *et al.*, 2008). However, establishment of coconut palms from seedlings is becoming difficult especially with extreme weather conditions due to changing climate, experiencing in the present world. In this context, soil organic carbon content at considerable levels enhance overall soil quality and it also contribute in mitigating climate change.

Therefore, the objective of this study was to evaluate and mapping of soil organic carbon levels in different soil groups in the Trincomalee district of Sri Lanka.

MATERIALS AND METHODS

This research was carried out as a part of the project on soil survey and land suitability assessment for coconut in the Eastern province of Sri Lanka, conducted by Coconut Research Institute, Sri Lanka (CRISL).

Study Area

The survey area included 41,981 ha land area in Trincomalee district. It excludes forest reserves, marshy lands and paddy lands. The major land form of the surveyed area was flat to undulating. The main land use in the area was shrubs with natural vegetation.

In this detailed soil survey conducted by soil survey team of CRISL in 2015-2016, had 16 different soil series identified and characterized within the surveyed area in Trincomalee district.

Soil Sample Collection and Preparation

Soil samples for the study were collected from representative locations of different soil series and great soil groups identified during the soil survey. The soil types in the area were belongs to three great soil groups namely Regosols, Reddish Brown Earth and Non Calcic Brown Soils.

Sampling locations for analysis of soil carbon were determined during the survey based on the area covered by each soil series and variability in the land form. Soil samples were collected from 0-23 cm depth (top soil) from representative locations from each soil series.

Soil samples were extracted using a stainless steel combined auger. A portable global position system (GPS) was used to record soil sampling locations. Total of 212 soil profiles were used for collection of soil samples. Collected soil samples were air-dried for few days and passed through 2 mm sieve to remove debris and samples were ground using an electric grinder.

Soil Analysis

Percentage organic carbon was estimated using Walkley and Black method (Walkey and Black, 1934) by oxidizing soil with excess dichromate solution and titrating against a standard ferrous sulphate solution to determine the amount of unreduced dichromate solution. By which organic carbon content (%) was calculated.

Mapping

The analyzed data were imported in a geographical information system (GIS) database; the digital geomorphological map was used as base map in the database. The spatial analyses function in Arc-GIS 10.1 was used to create the thematic layers of organic carbon and soil series obtained from detailed soil survey. The thematic layers were overlapped to produce the soil organic carbon map of the area.

RESULTS AND DISCUSSION

The surveyed area includes the potential agricultural areas in the Tricomalee district. Soil carbon levels of different soil series were ranged from 0.1-1.1%. All soil types have low organic matter content according to the classification of Brady (1990).

There were considerable variation in soil carbon levels in different soil series (Figure 1).

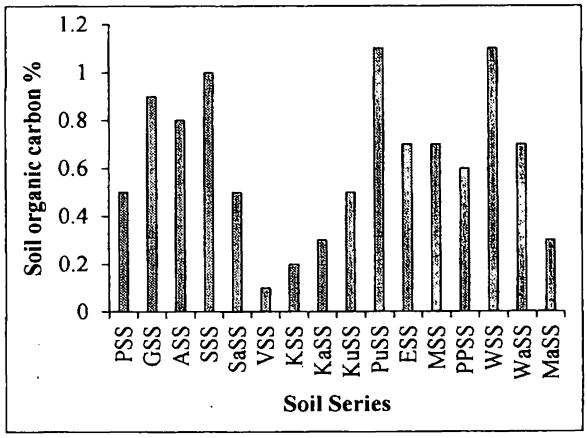

Figure 1. Soil organic carbon content in the top soil of different soil series in Trincomalee district of Sri Lanka. *PSS- Palamunai soil series, GSS- Gomorankadawala soil series, ASS- Arippu soil series, SSS- Sempadu soil series, SaSS- Sampoor soil series, VSS- Valaltoddam soil series, KSS- Kumburuppiddai soil series, KaSS- Kayankerni soil series, KuSS- Kuchchaweli soil series, PuSS- Pulmudei soil series, ESS- Egodawatta soil series, MSS- Mandur soil series, PPSS- Pulliyapodari soil series, WSS- Wellamaichenai soil series, WaSS- Wadamunai soil series, MaSS- Madurankerni soil series*

The enhanced decomposition rates of soil carbon due to high temperatures cause lower carbon levels in the soils of this area.

The highest mean organic carbon content of 1.1% was reported in the Pulmudai Soil Series and Wellamaichenai Soil Series belongs to reddish brown earth (RBE). The lowest soil carbon levels were reported in Valaltoddam soil series of Regosols. However, soil series among Regosols showed high variability of soil carbon ranging from 0.1-1% indicating the importance of characterization of soil properties at series level.

Out of total land area covered in the survey, 84% land area is found to have organic carbon less than 1%. This indicates that any

agricultural program need enhancing soil carbon levels to sustain production as well as to obtain best use of agricultural inputs such as fertilizer.

As visualized from the map, soil types found along the coast line have low soil carbon content compared with the soils towards inland areas (Figure 2). Most of these soils were sandy textured soils belong to the Regosols. Similar soil carbon values for sandy Regosols were reported in the soil in the fertility assessment study by Herath *et al.* (2007) conducted for coconut growing soils in Sri Lanka.

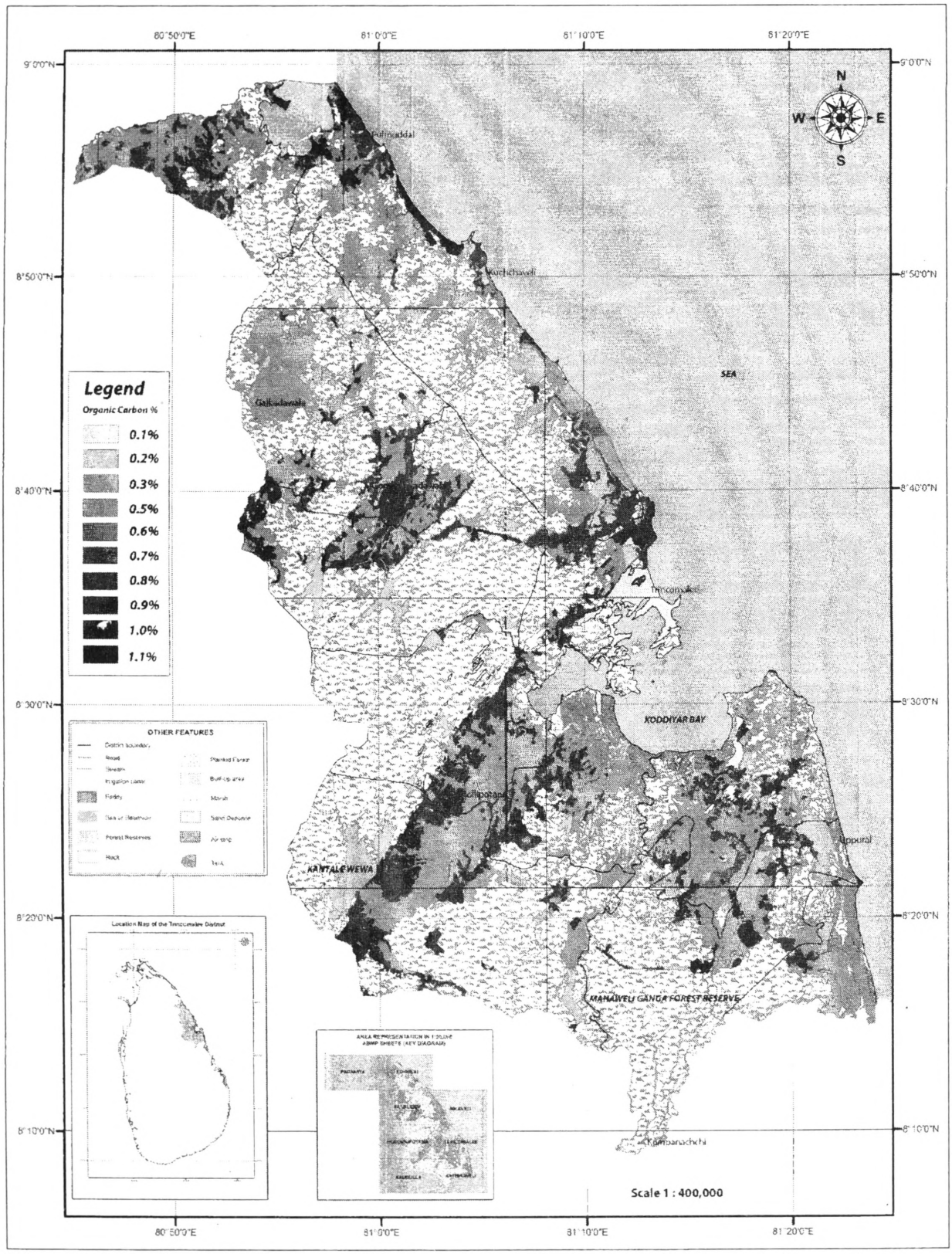

Figure 2. The map of Trincomalee District showing organic carbon levels of different soil types

CONCLUSIONS

Soil organic carbon levels were found to be low (0.1-1.1%) in all the soil types in the Trincomalee area. This highlights the need of enhancing soil organic carbon by introducing agricultural production programs. There is a risk of further declining of soil fertility of these soils along with agricultural occupation in the future. A high variability of organic carbon content in soils of same great soil group indicate the importance of characterizing SOC at lower taxonomic levels such as soil series.

ACKNOWLEDGEMENTS

Authors wish to express their gratitude to Ms. Pavani Dissanayake, Research Officer and G.A.M. Samanthi, Technical officer, soils and plant nutrition division of the Coconut Research Institute, for their support in the initial phase of this study. Thanks are also due to all staff members in the soils and plant nutrition division of CRI for their help in field and laboratory analysis.

REFERENCES

Brady, N. C. (1990). *The Nature and Properties of Soils.* 10th edition. Macmillan Publishing Company New York. Collier Macmillan Publishers, London, UK.

Brussaard, L., De Ruiter, P.C. and Brown, G.G. (2007). Soil biodiversity for agricultural sustainability. *Agriculture, Ecosystems and Environment,* **121**, 233-244.

Dexter, A.R., Richard, G., Arrouays, D., Czyz, E.A., Jolivet, C. and Duval, O. (2008). Complexed organic matter controls soil physical properties. *Geoderma.* **144**, 620–627,

Herath, H.M.I.K., Saumyakumara, A.P.A. and Tennakoon, N.A. (2007). Soil fertility status of common coconut growing soil series in Sri Lanka. *Journal of the Soil Science Society of Sri Lanka,* **18** ,52-61.

IPPC (Intergovernmental Panel for Climate Change). (2007). Climate Change 2007: The physical science basis. Intergovernmental panel on climate change. Cambridge University Press, Cambridge, U.K.

Jayasekara C. and Jayasekara K.S. (1995) Photosynthetic characteristics of tropical tree species with special reference to palms. *Energy Conservation and Management*, **36** (6–9), 919–922.

Karunaratne, S.B., Bishop, T.F.A., Baldock, J.A. and Odeh, I.O.A. (2014). Catchment scale mapping of measureable soil organic carbon fractions. *Geoderma*, **219**, 14-23.

Lamade, E. and Bouillet, J. P. (2005). Carbon storage and global change: the role of oil palm. *Oléagineux, corps gras, lipids*, **12** (2), 154-160.

Lasco R.D., Lales J.S., Arnuevo M.T., Guillermo, I.Q., de Jesus, A.C., Medrano, R., Bajar, O.F. and Mendoza, C.V. (2002). Carbon dioxide (CO_2) storage and sequestration of land cover in the Leyte Geothermal Reservation. *Renewable Energy,* **25**, 307-315.

Mialet-Serra I., Clement A., Sonderegger. N., Roupsard. O., Jourdan. C., Labouisse J.P. and Dingkuhn. M. (2005). Assimilate storage in vegetative organs of coconut (*Cocos nucifera* L.). *Experimental Agriculture*, **41** (2)161–174.

Ranasinghe, C.S. and Silva, L.R.S. (2007). Photosynthetic assimilation, carbohydrates in vegetative organs and carbon remover in nut producing and sap-producing coconut palms. *COCOS*, **18**, 45-57.

Roupsard, O., Lamanda, N., Jourdan, C., Navarro, M.N.V., Mialet-Serra I., Dauzat, J. and Sileye T. (2008b). Coconut carbon sequestration part 1 highlights on carbon cycle in coconut plantation. *Philippine Journal of Coconut Studies xxxiii*, **2**, 24-37.

Taylor, L.L., Leake, J.R., Quirk, J., Hardy, K., Banwart, S.A. and Beerling, D.J. (2009). Biological weathering and the long-term carbon cycle: integrating mycorrhizal evolution and function into the current paradigm. *Geobiology,* **7**, 171-191.

US NRC (United States National Research Council). (2001). Basic research opportunities in the earth science. National Academies Press, Washington, D.C., USA.

Walkley, A. and Black, I.A. (1934). An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*, **37** (1), 29-38.