Int. J. Curr. Res. Biosci. Plant Biol. 2015, 2(7): 38-42

EXCELLENT PUBLISHERS

International Journal of Current Research in Biosciences and Plant Biology

ISSN: 2349-8080 Volume 2 Number 7 (July-2015) pp. 38-42

www.ijcrbp.com

Original Research Article

Assessment of Soil Organic Carbon in Three Different Land Use Patterns in Semi Arid Kadapa District Andhra Pradesh (India)

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Abstract

Soil Organic Carbon (SOC) was estimated in three different land use patterns namely forests, crop lands and barren lands at 0-10 cm and 10-30 cm soil samples. A higher amount of SOC was observed in forest soils followed by crop lands and barren lands in both 0-10cm and 10-30 cm deep soils. Barren land soils were found to be with high content of SOC in 10-30 cm than 0-10 cm soil samples in contrast to other land use types. The estimated SOC in t/ha were in the range of 1.3 to 9.6t/ha in 0-10cm soils and 1.6 to 7.3 in 10-30cm soil depth layer with higher content in forests followed by croplands and barren lands. Bulk density got increased with soil depth in three land use patterns. ANOVA indicated a significant difference in the SOC mean values across the three land use patterns and two soil depth layers. Since croplands and barren lands contained significantly lower SOC values than natural forest ecosystems in the same climatic conditions; soil carbon accumulation management practices in crop lands and afforestation in barren lands have to be carried out to enhance carbon sequestration in soils.

Keywords

Bulk density

Land use

Semi arid regions

Soil Organic Carbon

Vegetal cover

Introduction

An increase in utilization of fossil fuels and land use changes has led to increased concentration of atmospheric CO_2 by about 40% since preindustrial times. The increase in atmospheric CO_2 will raise the mean global temperature and may disturb climate system in unforeseen ways (IPCC, 2013). Simultaneously, the interest in using soil-vegetation systems as carbon sinks is also rapidly increasing as they play an important role in the terrestrial carbon cycle (Dinakaran and Krishnayya, 2010). Soil forms the largest pool of terrestrial carbon and contains about 1.5-3 times more organic carbon than vegetation (Lal, 2004). The primary way that carbon is stored in the soil is as Soil Organic Carbon (SOC) that mainly includes plant, animal and microbial residues in all stages of decomposition (Post and Kwon, 2000). The inputs are mainly from leaf litter and root detritus and outputs are root respiration and microbial decomposition of organic matter (Davidson and Janssens, 2006). Soil carbon has much longer residence time than the carbon in the vegetation and thus carbon sequestration in soils and plants is the only strategy that can remove carbon from the atmosphere and, overtime, reduce atmospheric concentration of CO_2 (Schlesinger, 1990). Events like forest clearance and aforestation, can make the soils to can act as sink or a source for carbon in the atmosphere (Six, 2002). Thus soils show both temporal and spatial variation in their potential to act as a net sink for atmospheric carbon.

In India, large areas of Himalayan forests at lower elevations areas (Sheikh et al., 2009) and regions of arid and semi-arid region (ACZ-10) of southern plateau and hill regions has maximum reserves of carbon in the soil and greater carbon sequestration potential and can be regarded as major sinks of mitigating atmospheric carbon dioxide (Bhattacharya et al., 2009). Land use changes of these areas may lead to decomposition of SOC due to increase in soil temperature and result of reduction in vegetation cover (Bhattacharya et al., 2008). Hence, understanding of SOC dynamics and SOC distribution at a regional level is an essential step when quantifying regional and global 'C' budgets ((Jobbagy and Jackson, 2000). This is of more essential in dry and semi arid regions as they are vulnerable to environmental changes and as well has potential to store carbon (Ardo and Olsson, 2003). Thus the present study of assessing the Soil Organic Carbon was undertaken in three different land use types in Semi arid Kadapa district in Rayalaseema region of Andhra Pradesh.

Materials and methods

Study area

Kadapa district is one of the chronically drought affected districts of semi arid tropical Rayalaseema region of Andhra Pradesh (13^0 43' – $15^0$14' N to 77^0 55' - 79^0 29'E). The district experiences hot weather, from middle of February to the end of June. The normal annual rainfall of the district is 696 mm. The south west and north east monsoons contribute 389 mm (55.89 %) and 231 mm (33.18 %) respectively. Thus, overall the area experiences scanty rainfall and high temperature. The land use pattern comprises of 33% of forest area, 21% of barren land and 46% of cultivable land.

Soil samples were collected from ten sites in Sri Lanka malla wild life sanctuary forest areas, four sites in croplands and four sites in barren lands. At each site, three sample locations were marked for soil collection at both 0-10 cm and 10-30 cm soil depths and the soil samples were mixed to form a composite mixture. The soil samples were air dried and passed through 2 mm sieve for analysis. Soil pH was measured at a soil:water ratio of 1:5 in each land use pattern. Soil organic carbon was estimated by the standard Walkley and Black (1934) titration method. Soil bulk density was measured on dry weight basis by standard core method. Soil bulk density (g/CC) = Weight of soil/Volume of soil.

Results and discussion

Soil Organic Carbon was measured in three land use patterns – namely forests, crop land and barren land at 0-10 cm and 10-30 cm depths. Forest soils registered higher values followed by Crop land soils and the least was observed among barren land soils. This condition may occurred due to higher amount of litter being produced and returned back in natural forests as also observed in Himalayan forests of Uttarakhand state (Negi, et al., 2013).

Table 1. Physical properties and soil organic carbon content in three different land uses and soil depth layers.

Variable	pH Range (0-10 & 10-30cm)	Bulk density (0-10 & 10-30cm)	SOC (%) 0-10cm	SOC (%) 10-30cm	SOC (t/ha) 0-10cm	SOC(t/ha) 10-30cm
Forest	6.3 – 7.5 6.5 – 7.8	0.083 0.085	1.156±0.47	0.874±0.41	9.595	7.342
Cropland	8.64 – 9.05 8.5 – 8.7	0.093 0.101	0.615±0.04	0.29±0.16	5.966	2.959
Wasteland	8.5 – 8.6 8.8 – 9.9	0.076 0.081	0.175±0.05	0.19±0.09	1.33	1.579

The mean value of the forest soils in 0-10 cm is 1.156±0.47 with a range of 0.22 to 1.41%, and in 10-30cm soils the mean value is 0.874±0.41 (Table 1). Statistical 't' test between the two forest soils of 0-10cm and 10-30cm have showed a significant difference (Table 2). It indicates that the litter fall on the top soil has played an important role in supporting high SOC values than the deeper soils. The mean SOC value in cropland soil of 0-10cm is 0.615±0.04 and in 10-30cm is 0.29±0.16. Similar to forest soils, a significant difference was observed between the SOC values at two different soil depths in croplands. This indicates that agriculture land use practices has negatively impacted the soils SOC content and the continuous harvest of accumulated organic matter as crop produce may reduce the amount of organic carbon in both surface and deep layers as also observed in Indo gangetic plains (Singh et al., 2011).

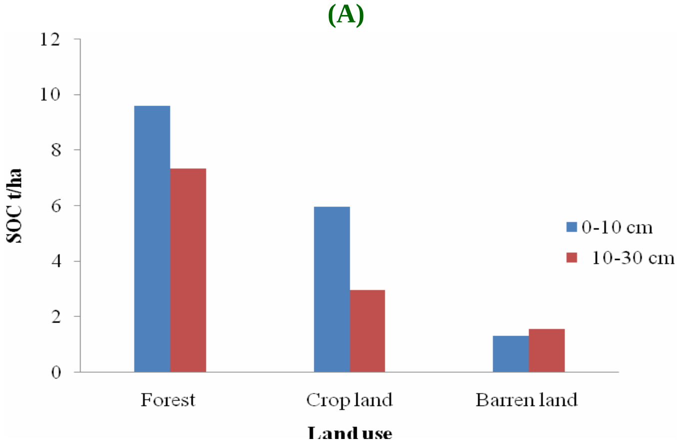
Barren land soils have scored lesser SOC values than the other land use types, with mean values of 0.175±0.05 and 0.19±0.09 in 0-10 and 10-30cm soil depths respectively. Interestingly, in contrast to forest and crop land soils, greater mean value of SOC is observed in 10-30 cm soil than 0-10 cm soil in barren land soils. This condition may rise due to the presence of ephemerals as dominant vegetation in waste lands and this herbaceous vegetation invest higher biomass in below ground (Dinakaran and Krishnayya, 2010). The early studies also report that carbon assimilation, storage, its transfer and release in below ground biomass depends upon the functional traits of the vegetal cover (De-deyn et al., 2008) and usually herbaceous cover provide higher inputs organic matter than grass cover vegetation (Dinakaran et al., 2011). The ANOVA results of mean SOC values ($F_{(3,2,\ 0.05)} = 0.038$) among the three land use patterns between two soil depths showed a significant variation (Table 2). It suggests that the vegetal cover might have prominently influenced the variations among the SOC values across the three land uses and soil depths.

Table 2. Statistical tests for determining the significant variations across the land use patterns and soil depth layers.

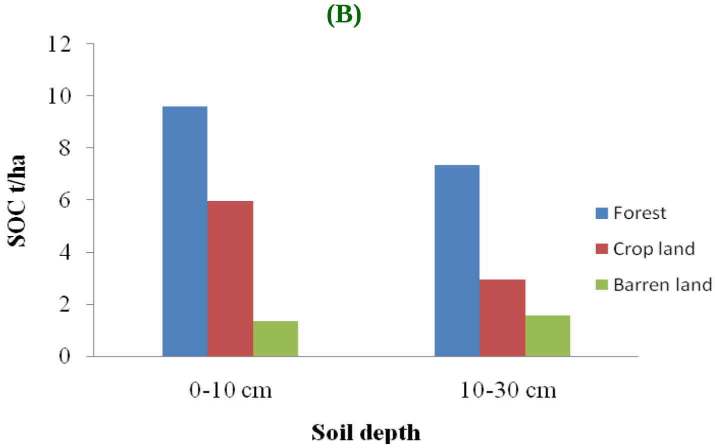
Variable	Statistical test	Significance level
SOC in Forest soils 0-10 Vs 10-30cm	Students 't' test $t_{(0.05,1)}$	p = 0.04 (Present)
SOC in Cropland 0-10 Vs 10-30cm	Students 't' test $t_{(0.05,1)}$	p <0.05 (present)
SOC in Wasteland 0-10 Vs 10-30cm	Students 't' test $t_{(0.05,1)}$	p >0.05 (absent)
SOC in 0-10 and 10-30 cm among the 3 land uses	ANOVA $F_{(3,2,\ 0.05)}$	p = 0.038 (Present)
SOC in 0-10cm Vs Bulkdensity	Correlation	Negative correlation
SOC in 10-30cm Vs Bulkdensity	Correlation	Negative correlation

Fig. 1: Soil organic carbon content in t/ha in three different land uses (A) and soil depth layers (B).

(A)



(B)



The pH range in forest soils is 6.3 – 7.5 and 6.5 – 7.8 in 0-10 cm and 10-30 cm depths respectively. Among the forest soils at 0-10cm depth, one site soil showed acidic value (6.3) and all other samples registered values greater than neutral value but less than eight. Similarly in 10-30 cm forest soil samples, three samples showed acidic values and rest of seven samples have near neutral values. A similar range of pH (6.5 – 7.3) was observed in semi arid forests of Jambughoda wildlife sanctuary in Gujarat and it was suggested that the prevailing hot conditions and low rainfall leads to higher content of $CaCo_3$ and reduction of SOC (Patil, et al., 2012). All the samples of crop land and barren land have shown alkaline nature and a high value of 9.9 in 10-30cm soil of barren land indicating highly alkaline nature of these soils (Table 1).

Bulk density of soils is closely related to total porosity and usually it shows a negative relationship with SOC and positive relationship with soil depth (Singh et al., 2011). The present study results also indicated the same pattern of increase in bulk density with soil depth across the three land use patterns and a negative correlation with SOC values across the land use patterns (Tables 1 and 2). Bulk density is used to calculate the amount of carbon per hectare at a given depth of soil by using 10,000 m^2 X soil depth X bulk density X SOC/100. The range of SOC among the three land use patterns in 0-10 cm depth is 1.3 to 9.6t/ha and in 10-30 cm soil depth is 1.6 to 7.3 (Fig. 1). Forest soils have accumulated higher amounts of SOC 16.93 t/ha up to 30 cm soil depth, in which the major portion (9.59 t/ha) came from the top 0-10 cm layer (56.6%). The results indicate that these dry deciduous forests store SOC content in the range observed in Jambughoda wildlife sanctuary in semiarid region (Patil et al., 2012) but lesser amount of SOC than Himalayan forests (Negi et al., 2013). Crop lands have registered 8.91 t/ha up to 30 cm soil depth with a major contribution from top 0-10cm layer (5.96 t/ha) (66.9%). The total value is nearly half (50%) of the forest SOC content of the study area. In comparison the Indogangetic agroecosystem soils stored higher amount of SOC with 12.4 to 22.6t/ha at 1.0m soil depth and 8.5 to 15.2 t/ha up to 40cm depth (Singh et al., 2011) and the SOC values were within the range observed in Patiala district and this can be attributed to high rate of decomposition of SOC in semiarid regions (Saxena et al., 1999). Barren lands with seasonal grasses and herbaceous vegetation contained only 2.9 t/ha and in contrast to other land uses the major contribution was the deeper 10-30 cm layer (54%). The results corroborate the study carried out in grass and herbs dominated ecosystem in Gujarat; which reveals that the herbaceous vegetation provides larger inputs of dead organic matter and uniformity in the decomposition of SOC (Dinakaran et al., 2011). The results suggest indicate that the prevailing above ground vegetal cover has highly influenced the surface SOC values. The observed variations in the belowground SOC across the land use types suggest that microbial activity and soil texture regulates the decomposition of SOC along the soil layers. Hence, more detailed studies are needed to reveal the SOC dynamics in the semiarid region.

Conclusion

Forest soils comprised of higher amount of SOC values followed by crop land and barren land. Only forest soils showed acidic nature, while the rest of soils are alkaline in nature. Significant variations were observed in SOC values between the two soil depths in forests and croplands but not in barren land soils. ANOVA showed a significant difference across land use patterns and between the two soil depths. Since croplands and barren lands contained significantly lower SOC values than natural forest ecosystems in the same climatic conditions; soil carbon accumulation management practices like residue replacement and reduced or no tillage and afforesation and preserving the prevailing herbaceous cover in barren lands have to be carried out to enhance carbon sequestration potential in these soils.

Acknowledgement

Authors profusely thank for the financial support provided by UGC New Delhi and Andhra Pradesh Forest Department for giving the permission to undertake the field work in the Kadapa forests.

References

Abbott Ardo, J., Olsson, L., 2003. Assessment of soil organic carbon in semi arid Sudan using GIS and the Century Model. J. Arid Env. 54, 633-651.

Bhattacharya, T., Ray, S.K., Pal, D.K., Chandran, P., Mandal, C., Wani, S.P., 2009. Sol Carbon stocks in India – Issues and Priorities. J. Ind. Soc. Soil Sci. 57(4), 461-468.

Bhattacharyya, T., Pal, D.K., Chandran, P., Ray, S.K., Mandal, C., Telpande, B., 2008. Soil carbon storage capacity as a tool to prioritise areas for carbon sequestration. Curr. Sci. 95(6), 482-494.

Davidson, E.A., Janssens, I.A., 2006. Temperature sensitivity of soil carbon decomposition and feed backs to climate sensitivity change. Nat. 440, 165-173.

De-Deyn, G.B., Cornelissen, J.H.C., Bardgett, R.D., 2008. Plant functional traits and soil carbon sequestration in contrasting biomes. Ecol. Lett. 11, 516–531.

Dinakaran, J., Krishnayya, N.S. R., 2010. Variations in soil organic carbon and litter decomposition across different tropical vegetal covers. Curr. Sci. 99(8),1051-1060.

Dinakaran, J., Mehta, N., Krishnayya, N.S.R., 2011. Soil organic carbon dynamics in two functional types of ground cover (grasses and herbaceous) in the tropics. Curr Sci. 101(6), 776-783.

IPCC, 2013. Summary of policy makers In Climate change 2013: The physical science basis, contribution of working group I to the fifth Assessment Report of the Intergovernmental Panel on Climate Change. (Eds.: Stocker, T.F., D. Qin, G-K Plather, M. Tiguor, S.K. Allen, J. Bosching, A. Naweb, Y. Xia, V. Bex, P.M. Midgley). Cambridge University Press, United Kingdom and New York, USA.

Jobbagy, E.G., Jackson, R.B., 2000. The vertical distribution of soil organic and its relation to climate and vegetation. Ecol. Appl. 10, 423-426.

Lal, R., 2004. Soil carbon sequestration impacts on global climate change and food security. Sci. 304, 1623-1627.

Negi, S.S., Gupta, M.K., Sharma, S.D., 2013. Sequestered organic carbon pool in the forest soils of Uttarakhand state, India. Int. J. Sci. Env. Tech. 2(3), 510-520.

Patil, V.P., Vaghela, B.N., Soni, D.B., Patil, P.N., Jasra, Y.T., 2012. Carbon sequestration potential of the soil of Jambughoda wildlife sanctuary, Gujarat. Int. J. Sci. Res. Pub. 2(12), 1-6.

Post, W.M., Kwon, K.C., 2000. Soil Carbon sequestration and land use change: processes and potential. Global change Biol. 6, 317-328.

Saxena, R.K., Verma, K.S., Kharche, V.K., 1999. Organic carbon stock in soils of Patiala district of Indo-Gangetic alluvial plain. Agropedol. 9, 131-142

Schlesinger, W.H., 1990. Evidence from chronosequence studies for a low carbon-storage potential of soils. Nat. 348, 232-234.

Sheik, M.A., Kumar, M., Bussmann, R.W., 2009. Altitudinal variation in soil organic carbon stock in coniferous subtropical and broad leaf temperate forests in Garhwal Himalaya. Carbon Bal and Mange. 4(6), 1-6.

Singh, H., Pathak, P, Kumar, M., Raghubanshi, A., 2011. Carbon sequestarion potential of Indo-Gangetic agroecosystem soils. Trop Ecol 52 (2), 223-228.

Six, J., Callewaert, P., Degryze, S., Morris, S. J., Gregorich, E. G., Paul, E. A., Paustian, K., 2002. Measuring and understanding carbon storage in afforested soils by physical fractionation. Soil Sci. Soc. Am. J. 66, 1981–1987.

Walkley, A., Black, I. A., 1934. An examination of the Degtjareff method for determining soil organic matter and proposed modifications of the chromic acid titration method. Soil Sci. 37, 29–38.