Indian J. Applied & Pure Bio. Special Volume 29-35 June, 2023. **ISSN: 0970-2091**
A web of Science Journal

Second International conference on "Biodiversity: Exploration, Exploitation and Conservation for sustainable development" was organized by the department of Botany, in association with the Department of Zoology & IQAC, PDUAM-Behali, Assam, India on 10-11th February, 2023.

Assessment of soil organic Carbon (SOC) in forested landscape of East Siang District

Omem Tadeng[1], Karabi Barman[2*] and Jyotishman Deka[3]

[1]Department of Botany, University of Science & Technology, Meghalaya, 9th Mile, Ri-Bhoi – 793101 (India)

[2*,3]Department of Botany, Assam Don Bosco University, Tepesia – 782402 (India)

[*]For correspondence: email- karabibarman27@gmail.com

Abstract

Apart from being a major source of atmospheric CO_2, soil also serves as an important sink. Several factors including soil moisture, soil pH, and bulk density are there which influence the release of carbon through their organic carbon matter. Therefore, the present study was conducted to assess the soil organic carbon in forested landscape of East Siang District. The study was conducted in two different forested landscape of Pasighat (150 to 300 m asl.), and Mebo (300 to 450 m asl.) area located in Pasighat East Siang district of Arunachal Pradesh. In the current research work three different soil parameters which influence SOC namely soil pH, soil moisture and soil bulk density were studied. Result of the analysis showed that SOC in Pasighat was found to be marginally higher than Mebo. SOC in the current study also showed a decreasing trend with increasing soil depth, in agreement with earlier studies. In case of soil pH two distinct characteristics have been observed, *i.e.*, in both the sites the soil is slightly acidic in nature (pH $\leq$ 6) and pH shows a decreasing trend with the increase in depth. Soil moisture was almost found to be low and consistent for both the soil depth in both the study sites. However, variability can be observed in case of seasonal pattern. Again, it has been observed that bulk density of the soil increased with increase in soil depth. Soil bulk density was found to be consistent over the studied period for both the sites. In order to find the relationship between SOC and other soil parameters, linear regression analysis was performed. All the test of significance were conducted at a level alpha = 0.05. Significantly, it is to be noted that the sample size (n = 6) is not large enough to provide a very precise estimate of the strength of the relationship.

Key words : Soil organic carbon, forested landscape, bulk density

One of the most vital parts of the biosphere, soil is known to contain the second-largest carbon pool after the oceans and to provide essential ecosystem services[5]. A crucial indicator for determining the state of the soil is soil organic carbon (SOC)[8]. It gives plants their main supply of nutrients, facilitates particle aggregation, develops soil structure, boosts soil water storage, and creates a habitat for soil biota[7,11]. Increasing SOC is also essential for reducing the global climate change[1].The outcomes are a consequence of the patterns of plant species' succession in both mangrove and wetland areas. The investigation of a variety of alternatives in the energy, transportation, industrial, construction, and agricultural sectors is necessary for effective reduction of greenhouse gas emissions.A clear plan for enhancing soil health and quality, achieving food security, and reducing climate change is SOC sequestration. According to reports, 62% of the world's soil carbon reserves are organic, and 38% are inorganic[4]. Significant SOC pool depletion is expected to have negative effects on water quality, biomass productivity, and soil quality.

There are many different SOC estimation objectives, and the required degree of accuracy varies as well. In SOC estimations, a number of protocols are recorded and followed. Every technique has benefits of its own. Convenience, cost-effectiveness, and accuracy are the three main factors that determine whether a laboratory will use a particular analytical technique. The correct quantification of SOC concentration, content, and change over time depends on the choice of the carbon assessment procedure[6]. In order to evaluate the soil organic carbon of various forested landscapes of the East Siang district, Arunachal Pradesh, North East India, the current study was carried out.

Study area :

The study was conducted in two different forested landscape of Pasighatlocated in 28.0632°N, 95.3239°E (150 to 300 m asl.), and Mebolocated in 28.1200°N, 95.2994°E (300 to 450 m asl.)in the East Siang district of Arunachal Pradesh. The district occupies an area 3603 km^2 and has a population of 99,214 (as of 2011). The East Siang district has cold mountainous climate in the north while tropical climate exists in the south. Copious rainfall during monsoon and wind circulation during the winter are important feature of the climate. The average annual rainfall varies from 150 to 460 mm.

Estimation of soil parameters :

The soil sample utilized for the study were collected from four different sites (two for each landscape) in three different months (January, March & October) with three replicates. Every soil sample was collected at two distinct depths (0-15 cm and 15-30 cm). The replicates were then mixed to form a composite for each depth, air-dried, ground and sieved and stored.

In the current research work, three different soil parameters which influence the soil organic carbon namely soil pH, soil moisture and soil bulk density were studied. Soil pH was measured in a 1:10 soil: water suspension. Soil moisture (SM) content was determined by estimating the difference between fresh and dry soil samples. Bulk density (BD) of the soil was determined using Hunt and Gilkes method[3]. Soil organic carbon

(SOC) was estimated following the Walkley and Black method[9] of rapid titration. The soil analysis was performed using the wet digestion method.

Statistical analysis :

In order to find the relationship between SOC and other soil parameters at both the depths *i.e.*, 0-15 cm and 15-30 cm, linear regression analysis was performed using MS excel. Linear relationship has been studied in the current study as it is considered to be the strongest relationship between two variables.

Soil organic Carbon :

Winter, pre-monsoon and post-monsoon SOC status in the forested landscape of the studied areais given in Table-1. Soil organic carbon was found to be marginally higher in Pasighat than in Mebo. The present study revealed that in Pasighat soil organic carbon for soil depth (0-15 cm) ranges from 1.33 to 1.44 %. Comparatively lower level of soil organic carbon was recorded duringthe post monsoon period (October), which gradually increases towards the winter period (December and January) and finally further increases towards the Pre-monsoon period (March). Almost similar pattern was also observed for the soil depth (15-30 cm), but almost same amount ofsoil organic carbon was found for both post monsoon and winter period. A decreasing trend in soil organic carbon with increasing soil depth was observed, in agreement with earlier studies[2,10], which may reûect less organic content leaching and consequently less accumulation at deeper depths. Again, the substantial plant residues deposited in the top soil layers were the cause of the higher soil organic carbon concentration. A decline in the SOC ratiowas anticipated, assuming that the upper soil layers were more heavily aerated than the lower soil layers.

Similarly, for Mebo, soil organic carbon for soil depth (0-15 cm) ranges from 1.24 to 1.41 %. Comparatively lower level of soil organic carbon was recorded during the post monsoon period (1.24%), which gradually increases towards the winter period (1.32%) and further increases towards the Pre-monsoon period (1.41%). Almost similar pattern was also observed for the soildepth (15-30 cm), which ranges from 1.12% in post monsoon period through 1.18% in the winterperiod to 1.28% in the pre monsoon period. Although soil organic carbon concentration declines with depth, subsoil has a larger soil mass than topsoil and a greater potential storage capacity. Asa result, subsoil has higher soil organic carbon stocks than topsoil.

Soil pH *:*

Two distinct characteristics have been observed in case of soil pH, i.e., in both the sites the soil is slightly acidic in nature (pH ≤ 6) and pH shows a decreasing trend with the increase in depth (Table-1). Soil pH at the depth 0-15 cm ranges from 5.9 – 6.2 from post monsoon to pre-monsoon showing a marginal decrease in acidity. This is due to the dry nature of the pre-monsoon periodthan the other periods. However, pH remains almost same for all the period at the depth of 15-30cm in Pasighat. Again, in Mebo, soil pH at the depth 0-15 cm ranges from 5.9 – 6.2 from post-monsoon to pre-monsoon. Whereas soil pH at the depth 15-30 cm ranges between 5.3 to 5.9, frompost-monsoon to pre-monsoon period. Soil in Pasighat was found to be slightly less acidic than thesoil in Mebo.

Soil moisture content :

It is the water stored in the soil which is afiected by numerous factors like the precipitation, temperature, soil characteristics, and more. In the present study soil moisture was almost found to be low and consistent for both the soil depth in both the study sites. However, variability can beobserved in case of seasonal pattern (Table-1). Soil moisture at the depth of 0-15 cm ranges from18% to 25% in Pasighat, whereas it ranges from 19% to 27% in case of Mebo. Again, at the depth of 15-30 cm soil moisture at the depth of 0-15 cm ranges from 18% to 23% in Pasighat, whereas it ranges from 18% to 27% in case of Mebo. It has been observed that soil moisture increases from post-monsoon period through the winter towards pre-monsoon period (Table 1). Soil moisture wasfound to be lowest in the post-monsoon period which is considered to be dry period with minimum precipitation, whereas it slightly increases during winter period, which may be mainly due to one ortwo spell of winter rainfall accompanied with foggy precipitation. The area experiences few heavy showers during early pre-monsoon period (March), which may be the cause of relatively high percentage of soil moisture during this period.

Bulk density :

Soil bulk density was found to be consistent over the studied period for both the sites. Bulk density of soil for both the areas ranges from 0.72 to 0.88 g/cm^3 at the depth of 0-15 cm whereas it ranges from 0.84 to 0.93 g/cm^3 at the depth of 15-30 cm depth. However, bulk density of soil in Pasighat was found to be slightly higher than of soil Mebo. Low soil permeability and compaction are indicators of high bulk density. Root development may be hampered, and air and water may not travel through the soil as well. Bulk density of <1.10 g/cm^3 in the landscape under study indicates that the soil is perfect for nourishing and promoting plant development.

Statistical analysis :

It is found that, both soil pH and soil moisture correlates positively with the soil organic carbon. Soil moisture and soil organic carbon shows the strongest positive correlation ($r = 0.6591$). The relationship between soil organic carbon and soil moisture is also found to be statistically significant ($p < 0.05$). 43.45% variation in soil organic carbon can be explained by the regression model (Table-2). The positive correlation ($r = 0.6591$) indicates that when soil moisture increases, soil organic carbon also tends to increase (Figure 2). Similarly, soil pH and soil organic carbon shows the strong positive correlation, but the relationship between soil organic carbon and soil pH is not found to be statistically significant as p-value was found to be > 0.05 ($p = 0.104$). Only 24.18% variation in soil organic carbon can be explained by the regression model.

Again, soil organic and soil bulk density show the strongest negative correlation ($r = -0.6578$) (Table-2). The relationship between soil organic carbon and soil bulk density is also found to be statistically significant ($p < 0.05$).

Table-1. Estimates of Soil parameters at different forest areas of the study area

Sites	Parameters	Depth	Oct	Jan	Mar
Pasighat	SOC (%)	15cm	1.33	1.36	1.44
		30cm	1.22	1.21	1.31
	pH	15cm	5.9	6.0	6.2
		30cm	5.7	5.8	5.7
	SM (%)	15cm	18	22	25
		30cm	18	21	23
	BD (gm cm^3)	15cm	0.88	0.87	0.88
		30cm	0.91	0.93	0.93
Mebo	SOC (%)	15cm	1.24	1.32	1.41
		30cm	1.12	1.18	1.28
	pH	15cm	5.5	5.8	6.0
		30cm	5.3	5.8	5.9
	SM (%)	15cm	19	22	27
		30cm	18	23	27
	BD (gm cm^3)	15cm	0.76	0.74	0.72
		30cm	0.84	0.88	0.86

43.27% variation in soil organic carbon can be explained by the regression model (Figure 1). The negative correlation (r = 0.6578) indicates that when bulk density decreases, soil organic carbon also tends to increase. Further if we study the relationship between soil moisture, soil pH and soil bulk density, it was observed that soil moisture and pH show a statistically significant positive correlation ($p < 0.05$). 41.03 % variation in soil moisture can be explained by soil pH. Positive correlation (r = 0.64) indicates that when soil moisture increases pH tends to increase. Other two relationships do not show any statistically significant relationship and hence cannot draw any inference.

Table-2. Scatterplot between SOC and other soil parameters at different area

Variable	Regression equation	r	R^2	p-value
SOC & pH	Y = 0.1437 + 0.1968X	0.4917	0.2418	0.104
SOC & SM	Y = 0.8676 + 0.0190X	**0.6591***	0.4345	**0.020***
SOC& BD	Y = 2.024 – 0.8697X	**-0.6578***	0.4327	**0.020***
SM & pH	Y = -29.53 + 8.871X	**0.6405***	0.4103	**0.025***
SM & BD	Y = 29.85 – 9.330X	-0.2039	0.0416	0.525
BD & pH	Y = 0.7377 + 0.0193X	0.0639	0.0041	0.844

**Values in bold are different from 0 with a significance level alpha=0.05*

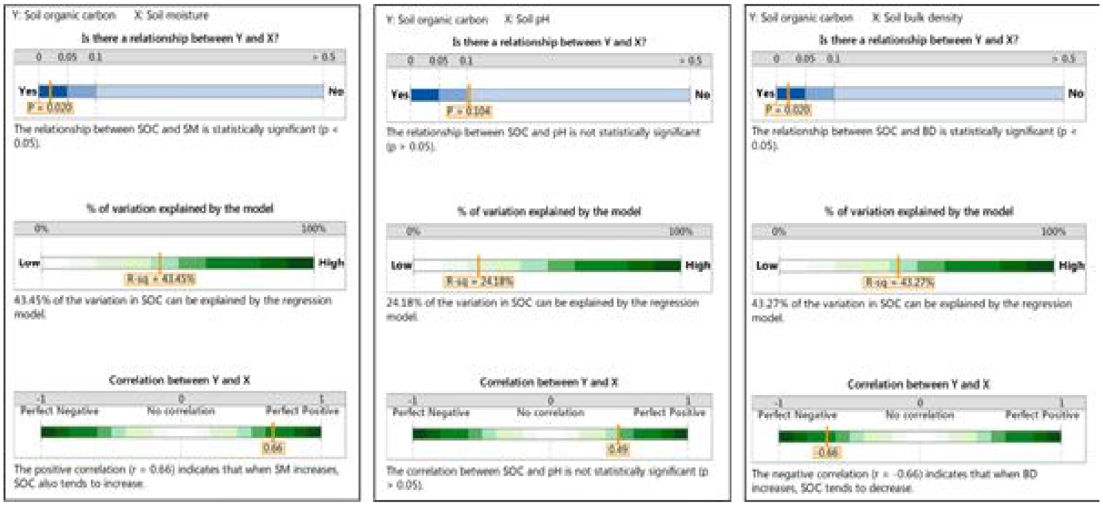

Figure 1: Statistical relationship SOC with soil moisture, soil pH and soil bulk density

Importantly, it is to be noted that the sample size (n = 6) is not large enough to provide a very precise estimate of the strength of the relationship. Measures of the strength of the relationship, such as r and R^2 (adjusted), can vary a great deal. For obtaining a more accurate estimate, larger samples (typically $\geq$ 40) should be used. Again, in the current datasets there are no unusual data points as unusual data points can have a strong influence on the results. Further as the study has been conducted with less than 15 data points, data normality might be error prone.

This study gives an account of how the different soil parameters (pH, SM and BD) are related to the SOC as well as with each other in the forested landscape of Pasighat and Mebo. It was observed that the soil organic carbon increases with the increases in soil pH but the relationship was not statistically significant. Similar pattern was also observed for the SOC and SM showing significance. But the BD and SOC showed a significant inverse relationship. Also, it was observed that SM and pH has a strong positive correlation showing that the pH tends to increase with increase in SM. Significantly, it is to be noted that the sample size (n = 6) is not large enough to provide a very precise estimate of the strength of the relationship.

The authors hereby express their deepest acknowledgements and heartfelt gratitude to PCCF (Principal Chief Conservator of Forest), Arunachal Pradesh for giving the required permission to carry out the research activity. The authors are also highly grateful to the local guides for helping in sample collection for successful completion of this research.

References :

1. Deluz, C., M. Nussbaum, O. Sauzet, K. Gondret, and P. Boivin, (2020). *Front. Environ. Sci. 8*.
2. Fu, X., M. Shao, X. Wei, and R. Horton,

(2010). *Geoderma*. *155*(1-2): 31-35.
3. Hunt, N. and R. Gilkes, (1992). Farm Monitoring Handbook- A practical down to earth manual for farmers and other land users. University of Western Australia: Nedlands, W.A., and Land Management Society: Como, W. A.
4. Lal, R. (2004). *Geoderma*. *123:* 1-22.
5. Ogle, S.M. and K. Paustian, (2005). *Canadian Journal of Soil Science*, *85:* 531-540.
6. Périé, C. and R. Ouimet (2008). *Canadian Journal of Soil Science*. *88:* 315-325.
7. Schoonover, J. E. and J. F. Crim, (2015). *Journal of Contemporary Water Research & Education*. *154*(1): 21-47.
8. Stockmann, U., J. Padarian, A. McBratney, B. Minasny, D. de Brogniez, L. Montanarella, S. K. Hong, B. G. Rawlins, and D. J. Field, (2015). *Global Food Security*. *6:* 9-16.
9. Walkley, A. and L.A. Black, (1934). *Soil Sci*. *37:* 29-38.
10. Yimer, F., S. Ledin, and A. Abdelkadir, (2007). *Forest ecology and management*. *242*(2-3): 337-342.
11. Yu, H., B. Kong, Q. Wang, X. Liu, and X. Liu, (2020). Hyperspectral remote sensing applications in soil: a review. *Hyperspectral Remote Sensing*. 269-291.