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Quantification of Soil Carbon in Ituri Forest, Democratic Republic of Congo

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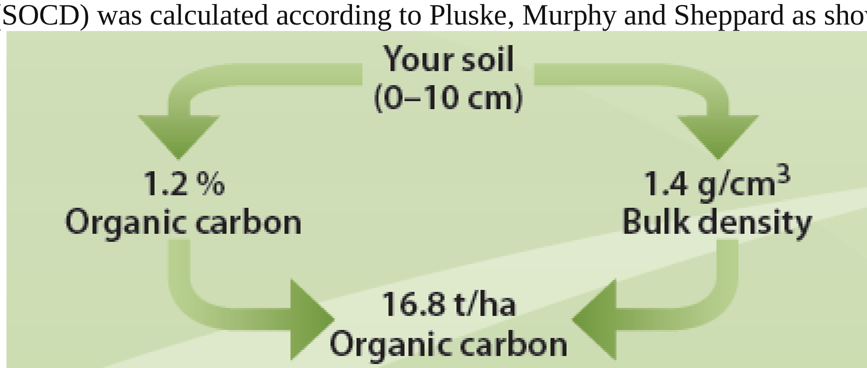
Introduction

Promoting carbon sequestration to offset atmospheric carbon dioxide by offering some sort of incentives via direct payments or carbon credits is a current topic of interest. However, several questions arise as to what is the best way to determine the quantity and quality of carbon in soils? How much carbon can a soil sequester? How fast can that carbon be sequestered? How stable is soil carbon? What proportion of soil carbon is labile and how much is recalcitrant? Is soil carbon in forests different than that in agricultural soils? Does our focus on soil carbon sequestration as an atmospheric offset prevent us from recognizing the other ecosystem services it provides? To address these questions, inventories of soil C concentrations are needed for constant monitoring of current C status and potential for sequestration. The objective of this study was to assess the status of soil carbon and other nutrients in Ituri Forest, Democratic Republic of Congo.

Methodology

This study was conducted at Lenda 1 Forest Dynamics Plots (FDP) in the Okapi Faunal Reserve (OFR), Ituri Forest, Democratic Republic of Congo. Lenda-1 Forest Dynamics Plot is located at the north of Lenda2, at 1º 19' N latitude and 28º 38' E longitude. The average annual rainfall at the Okapi Faunal Reserve administrative center is about 1600 mm, with a maximum of 2100 mm and a minimum of 1300 mm. The dry season lasts 3-4 months. The average annual maximum temperature is 25º C. The topography of the area is gentle, with occasional rolling hills containing exposed patches of shallow rocky soil (Torti et al., 2001). Plots are located approximately 750 m above sea level and the elevation range from 700 to 850 m. Surface soil samples (0-10 cm depth) were collected along a 20 m x 20 m grid in the 10 ha plot. A portable GPS receiver (Garmin GPSmap 60s) was used to record the coordinates of each sampling location. Eighty soil samples were collected using a 10 cm long and 10 cm diameter soil sampler, giving a soil volume of 785 cm^3 per sample. Soil samples were air-dried and brought to Harvard Forest, Harvard University for analysis of soil organic carbon and other nutrients. Soil organic carbon density (SOCD) was calculated according to Pluske, Murphy and Sheppard as showed below :



i.e. 10,000 m^2 in one hectare x 0.1 m soil depth x 1.4 g/cm^3 bulk density x 1.2 % = 16.8 t/ha.
Authors: **Wayne Pluske** (Nutrient Management Systems), **Daniel Murphy** (The University of Western Australia) and **Jessica Sheppard** (Avon Catchment Council).

Source: http://www.soilquality.org.au/factsheets/organic-carbon

Results

Soil bulk density (BDY) was within the range of normally reported values and varied between 0.92 to 1.89 g/cm^3 with an average of 1.69 g/cm^3 (Table 1) Its standard deviation was 0.17 g/cm^3 with a coefficient of variation (CV) of 9.88%. Soil organic carbon (SOC) ranged from 7.80 to 77.10 g kg^{-1} with a mean of 17.97 g kg^{-1}. It had high variability with a coefficient of variation (CV) of 62.265% and was best fitted to a Gaussian variogram model with a range of spatial variability (A_0) of 460 m and a coefficient of determination (R^2) of 0.83.

Table 1. Summary of simple statistics for soil bulk density and soil chemical properties

Variable	Mean	SD	C.V.	Minimum	Median	Maximum
BDY (g/cm^3)	1.69	0.17	9.88	0.92	1.73	1.89
SOC (gkg^{-1})	1.80	1.13	62.65	0.78	1.53	7.71
N (%)	0.19	0.12	64.94	0.09	0.16	0.86
C/N	9.38	0.97	10.30	7.20	9.35	11.78
OM (%)	4.68	2.81	60.06	2.28	4.00	20.56
SOC_D (tons/ha)	29.61	16.39	55.36	14.55	25.06	130.65

BDY = Soil bulk density, SOC = Soil organic carbon, N = Soil nitrogen, C/N = Carbon to Nitrogen ratio, OM = Organic matter and SOC_D = Soil organic carbon density.

An interpolated map was produced and showed that SOC decreased with altitude. SOC was also significantly correlated with other soil nutrients and soil physical properties. Soil organic carbon (SOC) was significantly and positively correlated Ca, P, Na, Fe, Cu, Mn, but the highest correlation was with Zn ($p = 0.0001$, $r = 0.64$). It was also negatively correlated with S, Al and elevation. Significant correlations were also found between soil carbon and soil physical and thermal properties. Soil organic carbon density (SOC_D) ranged from 14.55 to 130.65 tons C ha^{-1} with an average of 29.61 tons C/ha.

Discussion

The coefficient of variation for soil bulk density was less than 20%, implying that there was less variability and that BDY was well measured. Therefore, any effect of BDY in overestimating SOC can be ruled out. The results of this preliminary study also show the potential for soil carbon sequestration in this 10 ha pristine forest plot, dominated by *Gilbertiodendron dewevrei*. Soil organic carbon averaged 29.61 tons /ha in the 0-10 cm layer in Ituri Forest. This value seems to suggest greater SOC storage in Ituri Forest as compared to nearby forest of the same region. In fact, although they sampled in different forests and higher soil layer, but in the same province, Doetterl et al (2016) reported SOC values of 23.10 Mg C/ha in Yoko Forest and 55.70 Mg C/ha in Yangambi Forest for the 0-30 cm depth. Our results for a third of their sampling depth shows higher values of SOC.

Conclusion

It is suggested the study be pursued to include deeper soil layers (20-100 cm) for a better assessment of soil organic carbon in Ituri Forest, Democratic Republic of Congo

References

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