

EFFECT OF LAND USE TYPES ON THE VERTICAL DISTRIBUTION OF SOIL ORGANIC MATTER IN SOME SOILS OF THE HUMID TROPICS OF EDO STATE, SOUTHERN NIGERIA.

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Abstract

The humid tropical rain forest is said to be the most diverse ecosystem in the world, and essential for global carbon balance. In Edo State, several hectares have been converted to all sorts of plantation agriculture. An experiment was conducted in Igieduma community, Uhunwode L.G.A. Edo state to examine organic matter (OM) distribution in the soil profiles of a rubber (*Hevea brasiliensis*) plantation (Rb) and natural forest (Fo) located side by side and on an alfisols. In each site, a plot measuring 25mx25m was demarcated for profile pit, and surface soil sample collection. At the centre of each plot, one profile pit each was dug measuring 100cmx180cmx200cm. In each profile, soil samples were obtained with a steel core, from 0-15cm, 15-30cm, 30-45cm, 45-60cm, 60-75cm and 75-90cm, and from the four sides of the pit, making four core samples per layer. Samples were bagged separately, labelled and taken to the laboratory for analysis. Percentage organic matter content (%OM), particle size analysis, pH and moisture content were determined according to standard analytical procedures. Also within this plot five spots were randomly chosen, and soil temperature, humidity were assessed using mercury in glass centigrade thermometer, and wet and dry hydrometer respectively. Presence of earthworms and termites were assessed by counting numbers of earthworm casts for earthworm and termite mounds for termite. Data obtained were subjected to descriptive statistics-mean, range and percentages. Mean value of OM for Fo was 1.19% while Rb was 0.72%. For the two sites % OM was highest at surface soil, and decreases down the profile. While this decrease was regular for Fo, it was not so for Rb. This experiment revealed decrease and irregular distribution in OM content of soil when natural forest is converted to rubber plantation. Conversion of forest vegetation to rubber plantation may have some effect on soil carbon storage and global carbon circle. There may be the need also to supplement soil fertility in establishing rubber plantation.

Keywords: Forest conversion, rubber tree plantation, soil organic matter, land use type.

Introduction

Agriculture, the oldest profession of man, has been the attempt of man to carefully select desirable plants and animals which receive special attention for cultivation and rearing for his immediate needs and those of the larger society. This situation created a society which is segmented into various professions whose services are needed for the overall sustenance of the society – the origin of civilization. To sustain civilization, it was therefore necessary for man to continuously exploit, the natural world and ecosystems. One of such ecosystem is the humid tropical forest. The tropical rainforest is considered the most diverse ecosystem in the world, consisting of several species of plants and animals. This highly productive ecosystem is also occurring in soil of very low fertility, when compared to those in temperate regions. It is supported by a highly efficient nutrient recycling systems

(Terborgh 1992). The nutrient recycled is found in the body mass of plants and animals. Animals depend on plants for their energy sources. These nutrients also occur in the thin O horizon mixed with the mineral layer of the soil profile (Terborgh 1992). Most of the soils in the humid tropical forest lack weatherable rock minerals, and are highly weathered therefore soil fertility is maintained by efficient nutrient recycling (Eghaghara and Ighoyovwi, 2014). Every ecosystem offers, essential eco services, which are necessary for the survival of all forms of life, in each particular system as well as inter ecosystems. Among the several eco – services offered by the humid tropical forest which include maintenance of biodiversity, several life supporting cycles, and that of carbon dioxide global balance. The world forest store more carbon, than the entire atmosphere (683Gt in biomass, soils, dead wood and litters).Deforestation results in rapid release of

carbon into the atmosphere accounting for 20% of all anthropogenic activities' green house gas emissions worldwide (Erin, 2008).

Once the forest is cleared, the eco services are immediately affected, by influencing organic matter return and accumulation in the soil. Soil organic matter comprises a major pool in the global carbon cycle and plays an important role in regulating the atmospheric CO₂ concentration. (Zhoug and Zhao, 2001).

Since mankind must exploit his environment to sustain his ever increasing needs, it is essential that these activities be periodically monitored to see their effects on the environment. According to Ahukhaemere (2012) better understanding of soil down the profile is important for refining agricultural management practices and for improving sustainable land use.

More than half of Edo State land mass is of tropical rain forest. Much of the original forest area has been converted to one form of use or the other. Osunde (2008) observed that in free land area (that is area outside government control reserve) the continued uncontrolled exploitation has reduced the size of forested land in Edo State from 574,946ha to 361,304ha in the last 20years.

This experiment was conducted to examine the distribution of soil organic matter (SOM) down the profile of a rubber plantation, in comparism to that of rain forest.

Materials and Methods

Study area

The experiment was conducted at Igieduma community, near Ehor, headquarter of Uhunwode Local Government Area of Edo State. Igieduma is 59km from Benin City on the Benin – Auchu Okene federal highway. It is located at lat. 6° 41'E and Long. 6°. 61'N. The area experiences the humid tropical type of climate. Rainfall last for about 9 – 10 months in the years, with a range of 1500mm – 200mm, occurring in two peaks. Temperatures are high throughout the year averaging 27°C in a month. Humidity is high during the raining season, and it could be as high as 90%. The harmattan season lasts for only two months. (Remison, 1998).

The study location lies within the Esan plateau which according to Segynola (2011),

risers approximately 213 – 305m above sea level. It is characterize by sandstone hills and numerous dry valleys. It is a water shed to the numerous tributaries, of rivers Orley and Orhionwan, which course started from the plateau. The original vegetation is the humid tropical forest type. However, much of it has been converted to one use or the other. Several plantation tree agriculture are practiced in this region including oil palm and rubber plantations. Majority of the local farmers, practice subsistence agriculture.

Description of the site

Two sites or land use types were chosen for this investigation and they were secondary forest and rubber plantation. At each site a plot of 25m by 25m was demarcated for the exercise.

a.Secondary forest (Fo): The original forest has been greatly tampered with by man through lumbering. What we had was a secondary forest, with scattered timber trees. There were climbers, which depended on the trees for support, and in this way created a secondary canopy. The floor was opened, with all sorts of shade tolerant plants, shrubs, seedling of trees and left over logs of felled timber trees. Some of the trees included, mahogany, obeche, white afara, white stercular. Fallen twigs, branches and different sizes leaf litter form a thick matt on the forest floor.

b. Rubber plantation (Rb) (*Haevea braziliensis*): the plantation was about 30 years old. The trees were haphardly planted without standard spacing. Therefore the canopies overlapped, minimizing penetration of sunlight to the floor of the plantation. It was easy to walk through the plantation as a result of sparse undergrowth. The floor was covered with leaf litters. There were shade tolerant plants and seedlings of trees growing on the floor.

Profile Pit Examination and Soil Sample Collection

At each site, a 25mx25m was demarcated for profile pit and soil sample collection. A profile pit was dug measuring 100cm x 180cm and 200cm deep. Soil samples were obtained with steel core in the order of the following depth following of method of Nsor *et al.*, 2014 . 0 – 15, 15 – 30, 30 – 45, 45 – 60, 60 – 75 and 75 – 90cm. Four core samples were obtained, from each side of the pit to form one composite sample for each depth. Samples

obtained, were bagged separately, in polythene bags, labelled and taken to the laboratory for analysis. Within each plot, five spots (1m by 1m) were randomly chosen, cleared of litters and earthworm casts were counted. Earth worm casts are veritable indices of earthworm population (Lavelle, *et al.*1997).

Laboratory Analysis

Samples were air dried, and sieved with a 2mm copper wire sieve and made ready for laboratory analysis. The following properties were determined. % O.M., soil moisture and particle size according to Udo *et al* (2002). Particles size was determined according to Bouyoucos (1965). pH was assessed in 1:1 H₂O according to Maclean (1982).

Statistical Analysis: Descriptive statistic, (Ogbeibu 2005), range and percentages, were used to compare and interpret the results obtained.

Result and Discussion

Table 1 shows the values of SOM soil down the profiles of the two land use types at the two sites. Values were highest on the surface soils (0 – 15cm), and tapering towards the interior. Foth (1978) also observed a similar trend in his work. Dike and Mba (2011) attributed the trend of decreasing SOM from the surface to the interior of the soil, to be changes in land use type. The higher values of SOM) at surface soils is to be expected since the bulk of

biomass of terrestrial organisms is held above ground. When these or some of their parts die their litter is return to the soil surface, where they undergo decompositional processes. (King and Cambell 1994) observed that most biological processes occur in the surface soil (0 – 15cm) due to enhanced presence of energy sources derive from plant and animal litters. It is also possible for OM to be elluviated, from surface soil down the interior of the soil (Brady and Weil 2002). This will naturally be received first by soils closer to the surface. Hence the observed decreasing values of OM down the profile. Since this was the trend in both sites, the observed trends, was not as a result of the use type, but of surface biological activities and eluviation. However, the quantity of OM elluviated will depend on surface litter return, and rate of litter decomposition.

The mean values of % OM for both sites Fo and Rb were 1.19% and 0.72% respectively (a difference of 0.47%) (Table 1). This result shows, that introduction of rubber into this ecosystem resulted in lower OM reservoir in the soil. This we had earlier attributed to differences in litter return. This scenario has implications for carbon stock and sequencion with less carbon being stored in rubber plantation soils when compared to the original forest.

Table 1: Mean values of parameters investigated in the profile

Depth	% OM		pH		Moisture content		Text Class	
	Fo	Rb	Fo	Rb	Fo	Rb	Fo	Rb
0 – 15	3.5	2.04	4.42	5.25	12.40	12.20	SL	SL
15 – 30	2.00	0.33	4.50	4.39	12.40	12.20	SL	SL
30 – 45	0.79	0.43	4.38	44.48	12.60	12.10	SL	SL
45 – 60	0.38	1.10	4.53	4.52	12.30	12.20	SCL	SL
60 – 75	0.29	0.18	4.56	4.29	11.90	11.90	SL	SL
75 – 90	0.21	0.18	4.35	4.48	11.90	11.90	SL	SL
Total	7.15	4.32	26.74	28.41	73.50	75.50	SL	SL
Mean	1.19	0.72	4.46	4.72	12.25	12.09	SL	SL
Range	2.29	1.86	0.21	0.96	0.70	0.30	SL	SL

Litters, consumed and incorporated into the body mass of consumers, such as earthworms (Table 2) cannot be available for elluviated processes, at a particular point in time. All other surface parameters (Table 2) favour biological

activities, as both soil/ambient humidity and temperatures indicated adequate values for both sites. Presence of some earthworm cast for Fo compared to RB, suggest greater and more diversity in litter returns for the former.

Table 2: Mean value of some soil surface properties parameter

Site	Depth (cm)	Temp. (0C)	Humidity (%)	Earthworm Cast (Nos)	Termite Mound (Nos)	Roots > 2mm	Litters
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Fo	0 – 15	26	89	57	2	Numerous	Mixture of all sizes of leaves
Rb	0 – 15	28	89	52	2	Few	Mainly broad leaves

Fig (1) shows the value of OM for Fo and Rb profile. In Fo the trend is regular. The result is indicative of what happens when an ecosystem is tampered with. In the Fo, there had been a sort of equilibrium in all soil activities, which must have occurred over a long period of time. When the forest is opened up, almost all these activities are disrupted in one way or the

other. And the introduction of rubber plantation (Monoculture) into the stable ecosystem is a disruption. This disruption coupled with the effect of a mono crop must have resulted in the irregular distribution of OM in the profile of Rb. Similar observations were also made by Jeyauneg *et al.*, (2004).

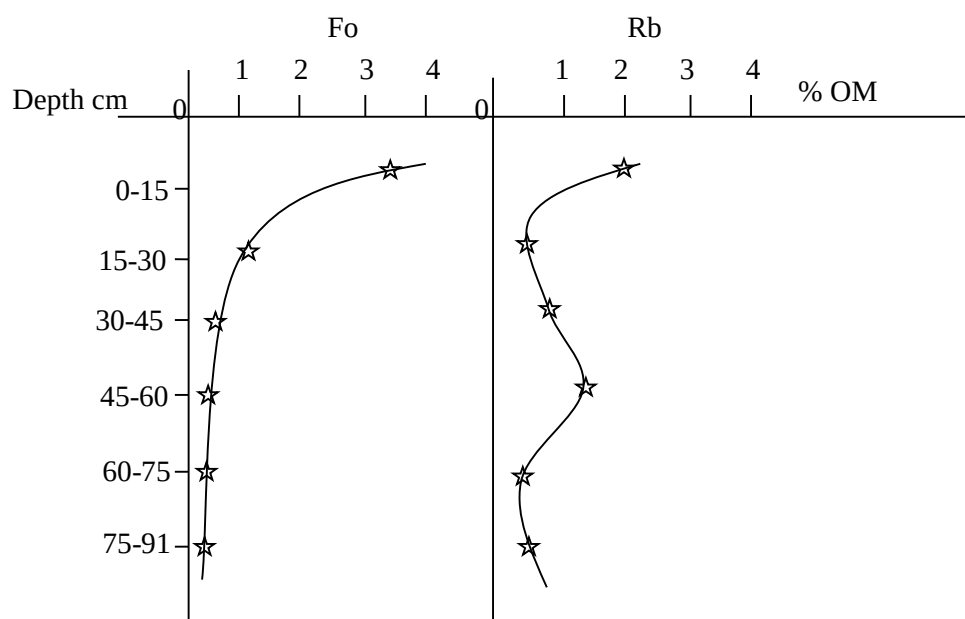


Fig 1: O.M Profile Distribution for Natural Forest and Rubber plantation

Summary and Conclusion

This experiment was conducted to investigate the distribution of soil organic matter. (S.O.M) in the soil profiles under natural forest (Fo) and Rubber plantation (Rb). The experiment revealed general decrease of % SOM from surface soils (0 – 15cm) down the profile for both systems. While the decrease was regular for Fo, it was not so for Rb. The difference in soil profile mean value of % SOM, between Fo and Rb was, 0.47% which could be the conversation of natural forest to Rubber tree plantation. This conversation may result in reduction of carbon stock, and subsequent release of more CO₂ into the atmosphere. It is recommended that this experiment be repeated and replicated with greater landmass coverage in order to generate more reliable data.

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