

An Investigation of the Role of Vegetation as a Determinant of the Vertical Distribution of Soil Organic Carbon

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Abstract

In Nigeria, natural forest areas are being converted for various land use. These land usage affect vegetation by reducing the organic matter and carbon content in the soil. Land use pattern has also had a significant impact on the quality of the soil in a typical environment and hence affects the structure and quality of the vegetation. Beyond taxonomic classification of soils, effort is rarely made to interpret the classification in terms of how soil constraints might affect sustainable production of crops, forage or vegetation and how this information can provide guidance on managing these constraints. Therefore, this study was undertaken to investigate the vertical relationship and distribution between soil organic carbon (SOC) and vegetation in various locations in Ikorodu, Etiosa Ikeja, and Isolo local government areas of Lagos state. Three soil levels being considered in this study were the top soil (0-10cm), mid soil (11-20cm) and bottom soil (21-30cm). Organic matter contents were also tested at the three levels and it was observed that the level of organic matter was highest in areas with much shrubs, grasses and trees. The carbon content was found to increase with increasing organic matter. Analysis of variance (ANOVA) was conducted to evaluate whether vertical distributions of SOC and vegetation differ significantly between the three levels of soil. The result showed that the soil moisture, carbon and the organic matter content of the bottom soil level were found statistically to be significantly higher than that of the top soil and mid soil. The bottom soil also had the highest SOC content with a total mean of 0.329400 followed by the middle soil with mean SOC of 0.308411 while the least mean SOC was found in the top soil with a mean value of 0.3045037. The study concluded that there is a reasonable level of relationship between vegetation and soil organic carbon. The findings in this research will form a guide on the best soil and crop management practices to be adopted.

Keywords: vegetation, soil, organic matter, soil organic carbon, vertical distribution, land use.

INTRODUCTION

The most physical observable element of the landscape is vegetation and it is the plant cover of the earth that consist of various plant species. Vegetation expresses and reflects environmental conditions, particularly climate and it is a known fact that healthy plants survive best in fertile soil. Plants utilize water and nutrients from soil and it is the inherent characteristics of the soil together with some environmental factors that determine soil fertility. Soils are complex and dynamic ecosystems with communities of organisms. According to Jeffrey 2009, essential functions like water storage, filtration and most importantly, decomposition occur in soils. Aweto et al.1994 observed that the major threats to vegetation varied from increase in urban areas, road building and industrial development, erosion, acidification, accumulation of pollutants, organic matter loss and deteriorating soil structure. Sources of soil contamination and organic carbon reduction could arise from geological parent material, industrial

processes (atmospheric emission, waste disposal ,and effluent disposal) as well as farming practices. Contaminants usually percolate into the soil and remain there for several years. Clayton 1958; Adejuwon & Ekanade 1984, Okeke 2003 reported that the relationship between soil and vegetation has continued to attract researchers since the 1950s up till date. Soil is a viable sink of atmospheric carbon. Several studies have indicated that the global potential for enhancing carbon storage in forest and agricultural ecosystem may be as much as 60-90 pentagram of organic carbon (De Jong et al. 1999). According to Schlesinger 1997, soil had the largest pool of terrestrial organic carbon due to storage of more carbon than what is obtained from both plants and atmosphere. Dalal & Chan 2001 also reported that about 60% of the stored carbon was organic carbon, in the form of organic matter in the soil 91,500 billion t C). Lal 2002 has also observed that about 60 to 70% of the carbon can be retained through adoption of recommended soil and crop management practices in

land where soil has lost 25 to 40 mg organic Carbon. The principal component of the soil carbon store is humus, a stable form of organic carbon.

The distribution of organic carbon in the soil and its relationships with vegetation is not clearly understood and so has become a contemporary issue. Soil organic carbon storage is controlled by the balance of carbon inputs from plant production and outputs through decomposition.

Vegetation and soil are interrelated and exert reciprocal effects on each other. This plays out since soil gives support in terms of moisture, nutrient and anchorage to vegetation for effective growth while vegetation in turn provides protective cover for soil, suppresses soil erosion and helps to maintain soil nutrient through litter accumulation and subsequent decay (Eni et al .2011).

Organic carbon forms are derived from the decomposition of plants and animals. They are capable of decay and are products of decay. They are carbon, oxygen, nitrogen and hydrogen containing compounds. The carbon content of the molecules in organic matter are quite high, about 50% while nitrogen is about 0.5 to 10% (dependent on residue type); some of which turns over rapidly (labile fraction) and is available to plants, whilst other more recalcitrant forms contribute to the stable (passive, slow turnover fractions) organic pools. (Pluske et al.2007).

Typically, soil contains about 45% minerals (soil particles), 25% water, 25% air and 2-10% organic matter. The soil carbon held in the soils organic matter comprises: freshly deposited and undecomposed organic matter (dead plant roots and leaves); temporary compounds from the process of decomposition; blackish-brown soil substance called humus (stable soil); and living organisms such as earthworms, arthropods, molluscas, nematodes, fungi, protozoa and bacteria (Cairns et al. 1997).

Organic matter is commonly and incorrectly used to describe the same soil fraction as organic carbon. Both terms are often confused and used interchangeably. Organic matter is different from organic carbon because it includes all the elements (hydrogen, oxygen, nitrogen etc) that are components of organic compounds, not just carbon. It is difficult to measure organic matter directly in laboratories, hence organic carbon is usually measured then a conversion factor of 1.72 is usually applied to convert organic carbon to organic matter:

Organic Matter (%) = Organic Carbon (%) x 1.72.

This conversion factor assumes organic matter contains 58% organic carbon but however this can vary depending on factors like type of organic matter,

soil type and soil depth. Conversion factors especially for sub-soils can be as high as 2.50 (Pluske et al. 2007).

Organic matter is universally regarded as a very useful component of soil. Krull et al. 2004 observed that farmers desire increase in organic matter due to the following advantages: better plant nutrition, ease of cultivation and seedbed preparation, greater aggregate stability, reduced bulk density, improved water holding capacity, enhanced porosity, earlier warming in spring and provides a reservoir of metabolic energy for biological processes to occur in the soil.

Due to human activities such as fossil fuel burning and land use practices that release carbon dioxide into the atmosphere, the carbon pool in the atmosphere has increased and the elevated carbon dioxide is considered to be a contributory factor to the danger of global warming and climate change. However, SOC is a very important component of the global carbon cycle. According to Falkowski et al.2000, the ocean contains the largest active pool of carbon near the Earth surface. Le Quéré C. et al (2007) divided the carbon cycle into two categories: first, the geological, which operates over large time scales (millions of years), and the biological - physical, which operates at shorter time scales (days to thousands of years) and as humans we meddle with both categories. It is the largest component of the terrestrial carbon pools, approximately twice the amount of carbon in the atmosphere and in vegetation.

With the process of soil carbon sequestration, that will allow more carbon to be stored as organic carbon, Weart 2004 opined that there would be a reduction in the amount present in the atmosphere, and this would go a long way to reduce global warming and climate change.

Ways by which soil organic carbon affects plant growth include availability of plant nutrients through decomposition of organic matter; improve in soil structure and other properties; and as a food source for soil fauna and flora. The objective of this study is to test the hypothesis that vegetation type through patterns of allocation is a dominant control on the vertical distribution of SOC, thereby showing that vegetation is a major determinant of the vertical distribution of soil organic carbon (SOC).

Statement of Problem

Economically, many occupations of Lagos have to do with agricultural products. However agricultural production is limited due to lack of sufficient water for irrigation and harsh climatic conditions (Kunwar, 2003), overgrazing in certain areas, change in land use pattern, illiteracy which leads to the misuse of farming lands (Wang et al., 2002).

The protection and sustainable management of vegetation also support livelihoods of certain groups of people through livestock rearing or collecting and marketing wild foods and vegetables such as mushrooms, bamboos shoots, medicinal plants and so on. (Pant & Devkota 2007).

The productivity of vegetation is decreasing day by day particularly by the reduction of the soil organic carbon in the soil which reduces the productivity of the vegetation in the state, so people are leaving agro pastoral occupation and searching alternative source of income to sustain their livelihood.

Limitations on the study

The major limitation on this study is the difficulty in having access to the locations under study. Another limitation is lack of corporation by the community members in some cases.

Another limitation is the distance between each area of study since the study covered many local government areas.

Another limitation was the high cost of transportation around all the local government areas under study. Sampling was time consuming.

MATERIALS AND METHOD

2.1 Study Area

The study was streamlined to three major areas in Lagos, namely Ikorodu (Ikorodu towns and environs), Etiosa (Victoria Island, Lekki Ajah Area) and Ikeja (Murtala International Airport, Isolo area and Ikeja) local government areas. The sampling locations were chosen to span a wide range of area and to give a good geographical coverage in the Lagos city. Five grids were selected for this study within Lagos and samples were taken from three locations for each grid and these locations are shown in the map below.

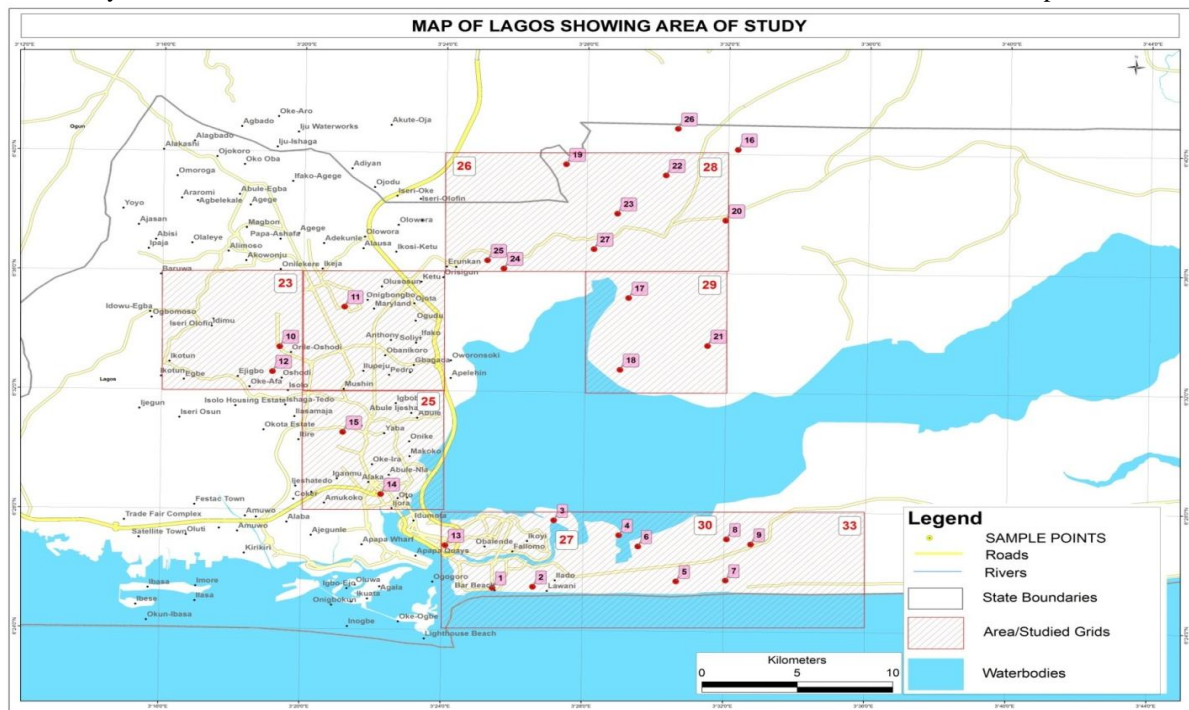


Figure 1: Map of Lagos state showing study area Soil Sampling

Lagos state was divided into 63 grids with each grid 20 (twenty) minutes apart- longitude and latitude. Three sample locations were then taken per grid at random locations depending on accessibility and three soil samples were taken per location with the first sample being at a depth of 0-10cm for the top soil, the second at a depth of 10-20cm for the mid soil and the third being at a depth of 20-30cm for the bottom soil with the aid of the Auger. It was noticed that most of the soil types at the various study areas where sandy soil which were mostly brown or dark brown. Very

few were clay soil and silt soil. Some colors of soil samples were also grey due to the land use and the vegetative pattern of the area.

The sampled position's coordinates were equally collected to produce field study map for analysis of result. The vegetation type such as Grasslands, Forest, shrubs in the location were also noted

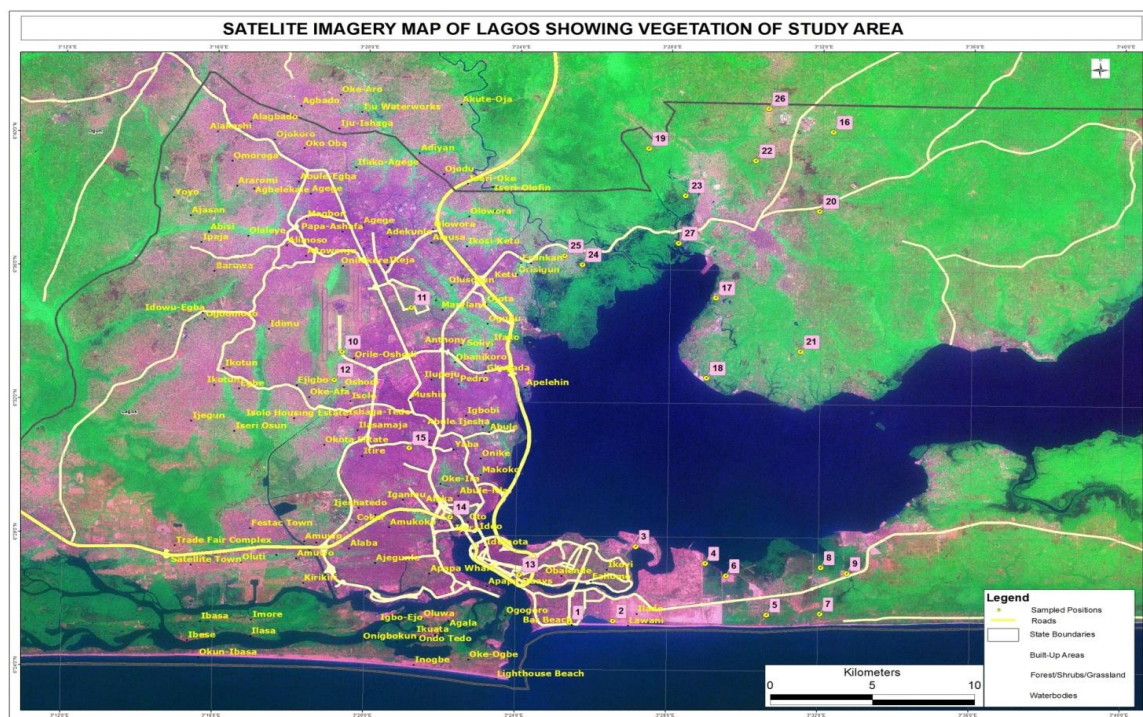


Figure 2: Map showing Satellite Imagery of the vegetative distribution of the study areas

Sample Preparation

Soil samples were wrapped with aluminium foil and placed in sample bags which were properly tagged according to the locations for proper identification in the laboratory. In the laboratory, the wet soil samples were spread onto plastic trays and air dried at ambient temperature for a few days. Large materials like stones were removed manually. The samples were sieved using a 2.0mm stainless steel sieve and stored in clean polyethylene bags.

Physicochemical Analysis of Soil

Determination of Moisture Content of Soil : This was carried out by gravimetry.

Determination of Organic Carbon was done by Walkley-Black Methods.

Reagents used were H₃PO₄ (85%), concentrated H₂SO₄ (96%), Standard 0.167M K₂Cr₂O₇ : 49.04 g of dried (105°C) K₂Cr₂O₇ was dissolved in water and diluted to 1Litre. , 0.5M Fe²⁺ Solution : 196.1 g of Fe(NH₄)₂(SO₄)•6H₂O (FAS) was dissolved in 800 mL of water containing 20 mL of concentrated H₂SO₄ and diluted to 1L. The Fe²⁺ in this solution oxidizes slowly on exposure to air so it was standardized against the dichromate daily), NaF, 0.2 g. and ferroin Indicator : 3.71 g of o-phenanthroline and 1.74 g of FeSO₄•7H₂O was dissolved in 250 mL of water . The ferrous ammonium sulphate was standardized by diluting 10.0 ml standard K₂Cr₂O₇ to about 100 ml. 30 ml conc H₂SO₄ was added and cooled. This was titrated against FAS using 0.10 to 0.15ml indicator.

Calculation:

Molarity of FAS =

$$\frac{\text{Volume of } 0.167\text{M K}_2\text{Cr}_2\text{O}_7 \text{ Solution titrated} \times 0.5}{\text{Volume of FAS}} \quad (1)$$

Carbon(C) and organic matter percentages were calculated as follows:

$$\text{Percentage of easily oxidizable organic C:} \\ \text{Percentage (\%)} \text{ C} = \frac{(\text{B}-\text{S}) \times \text{M of Fe}^{2+} \times 12 \times 100}{\text{Grams of Soil} \times 4,000} \quad (2)$$

Where:

B = mL of Fe²⁺ solution used to titrate blank.

S = mL of Fe²⁺ solution used to titrate sample.

12/4,000 = milliequivalent weight of C in grams.

To convert easily oxidizable organic C to total C, divide by 0.77 (or multiply by 1.30) or other experimentally determined correction factor.

To calculate *Percentage organic matter (OM)*

$$\text{Percentage (\%)} \text{ OM} = \frac{\% \text{C} \times 100}{0.58} \\ = \% \text{C} \times 1.72.$$

RESULTS AND DISCUSSIONS

This section describes the physical properties of the sample soil collected at the various sample sites as shown in the table below. Thereafter, observations were made concerning these physical properties. Also, the moisture content, carbon content and organic matter for the top soil, mid soil and bottom soil were measured and recorded. These values were used to plot graphs which were used to explain the data and also used to draw conclusions

Table 1: The physical properties of the sample soils and Vegetation of Study Area

SAMPLE	GRID	LABEL	TAG ON MAP	DESCRIPTION	LOCATION NAME	LONG	LAT	CLAY (%)	SILT (%)	SAND (%)	REMARKS	VEGETATION TYPE
1.	27	27/1A	1	Topsoil (0-10 cm)	Bar Beach	E3° 25' 27.007"	N6° 25' 25.083"	0.01	7.92	92.07		Built up Area/Grassland
2.		27/1B		Middle (0-20 cm)				-	0.34	99.96		
3.		27/1C		Bottom soil (0-10 cm)				-	-	100		
4.		27/2A	2	Topsoil 0-10cm	Oniru Estate	E3° 26' 35.627"	N6° 25' 27.795"	-	-	100	Seashell	Grassland
5.		27/2B		Middle soil 10-20cm				-	3.72	96.28		
6.		27/2C		Bottom soil 20-30cm				-	8.00	92.00		
7.		27/3A	3	Topsoil 0-10cm	Banana Island	E3° 27' 10.413"	N6° 27' 41.895"	2.94	0.25	96.81		Residential area, Reclaimed land/Grasses
8.		27/3B		Middle soil 10-20cm				-	-	100		
9.		27/3C		Bottom soil 20-30cm				-	-	100		
10	30	30/1A	4	Topsoil 0-10cm	Egu Village	E3° 29' 1.198"	N6° 27' 12.867"	-	3.08	96.92	Grey	Slum, Water logged area with Grasses
11		30/1B		Middle soil 10-20cm				-	1.23	98.77		
12		30/1C		Bottom soil 20-30cm				-	-	100		
13		30/2A	5	Topsoil 0-10cm	Maiyegun	E3° 30' 39.081"	N6° 25' 41.081"	-	1.47	98.53	Brown	Forest Area
14		30/2B		Middle soil 10-20cm				-	3.01	96.99		
15		30/2C		Bottom soil 20-30cm				-	1.07	98.93		
16	30/3A	6	Topsoil 0-10cm	Ikate	E3° 29' 33.991"	N6° 26' 50.710"	-	1.15	98.85	Grey	Slum Area	
17	30/3B		Middle soil 10-20cm				-	1.62	98.38			
18	30/3C		Bottom soil 20-30cm				-	-	96.76			
19	33	33/1A	7	Topsoil 0-10cm	Alpha Beach	E3° 31' 42.290"	N6° 25' 42.292"	-	-	100	Dark brown	Water logged Residential Area/Grassland
20		33/1B		Middle soil 10-20cm				-	-	100		
21		33/1C		Bottom soil 20-30cm				-	-	100		
22		33/2A	8	Topsoil 0-10cm	Northern Forshore	E3° 31' 51.074"	N6° 27' 0.905"	-	-	100	Grey	Sand filled Area with grown trees/Shrubs
23	33/2B	Middle soil 10-20cm		-				-	100			
24	33/2C	8	Bottom soil 20-30cm				-	-		Grey		
25	33	33/3A	9	Topsoil 0-10cm	Ikota	E3° 32' 45.734"	N6° 26' 56.389"	-	-	60	Brown	Virgin Forest
26		33/3B		Middle soil 10-20cm				-	-	100		
27		33/3C		Bottom soil 20-30cm				-	-	100		
28	23	23/1A	10	Topsoil 0-10cm	Airport Road	E3° 19' 20.844"	N6° 33' 27.296"	-	19.9	79.15	Dark Brown	Built Up Areas/Grasses
29		23/1B		Middle soil 10-20cm				-	19.6	89.09		
30		23/1C		Bottom soil 20-30cm				-	8.6	86.76		
31		23/2A	11	Topsoil 0-10cm	Oba Akinjobi Street, Ikeja.	E3° 21' 10.476"	N6° 34' 48.169"	-	36.6	62.63	Brown	Built Up Areas with Trees
32		23/2B		Middle soil 10-20cm				-	61.3	38.51		
33		23/2C		Bottom soil 20-30cm				-	59.4	41.27		

SAMPLE		LABEL	TAG ON MAP	SOIL INTERVALS	LOCATION NAME	LONG	LAT	CLAY (%)	SILT (%)	SAND (%)	REMARKS	VEGETATION TYPE
34		23/3A	12	Topsoil 0-10cm	NurudeenCl, Ajao Estate	E3° 19' 9.157"	N6° 32' 37.177"	-	29.5	69.84	Brown	Shrubs
35	23/3B	Middle soil 10-20cm		-				28.4	70.92	Dark brown		
36	23/3C	Bottom soil 20-30cm		-				41.3	57.23	Dark brown		
37		25/1A	13	Topsoil 0-10cm	Army Defense HQTRS	E3° 23' 55.658"	N6° 26' 52.665"	-	4.5	94.03		Shrubs
38	25/1B	Middle soil 10-20cm		-				6.04	90.39			
39	25/1C	Bottom soil 20-30cm		-				10.5	98.14			
40		25/2A	14	Topsoil 0-10cm	National Theater Iganmu	E3° 22' 15.544"	N6° 28' 31.833"	-	2.06	97.94		Forest
41	25/2B	Middle soil 10-20cm		-				3.11	96.89			
42	25/2C	Bottom soil 20-30cm		-				4.68	95.32			
43		25/3A	15	Topsoil 0-10cm	Surulere	E3° 21' 9.745"	N6° 30' 36.043"	-	21.5	88.33		Shrubs
44	25/3B	Middle soil 10-20cm		-				35.02	65.76			
45	25/3C	Bottom soil 20-30cm		-				19.25	81.15			
46		28/1A	16	Topsoil 0-10cm	Elesin			-	3.77	96.23		
47	28/1B	Middle soil 10-20cm		3.78				15.31	80.91			
48	28/1C	Bottom soil 20-30cm		4.54				19.64	75.82			
49		28/2A	17	Topsoil 0-10cm	Ibese	E3° 29' 13.553"	N6° 35' 10.149"	-	1.77	98.23		Forest
50	28/2B	Middle soil 10-20cm		-				1.53	98.47			
51	28/2C	Bottom soil 20-30cm		5.07				12.2	82.73			
52		28/3A	18	Topsoil 0-10cm	Isasi	E3° 29' 0.004"	N6° 32' 45.626"	-	1.16	98.84		Forest
53	28/3B	Middle soil 10-20cm		-				2.48	97.52			
54	28/3C	Bottom soil 20-30cm		-				2.72	97.28			
55		29/1A	19	Topsoil 0-10cm	Isawo	E3° 27' 24.894"	N6° 39' 38.125"	-	24.01	89.12	Grey	Forest
56	29/1B	Middle soil 10-20cm		-				30.93	63.79	Grey		
57	29/1C	Bottom soil 20-30cm		-				20.41	76.59	Grey		
58		29/2A	20	Topsoil 0-10cm	Itamaga	E3° 31' 57.084"	N6° 37' 47.245"	-	10.41	85.38	Grey	Forest
59	29/2B	Middle soil 10-20cm		-				10.47	85.53	Grey		
60	29/2C	Bottom soil 20-30cm		-				21.8	78.2	Grey		
61		29/3A	21	Topsoil 0-10cm	Ofin	E3° 31' 28.564"	N6° 33' 34.927"	-	26.51	73.49	Grey	shrubs
62	29/3B	Middle soil 10-20cm		-				19.84	80.16	Grey		
63	29/3C	Bottom soil 20-30cm		-				28.85	71.15	Grey		
64		26/1A	22	Topsoil 0-10cm	OkeEletu	E3° 30' 14.811"	N6° 39' 17.354"	-	16.82	98.03	Grey	Grassland
65	26/1B	Middle soil 10-20cm		-				8.36	97.68	Grey		
66	26/1C	Bottom soil 20-30cm		-				27.02	79.52	Grey		

SAMPLE	28	LABEL	SOIL INTERVALS		E3° 32' 17.111"	N6° 40' 10.159"		SILT (%)		REMARKS	Shrubs
67	28	26/2A	Topsoil 0-10cm	23	E3° 28' 53.091"	N6° 37' 59.643"	-	11.3	80.12	Grey	Forest
68		26/2B	Middle soil 10-20cm				-	11.81	77.89	Grey	
69		26/2C	Bottom soil 20-30cm	Ologede			-	36.61	69.69	Grey	
70	26	26/3A	Topsoil 0-10cm	Oruba	E3° 25' 40.883"	E3° 25' 40.883"	-	11.64	99.41	Brown	Forest
71		26/3B	Middle soil 10-20cm				-	11.54	85	Brown	
72		26/3C	Bottom soil 20-30cm				-	8.95	86.99	Brown	
73	25	31/1A	Top soil 0-20cm	Owode	E3° 25' 12.823"	N6° 36' 23.647"	-	15.4	84.6	Brown	Grassland
74		31/1B	Middle soil 10-20cm				-	8.56	91.44	Brown	
75		31/1C	Bottom soil 20-30cm				7.27	23	69.73	Brown	
76	28	31/2A	Top 0-10cm	Parafa	E3° 30' 34.486"	N6° 40' 51.314"	-	34.77	65.23	Brown	Grassland
77		31/2B	Middle soil 10-20cm				4.29	30.82	64.89	Brown	
78		31/2C	Bottom soil 20-30cm				6.10	21.87	72.03	Brown	Shrubs
79	28	31/3A	Top 0-10cm	Ebute	E3° 28' 13.504"	N6° 36' 47.987"	-	4.86	96.14	Brown	Forest
80		31/3B	Middle 10-20cm				-	4.51	95.49	Brown	
81		31/3C	Bottom soil 20-30cm				3.19	36.65	60.16	Brown	Forest

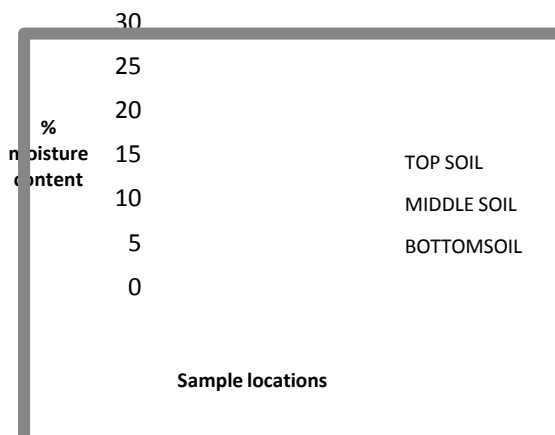


Figure 3: Moisture contents in the three soil levels

From the figure above, it is seen that at the top soil level, the highest value of moisture content was found to be 17.25% while the lowest value was found to be 0.75%. The mid soil had its lowest value of moisture content as 1.25% while its highest value was recorded to be 17.75%. The moisture content for the bottom soil ranged from 0.25 to 29.50%.

Also from the above figure, it is observed that the moisture content was highest in Alpha Beach (sample

location 7) mid and bottom soils with the values 17.75 and 29.50% respectively. The moisture content in the top soil of Alpha beach was the next highest with a

value of 16.25% which was just a little lower than the moisture content of the soil in Egu village which had a high topsoil moisture content of 17.25% but lower mid soil and bottom soil values of moisture content. The high moisture content of the top soil of Alpha Beach can be attributed to the elevation of the area above sea level. Alpha Beach is an area that is made up of 100% sand at every depth of the study. The spaces that exist between soil particles, called pores, provide for the passage and/or retention of gasses and moisture within the soil profile. The soil's ability to retain water is strongly related to particle size; water molecules hold more tightly to the fine particles of a clay soil than to coarser particles of a sandy soil, so clays generally retain more water (Leeper and Uren, 1993). Conversely, sands provide easier passage or transmission of water through the profile. Clay type, organic content and soil structure also influence soil water retention (Charman & Murphy 1977). However, from the above it is obvious that the soil type (sandy soil) of Alpha beach is not the cause for its high moisture content at the mid and bottom soil but its elevation above sea level. From geological studies, with elevation same as sea level, the water table is bound to be high and at the same level with the surface. Hence the high moisture content of the soil. With zero elevation of Alpha beach, it is expected that the water would be at surface, but that is not the case here due to the geological structure of the area and this is also the reason why the top soil of this area has lesser moisture content value compare to the mid and bottom soil. The moisture content of this area is said

to be gaining its recharge from the aquifer below and not water from surface.

However, for the Egu village soil, the presence of sand intercalation with silt and the waterlogged nature of this area gave rise to this level of moisture content. The sand due to its high porosity could not have high water retention capacity but for the intercalation of silt in the sand, this tends to block the pores of this sand thereby empowering the soil to hold more water. Also, the fact that the soil is waterlogged further buttress the reason for the high moisture content of the top soil while the sandy nature of the mid soil gave reason for its low moisture. However, the bottom soil with higher moisture content without silt intercalation is believe to be so because this area is close to the Lagos Lagoon and so recharges via the aquifer that recharges the Lagoon hence its high nature .

Moreover, it can also be seen that the area with the lowest moisture content in the top, mid and bottom soil was Banana Island (location 3) with values of 0.75%, 1.25% and 0.25% respectively. The low level of moisture content in Banana Island was followed by the low moisture content soil in Ikeja with top soil, mid soil and bottom soil moisture content value of 1.25, 1.75 and 1.5% respectively. The low moisture content of Banana Island sample is due to the soil type, compaction and the dry nature of the soil, also its elevation above sea level.

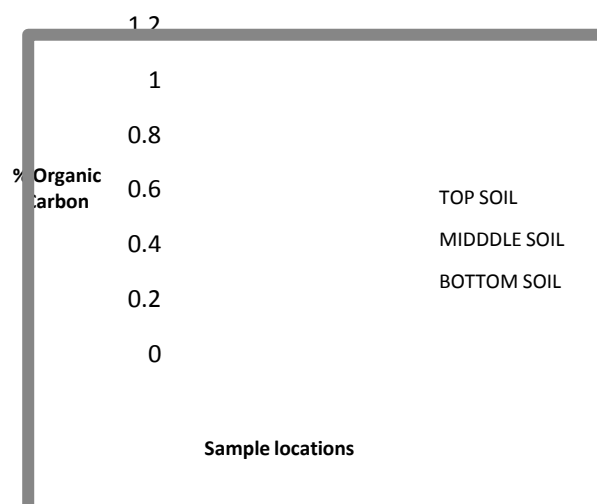


Figure 4: Soil Organic Carbon (SOC) contents in the three soil layers

The carbon content from the above figure showed that the top soil ranged from 0.03 to 0.88%, the mid soil ranged from 0.04 to 0.76% and the bottom soil ranged from 0.03 to 1.03%. It is observed that the Soil Organic Carbon content was highest in Egu village sample station 4 at its bottom soil level (20-30cm depth), an area covered with grasses, the values are 0.77% and 1.03% respectively while the highest value of carbon content at the top soil layer was found to be

0.88% at Ologede (location 23). On the opposite, the lowest values of carbon content were found in the top soil of Banana Island (location 3) with a value of 0.03%, the mid soil of Iganmu, Surulere with a value of 0.03% and at the bottom soil of Oniru with a value of 0.03%.

Analyzing the soil organic carbon content in the three soil layers, this shows that soil organic carbon (SOC) is highest in the topsoil of location 23 (Ologede), 19 (Isawo) and 16 (Elesin) which are all forest known for less or no human activities. Although, from the topsoil results of the study area, it is observed that the results are lob sided i.e. SOC is mainly highest at the bottom of most of the areas between Location 3 (Banana Island) and location 7 (Alpha Beach). These areas are known for high human activities such as dredging and sand filling activities. This could result in the original/natural top soils been at the depth of the sample bottom soil which could reverse the result.

At the middle soil level, we recorded high SOC at Location 23 Ologede, 19 – Isawo, 10 - Airport Rd., 4 - Egu village, 26 - Parafa. These areas are mainly grasslands and the results when compared with the mid soil results of the hypothesis under investigation prove to be against the hypothesis because of the bottom soil results that are in most of the locations higher than the middle soil level, which calls for further investigation of this hypothesis.

And at the bottom soil level, we recorded highest SOC at location 13 - Army Defense Headquarters, 12 - Ajao Estate and location 24 to location 27 which were shrubs like vegetation

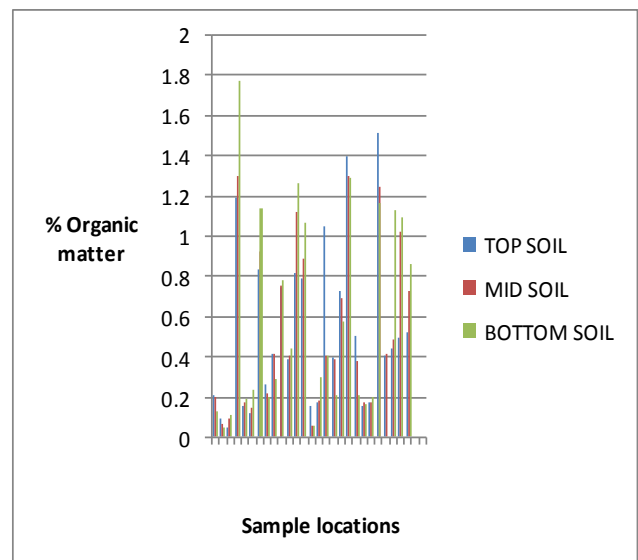


Figure 5: Soil Organic Matter (SOM) contents in the three soil layers

From the figure 5 above, it is observed that the soil organic matter content had the highest value in Ologede in the top soil region with a value of 1.52 while Egu village had the highest value of organic

matter in the mid soil and bottom soil with values recorded at 1.30 and 1.78 respectively. The lowest values of organic matter content were found in the top soil of Banana Island with a value of 0.05, the mid soil had its lowest value of organic matter at Iganmu, Surulere as 0.06 while the bottom soil had its lowest value of organic matter at Oniru.

Statistical Analysis

However, to further analyze the acquired data, we implored the Analysis of Variance (ANOVA) to determine the likely effect of the study area Soil Moisture, Soil Organic Carbon (SOC) and Soil Organic Matter (SOM) on the vegetation of the area. However, the focus will be on the carbon content. The ANOVA will enable us see how the variations in the soil carbon contents at different levels and sample locations affects the immediate vegetation of the areas

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.02	2	0.01	0.17	0.84	3.12
Within Groups	5.01	77	0.07			
Total	5.03	79				

Table 2: Analysis of Variance (ANOVA) for Carbon content

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
TOPSOIL	27	8.22	0.30	0.05
MIDSOIL	27	8.33	0.31	0.06
BOTTOM SOIL	26	8.89	0.33	0.08

From table 2, the mean carbon content at the top soil (0.30%) is lower than that of the mid soil (0.31%) and that of the bottom soil (0.33%). But according to the test result $F = 0.17$. With a critical value of 0.05, the critical $F = 3.12$. Therefore, since the F statistic is greater than the critical value 0.05, below which the analysis fails, we fail to reject the null hypothesis that the carbon content in the top soil, mid soil and bottom soil has no effect on vegetation. This simply means Soil Organic Carbon enhances the growth of vegetation in the study area. This also can equally be judged from Figure 2 Map showing Satellite Imagery of the vegetative distribution of the study area. From the map and photographs during the field exercise, it is said the study area is very rich in its vegetative cover i.e. area covered with ever green trees and grasses. Even areas which are predominantly habited, the neighboring environments are dominated with vegetation mainly of green trees and grasses.

Table 3: Soil statistical analysis

Soil	Vegetation Type	N	Mean	Std Dev	Std Error
Top soil	Built up areas/ Grassland	2	0.27635	0.22238508	0.1575
	Grassland	4	0.221225	0.19146365	0.095731182
	Residential area, Reclaimed land/Grasses	1	0.0282		
	Slum, Water logged area with Grasses	1	0.696		
	Forest Area	7	0.3859143	0.32728771	0.12370313
	Slum Area	1	0.0655		
	Water logged Residential Area/Grassland	1	0.4865		
	Sand filled Area with grown trees/Shrubs	1	0.1515		
	Virgin Forest	1	0.2397		
	Built Up Areas with Trees	1	0.2221		
	Built Up Areas with Trees and shrubs	1	0.4591		
	Shrubs	5	0.32666	0.19753835	0.08834183
	Residential	1	0.1007		
	Total	27	0.3045037	0.23665039	0.04554339
Middle soil	Built up areas/ Grassland	2	0.2782	0.22896118	0.1619
	Grassland	4	0.26695	0.27545528	0.13772764
	Residential area, Reclaimed land/Grasses	1	0.0505		
	Slum, Water logged area with Grasses	1	0.756		
	Forest Area	7	0.3663286	0.27860697	0.1086601
	Slum Area	1	0.0844		
	Water logged Residential Area/Grassland	1	0.537		
	Sand filled Area with grown trees/Shrubs	1	0.1264		
	Virgin Forest	1	0.2388		
	Built Up Areas with Trees	1	0.2369		
	Built Up Areas with Trees and shrubs	1	0.5153		
	Shrubs	5	0.29802	0.21127955	0.09448709
	Residential	1	0.1032		
	Total	27	0.3084111	0.23650905	0.04551619
Bottom soil	Built up areas/ Grassland	2	0.26245	0.26693281	0.18875
	Grassland	4	0.38185	0.36423554	0.18211777
	Residential area, Reclaimed land/Grasses	1	0.0635		
	Slum, Water logged area with Grasses	1	1.0328		

Soil	Vegetation Type	N	Mean	Std Dev	Std Error
	Forest Area	7	0.3225571	0.31184153	0.11786502
	Slum Area	1	0.134		
	Water logged Residential Area/Grassland	1	0.6627		
	Sand filled Area with grown trees/Shrubs	1	0.1163		
	Virgin Forest	1	0.1692		
	Built Up Areas with Trees	1	0.2573		
	Built Up Areas with Trees and shrubs	1	0.623		
	Shrubs	5	0.27098	0.23360218	0.10447007
	Residential	1	0.1699		
	Total	27	0.3294	0.29161533	0.0561214

Table 4: Summary of Statistical Soil Analysis

Data	Sum of squares	df	Mean square	F	Sig.
Between groups	29.389	12	2.449	0.002	1.00000
Within groups	454661.081	311	1461.933		
Total	454690.471	323			

From Table 3 above, where N represents the numbers of location of a particular vegetation type, it can be seen that at the Top Soil, consisting of the slum, waterlogged areas with grasses vegetation type had the highest mean with the highest SOC content of 0.696 while the vegetation type Residential area, Reclaimed land and grasses with the lowest mean of 0.0282 has the lowest SOC content.

At the Middle Soil level, the highest mean SOC of 0.75600 was found to be from the Slum, water logged area with grasses, this value is higher than the top soil SOC mean value. However the lowest SOC content of 0.0505 was also from "Residential area, reclaimed land with grasses" which is even lower than that of the top soil (0.028200). At the Bottom Soil level, it is observed that the area with highest mean SOC of 1.032800 was from the Slum, waterlogged area with grasses, the lowest mean SOC of 0.063500 was also from the Residential area, reclaimed land with grasses. This value at the bottom soil was the highest in this vegetation type.

Our findings can best be interpreted when compared to a similar study carried out by Esteban et al. 2000 who stated that the relative distribution of SOC in the relative distribution of SOC in the first meter of soil was deepest in Shrub lands, intermediate in grasslands, and shallowest in forest (e.g., 33%, 42%, and 50% of all SOC in the top 1 meter was contained in the uppermost 20cm).

This best explains the outcome of the investigation on the hypothesis. Although the study put into consideration, atmospheric conditions like climate, weather, temperature, precipitation and other factors but our study did not, due to the homogeneous nature of the study area, i.e. small study area when compared to the area studied in the hypothesis. However SOC content (%) decreased with increasing depth across all

land use types. This trend in the data has also been reported in several similar research findings carried out by Morisada et al. 2004; Sheikh et al. 2009; and Su et al. 2006. The trend was also reported by Esteban et al. 2000 in the study of the proportional distribution of the interval and vertical (0 – 100cm) SOC content of soils.

In summary, of the three soil levels being considered in this study, the bottom soil has the highest SOC content with a mean of 0.329400 followed by the middle soil with mean SOC of 0.308411 while the least mean SOC was found in the top soil with a mean value of 0.3045037

These results are generally being interpreted this way base on the homogeneity of the study area and the low numbers of sampled position, whereas the hypothesis under proof has so far been tested with larger volumes of data collected over a wide range of area with atmospheric conditions put into consideration. It is therefore of paramount importance that further studies be conducted.

However, from table 4 analysis, our significant $F = 0.002$ which is less than 0.05 significant level means that we accept the alternative hypothesis that there is a difference among the various levels of SOC meaning that vegetation type through patterns of allocation is a dominant control on the vertical distribution of SOC which agrees with the hypothesis under investigation.

In the above light, from our studies which was based on a depth of (0 – 30cm) depth, this correlated positively with our results from the SOC chart and Vegetation cover map that the highest value of SOC in the area of study was found at the topmost soil of a forest sample area (Ologede) classified as undisturbed relative to human activities around the sampled area. Also sample locations like Isiawo, Itamaga and Elesin with similar characteristics also prove the hypothesis to be true. However, the mid soil values were not of any significant difference when compared with depth of hypothesis results being investigated. The hypothetical study on soil organic carbon relationship with vegetation was carried out on the first three meters of the soil while our study was on the first 30cm of Forest, Grassland and Shrubs vegetation.

CONCLUSION

The areas with more vegetation had higher levels of soil organic carbon content an indication that the organic carbon content present in a soil determines the vegetative growth of the area. High organic carbon content was mainly obtained in slums and water logged soils in the study area. Consequently, In the light of the above detail analysis, it can conveniently be said that vegetation type through patterns of allocation is a dominant control on the vertical distribution of SOC

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