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Original Research Article

The Effects of Land Use on Soil Physiochemical Properties in Ughelli and its Environs. Delta State. Nigeria.

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ABSTRACT

The extent of deforestation and its effects on Nigeria soils cannot be over emphasised. The study was conducted in Omavovwe - Agbarha in Ughelli North LGA of Delta State in sole aim of assessing the variation in soil physicochemical properties in relation to change in land use type, depth and seasonal variation effect. In other to effectively undertake this study, Soils characteristics in three land cover areas, rubber plantation, farmland, and residential land use, were recorded and soil samples were analyzed. In each of the sample sites, ten soil surface samples at (0-15 cm) and (15 - 30cm) depth were collected in triplicates and in two seasons – dry and rainy season. The samples were dried at room temperature until constant weight is achieved and sieved using a 2-mm Sieve. Soil characterization and analyses were carried out using various Laboratory experiment and statistical methods. Deforestation was found to increase erosion rates and also it was discovered that the sand content increased with cultivation. The pH was acidic in all soils but they varied. Soil particle sizes were significantly different between the three soils types, rubber plantation had less sand which again relates to reduced erosion activity and high SOM. Rubber plantation had a high amount of pH, CEC, soil organic matter (SOM), total P, total K when compared with deforested land and farm land, although we had a similar case in total C, but it was so only for dry season. Deforestation significantly decreased soil pH, CEC, SOM, total P, total K, but increased bulk density and N. Exchangeable Ca, Na, Mg and K were significantly reduced in deforested land. It is therefore concluded that deforestation has significant negative effects on soil physicochemical properties and as such there is need to curb the trend.

Keywords: Physicochemical, Land use, Rubber Plantation, Resident Area and Farmland.

INTRODUCTION

Delta State amongst other states in Nigeria has experienced massive deforestation with unacceptable consequences. At 11.1%, Nigeria's annual deforestation rate of natural rubber plantation is the highest in the world during the 2000-2005 periods and puts it on pace to lose virtually its entire primary rubber plantation within a few years. (Rhett, 2005) Deforestation is the process where vegetation is cut down without any simultaneous replanting for economic or social reasons for example the conversion of rubber plantation to farmlands, ranches, or urban use. It has a negative effect on the environment. The annual rate of deforestation in Nigeria is 3.5%, approximately 350,000-400,000 hectares per year. Deforestation is almost an inevitable occurrence as more than 1.6 billion people depend to varying degrees on forests for their livelihoods, e.g. fuel wood, medicinal plants and forest foods (World Bank, 2004). Deforestation or logging can have certain effects on the physical and chemical properties of the soil which impair land utilization and the functional relationships between plants and soil. Soil structure parameters, such as soil density, proportion of large pores and infiltration capacity deteriorate faster in areas cleared by machines than in areas cleared by fire. (Seubert, 1975) Due to the low humus content of the soil, the available plant nutrients are also lost much faster in areas cleared mechanically.(Seubert,1975) Deforestation and shifting cultivation in tropical forest ecosystems lead to considerable reduction of nutrient reserves available to the vegetation (Awiti *et al.*, 2008). This loss of nutrients is as a result of fire, intake by cultivated plants, and erosion of the top layer of soil. Soil degradation is commonly reported in the tropics where rubber plantation is converted to crop faming (Awiti *et al.*, 2008) In Nigeria, the rubber plantation is underestimated in value within the national reckoning. Nigerian forest and woody vegetation resources include the high forest, woodland, bush lands, plantations and trees on Farms. Each of these various resources contributes to production, protection and conservation functions. Studies have shown that forest reserves occupy about 10 million ha in Nigeria, which accounts for about 10% of a land area of approximately 96.2 million ha (Alamu and Agbeja, 2011). There has also been an increased population growth over the years in Ughelli North LGA and these has led to the increase in demand for shelter and resources which obviously has led to increased conversion of forestland for residential and farming purposes. The environmental awareness of the population is also a factor that contributes to the indiscriminate felling of trees for energy production. Much work has not been done on the effect of deforestation on soil physicochemical properties in the area of study; so this research would serve as a source of baseline information about the study area. The research aims at determining the effect of deforestation on soil physicochemical properties in Ughelli North LGA.

Aim and Objectives of the Study

Aim and Objectives: The aim of this study is to determine the effects of landuse on the physicochemical properties of the soil in Omavovwe - Agbarha Otor, Ughelli North LGA, Delta State.

The objectives of this study were to:

i. Study the variation in soil physicochemical properties of the study areas;
ii. Study the relationship between land use, depth of sample collection and soil physicochemical properties of the study area; and
iii. Compare the physicochemical properties of the soil as an index to effects of land use on soils.

Study Area

The study was conducted in Omavovwe - Agbarha Otor, in Ughelli North LGA of Delta State, Nigeria. Soil samples were collected from three land use types namely a rubber plantation, a farmland and residential land. It's a village 5km away from Ughelli and 2.98km from Afiesere Village. They are Urhobo speaking people and they are mostly subsistence and commercial Farmers. The main crop planted in the village is cassava with a few palm trees and vegetables. The main form of occupation is rubber tapping. Crude oil exploration activities take place in some part of the village and its rivers flow into the Afiesere River which in-turn flows into the Ughelli River. Omavovwe-Agbarha Otor is a peripheral village to Ughelli town. The highest elevation within the study site was 37m. The average rainfall is 66mm per year with May and June having the highest rainfall. During Dry season the temperatures can rise to above 25^{o}C - 30^{o}C and fall to below 18^{o}C in the Harmattan.

Rubber Plantation

The floor of the Rubber Plantation is very rich in humus content and the penetration of sun to the floor is minimal as a result of the thick shades. Shrubs and grasses which grow underneath the tree canopies make movement difficult. The Rubber Plantation is located at a distance of about 323m off the Omavovwe - Afiesere road. It has a GPS location of Latitude 5^{o} 32' 52" and Longitude 6^{o} 2' 23.46", with an Altitude of 37m. Human activity like extraction of latex from rubber tree, tree felling and herbs collection take place in the Rubber Plantation but this is drastically reduced in the deep interiors of the Rubber Plantation see (Plate 1-2).


Plate 1: The Interior of the Rubber Plantation **Plate 2**: The Interior of the Rubber Plantation

Farm land

The Farmland is located at about 260metres away from the Rubber Plantation, and the land has been Farmed upon for about ten years by villagers in the area. The Farm consists of cassava crops. Latitude 5^{o} 32' 51.80", Longitude 6^{o} 2' 23.46" is the GPS location of the Farmland with an Altitude 34m. The Farm practices include bush fallowing during non-season period, slashing and bush burning before farming activities commence (Plate 4). The use of herbicide to kill weed in the Farm is also a common practice in the area. Mulching activities were noticed in the Farm where weed cleared are spread on the soil in the Farm amidst the cassava plants (Plate 3).


Plate 3: The Farmland (Cassava Farm) **Plate 4:** Mulching Activity on Farmland

Residential Area

This is where the people of Omavovwe- Agbarha Otor reside. The houses are mostly mud houses with a few block houses. It is about 584m (0.584km) away from the Rubber Plantation. It is located at Latitude 5^{o} 32 ^{l}N- 5^{0} 46^{l} N and Longitude 6^{o} 20'E – 6^{0} 24^{l} E with an Altitude of 34m (Plate. 5-6)

Plate 5: Showing Residential Area **Plate 6**: Showing Residential Area

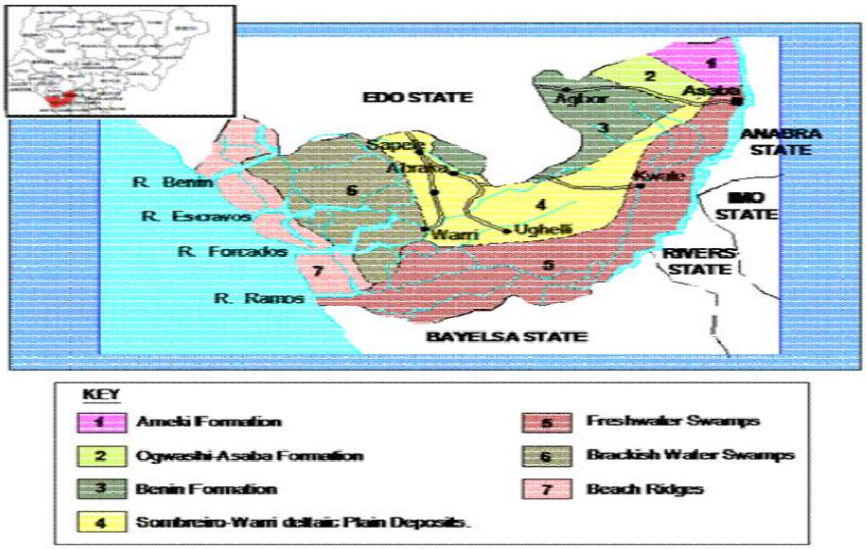

Fig. 1: Aerial distribution of Quaternary- Holocene deposits and the Benin Formation in part of the western Niger Delta. The map of Nigeria is shown as an inset. (Modified from Akpoborie et al., 2011).

Geology of the Study Area

The subsurface geology of the Niger Delta basin to which Otovwodo - Ughelli belongs is well established as shown in Figure.1. The basin fill is made up of three Formations, namely from the oldest to the youngest Akata, Agbada and Benin Formations. The Akata formation is composed of continuous shale and about 10% sandstone. The shale is believed to be over pressured and under-compacted. It ranges from Eocene to Recent and was deposited under marine conditions. Agbada Formation comfortably overlies the Akata Formation (C.S Nwajide, 2006; Murat,1970; Asseez, 1989 Short et al., 1967). It is a parallic sequence of alternating shale and sandstone with variable age ranging from Eocene in the north to Pliocene/Pleistocene in the south, and Recent in the Delta surface. Its lateral equivalent at the surface, the Ogwashi-Asaba Formation and Ameki Formation are of Eocene - Oligocene age. The continental Miocene-Recent Benin Formation conformably overlies the Agbada Formation. It is composed of 90% sands and about 10% shale/clays; the sand ranges from gravelly, coarse to fine grained (Akpoborie et al., 2011).

MATERIALS AND METHODS

The study was conducted in Omavovwe - Agbarha Otor, Delta State of Nigeria. Soil a sample was collected from three land use types namely a rubber plantation, a farmland and residential land.

Soil Sampling

Soil samples were collected using a soil auger from three sample sites; a farmland, residential land and rubber plantation. In each of the sample sites, ten soil surface samples at (0-15 cm) and (15 – 30cm) depth were collected in triplicates. The samples were collected once in each season, dry season (February) and rainy season (august). The latitude, longitude, elevation, slope, aspect, and topography were recorded in each sample site. A random sampling method was used to collect samples from all sample locations at distances of 5m apart. The soil characte3ristics were recorded and about 200g of soil was collected from the depth of 0-15 cm and 15-30cm at each sampling spot. The samples were dried at room temperature until constant weight is achieved and sieved using a 2-mm Sieve. Soil characterization and analyses were carried out at the God's Well Laboratory, Benin City, Nigeria. Statistical analysis was done using the statistical analytical system (SAS). The means were separated using the Duncan Multiple Range Test (DMR) (SAS 2000).

Physicochemical Analysis: The samples were dried at room temperature until constant weight and sieved using a 2-mm Sieve. Soil Samples were analyzed for Particle Size, pH, P, Carbon, cation exchange capacity (CEC), Bulk Density, exchangeable Ca, Mg, K and Na. Particle size was analyzed with the Pipette method. Soil pH was measured in slurry of soil and distilled water (1:5 mixture). (ISO 10390, 1994). Phosphorus was determined colorimetrically after extraction in ammonium fluoride (1 M) and concentrated hydrochloric acid (0.5 M) (Olsen and Sommers 1982). Organic carbon was determined using acid potassium dichromate (1 M) oxidation without heating, known as the "Walkley-Black" procedure. Total nitrogen was found using the Kjeldahl digestion method (Bremmer and Mulverney, 1982). The particle size was determined using the hydrometer method (The Bouyoucos, 1962) while the Texture was determined by sieving. The carbon to nitrogen ratio was determined from the respective carbon and nitrogen results. The bulk density was determined using the core method by dividing the weight of the samples by the volume of the bulk density sampler (63.68cm3 (ISO 11260, 1994). Determination of cation exchange capacity (CEC) for the soil sample was done using the summation method (ISO 11260, 1994).

RESULTS

Tables 1-3 Showing Least Significant Difference for effects of Seasonal variation, Land use and Depth of sample collection on soil physicochemical properties.

Soil pH or soil reaction is an indication of the acidity or alkalinity of soil and is measured in pH units. Soil pH is defined as the negative logarithm of the hydrogen ion concentration. The pH scale goes from 0 to 14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic. The PH values ranges from 4.2 - 6 respectively with the highest value during the dry season at a depth range of 15-30cm (Fig. 2).

Table 1: Effect of Land Use on Soil Physicochemical Properties

Land Use Type	PH	EC (Ms /m)	C (gkg^{1})	N (gkg^{-1})	P (mg/ kg)	Bulk Density (g/cm^{3})	OM	CA (Cmol /kg)	K (Cmol /kg)	MG (Cmol/ kg)	Na (Cmol/ kg)	CEC (Cmol/ kg)	Sand (%)	Silt (%)	Clay (%)
Rubber plantation	5.09 b	4.08 a	2.38 b	0.39b	0.17 a	1.23c	0.4 7a	1.58a	0.82a	1.12a	0.24a	3.76a	79.77b	7.12 ab	13.1 1a
Farmland	5.40 a	4.14 a	2.65 a	0.70a	0.14 b	1.44b	0.1 1c	1.08b	0.16c	0.40b	0.24a	1.88b	87.11a	5.5b	7.39 b
Residential	5.17 b	3.54 b	1.84 c	0.37b	0.07 6c	1.53a	0.1 7b	1.07b	0.28b	0.36b	0.18b	1.89b	84.43a	11.0 2a	4.55 c

Note: Means with the same letter are not significantly different

Table 2: Effect of Seasonal Variation on Soil Physicochemical Properties

Season	PH	EC (mS/ m)	C (gkg^{-1})	N (gkg^{-1})	P (mg/k g)	Bulk Density (g/cm^{3})	OM	CA (Col /kg)	K (Cmol/ kg)	MG (Col /kg)	Na (Col /kg)	CEC (Cmol/ kg)	Sand (%)	Silt (%)	Clay (%)
Dry Season	5.51 a	4.84 a	1.79b	0.90a	0.22 a	1.44a	0.38 a	1.76 a	0.58a	0.82 a	0.27 a	3.44a	87.96a	6.95 a	5.09 b
Rainy Season	4.92 b	3.00 b	2.78a	0.06b	0.04 b	1.35b	0.1b	0.72 b	0.26b	0.44 b	0.16 b	1.58b	83.99b	6.71 a	9.3a

Note. Means with the same letter are not significantly different

Table 3: Effect of Depth of Sample Collection on Soil Physicochemical Properties

Depth Of Sample Collection (cm)	PH	EC (mS /m)	C (gkg^{-1})	N (gkg^{-1})	P (mg/ kg)	Bulk Density (g/cm^{3})	OM	CA (Cmol /kg)	K (Col /kg)	MG (Col /kg)	Na (Col /kg)	CEC (Cmol /kg)	Sand (%)	Silt (%)	Clay (%)
0 – 15	5.28 a	4.13 a	2.47a	0.51a	0.14 a	1.39a	0.17 b	1.37a	0.45 a	0.61 a	0.218a	2.59a	86.44b	5.97 a	7.59b
15 – 30	5.16 a	3.71 b	2.11b	0.46b	0.11 b	1.41a	0.33 a	1.11b	0.39 b	0.65 a	0.219a	2.42b	81.05b	7.15 a	11.8a

Note: Means with the same letter are not significantly different

Physicochemical Parameters As Observed From Results of Laboratory Analysis of Soils:

PH

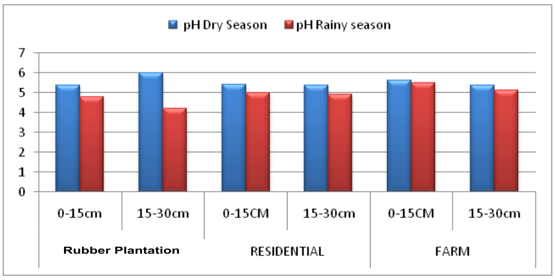

Fig. 2: pH of Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

ELECTRICAL CONDUCTIVITY

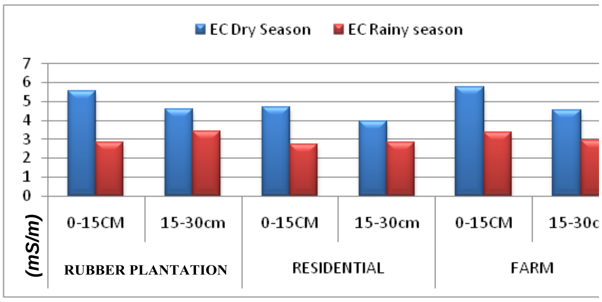

Fig. 3: Electrical Conductivity of Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

Soil electrical conductivity is an indirect measurement that correlates very well with several soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics..Electrical conductivity is the ability of a material to conduct (transmit) an electrical current and it is commonly expressed in units of milliSiemens per meter (mS/m). Electrical conductivity during dry season had its highest reading in the farm soils (5.74 mS/m) at depth 0-15cm followed by the Rubber Plantation Soils (5.52 mS/m) at depth 0 -15cm. During rainy season the farm also had the highest reading (5.74 mS/m) at depth 0-15cm with the Rubber Plantation soils following. The soils from residential area had the lowest reading during rainy season (Fig.3). Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics.

CARBON

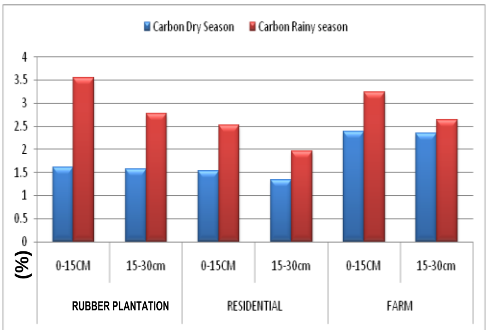

Fig 4: Carbon Means of Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

It is widely accepted that the carbon content of soil is a major factor in its overall health. Soil carbon improves the physical properties of soil. It increases the cation-exchange capacity (CEC) and water-holding capacity of sandy soil, and it contributes to the structural stability of clay soils by helping to bind particles into aggregates. (Leeper, G.W and Uren, N.C. 1993). Carbon value in dry season ranges from (1.3 - 2.4) in rubber plantation, residential and farm land respectively with the high value in farmland at a depth of (0 - 15 cm and 15 - 30cm) with value of 2.4 (Fig. 4).

NITROGEN

Nitrogen value in rubber plantation during the dry season ranges from 0.08 - 0.14 at a depth of 0 - 30cm respectively, while the value of rainy season is 0.8 at a depth of 0 - 30cm. In residential the value of nitrogen ranges from 0.11 - 0.14 at a depth of 0 – 30cm. And in farmland the highest value of nitrogen was noticed during the dry season at a depth of 0 – 15cm with value of 1.3 and at the depth of 15 – 30cm the value is 1.2, while that of rainy season at the depth of 0 – 15cm has the highest value of nitrogen which is 0.2 and at the depth of 15 – 30cm the value of nitrogen is 0.1. (Fig. 5)

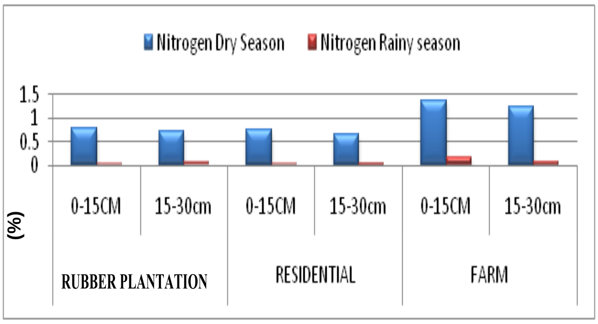

Fig. 5: Nitrogen levels for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

PHOSPHORUS

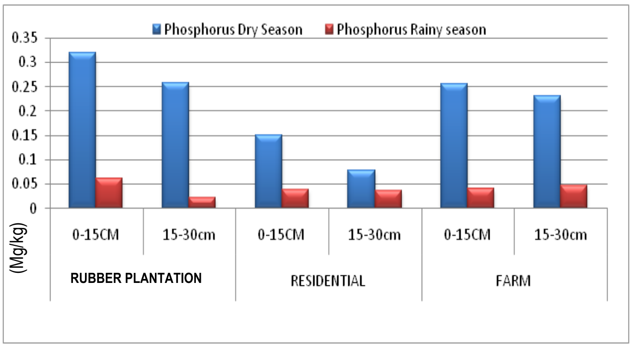

Fig. 6: Phosphorus levels for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

High phosphorous levels in your soil are usually as a result of over-fertilizing or adding too much manure. Not only does excessive phosphorous harm plants, it can also stay in your soil for years. While there's nothing you can do to lower phosphorous levels immediately, options do exist to continue feeding your plants the nutrients they need without introducing more phosphorous. The value of phosphorus in dry season ranges from (0.08 - 0.32Mg/kg) respectively in rubber plantation, residential areas and farmland at depth of 0 - 30cm. While during the rainy season the value of nitrogen ranges from 0.02 - 0.06 Mg/Kg) from depth of 0 - 30cm respectively in rubber plantation, residential area and farmland the highest value was noticed at depth of 0 -15cm during the rainy season with value of 0.06Mg/Kg. (Fig. 6)

BULK DENSITY

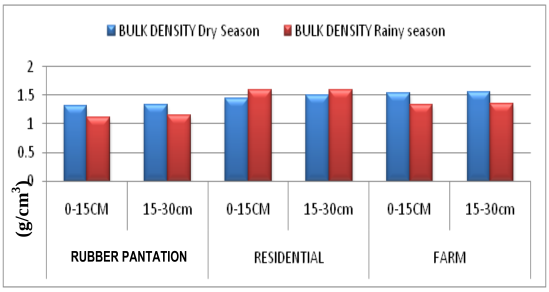

Fig. 7: Bulk density for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

Bulk density is an indicator of soil compaction. It is calculated as the dry weight of soil divided by its volume. This volume includes the volume of soil particles and the volume of pores among soil particles. Bulk density is typically expressed in g/cm3. Bulk density is changed by crop and land management practices that affect soil cover, organic matter, soil structure, and/or porosity. Plant and residue cover protects soil from the harmful effects of raindrops and soil erosion. Cultivation destroys soil organic matter and weakens the natural stability of soil aggregates making them susceptible to damage caused by water and wind. High bulk density is an indicator of low soil porosity and soil compaction. It may cause restrictions to root growth, and poor movement of air and water through the soil. Compaction can result in shallow plant rooting and poor plant growth, influencing crop yield and reducing vegetative cover available to protect soil from erosion. By reducing water infiltration into the soil, compaction can lead to increased runoff and erosion from sloping land or waterlogged soils in flatter areas. (Arshad, et al., 1996)

The differences in the bulk density levels varied according to land use. It has the highest value in residential area during rainy season at both depths (0-15cm and 15-30cm respectively) with value 1.6g/cm^3 highest bulk density can be attributed to sand fraction which is as a result of high rainfall witnesses and its consequent leaching problem (Ruth, *et al*., 2015). And have the lowest value at a depth of 0 – 15 and 15 - 30cm) with value ranging from (1.11 - 1.18g/cm^3) respectively on rubber plantation soils. While during dry season, the farm land had the highest mean bulk density values at the depth of (0 - 15cm) its value is 1.3 g/cm^3. While at the depth 15 -30cm its value is 1.3 g/cm^3 (Fig. 6)

This is a result of the management of the soil, the continuous alterations and cultivation of the soil has cause the soil structure to decline. However, the rubber plantation soils has minimal damage as the vegetation would add organic matter, pores and higher microbial content all aiding a healthier soil structure (Grossman and Reinsch, 2002). Dominy *et al*., (2002); Yimer *et al*., (2007) found bulk density to have increased with the clearing and conversion of rubber plantation lands. Eden *et al*., 1991 and Desjardins *et al*., 2004 stated that deforestation and conversion to pasture land can increase bulk density., Lal in his Research on deforestation and land use effects on soil degradation in Southern Nigeria, Ibadan also observed that deforestation and cultivation increased bulk density. (Lal, 1996).

SOIL ORGANIC MATTER

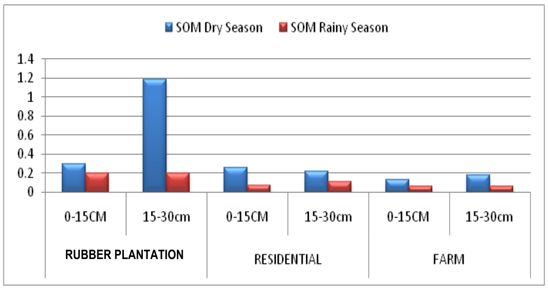

Fig. 8: Soil Organic Matter for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

Soil organic matter is a key factor that affects the presence of carbon and nitrogen in soils. The humus content of the soil could be positively directed to the level of soil organic matter in the soil. Organic matter was not significant when tested in relation to depth. It was also tested in relation to land use and season and it was significant. (Fig. 8) shows the mean of soil organic matter of the various forms of land use in both rainy and dry season, the Rubber Plantation had higher levels of SOM (1.187) at depth 15-30cm during dry season than the soil from residential land-use and the soils for farmland having the lowest level of soil organic matter. For rainy season, Rubber Plantation soils had the highest value at both depths (0.203 for 0-15cm and 0.202 for 15-30cm).

CATION-EXCHANGE CAPACITY

Cation-Exchange Capacity is defined as the degree to which a soil can absorb and exchange cations. Mineral cations can absorb to the negative surface charges or the inorganic and organic soil particles. Once adsorbed, these minerals are not easily lost when the soil is leached by water and they also provide a nutrient reserve available to plant roots. The rubber plantation soils had more capacity for cation exchange during dry season when compared to farmland and deforested land (residential area) soils while on assessment during rainy season, rubber plantation soil had CEC that was less than both the farmland soils and deforested soils. The mean for all three types of land use are represented in the (Fig. 9).

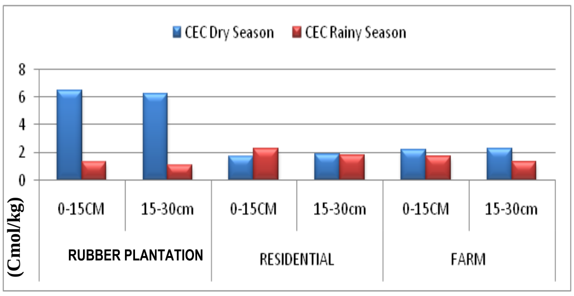

Fig.9: Cation-Exchange Capacity for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

EXCHANGEABLE Ca, Na, Mg and K

The highest value was observed in rubber plantation in calcium (Ca) at the depth of 0 – 15cm it has the 2.8 cmol/Kg while at depth 15 – 30cm it has is at 2.6 cmol/kg.

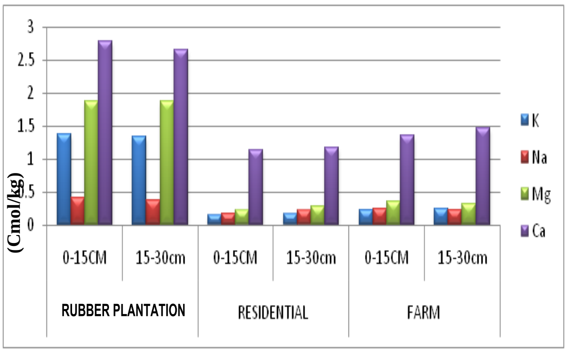

Fig. 10: Exchangeable Ca, Na, Mg and K in Rubber Plantation, Residential and Farmland Treatments and Depth of Sample Collection.

And the least of calcium was observed in residential area at the depth of 0 -15cm with value of 1.04 cmol/Kg. (Fig. 10). While potassium has the lowest value of 0.12 cmol/Kg at a depth of 0 -15 cm on residential area. Potassium value ranges from 0.12 – 1.41 cmol/Kg in rubber plantation, residential area and farmland from the depth of 0 – 30cm respectively, with the highest value on rubber plantation at the depth of 0 – 15cm. Sodium (Na) has its highest value on rubber plantation at the depth of 0 – 15 cm with value of 0.41 cmol/Kg, while at a depth of 15 – 30cm the value of calcium is 0.31 cmol/Kg. The highest value was observed in rubber plantation in magnesium (Mg) at the depth of 0 – 15cm it has the 1.8 cmol/Kg while at depth 15 – 30cm it has is at 1.8 cmol/kg. The least value of magnesium was observed in residential area at depth range of 0-15cm with the value 0.19 cmol/kg.

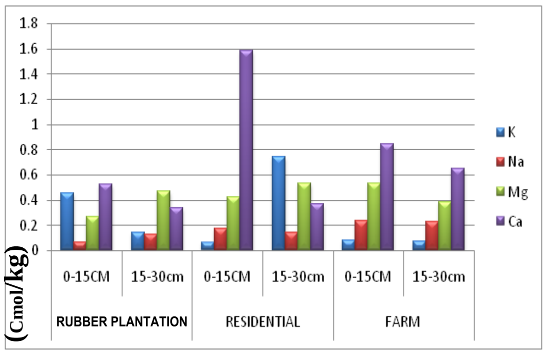

Fig. 11: Bar chart of CEC for Rainy Season for Rubber Plantation, Residential and Farmland Treatments and Depth of Sample Collection.

The bar chart of cation exchange capacity shows that for calcium concentration has the highest value of 1.6 cmol/Kg at a depth of 0-15cm in residential area, while the least concentration of calcium was found (0.08 cmol/Kg). Potassium has the least concentration in residential area at depth of (0 - 15cm) and the highest concentration of potassium was noticed in residential area with concentration value of 0.67 cmol/Kg. Sodium has the highest concentration on farmland with concentration of 0.24 cmol/Kg and the least concentration of sodium is on rubber plantation at a depth of (0-15cm) with concentration of 0.04cmol/Kg. Magnesium has the highest concentration on farmland at a depth of 0 -15cm with concentration of 0.48 cmol/Kg and the lowest concentration was noticed 0.29 cmol/Kg.(Fig. 11)

PARTICLE SIZE

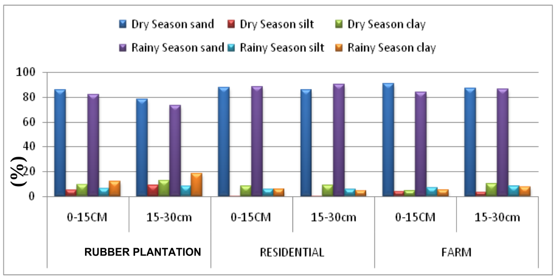

Fig.12: Bar chart of Particle Size for Rubber Plantation, Residential and Farmland Treatments, Season Variation and Depth of Sample Collection.

The particle size of sand in dry season has it highest value on farmland at the depth range of 0 -15cm with a value of 92% and the least value on rubber plantation at depth of 15 - 30 cm with the value of 79.1%. While sand in rainy season has the highest value on residential area at a depth of 15 - 30cm with the value of 90.14%, the least value of sand during rainy season is on rubber plantation at a depth of 15 - 30cm with value of 73.4%. For particle size of silt during dry season has value at depth of 15 - 30cm with a value of 9.8% while during the rainy season the value is 0.4 % at a depth of 15 -30cmon residential area. For clay (dry season) its highest value is 12.1 % at a depth of 15 -30cm on rubber plantation while the least value was at a depth of farmland at a depth of 0 - 15cm with a value of 1.5 % and the value of clay (rainy season) has its highest value at the depth of 15 - 30m with a value of 20 % on rubber plantation and the least value was noticed in residential area at a depth of 15 – 30cm with a value of 2.4%. (Fig. 12)

DISCUSSION

The Nigerian environment has been drastically deforested and the trend still goes on. Soil properties (physicochemical) have greatly changed as land use type promotes rubber plantation clearing. With little or no vegetal cover, the erodibility of the soils appears to have increased. (Rhodes, 2008) In this work, it was observed and deduced from the particle size distribution analysis that the percentage of sand increased with increased disturbance of forest land which shows that in the absence of vegetation cover exposed the soil to denudation activities with the finer particles being washed away leading to the increase of the sand content in soil. Deforestation has therefore acted as a driver, which affected other soil characteristics (Rhodes, 2008). In this research, it was found that there was a significant difference in soil pH in relation to depth soil horizon at the rubber plantation land and residential area but there was no significant difference in farm soil (see Fig. 2). Pamela *et al.*, (2009) also found significant differences between pH and soil horizon between primary oak rubber plantation, open pasture, and secondary older plantation. In dry season, the soil pH reading from rubber plantation land was observed to be lower than soils pH from Farm land, this is because bush burning practices occurred on the farm land. This is because of the release of OH ions when compound like $Fe(OH)_2$ are oxidized by increased temperature. It was observed by some previous studies which showed an increase in soil pH and Av. P due to fire (Trapnell *et al*., 1976; Stromgaard, 1984; Chidumayo, 1994), The insignificant change in pH when related to depth farm land could be related to the use of manure/fertilizers to farm soils as stated by Okwuagwu *et al.*, (2003) related change in pH to fertilizer application. The trend observed in conductivity, with higher conductivity in the Farmland compared to the Rubber Plantation soils and residential, may be biologically significant. This may be due to the artificially introduced nutrients (fertilizers) could play key role in the high concentration of EC in farms. Observing closely the EC values in residential land use soil the low EC values indicate otherwise that the low concentration of dissolved materials (ions) in aqueous solution can again be attributed to it being washed off by erosion (Fig.3). Pamela *et al.*, (2009) also observed higher conductivity in the pasture compared to the oak and older rubber plantation. In this study, there were correlations between conductivity, pH, and nutrient availability. It was shown in Heiniger *et al*., (2003) that conductivity is one of several variables that influence changes in nutrient concentrations.

The sand silt clay ratio gave an outstanding indication that deforestation affects the soil properties, the sand content increased as deforestation occurred. Rubber plantation soils had less amount of sand when compared to Farmland. This could be attributed to increased top soil removal as a result of removal of vegetation cover. The top soil showed decreased sand content as one moves down into subsoil while the clay content increased with depth. But in the same vein clay content was higher in rubber plantation soils when compared with farm land and residential area having the lowest amount of clay. According to Igue, (2004) continuous cropping and intensive land use also affected the particle size distribution in his work he discovered that the sand content of the both layers increased with increasing time or cultivation duration. Also similar to what was discover in this research, Lal, (1996) discovered reduced clay and silt contents, which was of about the same magnitude as the gain in sand content, was probably due to erosion and illuviation. Kauffmann *et al.,* (2001) and Voundi and Tonye (2002) found similarly that continuous cropping and intensive land use affected the particle size distribution and that these changes related to cultivation time. On the contrary, Shepherd *et al.*, (1975) observed no effect of land-use systems on soil particle size distribution. This differences of results as observed by Shepherd *et al*, (1975) might be due to the differences in ecosystems and climates of the places of the experiments.

Nitrogen is one of the important elements in soils. It is largely affected by environment factors such as pH, moisture condition, temperature and land use. There was significant difference between soil total nitrogen content of the Rubber Plantation and farmland see (Table 1). Cultivation reduces the content of amino sugar (Zhang *et al*., 1999). In this research, the Rubber Plantation soils had less nitrogen when compared with the farm land soils, the use of fertilizers may have contributed to this increase. The observation concurs with the observations of Koutika *et al*. (1997), Glaser *et al*., (2000), and Savozzi *et al*., (2001) that reported grasslands and pastures to have higher levels of nitrogen than Rubber Plantation land. According to Rhodes, (2008) The disparity in these findings with regards to the results found in this study are probably due partly to the low levels of organic matter in the Farmland and point to its over-cultivated and degraded nature. The Nitrogen content in the rubber plantation and residential area soils was in accordance with the results of the studies conducted by Dominski, 1971; Harvey *et al*., 1980; Mroz *et al*., (1985); Pennock and Kessel, 1997; Khresat *et al.,* 2008. Zheng *et al.* (2005) reported that erosion following deforestation resulted in a 46.7% decrease in total nitrogen. This was probably the factor that was responsible for the reduced nitrogen content in Residential land use when compared to Rubber Plantation soils. In a study with contrasting results, Boyle *et al*., (1973) found no long term losses in N but speculated that overall nutrient losses could potentially be greater on a steep slope. This speculation falls on the action of erosion. Total phosphorus of the soil in Rubber Plantation, Farmland and Residential land was different in both seasons. Total phosphorus reduced with deforestation in this research. Satrio *et al.,* (2009) and Golchin *et al*., (1995) reported that total P was higher in (peat) soil because forest is an organic soil which contains large amount of decomposed organic matter they also stated that as the rubber plantation land is tempered with, decreases in organic matter leading to decrease in P. The soil carbon in Rainy season was observed to be highest in Rubber Plantation soils, this obviously concurs with anticipated yearly increase in organic activity during this times. Decay of withered leaves in Rubber Plantation is favoured during this time thereby introducing more organic matter which in turn indicates organic carbon content. The level of organic carbon content in soils absolutely correlates with the total organic matter in that soil and various formulas exist from which one can use organic carbon to estimate total organic matter. Organic carbon and organic matter are added to the soil primarily from decomposing vegetative residues such as leaves, litter, and roots and a decrease in these inputs can lead to a decrease in soil organic carbon and matter (Harvey *et al.*, 1980; Anderson and Coleman, (1985); Lugo *et al.*, 1986; Bernoux *et al.*, (1998). The findings in this research work were similar to Murty *et al.*, (2002): that the conversion rubber plantation to Farmland generally leads to loss of carbon. We further saw that soils from the Residential land use which are more exposed to man interference even had low soil carbon. Similar result observed by Yimer *et al.*, (2007) and Khresat *et al.*, (2008) whose findings shows that the unplanned and unregulated clear cutting of the coppice and the essential removal of all tree biomass for use as fuelwood removed organic material high in nutrients. Schwendenmann and Pendall 2006; also has similar results in their research. SOM is an essential, but transient component of the soil that controls many physical, chemical and biological properties of the soil. In this study, there was significant difference in the percentages of SOM where the value decreased from Rubber Plantation to Residential land however; the results agreed with the findings of Dominy *et al*., (2002), who described a large decline of soil organic matter after conversion of undisturbed rubber plantation and grassland into sugarcane plantations. Magdoff and Van (2000) also stated that timber harvesting and land clearing for cultivation purposes caused destruction of the native vegetation cover and tillage of soils, results in a rapid decay of the organic matter accumulated over a long period of time. Lal (1988) stated the principal impact of deforestation on chemical and nutritional properties is related to a decrease in the organic matter content of the soil and to disruption in nutrient recycling mechanisms owing to the removal of deep-rooted trees. Total potassium in the Rubber Plantation was higher as compared to Residential land. It is suggested that trees can utilize both directly or indirectly atmospheric nitrogen and potassium or increase the availability of these elements in the soil. Much of the K found in peat soils is readily available, once it is used up, K deficiency in soil become severe. Soil in open condition without rubber plantation cover and presence of high rainfall causes leaching, while with sufficient drainage system in land development will lead to decreasing of total potassium content in cultivated peat soil (Andriesse, 1988). The decline is attributed to overgrazing, intensive cultivation of horticultural crops and erosion by water without adequate soil conservation measures (Kimigo *et al.*, 2008). Intensification of horticultural production to meet consumer demands in Nairobi has encouraged a low input-high output system in the catchment. Farmers have observed declining yields despite inorganic fertilizer inputs. The observed decline of soil pH to less than 5.5 implies that Ca and Mg have continued to be unavailable to crops (Schulte, 2004) over the 30 years period. The decline of calcium, magnesium and potassium also indicate that the sustainability of current agricultural production systems is not tenable and has led to encroachment of Aberdare forest Reserve for livestock grazing purpose. (Akotsi and Gachanja, 2004) In this research it was observed that the bulk density increased with conversion of Rubber Plantation to other land uses, and it was so in both Rainy and Dry season. (Fig.7).

CONCLUSION

The findings of this study show limited advantages of deforestation on soil physicochemical properties. However, when deforestation is followed by cultivation a significant reduction in topsoil organic matter may occur. It is apparent that considerable SOM and nutrients are lost from the plow layer due to erosion following deforestation. The loss in clay and silt contents was probably as a result of erosion which can be attributed conclusively to deforestation. With the shift of land use form the Rubber Plantation through Residential land use to farming reduces the acidity of the soil. Slashing and burning reduced the availability of Nitrogen which becomes easily removed from the system as a result of a different kind of nitrification process that releases it into the atmosphere as nitrous oxide. One of the consequences of deforestation is that the carbon originally held in Rubber Plantation is released to the atmosphere or washed off by erosion either immediately if the trees are burned, or more slowly as unburned organic matter decays, leading to the reduction of the carbon sink in Rubber Plantation soils.

While this study was limited to just Omavovwe clan and so does not have replicates in other places in Delta State, the findings are consistent with other studies on deforestation and land cover change from a variety of locations around the world Therefore, it is reasonable to expect that the impacts found in this study, and the other studies cited, would also be occurring in other locations within Delta State and at large Nigeria where deforestation and land cover change have occurred. Until more studies are conducted, it would be prudent to assume that deforestation and land cover change may be having significant and long term impacts on soils throughout Nigeria.

REFERENCES

1. Akotsi, E.F.N. and Gachanja, M. (2004). Changes in Forest Cover in Kenya's Five Water Towers 2000-2003. KFWG (Kenya Forest Working Group), Nairobi.
2. Atakpo, E. A. and Akpoborie I.A. (2011), Investigation of sand deposit in parts of Okpe LGA, Delta State, Nigeria. Accepted for Publication: *Nig. Jnl. Of Science and Environment.*
3. Alamu, L.O. and Agbeja, B.O. (2011). Deforestation and endangered indigenous tree species in South-West Nigeria. *International Journal of Biodiversity and Conservation* 3(7): 291 297.
4. Arshad MA, Lowery B, and Grossman B. 1996. Physical Tests for Monitoring Soil Quality. In: Doran JW, Jones AJ, editors. Methods for assessing soil quality. Madison, WI. p 123-41.
5. Anderson, D. W. and D.C. Coleman, 1985. The dynamics of organic matter in grassland soils. *Journal of Soil and Water Conservation,* 40(2): pp. 211-216.
6. Andriesse, J., P. (1988). Nature and Management of Tropical Peat Soils. Soil

Resources, Management and Conservation Service. FAO Land and Water Development Division. FAO Soils Bulletin 59.
7. Asseez. L.O. (1989) Review of the Stratigraphy, Sedimentation and Structure of the Niger Delta, in Kogbe C.A. (ed), Geology of Nigeria, Rockview Nigeria Limited; pp. 311-324.
8. Bouyocus, C.J. (1962). Hydrometer method improved for making particle size analysis of soil. Soil Sci. Soc. Amer. Proc. 26: 446-465.
9. Boyle, R., Phillips, J. and Ek, A. (1973). “Whole tree” harvesting: nutrient budget evaluation. *Journal of Forestry*, 71(12):760-762.
10. Moreno-Sanchez, R and Sayadyan H. (2005) Evolution of Forest Cover in Armernia. *International Forestry Review* 7:2
11. Moreno-Sanchez, R and Sayadyan H. (2006) Non- Regulated and Illegal Logging in Armernia and Its Consequences. *International Environmental Conservation* 33(1):1 - 13pp.
12. Brady and Weil (2002). The nature and properties of soils. 13th ed. New Jersey, Prentice Hall. 85pp.
13. Bremner, J. and Mulvaney, C. (1982). Nitrogen-Total. In: Page, A., Miller , R, (Eds). Methods of Soil Analysis. Part 2. 2nd Ed. *Agron. Monogr.* 9:595-624.
14. Chidumayo, N. Kwibisa L. (1994) Effects of deforestation on grass biomass and soil nutrient status in miombo woodland, Zambia. *Agriculture, Ecosystems and Environment* 96:97–105.
15. Nwajide, C.S. (2006). A guide for geological field trips to Anambra and related sedimentary basins in southeastern Nigeria. PTDF Chair , University of Nigeria, Nsukka
16. Dominski, A., (1971). Nitrogen transformations in a northern-hardwood podzol on cutover and Forested sites. Ph.D. Thesis. Yale University, New Haven.
17. Dominy, C.S., Haynes, R.J., Van Antwerpen, R., (2002). Loss of soil organic matter and related soil properties under long-term sugarcane production on two contrasting soils. Biology and Fertility of Soils 36:350–356.
18. Desjardins, T., E. Barros, M. Sarrazin, C. Girardin, A. Mariotti, (2004). Effects of forest conversion to pasture on soil carbon content and dynamics in Brazilian Amazonia. *Agriculture Ecosystems and Environment*, 103: pp.365-373.
19. Eden, M., Furley, P., McGregor, D., Milliken, W., and Ratter, J., (1991) Effect of forest clearance and burning on soil properties in northern Roraima, Brazil. *Forest Ecology and Management*, 38:283-290.
20. Golchin A, Clarke P, Oades J and Skjemstad J (1995). The effects of cultivation on the composition of organic matter and structural stability of soils. *Aus. J. Soil. Res*., 33: 975-99.
21. Grossman, R. And Reinsch, T. (2002) SSSA Book Series: 5 Methods of Soil Analysis Ch2. Ed. Dane, J. Clarke, Gud mrn. Soil Science Society of America.
22. Glaser B, Balashov E, Haumaier L, Guggenberger G, Zech W (2000) Black carbon in density fractions of anthropogenic soils of the Brazilian Amazon region. Org Geochem 31: pp. 669–678.
23. Hargrove, C. (1981) Effects of organic matter on exchangeable aluminium and plant growth in acid soil environment. *Amer. Soc. Agron. And Sci.Soc. Amer.* 40:82 – 91
24. Heiniger, R., McBride, R. and Clay, D. (2003). Electrical conductivity and nutrient management. *Agronomics J.* 95:508-519.
25. ISO 10390. (1994) Soil Quality - Determination of pH. International Organization for Standardization.
26. ISO 11260 (1994) Soil Quality - Determination of effective cation exchange capacity and base saturation level using barium chloride solution. International Organization for Standardization. Geneva, Switzerland. 10 p.
27. ISO 11272. (1993) Soil Quality – Determination of Dry bulk density. International Organization for Standardization. Geneva, Switzerland. 10 p.
28. Kauffmann S., Sombrooek W. and Mantel S. (1998) Soils of rainforests: characterization and major constraints of dominant forest soils in the humid tropics. *In:* Schulte A. and Ruhiyat D. (2004) Soils of Tropical forest Ecosystems (eds): Characteristics, *Ecology and Management*, Springer-Verlag, Berlin, 9-20 pp.
29. Khresat, S., Al-Bakri, J. and Al-Tahhan, R. (2008). Impacts of land use/cover change on soil properties in the Mediterranean region of northwestern

Jordan. *Land Degradation and Development*, 19(4):397-407.
30. Kimigo, J., Mbuvi, J., Kironchi, G. and Gicheru, P., (2008). Effects of land use change on soil qualities in the Sasumua catchment of Tana River Drainage system in Nyandarua District, Kenya. E. *Afr. agric. For. J.* 74(2):85-94.
31. Kouita, L.-S., F. Bartoli, F. Andreux, C.C. Cerri, G. Burtin, T. Chone, R. Philippy, (1997). Organic matter dynamics and aggregation in soils under rain forest and pastures of increasing age in the eastern Amazon Basin. *Geoderma*, 76:87-112.
32. Lal, R. (1996). Deforestation and land-use effects on soil degradation and rehabilitation in western Nigeria. *Land Degradation and Development* 7(1): 19 - 45.
33. Lal, R. (1988) "Soil Degradation and the Future of Agriculture in Sub-Saharan Africa", *Journal of Soil and Water Conservation.* 43:444-451 pp.
34. Leeper, G.W.; Uren, N.C. (1993). Soil science, an introduction (5th ed.). Melbourne: Melbourne University Press.
35. Lugo, A.E., M.J. Sanchez, and S. Brown, (1986) Land use and organic carbon content of some subtropical soils. *Plant and Soil*, 96: 185-196.
36. Magdoff F, Van Es H. 2000. Building Soils for Better Crops. 2nd ed. Sustainable Agriculture Network, Handbook Series Book 4. Maryland: Beltsville, pp 230.
37. Mehlich, A. (1984) Mehlich III Soil Extractants: A modification of Mehlich II Extratant. *Communications in Soil Science and Plant Analysis.* 15:1409 -1415.
38. Moreno-Sanchez, R and Sayadyan H. (2006) Non- Regulated and Illegalm Logging in Armernia and Its Consequences. *International Environmental Conservation* 33(1): pp 1 -13.
39. Mroz, G., Jurgensen, M. and J. Frederick, D. (1985) Soil nutrient changes following whole tree harvesting on three northern hardwood sites. *Soil Science Society of America Journal*, 49:1552-1557.
40. Murty, D., M.U.F. Kirschbaum, R.E. McMurtrie, and H. McGilvary. (2002) Does conversion of forest to agricultural land change soil carbon and nitrogen? *Global Change Biology*, 8:105-123.
41. Murat R. C (1970). Stratigraphy and Paleogeography of the Cretaceous and Lower Tertiary in Southern Nigeria. In Africa Geology (1972) (Eds: Dessauvagie, T.F And Whiteman, A. J.). Ibadan University press. Pp251-266.
42. Nelson D. and Sommers L. (1982). Total carbon, organic carbon, and organic matter. In *Methods of soil analysis. Part 3 – Chemical methods.* (D.L. Sparks, ed.). Madison, USA.
43. Okwuagwu M., Alleh M. and Osemwota, I. (2003) The effect of organic and inorganic manure on soil properties and yield of okro in Nigeria. *African Crop Science Proceedings.* 9(37):6085 – 6090.
44. Olsen, S. and Sommers, R. (1982) Phosphorus. Pp. 403-430. In A. L. Page (ed.): Methods of soil analysis. Part 2: Chemical and microbiological properties. American Society of Agronomy Inc., Soil Science Society of America Inc., Madison, WI.
45. Pamela M. Collins, Brigette A. Jones, And Mayda H. Nathan (2009) Effects of deforestation and succession on soil at Cerro Cuericí, Costa Rica. 1 – 7.
46. Pennock, D. J. and van Kessel, C. (1997) Effect of agriculture and of clear-cut forest harvest on landscape-scale soil organic carbon storage in Saskatchewan. Can. J. Soil Sci. 77: 211–218.
47. Ruth Oghenerukevwe Eyankware, Moses Oghenenyoreme Eyankware, And Solomon Chukwuedum Effam. (2015). Soil Erodibility Assessment in Selected Part of Ekwusigo Local Government Area Anambra State South-Eastern Nigeria," *International Journal of Innovation and Scientific Research*, Vol. 13, No. 1, Pp. 50–62.
48. Rhodes, R. E., Symons Downs, D., & Bellows Riecken, K. H. (2008). Delivering inactivity: A review of physical activity and the transition to motherhood. In L. T. Allerton & G. P. Rutherfode (Eds.), Exercise and women's health research (pp. 105–127). Hauppauge, NY: Earthlink Science Press.
49. SAS (2002.) SAS Institute Inc. Cary, NC. USA.
50. Short, K.C, and Stauble, A.J (1967). Outline of Geology of Niger Delta: AAPG Bull., vol. 51pp.761-779.
51. Satrio A, Gandaseca S, Ahmed O and Majid N. (2009) Effect of precipitation fluctuation on soil carbon storage of a tropical peat swamp forest. *America. Journal of Applied Science*., 6: 1484-1488.
52. Schwendenmann, L., and E. Pendall, (2006) Effects of forest conversion into grassland on soil aggregate structure and carbon storage in Panama: evidence from soil carbon fractionation and stable isotopes. *Plant Soil*, 288:217-232.

53. Trapnell, C.G., Friend, M.T., Chamberlain, G.T., and Birch, H.F. (1976). The effects of fire and termites on a Zambian woodland soil. Journal of Ecology 64: pp, 577-588.
54. Voundi, N. J. C. and Tonye, J. (2002). Assessment of certain soil properties related to different land-use systems in the Kaya watershed of the humid forest zone of Cameroon. Land Degradation and Development. *Published online in Wiley Inter Science* (www. Interscience.wiley.com) OI:10.1002/Idc.519.
55. Stromgaard, P., (1984) The immediate effect of burning and ash-fertilization. *Plant and Soil* 80: 307–320.
56. Seubert, C.E. (1975). Effect of land clearing methods on crop performance and changes in soil properties in an Ultisol of the Amazon Jungle of Peru. M.S. thesis, North Carolina State University, Raleigh, North Carolina.
57. World Bank (2004). "The Future of Biodiversity". *Science* 269 (5222): 347–350.
58. Yimer, F., S. Ledin and A. Abdelkadir, (2007). Changes in soil organic carbon and total nitrogen contents in three adjacent land use types in the Bale Mountains, southeastern highlands of Ethiopia. *Fores. Ecol. Manage.*, 242: 337–342.
59. Zhang, T., Barry, R.G., Knowles, K., Heginbottom, J.A. & Brown, J. (1999). Statistics and characteristics of permafrost and ground-ice distribution in the Northern Hemisphere. *Polar Geography*, 23(2): 132–154.
60. Zheng, F., X. He, X. Gao, C. Zhang, K. Tang, (2005). Effects of erosion patterns on nutrient loss following deforestation on the Loess Plateau of China. *Agriculture and Environment*, 108:85-97.
61. Yimer, F., S. Ledin and A. Abdelkadir, (2007). Changes in soil organic carbon and total nitrogen contents in three adjacent land use types in the Bale Mountains, southeastern highlands of Ethiopia. *Fores. Ecol. Manage.*, 242: 337–342.
62. Zhang, T., Barry, R.G., Knowles, K., Heginbottom, J.A. & Brown, J. (1999). Statistics and characteristics of permafrost and ground-ice distribution in the Northern Hemisphere. *Polar Geography*, 23(2): 132–154.
63. Zheng, F., X. He, X. Gao, C. Zhang, K. Tang, (2005). Effects of erosion patterns on nutrient loss following deforestation on the Loess Plateau of China. *Agriculture and Environment*, 108:85-97.

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