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EVALUATION OF SOIL CHEMICAL AND PHYSICAL PROPERTIES AT THE LOGGED FOREST AT ONIGAMBARI FOREST RESERVE

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ABSTRACT

S. Soil samples were collected randomly from five locations around the forest at depth of 0-45cm. Samples of about 500g each were collected in plastic bags and taken to the laboratory for analysis. Results presented shows that sand had the highest % in soil of the area (91.62). Bulk densities were at ranges of (1.43, 1.45 and 1.23g/cm3) at the depth of 0-15, 15-30 and 30-45 respectively. The textural classification for each depth of soil was sandy-loam. Calcium present in the soil ranges between 2.33- 2.60 which is at its lowest and cannot properly support the growth of plant. Magnesium which functions as the central core of the chlorophyll molecule in plant tissue seems to be deficient at each level of the soil depth. Therefore, if Mg is deficient, the shortage of chlorophyll will results in poor and stunted plant growth.

Keywords: Decomposed, biomass, bulk density, deficient

INTRODUCTION

In most developing countries like Nigeria, there is the concern of land degradation (Mesfin *et al*, 2018). Land degradation, when considering soil properties of a particular forest, is a major threat in long-logged lands and may negate the livelihood of rural communities. Alves *et al.* (2010) observed that many soils in these developing countries are still at high risk of soil degradation due to anthropogenic activities that reduces their ability to have better yield. Physical qualities of a soil can be affected when soil degradation is viewed in-terms soil erosion. Soil erosion due to excess logging on a particular land opens up the soil to erosion where fine materials are washed away by water erosion, leaving a sandy texture. It can be said further, a constantly logged area soil have low soil organic matter (SOM) contents due to frequent cultivation, low vegetation cover, and high soil compaction (Reynolds & Topp,2008). Usually, soils with low physical quality have low penetration rates, increased surface runoff, in adequate aeration, bad plant rooting, and hard soil workability (Dexter, 2004). As a result, soil physical degradation has become a source of worry in supporting the growth of economic trees and the sustainability of the forest. Soil physical degradation also resulted in a low soil nutrient-holding capacity.

Degradation of soils in forest usually occur with the deterioration of the vegetative cover due to over grazing, wood-cutting, excess logging, improper cultivation and bush fire (Weert and Lenselink, 1972). These lead to accelerated water erosion, soil compaction, increase in bulk density, decrease in porosity and reduction in infiltration rate, surface crusting and loss of soil fertility. Structural deterioration through lack of organic matter is a danger to productivity of agricultural soils (Hubert, 1983). Characteristically, forest soils contain large quantities of biomass and, therefore, large inventory of chemical elements. Organic matter is constantly added to the soil through litter fall, twigs, branches, fruits and from aerial parts of trees and also from their roots (Brinson *et al.,* 1980). The bulk of the organic matter added to the soil is located in the topsoil (Armson, 1977). Organic matter through root decay represents as much as 20-25 percent of the total biomass produced by wood species (Nair, 1984). There is also a significant formation of carbohydrate rich organic matter during active root growth (Martin, 1977). There is a steady release of carbohydrate-rich organic material, from actively growing roots, representing an energy input into the soil ecosystem that is capable of supporting a substantial microbial population. This phenomenon is very important in organic matter and physical relations of soils under stress.

Litter fall is the major recognized avenue for the addition of organic matter to the soil. Trees have the potential role of reducing runoff and erosion losses. Natural forest provides a multi-layer defense against the impact of raindrops (Nair, 1984). The different strata .of the canopy progressively reduces the forces of rain, thereby reducing the adverse effect of the impact on the soil below. The most important conservation impact of logging forest is the attendant loss of biological and genetic diversity. It is quite clear, felling substantial areas of forest will result in loss of species. The detrimental effect of logging, which has been underestimated, for sometimes has become, according to most studies, concentrated on the larger and more obvious species, such as mammals, birds and flowering plants. Although these groups are likely to suffer decline after felling, effects are often partial and confusing with certain species showing at least short term increase. This has blunted "the conservationist" response to forest loss for many years. The impact on invertebrates, lower plants and microscopic life forms is far more significant but has generally still not been assessed and often goes unrecognized (Eruotor, O.R. 2003). Soil quality is the ability of a soil to function within its surroundings for its given purpose. The use of indicators is essential to measure how well a soil is performing its functions.

Soil indicators are measurable physical, chemical and biological properties, processes and characteristics that influence the capacity of a soil to function. Keller *et al*. (2004), reports that logging is likely to cause subtle changes in soil structure and nutrient dynamics that are detectable both immediately after logging and for years to come. However, these changes do not indicate any substantial loss of nutrients as compared to the soil stores. Martinelli *et al*. (2000) reports that estimates of nutrient losses with log removal, may be replaced by atmospheric deposition, but could become critical with frequent repeated logging, or high extraction rates. It is possible that nutrient losses could begin affecting forest productivity and still be too subtle a change to be detected in soil nutrients. Measurable increases in Ca and Mg in the surface soils may facilitate regeneration and rapid re-growth after logging.

One of the major impacts of logging is the removal of the top soil during log dump, haulage road and large skid trail construction resulting in loss of soil fertility. Congdon and Herbohn (1993) observed that nutrient concentrations in felling gaps were depressed in wet tropical forests compared to unlogged forests even 25 years after selective felling. Onyekwelu *et al.* (2008) reported that when rainforest soils are exposed by deforestation or degradation, the consequences include soil structure degradation, impaired soil nutrients and soil compaction. However, as logging intensity increases, nutrient loss also increases and it takes a much longer felling cycle for the forests to cope with such loss.

MATERIALS AND METHODS

Study Area

The study was carried out at Onigambari Forest Reserve, Oyo State. The Onigambari Forest Reserve was declared from Ibadan Forest Reserve by a resolution of the Ibadan city council passed in September 1899 (Ajibode, 2002). Two sections were consolidated to form a Forest Reserve in 1953 making a total area of 125.62 km^2 (Ajibode, 2002). Hence tree like Teak (*Tectona spp*), Mahogany (*Khaya ivorences*), and other Agricultural crops like cocoa (*Theobroma cacao*), cassava (*Manihot spp*) with exotic trees and crops were cultivated. Onigambari Forest Reserve lies on latitude $7^o\ 8^1$ N and $7^o\ 3^1$ N longitude $3^o\ 49^1$ E and $3^o\ 22^1$ E (Fig 1). The plot lies within 17 km South-east of Ibadan on the Idi-Ayunre-Ijebu-Ode road, Oyo State. It was laid about 2 km away from the nearest road well obscured by some forest fallows in the neighborhood.

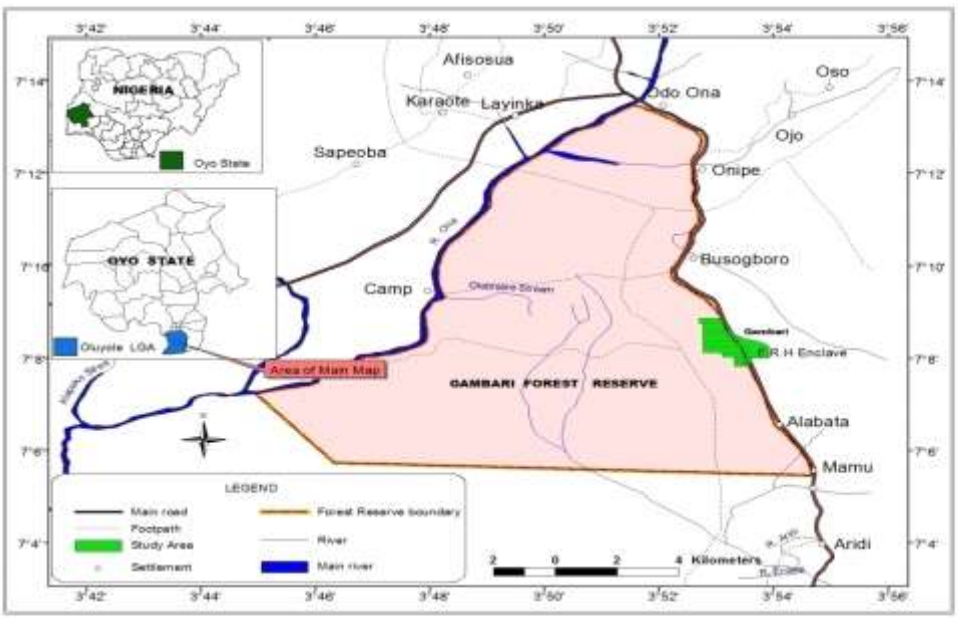

Figure 1: The Map of Onigambari Forest Reserve showing the study sites

The area is characterized by defined wet (rainy) season spanning from May to October and peak rainfall in October (150-200cm) and the dry season occupies the rest of the year. The mean annual temperature is 27^0C, while humidity less than 60%.

Soil Sampling and Collection

For better understanding of the difference between the plants communities covered and its soil properties, sub plot of 6 m x 6 m was laid at the center of each plot to be sampled and 24 soil samples were collected at the study sites to the depth of 0-15 cm, 15-30 cm, and 30-45 cm by simple random technique method using soil auger. Soil collected was taken to Forestry Research Institute of Nigeria's soil laboratory for physicochemical analysis. The soil samples collected was air-dried and ground in a Wiley mill to pass through a 2 mm sieve. Core cylinder samples were dried for two days at 105 °C and bulk density calculated as the ratio of oven-dry weight of soil to cylinder volume. Soil pH was determined using a digital pH meter in 1:2 soil/water solutions. Organic carbon was estimated by Walkley and Black (1934) method. Extract for available P was prepared with ammonium fluoride and P determined using molybdenumblue method (Murphy & Riley 1962). Total N was determined using micro-Kjeldahl method with selenium catalyst (Bremner 1965). For determination of exchangeable Ca, Mg, K and Na, soil samples were first leached with 1 N ammonium acetate solution (pH = 7.0). Exchangeable Ca and Mg were determined by atomic absorption spectrophotometer.

Laboratory Procedures

The collected soil samples were air dried, gently crushed and sieve through 2mm mesh for laboratory analysis. Samples for bulk density were also oven dried using standard laboratory procedures. Physical and chemical properties as well as microbial count of the soils were determined as follows:

Chemical Properties Determination

Soil pH was determined using electrode pH meter in 1:1 soil-water solution. Soil organic carbon content was determined by method, and then multiplied by 1.724 to estimate organic matter content. Determination of total N was achieved by macro-Kjeldhal method with selenium catalyst, while available P by electro-photometer method, exchangeable K and Na by digital flame photometry, while exchangeable Ca and Mg were determined by EDTA. Cation exchange capacity of the soils was determined by saturating the soil with normal neutral ammonium acetate solution, washing excess with alcohol, distilled and titrated against standard hydrochloric acid.

Physical Properties Determination

Particle size distribution was determined by the hydrometer method. Particle density (Pd) determination using pycnometre bottle method. Bulk density (Bd) of the soil was determined by drying the undisturbed core samples to a constant weight at 105°C and dividing the oven dried weight of the sample by its volume.

Data Analysis

Data from laboratory analysis of the soil samples were subjected to analysis of variance (ANOVA) using SPSS and where significant difference existed, Duncan's New Multiple Range Test (DNMRT) was used to separate the means.

RESULTS

Soil Physical Properties of the Logged Site

At 0-15 cm, the sand content (91.62%) in the logged site is about (90.04%). At 15-30 cm, the sand content is (90.18%) is also high in the logged site. At 30-45 cm, the sand content is (88.78%) at the logged site. At 0-15 cm, the clay content is at (3.68%) at the logged site. At 15-30 cm, the clay content is at (4.94%) at the logged site. At 30-45 cm, the clay content is at (6.25%) in the logged site. At 0-15 cm, the silt content stood at (4.87%) at the logged site. At 15-30 cm, the silt content stood at (5.03%) in the logged site. At 30-45 cm, the silt content was (4.96%) at the logged site.

DISCUSSION

The soil's physical and chemical properties obtained for logged forest were presented in Table2. Results were analyzed using Analysis of variance (ANOVA) and their means were separated by Duncan's Multiple Range Test at $p < 0.05$. The results from the sampled locations indicated that; silt, sand, and clay contents of the soil ranged from 4.81-5.03%, 88.79-97.62% and 3.68-6.26% respectively, and they differ statistically at ($p<0.05$). In texture, the soils obtained from the forest were predominantly loamy sand because it contains 70-90% sand (Brown, 2009) and its porosity at the range of from 38 to 55%. The result shows the level of spore space that determines the bulk density that can be obtained which is proportional to the rate at which water/air moves within the soil. The Bulk density obtained at 0-15cm depth varied from 1.23 to 1.45 g cm-3 and this is in line with the findings of (Birkeland, P.W. 1999) who reported the general limit of soil to be at 1-2g cm^2. The more pore spaces in a soil, the lower the value of bulk density (Blake, G.R., 1986). Depth wise, sand reduces significantly with increase in depth ($p>0.05$), silt followed an opposite direction with no significant difference. Clay showed a different trend as it increases significantly with increase in depth.

Soil Chemical Properties of the Study Area

Generally, exchangeable cations (k^+, Ca^{2+}, Mg^{2+} and Na^+) were found in quantity at the logged site at all depths (Table 1). Potassium (K) content did not show significant difference as it varies from one depth to another. Sodium (Na) content was also visible in logged site at all depth. Calcium (Ca) content was encountered in logged site at 0-15 cm. Magnesium (Mg) content increased significantly with increase in depth of the soil.. Nitrogen (N) content varies at all depth in the logged site. Considering the depth of the soil chemical properties; Calcium content from the logged site decreased with increase in depth (2.33-2.60), the difference is not statistically different. For nitrogen (N) content, there is an increase in nitrogen with increase in depth in the logged site. The difference is not statistically different. Potassium (K) content, increased with increase in the depth of the soil, the difference is statistically different. As for the sodium content in the soil, there was no significant difference with an increase in the sodium content with increase in depth. Organic carbon significantly decreased with increasing soil depth with a range of 0.90-2.08. These values were comparatively lower to the values obtained by (Muhammed, A. 2010) where 1.0, 7.38, 11.57 and 8.42g/kg were recorded at Wassaniya, Jimajimi, Yartagimba and Daiji of the study area. This may be as a result of the lower microbial count that could undertake litter decomposition or low moisture that will enhance the microbial activity at the study area.

Table 1: Soil Chemical and Physical Properties at the logged sites in Onigambari Forest Reserve

Soil depth (cm)	Study site	Chemical Properties						Physical Properties				
		Ca^{2+} ($cmol\ kg^{-1}$)	Mg^{2+} ($cmol\ kg^{-1}$)	N^{+} (%)	K^{+} ($cmol\ kg^{-1}$)	OC g/kg	Na^{+} ($cmolkg^{-1}$)	Clay (%)	Sand (%)	Silt (%)	Textural class	Bulk Density (g/cm^3)
0-15	Logged	2.33±0.37	0.75±0.07	0.35±0.13	0.50±0.11	2.08±0.41	0.28±0.09	3.68±0.52	91.62±0.88	4.87±0.78	Sandy loam	1.43
15-30	Logged	2.50±0.43	0.84±0.15	0.49±0.10	0.57±0.07	1.43±0.15	0.34±0.12	4.94±0.56	90.18±1.11	5.03±0.64	Sandy loam	1.45
30-45	Logged	2.60±0.33	0.86±0.03	0.62±0.06	0.63±0.07	0.90±0.08	0.39±0.06	6.26±0.39	88.79±1.62	4.96±1.92	Sandy loam	1.23

Microbial Count

The soil microbes (Bacteria and Fungi) also varied with location, with locations 3 and 5, there was total absence of bacteria. The bacterial count within the sampled locations ranged from 2 to 14 x10^4. Furthermore, fungi were also absent in location 2, 3 and 5, the fungal count ranged from 14 to 16 x 10^4 as seen in Table 2. This result shows a low level of microbes load on the site and this may be attributed to the acidic nature of the soil due to absence of forest covers that shields the forest from direct sunlight. These forest covers are been destroyed by human activities such as illegal/indiscriminate logging. This must have in one way or the other had a negative consequences on the nutrient cycling processes and fertility (Xiao, *et al*., 2008) which in turn may alter the plant (tree) nutrition and hence its survival and growth. With the tolerance level of microbes, a wide range of pH can have adverse effect on the type and amount of anions and cation that soil solutions contain and that which is exchanged with the soil atmosphere and biological organisms.

Table 2: Microbial Load Found in Onigambari Forest Reserve Soils

Location	Bacteria (Cfu/ml)	Fungi (Cfu/ml)
1	2 x 10^4	14 x 10^4
2	14 x 10^4	Nil
3	Nil	Nil
4	5 x 10^4	16 x 10^4
5	Nil	Nil

CONCLUSION

The aim of this study was to evaluation of soil chemical and physical properties at the logged forest at onigambari forest reserve determine the chemical and physical properties and to describe the soil of Ombi area. The investigation has shown from laboratory analysis that some of the trace elements such as Boron, Zinc, Copper and Iron were not present in the soil of the area. Sand has the highest percentage in the soil of the area while silt was the lowest. Soil of the area can be described as light with its higher % of sand. Soil of the area is good for the cultivation of tuber crops as is presently the case in the area, because of its low or neutral soil reaction. Forest trees would therefore thrive well. Plantation establishment of tree crops is recommended.

REFERENCE

Armson, K.A. (1977). Forest Soils: Properties and Processes. University of Toronto Press; 1st Edition

Ajibode, M.O (2002).Wood species composition and regeneration potential of Onigambari ForestReserve, Oyo state. A project submitted to the Department Forestry and Wildlife Management FUNNAB Pp.18.

Alves, S., Neiri, L, Chaves S.R., Vieira, S., Trindade, D., Manon, S., Dominguez V., Pintado B., Jonckheere, V., Van Damme, P., Silva, R.D, Aldabe, R., & Côrte-Real, M. (2018). N-terminal acetylation modulates Bax targeting to mitochondria. *Int J Biochem Cell Biol* 95:35-42.

Microderoceras bispinatum subsp. *ancyrense* (Bremer, 1965) in GBIF Secretariat (2019). GBIF Backbone Taxonomy. Checklist dataset https://doi.org/10.15468/39omei accessed via GBIF.org on 2020-12-16.

Muhammed, A., Abdullah, W.R. and Abdullah, S.K. (2010). Identification of aflatoxigenic and ochratoxigenic Aspergillus strains isolated from soil and agricultural commodities in Duhok. J. Duhok Univ. 13(1) 296-302

Blake, G.R. and Hartge, K.H. (1986) Bulk density. In: Klute, A., Ed., Methods of Soil Analysis, Part 1—Physical and Mineralogical Methods, 2nd Edition, Agronomy Monograph 9, American Society of Agronomy—Soil Science Society of America, Madison, 363-382.

Birkeland, P.W., 1999. Soils and Geomorphology. Oxford Univ. Press, New York. 430 pp.

Brinson, M.M., Bradshaw, H.D., Holmes, R.N. & Elkins, Jr. J. 0. (1980). Litterfall, stemflow, and through fall nutrient fluxes in an alluvial swamp forest. Ecology 61:827-835

Congdon, R.A., and J.L. Herbohn, (1993): Ecosystem dynamics of disturbed and undisturbed sites in north Queensland wet tropical forest. I. Floristic composition, climate and soil chemistry. J. Trop. Ecol., 9, 349–363

Martinelli, L.A., Almeida, S., Brown, I.F., Moreira, M.Z., Victoria, R.L., Filoso, S., Ferreira, C.A.C. & Thomas, W. W. (2000): Variation in nutrient distribution and potential nutrient losses by selective logging in a humid tropical forest of Rondonia, Brazil. Biotropica, 32, 597–613.

Martin A., John, W. & Sons, Inc. (1977). Introduction to Soil Microbiology, Second Edition 605 Third Avenue, New York, NY 10016. 467p.

Murphy, J. and Riley, J. P. (1962) A modified single solution method for the determination of Phosphate in natural waters. Anal. Chim. Acta, 27: 31-6.

Nair, P.K.R. (1984) Soil Productivity Aspects of Agroforestry. International Council for Research in Agroforestry, Nairobi.

Onyekwelu, J.C., Mosandl, R., and Stimm, B. (2008). Tree species diversity and soil status of primary and degraded tropical rainforest ecosystems in South-Western Nigeria. *Journal of Tropical Forest Science*, *20*(3),193

Keller, M.G.P., Asner, N.S, & M. Palace. (2004). Sustainability of selective logging of Upland forests in the Brazilian Amazon: Carbon budgets and remote sensing as tools for evaluation of logging effects. *Working Forests in the Neotropics: Conservation through Sustainable Management?* D. J. Zarin *et al*., Eds., Columbia University Press, 41–63.

Samuel M. (2018). Evaluation of chemical composition of improved and released soybean varieties in Ethiopia. Academic Research Journal of Agricultural Science and Research. Vol. 6(9), pp. 577-583.

Eruotor, O.R. (2003): logging and its impact on forest as a life source. 12th World Forestry Congress, Conference Proceedings

Reynolds, W.D. and Topp, G.C. (2008) Soil Water. Analyses, Principles and Parameters. In: Carter, M.R. and Gregorich, E.G., Eds., Soil Sampling and Methods of Analysis, CRC Press, Taylor & Francis Group, Boca Raton.

Dexter, (2004). Soil physical quality. Part I. Theory, effects of soil texture, density, and organic matter, and effects on root growth. Geoderma 120(3-4):201-214

Walkley, A. & Black, I.A., (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed mordification of the Chromic Acid Titration Method. Soil Science, 37: 29–38.