Journal of Sciences, Computing and Applied Engineering Research (JSCAER), Vol. 1, No.2, pp. 42-53

Published Online (https://jcaes.net) on July 10, 2025 by SciTech Network Press ISSN: 3092-8648

Evaluation of Biophysical Indicators of Land Degradation across a Vegetational Composition in Osara

*Aina, G. E[1], Jibril, Z.O[1], Lawal, J. A[2], Abulsalami, M. [2], Isah, M. H[1] & Abdul, N. B [3],

[1] Confluence University of Science and Technology, Osara/ Department of Biology, Osara, 264103, Nigeria

[2]Confluence University of Science and Technology, Osara/ Department of Physics, Osara, 264103, Nigeria

[3]Kogi State Polytechnic, Lokoja./ Department of Science Laboratory Technology, Lokoja 260102, Nigeria

Corresponding author **ainaeg@custech.edu.ng

Received: June 8, 2025; Revised: June 30, 2025; Accepted: July 3, 2025; Published: July 10, 2025

Abstract: Biophysical indicators of land degradation in Osara woodland contiguous to Confluence University of Science and Technology, Osara was evaluated between July-October 2024 by exploring vegetation characteristics and soil physicochemical features. Three sample plots were taken randomly measuring 0.25ha divided into (10m x 50m) strips each. In these plots, samples were collected and analyzed according to land use pattern (farming, grazing and previously mined site) Shannon-Weiner and Simpson's index of diversity shows that plot 2 (cultivated area) had indexes of 2.450 and 0.9121, respectively over grazed and previously mined areas of 0.691, 1.950 Shannon-Weiner indexes, while Simpson's index of diversity area 0.6189 and 0.7928 respectively. Cultivated /farmed area had herbaceous yield of 0.835kgm^{-2}h^{-1} as against 1.892kgm^{-2}h^{-1} and 1.568kgm^{-2}h^{-1} of previously mined and overgrazed sides respectively. The vegetation analysis revealed a very low similarity of 21.42% which suggest a highly diversified heterogeneous ecosystem. The soil sample analysis shows that areas with evidence of past mining activities has sandy components with moderate slightly acidic pH while the over- cultivated and grazed site had sand clay loam consistency in terms of textural components. The vegetation of the study area hold a great potential for biodiversity conservation, efficient, soil management practice is recommended to maintain nutrient availability for a longer period of years ahead.

Keywords: Biodiversity, Conservation, Human Activities, Soil Characteristics.

1.0 Introduction

Land degradation, stemming from human activities, has been a significant global concern throughout the 20th century and will continue to be a priority in the 21st century. Soil degradation specifically refers to the deterioration of the natural quality of soil within any ecosystem threatening its inherent potential. This degradation is a critical issue due to its profound impact on both global food security and environmental quality [6; 36; 26; 24]. The intensity of land degradation is determined not solely by population density, but rather by human activities on the land. In regions where, large segments of the population rely heavily on land resources for sustenance, there is a growing competition for land use, including activities like grazing, crop farming, and construction among others. However, people can also play a crucial role in reversing this trend towards degradation [9].

Land degradation encompasses the loss of actual or potential productivity due to natural or human-induced factors, resulting in a decline in land quality or productivity. This degradation is often caused by a mismatch between land quality and its intended use.[17;18;23] Mechanisms initiating land degradation include physical, chemical, and biological processes such as soil erosion, desertification, acidification, and biodiversity loss. Soil structure is a key property influencing these degradative processes. [52]

The economic consequences of land degradation are particularly severe in densely populated regions like South Asia and Sub-Saharan Africa. Erosion for example, can lead to substantial yield reductions, ranging from 30-90% in some areas of West Africa and 20-40% for row crops in places like Ohio and the mid-west USA. In Nigeria, soil erosion and desertification have led to a 50% decline in land productivity, while across Africa; accelerated erosion was projected to result in yield reductions of up to 165% by 2020.[49;50;51] The annual reduction in total production due to erosion is significant, affecting cereals, roots, tubers, and pulses alike.

The waves of concern of environmental problems on humans and the environment, have translated into a number of researches. Among the academics, scholarly writings have tried to explain the dimension and severity of the environmental problems [7; 36; 24]. [7] Reported that environmental devastation has led to the loss of means of livelihood of people, fall in agricultural output out-migration of able -bodies youth and engendered social rift and intensified confusion. [34] Reported that at least 12 million of forest are cleared or degraded worldwide every week. Besides, about 24 billion tons of top soils are lost to erosion every year in the world, while the ocean and tropical forest species are being driven into extinction at 25,000 times the natural rate.

It is important to note that, the rate of forest loss at both local and national levels is not known with any accuracy. [11] argued that the often-quoted rates of deforestation for Nigeria were based on mere estimates or surrogate data rather than empirical studies. Most of the vegetation maps produced by international organizations, such as FAO, for the country are nothing more than broad generalizations which are not usually in tandem with local realities and are therefore of little use to local authorities for planning purposes. Moreover, literature is sparse on the spatial and temporal patterns of deforestation, which indicates a gap in knowledge.[1;9]

Sustainable development goal is its target number15.3 on land degradation neutrality (LDN) encourages nation to endeavor for land degradation neutral world by halting desertification and restoring degraded land by 2030 (United Nation General Assembly). This is a unique opportunity for countries to halt the growing threat of land degradation and reap multiple socio economic benefits of land degradation neutrality [35]. Other development agenda such as water security, poverty eradication, economic growth, gender equality and climate change adaptation, solely depend on how land is managed.

2.0 Materials and methods

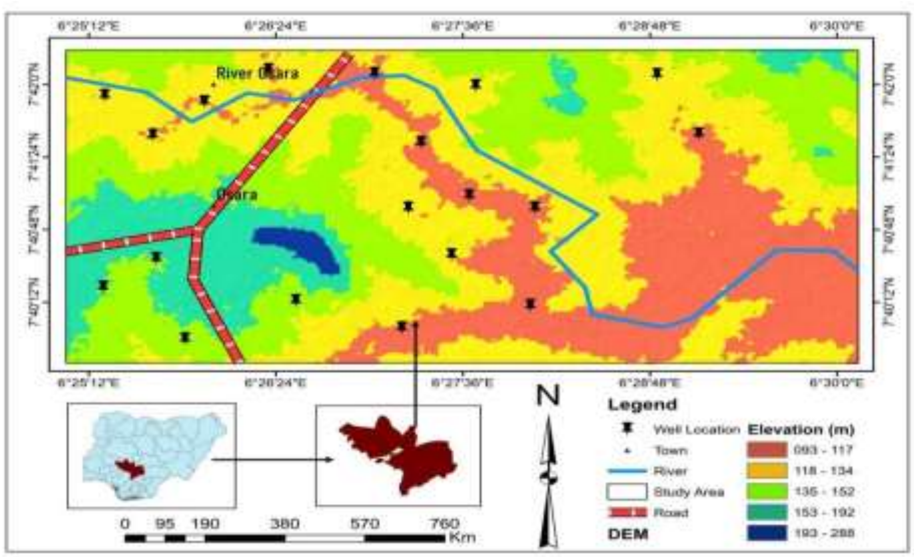

Figure 1- map of Osara showing study sites.

2.1 DESCRIPTION OF THE STUDY AREA

Osara is located in Adavi Local Government Council of Kogi State with latitude of 7° 40' 52" N and longitude of 6° 25' 42" E. Adavi Local Government Council of Kogi State was created from Okehi Local Government Area on 27th August, 1991 along with the creation of Kogi State. The Local Government council which is located in the central part of Kogi State has Ogaminana as its headquarters. Adavi Local Government Council is located between latitudes 7°15′ - 8°51'N and longitudes 6° - 6° 5'E. The council is bounded in the North by Okehi LGA, in the west by Okene Council, in the East by Lokoja LGA and in the south by Ajaokuta LGA. (www.google.com)

2.2 STUDY SITES

The area gazetted for this study was the part of the university initially marked as the botanical garden along with its contiguous woodland in the campus of Confluence University of Science and Technology, Osara. These areas have shown evidence of past human encroachments of some sort including farming, grazing and light mining of stones and gravels for building construction.

2.3 Floristic Studies

The floristic studies parameters were conducted from late July - early September 2024. The 250 plot (0.25ha) was sectioned in to fives strips of 10m×50m. Within each strips, total woody plants and herbaceous identification and enumeration were carried out. Each plant was identified and basal diameter of each woody plant (except wildings) was measured with measuring tape. Each plant was identified using an alpha identification method with the help of flora of tropical West Africa (3rd edition) and field experts, appropriate plant identification apps, photographs were also taken for documentation purposes.

2.4 Sampling Design and Data Collection

The vegetation of study area was extensively surveyed in order to determine the patterns of plant species diversity across various sampling sites within the areas. Three major vegetation types area were categorized based on land use pattern

a Area with past evidence of mining activities

b Cultivated area

c Overgrazed areas

A plot measuring 0.5km×0.km was mapped out across the land use pattern, representing segments of vegetal exploitation in the study sites, within each of these plots two clusters of 50m×50m (0.25 ha) was set up avoiding the edge of the larger plot by at least 50m

The dry weight of herbaceous plant in each location was reported separately as herbaceous plants yield.

2.5 Floristic Data Analysis

2.5.1 Species richness will be estimated using Mechinick index

$$D = \sqrt[\frac{S}{\square}]{n} \quad (1)$$

where
D= species richness
S= number of species
N= Total number of individual Species diversity (is measurement of species richness and species evenness) this will be calculated using;

2.5.2 Shannon-Wiener index (H')

$$H' = \sum_{i=I}^{S} PiLnPi \quad (2)$$

where
s= is the number of species

Pi= is the relative abundance of each species, taken as the proportion of individual of a given species, to the total number of individual in the community.

2.5.3 The Simpson's index of diversity is better than Shannon -wiener index as it take into account the degree of evenness of all the species present simultaneously in the entire study area

$$D = 1- \frac{\sum \square_n (n-1)}{N(N-1)} \quad (3)$$

2.5.4 Species evenness of the plot will be calculated using Pielou index.

$$E = \frac{H}{Logs} \quad (4)$$

where

H= Shannon -wiener index,

S=natural logarithm of number of species in base 10

2.5.5 Similarity index was used to compare plant species composition across vegetation types using Sorenson's' Index. [43]

$$SI = \frac{k}{k+a+b+c......+n} \times 100 \quad (5)$$

where k is the number of plant species common to all the vegetation types A,B,C……while a,b,c…..are number of species unique to sites A,B,C respectively.

2.6 SOIL STUDY

15 soil samples were collected, with the use of auger and bulk soil sampler. The bulk samples were measured from (0-20cm) while the auger sample was measured from (20-40cm). The following analyses were taken: Soil moisture, Organic carbon, PH, Nitrate nitrogen, Phosphate and Electrical conductivity. The collected samples were securely transported quickly to Department of Environmental Soil Science Laboratory, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba for processing and analysis.

The methods and instruments used in the analyses of the various parameters are as follow:
PH in H_2O, pH in Kcl, EC was analyzed electronically using pH Meter (HI 9813-6. Made in Romania

Percentage Organic Carbon, Percentage Organic Matter & percentage Total Nitrogen was analyzed by: The Walkey-Black Wet Oxidation (Titration) & for percentage Total Nitrogen: it was analyzed by Kjeldahl method.

Available phosphorus (mg/kg) analyzed by Bray P-1 Instrument Used: UV/VIS Spectrophotometer (UV 752) PEC MEDICAL, USA.

Effective Cation Exchangeable Capacity (Cmol/kg) was analyzed by summation method

Instrument Used: Flame Photometer (JENWAY PFP 7, ENGLAND).

Particle Size Analysis (%) Method Used: Hydrometer.

3.0 RESULTS AND DISCUSSION

3.1 FLORISTIC ANALYSIS OF SAMPLED PLOTS

The results presented in this table showed that six herbaceous species were recorded, with seven woody species. The result revealed evidence of serious degradation as a result species like *Daniela oliverii, Piliostigma thoningii and Vitex simplicifolia* only exist as wildlings (evidence of regenerative stress). The removal of trees for mining and farming activities further worsen this condition which bring about low diversity as shown in Table 1.1a

The second plot shows a better copious quantitative growth than the first plot. Tall trees form a continuous close canopy typical of savanna woodland. Diversity is higher with less dense herbaceous stratum. 15 woody species were encountered with 8 herbaceous species in the herbaceous floor flora. Other than land clearing for farming activities, evidence of massive charcoal production was observed within the study plot. The fuel wood and charcoal business have rendered species like *Anogeisus leiocarpus , Diospyros mespiliformes, Combretum sp Prosopis africana, Pterocarpus erinaceous* and *Daniella oliverii* relatively scarce in terms of numbers of individuals a sure sign of vegetative vulnerability to further degradation. What was common was the replacement of woody species by succulents like *Piper umbellata, Syzygium jambos* there was also increase in the number of *Agave sisalana, Hiptis suaveolense, Sida acuta, Chromolaena odorata, Funaria sp. (bryophyta) Loranthus sp.*
The results in table 1.1c below revealed the physiognomic structure of plot 3. The plot has the most dense growth forms within the sampled area. The plot recorded new species that were not seen in the previous plots – the presence of *Entalda africana, Thaumatococcus danielli, Securidaca longipedunculata and Tectona grandis* make this plot unique, the dominant species is *Thaumatococcus danielli..* Herbaceous stratum consist of *Hiptis suaveolense, Crotalaria retusa, Puereria phaseoloides, Chromolaena odorata, Mimosa diplotricha and Strophanthus hispidus.*
The study revealed that, the plants encountered were classified into 14 families, with total individuals of 392; the major botanical entities were of Caesalpiniodeae and Combretaceae. There were evidences of incursion of species peculiar to dry and semi-arid region such as *Acacia siberriana, Dichrostachys cinerea, Acacia ataxacantha, Borassus aethiopum.*

3.2 Beta – Diversity of the plots- (Vegetation Analysis Description)

In this analysis, the three plots that were evaluated for these diversity indices- evenness, similarity, and herbage yield showed that each plot presents unique characteristics, which help to understand the biodiversity and ecosystem structure within the study areas. The Shannon-Weiner index (H') measures species diversity in each plot, with higher values indicating greater species richness and evenness Plot 2 exhibited the highest species diversity, followed by Plot 3, with Plot 1 showing significantly lower diversity. Plot 2 represents areas marked with farming activities which implies that farming activities impact less negative effects on diversity than mined area and heavily grazed areas, higher values indicate a more diverse ecosystem. The Diversity index (D) which revealed the richness of the ecosystem, showed interestingly that, Plot 1 has the highest diversity, according to this index, contrary to the Shannon-Weiner results, suggested that different factors might be responsible for these outcomes.

Simpson's index of diversity showed; that the probability that two individuals randomly selected from a sample will belong to different species. Higher values reflect greater diversity. Again, Plot 2 is the most diverse based on this metric, followed by Plot 3, while Plot 1 shows the least diversity. Evenness measures how equal the populations of different species are within a plot. Plot 2 exhibits the most even species distribution, with Plot 1 showing very low evenness, indicating that a few species dominate the ecosystem in Plot 1

3.2.1 Similarity between Plots

The highest similarity is observed between Plot 1 and Plot 3, while Plot 1 and Plot 2 show the least similarity. This indicates that the species composition between Plot 1 and Plot 3 is more alike compared to the other pairings.

Similarity across Plots

This value suggests low overall similarity between the species compositions across all three plots, indicating a fairly diverse ecosystem across the landscape

3.3 HERBAGE YIELD

Herbage yield refers to the biomass produced in each plot, measured in kilograms per square meter per hectare ($kg/m^2/ha$).
Plot 1 shows the highest herbage yield, followed by Plot 3, while Plot 2 has the lowest yield. This suggests that Plot 1 supports greater biomass production in the herbaceous substratum. Plot 3 contributes the most to the overall herbage production, followed closely by Plot 1. Plot 2 has a significantly lower contribution to the total herbage yield.
In summary, Plot 2 (areas with heavy cultivation) stands out with the highest species diversity and evenness, despite having the lowest herbage yield. Plot 1 (Areas with Mined Activities), while showing the least species diversity and evenness, has the highest herbage yield. Herbage yield is supported by open areas with fewer trees. Plot 3

(overgrazed areas) strikes a balance between the two extremes, having relatively high diversity and yield. The low similarity across the plots suggests considerable variation in species composition, highlighting the ecological heterogeneity within the study area.

3.4 Results of Laboratory Soil Analyses

This soil analysis evaluates the chemical and physical properties of three soil samples, Areas with Evidence of Mining, Cultivated Areas and Grazed environment. The parameters measured include pH, organic matter content, total nitrogen, electrical conductivity, phosphorus, effective cation exchange capacity, and particle size analysis. The results provide insights into soil fertility, structure, and potential productivity

1. PH Analysis

PH in water measures the acidity or alkalinity of the soil, with lower values indicating more acidic soils the results indicate that the mined soil sample is moderately acidic, while the two other sample analyzed were slightly acidic. PH in KCL shows a more precise result though consistent with pH in water.

2. Organic Carbon (OC) and Organic Matter (OM)

Percentage Organic Carbon

Organic carbon is an indicator of soil organic matter, crucial for nutrient retention and soil structure the Soil sample collected from grazed areas has the highest organic carbon content, suggesting greater organic material in this sample.

Percentage Organic Matter

Organic matter is derived from organic carbon and represents the total organic components in the soil Similar to organic carbon, grazed areas has the highest organic matter content, while Mined areas shows the lowest.

4. Total Nitrogen (TN)

Nitrogen is an essential nutrient for plant growth. The highest total nitrogen content is found in **cultivated site**, indicating potentially greater fertility, while **mined area** has the least.

4. Electrical Conductivity (EC)

Electrical conductivity reflects the soil's salinity levels. Higher EC indicates higher salt content. All samples have low EC values, indicating low salinity and minimal risks of salt stress on plants.

5. Phosphorus (P) Content

Phosphorus is another critical nutrient for plants, affecting root development and flowering .Cultivated area has the highest phosphorus content, which is beneficial for plant nutrition, while the other samples have relatively lower levels.

6. Effective Cation Exchange Capacity (ECEC)

The cation exchange capacity (CEC) measures the soil's ability to hold onto essential nutrients, including sodium (Na), potassium (K), magnesium (Mg), and calcium (Ca). From the results the ECEC is highest in cultivated area than all other sites which is an indication of the soil fertility potential.

7. Particle Size Analysis

Silt (g/kg); the results shows a greater potential for silt in overgrazed areas than cultivated areas while the least occur in mined area

Clay (g/kg): The cultivated site and grazed areas are very similar in terms of clay composition while the mined area has very low clay composition.

Sand (g/kg): The Mined area has a very high sandy composition compared to grazed or cultivated areas in the study sites.

The remote sensing satellite data extrapolated backward for ten years, the result shows similar soil acidity moderately acidic to strongly acidic soils with a slight increase in soils chemicals characteristic acidic properties especially with reference to areas with mining activities, cultivated areas also show very minute increase in acidic properties by virtue of heavy use of agro-based chemicals.

Past studies revealed that direct indicators (mineral compositions, organic matter, surface roughness and moisture content of soil) and indirect proxies (Vegetation condition and land use/land cover change) are effective tool for evaluating soil degradation based on RS [28] Soil degradation is a highly non-linear process with strong temporal dynamics and spatial heterogeneity which cut across many field [28].

The soils of the area shows silt- loam texture in the past, as shown by the data, the present result shows sandy clay loam composition. The general vegetation structure over the years under review revealed that members of the family

Palmae (Ralphia palms) with dense population of ferns in close epiphytic communities which suggest a dense and conspicuous forest growth of some sort.

TABLE 1.1A: ALPHA DIVERSITY OF PLOT 1 (Area with Past Evidence of Mining Activities)

PLOT	BOTANICAL	FAMILY NAME	N	N1	Lini	PiLinPi	D		
1	*Piliostigma thoningii*	*Caesalpinaceae*		10	0.08	-2.53	0.2024		0.917
2	*Combretum ghaselense*	*Combretaceae*	15	0.13	2.56	0.3328		1.376	
3	*Vitex simplicifolia*	*Verbanceae*		112	0.10	-2.30	-0.23		1.100
4	*Annona senegalensis*	*Annonacease*		10	0.08	-2.53	-0.2024	0.917	
5	*Combretum molle*	*Combretaceae*	1	0.008	-4.83	-0.0386	0.092		
6	*Nauclea leucocephala*	*Rubiaceae*	1	0.008	-4.83	-0.0386	0.092		
7	*Damela oliverii*	*Caesalpiniodeae* 70	0.588	-0.531	-0.3122	6.422			

TABLE 1.1B: ALPHA DIVERSITY OF PLOT 2

WOODY ANALYSIS	FAMILY NAME	N	NI	lnpi	piLinpi		D	
Combretum ghaselense	*Combretaceae*		6	0.055	-2.900	-0.1595	0.577	
Vitex Laxiflora	*Verbanaceae*		6	0.055	-2.900	-0.1595	0.577	
Piliostigma Thoningii	*Caesalpinacea*			12	0.111	-2.198	-0.2440	1.155
Combretum glutinosum	*Combretaceae*		2	0.018	-4.017	-0.0723	0.192	
Diospyros mespiliformes	*Ebenaceae*		5	0.046	-3.079	-0.1416	0.481	
Anogeisos leiocarpus	*Combretaceae*			11	0.101	-2.293	-0.2316	1.058
Ziziplius mucronata	*Rhamnaceae*			4	0.037	-3.296	-0.1055	0.385
Annona senegalensis	*Annonaceae*			12	0.111	-2.198	-0.2440	1.155
Daniella oliveni	*Caesalpinodeae* 12		0.111	-2.198	-0.2440	1.155		
Gardenia aqualla	*Rubiaceae*		19	0.176	-1.737	-0.3057	1.829	
Prosopis africana	*Mimosoideae*			6	0.035	-2.900	-0.1595	0.577
Combretum molle	*Combretaceae*		6	0.035	-2.900	-0.1595	0.577	
Pteocarpu serinaceou	*Fabaceae*		4	0.037	-3.296	0.1055		0.385
Syzygium jambos	*Myrtaceae*		1	0.009	-4.710	-0.0424	0.096	
Piper umbellata	*Piperacae*		2	0.019	-3.963	-0.0753	0.192	

TABLE 1.1C: ALPHA DIVERSITY OF PLOT 3

TABLE 1.1c	FAMILY		n	n1		linP1	P1linP1	D
Diospyrors mespiliformes	*Ebenaceae*	1	0.0060		-5.115	-0.0307	0.072	
Combretum ghaselense	*Combretaceae*	07	0.0424		-3.160	-0.1340	0.545	
Anogeusis leiocampus	*Combretaceae*		11	0.0666		-2.709	-0.1804	0.856
Daniella oliveni	*Fabaceae*	08	0.0484		-3.028	-0.1466	0.623	
Nauclea leucocephala	*Rubiaceae*		3	0.0181		-4.012	-0.0726	0.234
Vitex simplicifolia	*Verbanaceae*		17	0.0130		-2.273	-0.2341	1.324
Annona senegalensis	*Annonaceae*		16	0.0969		-2.334	-0.2262	1.246
Combretum molle	*Combretaceae*	20	0.1212		-2.110	-0.2558	1.557	
Entada Africana	*Fabaceae*	8	0.0484		-3.137	-0.1518	0.623	
Thaumatococeus danielli	*Marantaceae*	67	0.4061		-0.901	-0.3659	5.218	
Securidaca longi pedunculata	*Polygalaceae*		5	0.0303		-3.497	-0.1060	0.389
Tectona grandis	*Lamiaceae*	2	0.0121		-4.415	-0.0534	0.156	
	TOTAL	**165**						

Table 2.1: SUMMARY OF WOODY SPECIES ON FAMILY BASIS

S/NO	FAMILY	NUMBER
1	*Caesalpinaceae*	104
2	*Combretaceae*	79
3	*Verbanaceae*	35
4	*Annonaceae*	38
5	*Rubiaceae*	23
6	*Ebenaceae*	06
7	*Rhamnaceae*	04
8	*Mimosoideae*	06
9	*Fabaceae*	20
10	*Myrtaceae*	01
11	*Piperaceae*	02
12	*Marantaceae*	67
13	*Polygalaceae*	05
14	*Lamiaceae*	02
	TOTAL	**392**

Table 2.2: Beta – Diversity of the plots- (Vegetation Analysis Description)

Diversity Indices	Plot 1	Plot 2	Plot 3	Mean value
H'	0.691	2.450	1.950	1.697
D	1.559	0.6930	1.070	1.107
1-D	0.6189	0.9121	0.7928	0.775
Evenness	0.1446	0.5232	0.3819	0.349
Similarity between plots	36.36%	38.46%	44.44%	39.75
Similarity Across plots		21.42%		
Herbage Yield	1.892	0.835	1.568	1.431
Biomass	39.38%	29%	41%	36.46%

Table 3.0: Table Showing Physicochemical Properties of Soil Samples from Three sampling Sites

Physiochemical.	**A**	**B**	**C**	**Mean value**
PH in H20	5.60	6.10	6.00	5.90
PH in KCl	4.90	5.20	5.30	5.13
% OC	0.61	1.13	1.24	0.99
% OM	1.05	1.95	2.14	1.71
% TN	0.041	0.076	0.083	0.066
EC mS/cm	0.22	0.19	0.20	0.20
P mg/kg	2.92	2.80	4.27	3.33
Na	0.45	0.31	0.37	0.38
K	1.43	1.90	2.02	1.78
Mg	1.58	1.97	2.28	1.94
Ca	3.29	4.01	4.27	3.86

TEB	6.75	8.19	8.94	7.96
Ex Acidity	1.13	1.02	1.09	1.08
ECEC	7.88	9.21	10.03	9.04
SILT (gkg-1)	37.73	154.73	151.73	114.73
CLAY (gkg-1)	76.93	268.93	273.93	206.60
SAND (gkg-1)	885.30	576.34	574.34	678.66
TC	S	SCL	SCL	

OC = Organic Carbon, OM = Organic Matter, TN = Total Nitrogen, EC = Electrical Conductivity, P = Phosphorus, TEB = Total Exchangeable Bases, Ex = Exchangeable and TC = Textural Class, S = Sand, SCL = Sandy Clay Loam.

A- Mined-site B-cultivated-site C-Grazed-site

The conversion of initially vegetated areas of the studied green spaces into almost bare soil modified the physical soil structure. Soil collected and analyzed from mined site has higher textural components as compared with others sites. The study also revealed that vegetated soils present higher levels of organic matter than bare soils. High organic matter content is good indicators of structural strength and resilience to compaction. This observation is in line with [19]. The observation from this study is corroborated by [15; 31]. [15; 16], asserted that leaving soil unvegetated/uncovered exerts a negative influence on physical characteristics desirable for the provision of ecosystem services.

[30] Emphasized that the impact of precipitation intensity on the environment is relative and depends on several factors (nature of the soil, anthropogenic influences) but more importantly on vegetation cover. Vegetated soils with a high CEC and a large quantity of organic matter promotes ecosystem services related to nutrient cycling [12] A high organic matter content is a good indicator of soil fertility. [10; 11]

Evidenced from past research showed that mineralization was also affected by vegetation degradation by virtue of a lower C/N ratio in bare soils than in vegetated soils. The C/N ratio is an indicator of the level of degradation of organic matter. It is commonly accepted that the higher the C/N ratio of organic matter is, the slower it decomposes in the soil and the more stable the humus obtained. [8]

4.0 CONCLUSION

The contribution of soils to human well-being beyond food production requires very deep acknowledgement and this can be achieved by integrating soils into the ecosystem services framework and linking it to the multitude of functions it provides. [2]. Soil ecosystem services depend on soil properties and their interactions and are mainly influenced by its use and management. [2; 13; 14 33].

The study area is rich in terms of floristic diversity, with plants species moderately distributed across the study area, vegetation diversity indexes showed that the area is highly heterogeneous ecosystems that hold a great potential for biodiversity conservation.

The woodland under consideration is rich but highly vulnerable to further deterioration which the forest might not recover from if the current trend continues unabated. The study shows that mined areas and grazed area have similar species composition with a higher potential or capacity for woody species being replaced by herbaceous species, which might further reduce the vegetation complexity to simple ones.

The Soil Physicochemical characteristics showed that the soil chemical nature is relatively stable for the past ten years, the grazed areas and cultivated areas hold potential for high nutrient supply to crop plants. The soil is majorly sand clay loamy types, mined areas showed a greater degree of nutrient pauperization which may further worsen it to leaching and soil erosion. The study showed that the soil has been relatively stable only acidic properties and crop that can be supported need adaptation, hence requires proper management for better yield, organic farming is sure bet for this management technique.

ACKNOWLEGMENT
The authors acknowledgment the effort of Dr. Tanko Soil Science Laboratory, Department of Environment Soil Science, Faculty of Agriculture, Prince Abubakar Audu University, Anyigba.

REFERENCES

[1] Adesina, F.A (1997) Vegetation degradation and environmental changes in the tropics.Ife research publication in 6 (12 *geography)*, 68-78.

[2] Adhikari K, Hartemink A. E (2016) Linking Soils to ecosystem services- A global review. *Geoderma,* 262 (2016), Pp. 101-111

[3] Aina T.D and Salau A.T.(1992) The challenges of sustainable development in Nigeria Ibadan ; Nigeria Environmental Study\Action Team (NEST)

[4] Agray-Mensah W. 1985. Ethiopian highland reclamation study: Cost and benefit analysis of alternative strategy proposals for reclaiming and developing the Ethiopian highlands.EHRS Working Paper 18. Food and Agriculture Organization of the United Nations (FAO)/United Nations Development Program (UNDP)/Ministry of Agriculture (MOA), Addis Ababa, Ethiopia. 115 pp.

[5] Alvarez, E, and Tippins, S. (2019). Socialization agent that Puerto Rican college student use to make financial decision .journal of social change,11(1) 75-85.

[6] Areola, O.(1994) Geography sense and national development .The nigerian Geographical journal, New serial 1,20-35

[7] Arokoyo, S.B (1999) "Environmental degradation resource alienation and activities; A case Study Eleme local Government Area of Rivers state, Nigeria "Abstracts of paper presented at the 42nd Annual conference of the Nigeria Geographical Association, held at Ogun State University, Ago Iwoye. Nigerian May 16-20th, In S. O. Onakomaiya & K.T.Gbadamosi (eds),Geographical perspectives on Nigerian development in the next millennium. Ijebu- Ode, Ogun state, top speed press. pp 88-89

[8] Assandri D, Pampuro, N. Zara, G, Cavallo, N. and Budroni, M (2020), Suitability of Composting processing for the disposal and valorization of brewers's spent grain. *Agriculture 11 (1) (2020), P.2*

[9] Babbies, E. (1998). The practice of social research (8th ed.).Abanny NY:Wadsworth Publishing

[10] Barber, R. 1984. Ethiopian highland reclamation study. An assessment of the dominant Soil degradation processes in the Ethiopian highlands: Their impacts and hazards. EHRS Working Paper 23. Food and Agriculture Organization of the United Nations (FAO)/United Nations Development Program (UNDP)/GOE (Government of Ethiopia) Addis Ababa, Ethiopia. 82 pp.

[11] Boroffice, R.A (2006). Press conference Address at International stakeholder' workshop on Geo-Information system-Based forest monitoring in Nigeria (GEOFORMIN) March 27-30, 2006 at NUC Auditorium, Maitama, Abuja. Cassel-Gintz, M.& Petschel-Hels, G. (2001).GIS-based assessment of the threat to world forests by patterns of no sustainable civilization nature interaction. Journal of Environmental management, 59, 279-298

[12] Blanchart A, Sere, G, Stas M. (2007), Contribution Des sols a La production de services Ecosystemiques En Milieu Urban-Une Revue Soils Contribution to the production Ecosystem Services in Urban Areas- A Review.

[13] Dominati, E. Patterson, M. Mackey, A. (2010) A Framework for Classifying and quantifying the Natural capital and ecosystem services of soils. *Ecol. Eons*; *69(9) (2010), pp-1858- 1868.*

[14] Dominati, E. Mackey, A. Green, S, and Patterson, M. (2014), A Soil Change based Methodology for the Quantification and Valuation of Ecosystem Services from Agro ecosystems; A Case Study Pastoral Agriculture in New Zealand. *Ecol. Econ., 100 (2014), pp 119-129.*

[15] Jim C.Y (1993), Soil Compaction as a constraint to tree growth in tropics and Subtropical Urban Habitats. *Environ. Conserve, 20 (1) (1993), Pp35-49*

[16] Jim C Y (1998) Physical and Chemical Properties of Hong Kong Roadside Soil in Relation to Urban Tree Growth Vol.2 (1998).

[17] FAO (2001) .Global forest resources assessment 2000: Main report. FAO forestry paper No.140.Rome (www.fao.org\forestry\fo\fra\main\index.jsp)

[18] FAO (food agricultural organization) (1983) forest product price No.46, 1963 1982.Rome: FAO of the United Nations.

[19] Grace Q .M, Bazirake, B M, Gilles C, Gregory M (2024), *Geoderma Regional* vol. 37, June 2024; COO 810

[20] Hurni H. (1988a). Degradation and conservation of resources in the Ethiopian highlands. Mountain Research and Development 8(2/3):123-130.

[21] Hurni H. (1993). Land degradation, famine and land resources. Scenarios in Ethiopia. In: Pimentel D. (Ed), Soil erosion and conservation. Cambridge University Press, Cambridge, UK. Pp.27-62.

[22] Ibah, L.(2001) The Nigerian Environmental score sheet "The punch, Thursday, January 11, pp. 29.

[23] Ikhuoria, I A (1993). Vegetation and land use changes in rainforest ecosystem, Nigeria, *Journal of Remote sensing, 1, 73-82*

[24] Jaiyeoba I.A (2002) Environmental atlas of Nigeria (pp.122-123) Paris: Les Edition, JA

[25] Jerrentrup, A. Mueller, T. Glowalla, U. Herder, M. Henrichs, N. Neubaver, A.J & Schaefer, J.R (2018) .Teaching medicine with the help of 'Dr House' plos one,

[26] Jimoh, H.I (2000). Man-Environmental interaction in H.I. Jimoh &J.P Ifabiyi (eds) Contemporary issue in Environmental studies (pp.20-24). IIorin: Hay1998 tee press & Publishing

[27] Jingzhe W, Jianing Z, Weifang H, Songchao C, Ivan L, Mojtaba Z, Xiaodong Y (2023), International Soil and Water Conservation Research, Volume 11, Issue 3, September 2023 Pp 429-494.

[28] Keesstra S D, Bourma J, Walhnga J, Tittonell, P, Smith, P. Cerda A, (2016), The Significance of Soils and soil Science towards realization of the United Nations, Sustainable Development goals. Soil, 2 (2016), pp. 111-128

[29] Krueger, R.A (1998). Focus groups. Newbury Park, CA: sage.

[30] Krauer, J. 1988. Rainfall, erosivity and isorodent map of Ethiopia. Soil Conservation Research Project Report 15. University of Berne, Switzerland. 132 pp. Lines, C.Bolwell, L & Norman (1997) Geography study guide GCSE (pp. 152-153), Letts Educational London.

[31] Lehmann A, Stahr K, (2007), Nature and Significance of anthropogenic Urban Soils. *J. Soils sediments, 7 (4) (2007), Pp, 247-260*

[32] Lui, X., (2002). Impact of land use change on Soil physiochemical characteristics Environmental Research Letters, 17(3), 03400. doi: 10. 1088/1748-9326/acf2b

[33] McCartney, A. Field D.J, Koch A. (2014),The Dimensions of Soil Security. *Geoderma, 213 (2014). pp.203-213*

[34] Nagele, G. and Spencer k.(1997) Advanced Geography :Revision handbook(p. 79) Oxford University; Oxford.

[35] Nkonya, E., Braun, J. Von, and Mirzabaev, A. (2016). A Global Assessment for Sustainable Development. Journal of Economics of Land Degradation and Improvement, 16 (1), 15–33.

[36] Ogunsanya A.A (2000). Contemporary Issues in Environmental Studies. IIorin: Haytee press & publishing

[37] Okafor, F.C (1988) Rural development and the environment degradation versus protection. In P.O sada & F.O Odemerho (Eds.), Environmental issues in Nigerian development. Ibadan, Nigerian; Evans brothers

[38] Olofin, E. A (2000). Geography and Developmental Monitoring for Effectives Resources Management. *The Nigerian Geographical journal, 3& 4, 5-8.*

[39] Olokesusi, F (1992) Environment Impact Assessment in Nigeria; Current Situation and Future. *Journal of Environmental Management, 35, 163-171*

[40] Olorunfemi, J.F, & Jimoh H. I (2000) Anthropogenic Activities and the Environmental. In H.I. Jimoh & J.P Activities and the Environment. In H.I. Jimoh & J. P Ifabiyi (Eds), Contemporary issues in Environmental Studies (pp.25-44). London; *Earth scan Publication*.

[41] Rees, W E.(1990). The ecology of sustainable development. *The Ecology, 20, 18-23*

[42] Rowe, R. N, Sharma, N. P,& Browder, J. (1992). Deforestation; problems, cause and Concerns. In N.P. Sharma (Eds), Managing the world's Forests; Looking for balance between conservation and developing (pp. 33-45). Lowa; Kendal\Hunt publishing

[43] Singh, A., et al. (2002). Soil Physiochemical Characteristics and their Effects on Plant Growth. *Plant and Soil, 75(1-2), 1-17. doi:10. 1007/s1110-022-05351-4"integrated assessment of soil physiochemical characteristics for ecosystem management" (2022)*

[44] Smith, L. G. (1993). Impact assessment and sustainable resource management. Longman Harlow. *Soil chemical properties and their impact on ecosystem services (2022)*

[45] Solomon Abate. 1994. Land use dynamics, soil degradation and potential for sustainable use in Metu area, Illubabor Region, Ethiopia. University of Berne, Switzerland. 135 pp.

[46] Abeauel, M,& Simon, L. (1996). Forest and greenhouse warning, (forest et. Rechauffement global) Bulletin Association de Geographes . Francais 1996, 4,313-323

[47] Taylor, D.M, Hortin, D., Parnwell, M. J. G, & Marsden, T.K. (1994). The degradation of rainforest in Sarawak, East Malaysia, and its implication for future management policies *Geoforum , 25(3), 351-369.*

[48] Thomas D.B. 1997. Soil and *water* conservation manual for Kenya. Soil and Water Conservation Branch, Ministry of Agriculture, Nairobi, Kenya. 296 pp.

[49] Thomas Tolcha. (1991). Aspects of soil degradation and conservation measures in Agucho Catchment, West Hararghe. Soil Conservation Research Project Report 19. University of Bern, Switzerland. 125 pp.

[50] Van Raji B, de Andrade JC, Canterella H and Quaggio J A (ed) (2001)

[51] Young R.A. and Wiersma J.L. (1973). The Role of Rainfall Impact on Soil Detachment and Transport. Water Resources Research 9(6): 1629-1636.

[52] Zhang, Y. (2002). Integrated assessment of soil physiochemical characteristics for Ecosystem management. Ecological indicators, 136, 108436. doi: 10. 1016/j.ecolind. 2022.108436