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Evaluation of the Effects of Sand and Laterite Excavation in Selected Open Pits in Ondo State, Nigeria.

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Abstract: The study investigates the degree of land degradation resulting from sand and laterite excavations in eleven selected locations in Ondo State Nigeria. The objectives of the research were achieved through field visitation, digital photography, collection of field data and samples analyses. Well structured questionnaire was also prepared and administered to the people in the field. The collected samples (sand and laterite) were taken to the laboratory for the determination of physical properties, Moisture content, particle density, bulk density, soil texture and the percentage composition of clay, silt and sand and Chemical properties pH, Na, Ca, P, and percentage compositions of the N, P and OM. Water samples were also collected and analyzed in the laboratory using Atomic Absorption Spectrometer (AAS). The determined physical and chemical properties were subjected to statistical analysis using SPSS model 2.0. There are significant loss of forest in the excavated areas compared to the control (unexcavated) locations. The activities of the people in the study area is mainly farming; cultivation of food crops (62%), cocoa farming (13%), hunting (13%) and fire wood fetching (12%). The level of reclamation of the excavated areas after the exploitation of the available resources is zero as it is evidence from all the sites and respondents from the structured administered questionnaires. There are scattered excavated sites with deformed landscape and there is no reclamation of the pits by the operators.

Key Words: Degradation, Excavation, Land , Laterite, pits, Sand, Scattered and unreclaimed.

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1. INTRODUCTION

The extraction of minerals in Nigeria especially by the open pit process causes change of the land surface. The most common destruction of the rural landscape is caused by indiscriminate quarrying of sand and laterite as well as gravels for road construction and building purposes (Udo, 1990).

Sand and laterite quarrying and land degradation are connected. Nigeria recognizes that if mining activities are not properly regulated, it can have adverse environmental and social consequences hence the role of the Ministry of Solid Minerals Development in controlling all quarrying including sand and laterite excavations cannot be over emphasized joined by other stakeholders on environmental management.

Mining is essentially a destructive development activity where ecology suffers at the altar of economy. Scientific mining operations accompanied by ecological restoration and regeneration of mined wastelands and judicious use of earth resources with search for eco-friendly substitutes and alternatives must provide sensational revelation to the impact of mining on human ecosystem (Geerken and Ilaiwi, 2004).

The need for sand and laterite for building, backfills and road construction is on the increase due to massive infrastructural development in Ondo State. Environmental degradation extends beyond the excavation and surface areas of both surface and subsurface. Large mining operation disturbs the land by directly removing material in some areas and dumping waste in others, thus changing the topography (Botkin and Edward, 2006). The search for and extraction of mineral resources is one of such activities through which the environment suffers damages. Man has always been conspicuous in his abi1ity to alter the surface of the earth for various purposes. Pockets of mining pits and it abandonment have caused serious negative environmental and ecological impact (Akande, 2013). The physical result of indiscriminate open pits quarrying of sand and laterite is a topic of public concern. It is against this background that the study is designed to examine land degradation due to sand and laterite excavations in Akure and other parts of Ondo State, Nigeria. Mining was a primary activity that has competed with farming in the area.

1.1 LOCATION OF THE STUDY AREA

The study areas are in Ondo State in the Southwest of Nigeria and lies within Longitude 4° 20' and 6° 00' East and Latitude 5° 45' and 7° 45' North. The locations are; Shagari, Kajola Olokuta, Oke-Oge, Ilu Abo, Eleyeowo, Ipele-owo, Ore, Okitipupa and Ile-Oluji.

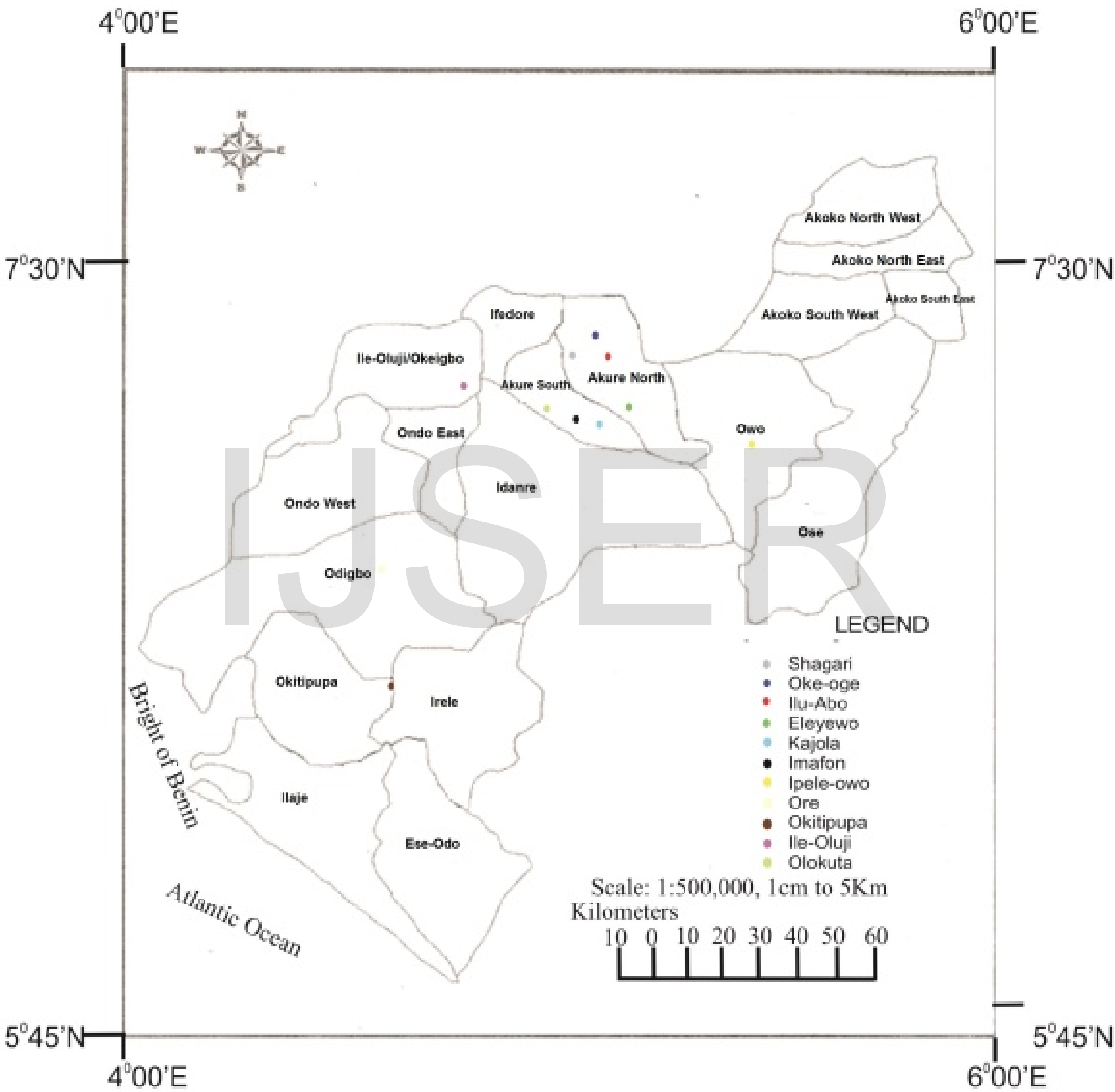

Figure 1: Location Map of Study Area (Ondo State Ministry of Lands and Housing, 1977)

2. MATERIALS AND METHOD

General observations of the area were made and sample sites identified. The identification of sample sites was based on the stratified random sampling technique (Rejoice, 2013). Eleven sample locations were selected for detailed studies with a control location each for the selected locations. Each study area was divided into four sections for random sampling. The excavated and unexcavated sites were used to measure the vegetation parameters. Assessments of the pits were also conducted. The sources used in collecting data for this study were both primary and secondary sources. The primary sources of data were physical observation and interview conducted with the resident of the area at the various phases of the research work. Also, soil and water samples were collected and analyze for physical and chemical properties as well as the presence of heavy metals in the water.

Soil sampling

Soil samples were collected randomly from the fields at depths 0-20cm to have a good sample representation (Ibitoye, 2008) using a soil auger and shovel. Another set of soil samples were also collected at the same depths from undisturbed land at 100m away from the selected locations to serve as control. The soils were air dried for three days, ground and sieved through a 2mm sieve. These were stored in labeled crucibles in the laboratory for analysis using ASTMD (1992) standard.

Analyses of some physical and chemical parameters of soil samples

Particle size distribution analysis was determined by hydrometer method using sodium hexametaphosphate as dispersant. The texture class was also determined using the texture triangular diagram (NSTA Scilink, 2014).

The soil pH was measured using the glass electrode coupled pH meter.

The cation exchange capacity (CEC) was determined by extracting the cations with 10ml Ammonium Acetate ($NH_4OAC(aq)$) added to 10g of soil sample. The suspension was stirred for one hour filtered and filtrate collected. After centrifugation and filtration, the filtrate was transferred into a 100 ml flask of ammonium acetate solution (Jackson, 1962).

Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) were determined by Ethylene De-amine Tetra Acetic (EDTA) titration while Potassium (K) and Sodium (Na) were determined by flame photometer.

The percent Organic matter (%OM) was calculated from the organic carbon (OC) measured using Walkey-Black wet oxidation method. Total nitrogen (TN) was determined using the modified Kjeldahl distillation methods.

Percentage Nitrogen content on the soil was calculated as follows:

$$\%N = \frac{T \times M \times 14 \times 100}{\text{Weight of soil used}} \quad (1)$$

Where; T is the titre value and M is the molarity of HCl.

Percentage % organic Carbon (C) in soil is thus calculated using the formula:

$$\%C = \frac{(\text{Me}\,K_2CrO_2 - \text{MeFeS}\,O_4) \times 0.003 \times 10 \times F}{\text{gm of air dried soil}} \quad (2)$$

where F is the correction factor which is 1.33

Me is the Normality of solution + Volume of solution used in ml.

Soil and water samples collected from the study areas were digested by dissolving it in a mixture of 25ml concentrated nitric acid and 10ml of sulphuric acid solution atomized in an air-acetylene flame (Atomic Absorption Spectrometer (AAS)) to analyze the concentrations of heavy metals, Pb, Mn, Zn, Cu and Ni.

SPSS 2.0 was use to carry out the ANOVA test analysis of the data generated from the physical and chemical properties of the soil samples and results of the questionnaire.

3.0 RESULTS

Table 1 shows the density of the trees and shrubs for the excavated and unexcavated sites and the depth of pits. Table 2 shows the SPSS analysis of the physical properties while Figures 1 and 2 show the graphic analyses of the physical and chemical properties of the soil. Figures 3-5 presents the results of the respondents on economic activities, environmental impact and landscape deformation resulting from the sand excavation.

Table 1: Tree and Shrub Density at the Excavated and Unexcavated Sites

Plots	Unexcavated Site			Excavated Site			
	Vegetation type	Density	%	Density	%	Differences in Density	Depth of pits (m)
1	Trees	10	1.7	3	4.5	7	0.5 - 1.5
	Shrubs	40	7.0	4	6.1	36	
2	Trees	05	0.9	0	0	5	0.5 - 0.9
	Shrubs	55	9.6	5	7.6	50	
3	Trees	4	0.7	0	0	4	0.5 - 0.9
	Shrubs	43	7.5	4	6.1	39	
4	Trees	5	0.9	1	1.5	4	0.5 - 1.0
	Shrubs	44	7.7	6	9.1	38	
5	Trees	6	1.0	2	3.0	4	1 - 4.9
	Shrubs	49	8.5	8	12.1	41	
6	Trees	5	0.9	0	0	5	0.5 - 0.9
	Shrubs	50	8.7	5	7.6	45	
7	Trees	4	0.7	1	1.5	3	1 - 1.3
	Shrubs	49	8.5	6	9.1	43	
8	Trees	7	1.2	0	0	7	0.5 - 2.0
	Shrubs	48	8.3	3	4.5	45	
9	Trees	3	0.5	1	1.5	2	0.5 - 0.9
	Shrubs	50	8.7	2	3.0	48	
10	Trees	4	0.7	1	1.5	3	0.5 - 0.9
	Shrubs	44	7.7	6	9.1	38	
11	Trees	3	0.5	2	3.0	1	0.5 - 1.0
	Shrubs	47	8.1	6	9.1	41	
Total		575	100	66	100		

Table 2: Results of Statistical Analyses of the Physical Properties of Soil

Sample Code	MC (%)	WHC (%)	Db(g/cm^3)	Dp(g/cm^3)	Clay (%)	Silt (%)	Sand (%)
A	15.84±1.61	39.16±4.00	1.16±0.03	2.17±0.03	25.41±3.12	39.27±9.35	35.32±11.04
Ac	8.50±0.00	44.78±0.00	0.22±0.00	1.32±0.00	32.38±0.00	59.30±00	8.32±0.00
B	16.35±1.40	44.68±1.3	1.32±0.17	1.77±0.29	36.38±2.11	50.87±7.38	12.82±6.27
Bc	18.22±0.00	38.65±0.00	1.25 ±0.00	2.18±0.00	25.73±0.00	42.25±00	30.40±0.00
C	14.12±2.03	33.53±3.49	1.40±0.14	1.89±0.24	40.41±2.05	27.38±10.76	32.56±11.60
Cc	18.22±0.00	38.65±0.00	1.25±0.00	2.18±0.00	25.73±0.00	42.25±00	30.40±0.00
D	14.96±2.40	32.37±3.50	1.49±0.17	1.76±0.30	29.71±7.44	45.36±11.62	24.93±10.39
Dc	11.17±0.00	32.04±0.00	1.72±0.00	1.58±0.00	30.48±0.00	58.32±00	11.20±0.00
E	19.01±3.19	47.92±4.49	1.40±0.14	2.18±0.19	38.42±9.17	34.91±9.80	26.68±11.35
Ec	13.18±0.00	32.24±0.00	1.20±0.00	1.72±0.00	44.28±0.00	49.36±00	6.36±0.00
F	17.61±3.74	38.28±7.70	1.47±0.15	2.00±0.20	30.67±2.91	43.98±10.54	25.36±10.48
Fc	8.50±0.00	44.78±0.00	0.22±0.00	1.32±0.00	32.38±0.00	59.37±00	8.32±0.00
G	13.23±1.86	32.99±3.37	1.73±0.08	1.74±0.28	25.00±7.77	52.84±15.54	22.17±11.11
Gc	15.35±0.00	43.09±0.00	1.38±0.00	2.18±0.00	42.21±0.00	50.88±00	6.91±0.00
H	14.41±1.53	38.23±3.77	1.45±0.15	1.84±0.35	32.58±5.74	37.79±11.36	29.64±14.30
Hc	15.35±0.00	43.09±0.00	1.38±0.00	2.18±0.00	42.21±0.00	50.88±00	6.91±0.00
I	21.56±2.68	37.45±0.73	1.48±0.13	2.19±0.19	38.00±1.23	39.70±3.82	22.33±4.75
Ic	12.42±0.00	28.72±0.00	1.22±0.00	0.32±0.00	27.30±0.00	20.50±00	52.20±0.00
J	9.51±1.64	22.79±3.90	1.34±0.12	1.57±0.43	16.66±6.30	13.36±3.83	69.96±10.08
Jc	11.18±0.00	36.70±0.00	1.70±0.00	1.18±0.00	34.24±0.00	9.41±00	56.35±0.00
K	28.27±7.07	53.84±6.26	1.40±0.22	1.78±0.27	63.17±6.00	23.80±9.28	13.03±3.38
Kc	16.75±0.00	60.28±0.00	1.72±0.00	2.28±0.00	65.35±0.00	22.20±00	12.45±0.00

KEY:

S/N	1	2	3	4	5	6	7	8	9	10	11
Location	A	B	C	D	E	F	G	H	I	J	K
Control location	Ac	Bc	Cc	Dc	Ec	Fc	Gc	Hc	Ic	Jc	Kc
location Name	Shagari	Oke Oge	Ilu Abo	Eleyeow o	Kajola-Oda	Imafo	Ipele-Owo	Ore	Okitipu pa	Ile-Oluji	Olokuta

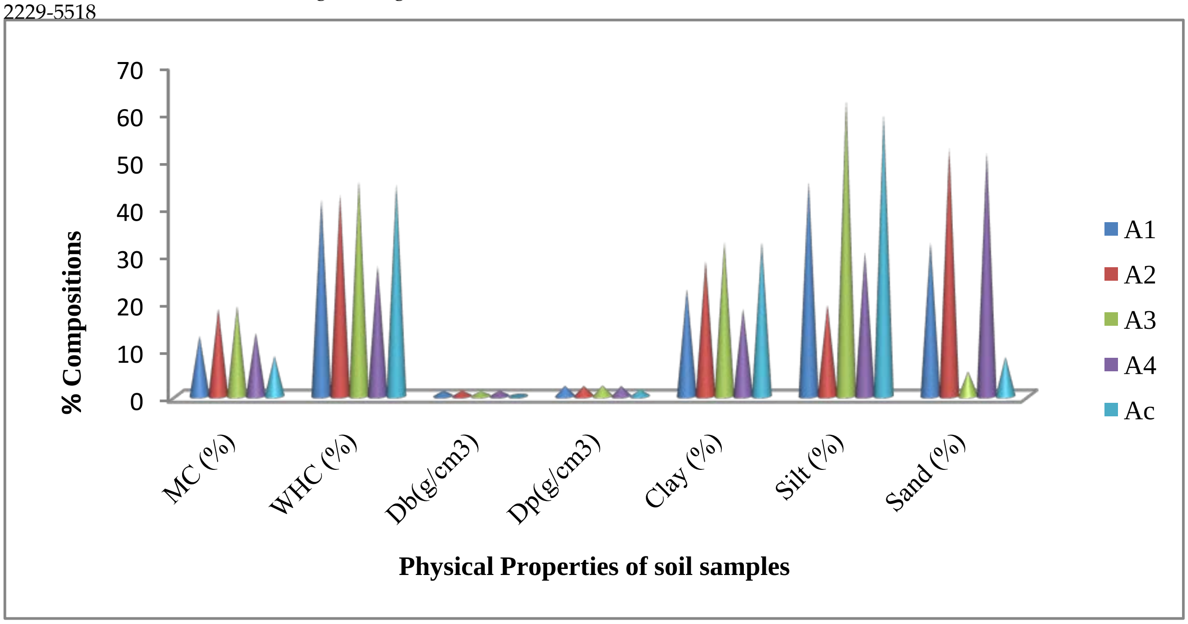

Figure 2: 3D bar chart of the percentage compositions of the physical properties of the soil samples collected from selected points in location A. A1- A4 are four selected sampled areas in location 1, Ac= Control site of location 1

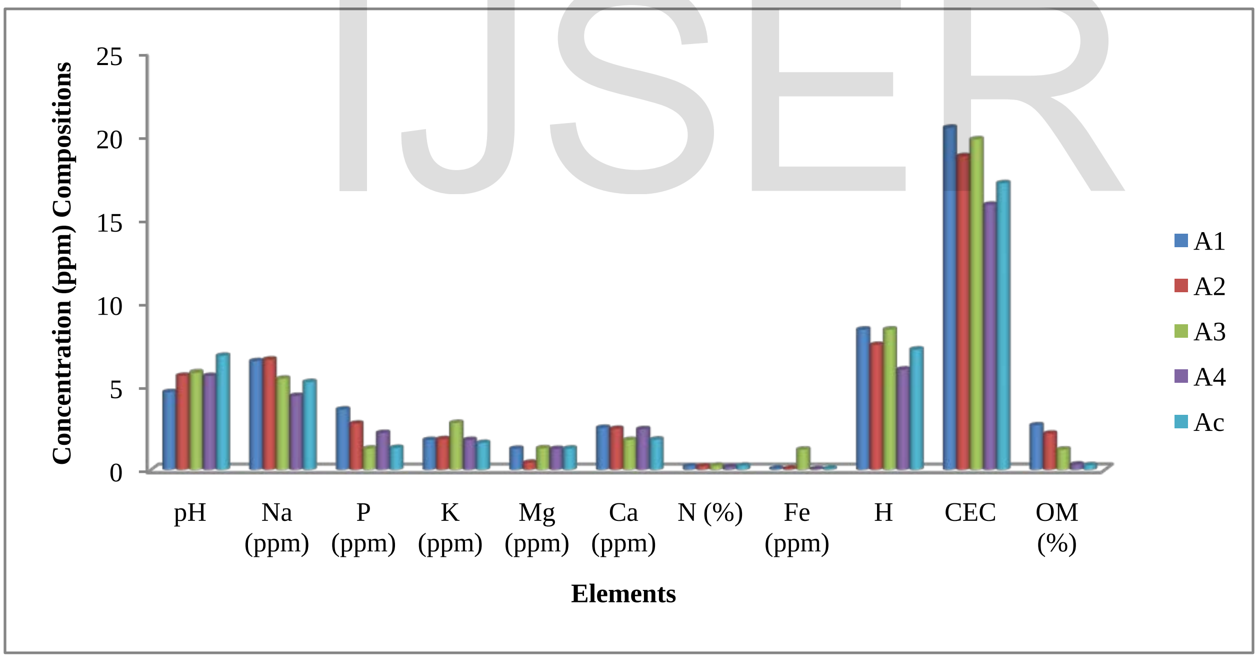

Figure 3: Concentration of Elements in the Soil samples of selected points in location A

Figure 4: **Respondent on Environmental impact**

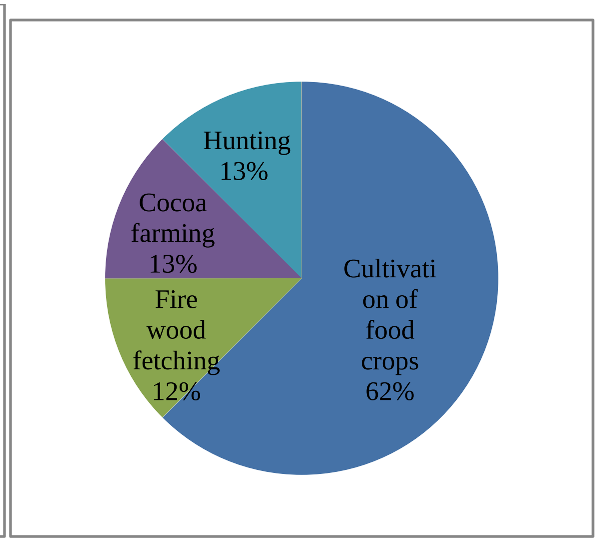

Figure 5: **Respondent on Major Economic Activities in the Area**

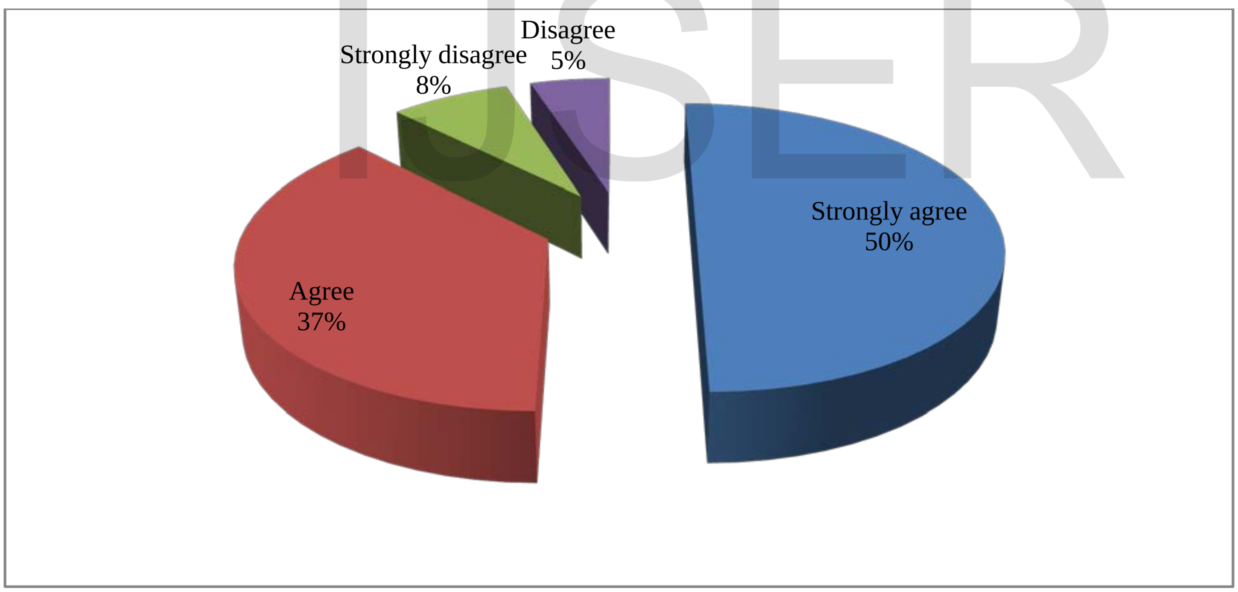

Figure 6: **Respondents on Sand Excavation Responsible for Landscape Deformation**

4.0 DISCUSSION

Effect of Excavation on Vegetation and Scattered Open Pits

The effect of excavation on the vegetation and scattered open pits was investigated on the eleven selected study areas using tree density and composition within the study areas and detailed survey of the excavated areas compared with the control sample sites. Reconnaissance survey was carried out on the excavation activities in the study areas, vegetation and the tree density measurement which is the number of plant unit per area as defined by Rejoice (2013). The results obtained for the eleven selected areas are as presented in Table 1. The numbers of trees and shrubs present in the excavated areas have been greatly reduced as a result of the excavation activities taken place in the area. The excavations exposed tree roots and produces patches of pits.

Respondents on the Economic Activities

The result shows that the major activity of the people in the study area is agriculture; food crops cultivation 62%, hunting 13%, cocoa farming 13%, fire wood fetching 12%. The cultivation of food crops is the major income generating economic activities. However, the increase in the excavation of the arable soils reduces the farming activities.

Respondents on Landscape Deformation

The sites where the excavations of sand and laterite were carried out show evidence of uneven landscapes caused by the activities of the unprofessional and indiscriminate excavations of the top soils, (figure 6). The loss of agricultural lands was caused by the uncontrolled making of every farm of the land a quarrying site for sand and laterite excavation.

Physical and Chemical properties of the Soil and Water samples

The soil samples were collected, air dried, sieve and analyzed in the laboratory for physical properties such as Moisture content, particle density, bulk density, soil texture and the percentage composition of clay, silt and sand using soil triangle (NSTA Scilink, 2014). Chemical properties of the soil samples such as pH, sodium Na, Calcium Ca, phosphorous P, and percentage compositions of the Nitrogen, Phosphorous and Organic matter were determined using Walkey Black method and Atomic Absorption Spectrometer (AAS) was used to determine the heavy metals Manganese (Mn), Lead (Pb), Copper (Cu), and Nickel (Ni) concentrations.

5.0 CONCLUSION

The research work investigated the degree of land degradation resulting from sand and laterite excavation in selected locations in Ondo State. The results of the work showed that the physical and chemical properties of the soil have very good agricultural and engineering properties. The excavated areas are not reclaimed after the exploitation of the available resources; they abandon it for many years for the land to regain its value. The excavation activities have caused a lot of deforestation. Many trees been removed during the mining operations and are not replanted leaving much open scattered pits and uneven landscape indiscriminately without any form of reclamation. The level of land degradations resulted from the excavation of sand and laterite are high due to high rate of development activities; roads constructions, building of houses in the urban centre of Akure, Owo, Ondo and Ore and these towns have no river that supports sand mining.

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