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Effect of Anthropogenic Activities on the Physico-Chemical Properties of Soils of Awka South L.G.A.,Anambra State,Nigeria

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ABSTRACT

The study evaluated the effect of anthropogenic activities on the physico-chemical properties of soils of Awka South, LGA, Anambra state, Southeastern Nigeria. Triplicate soil samples were collected from different soil depths (0-15, 15-30 and 30-45 cm) in four land use types: sand mining, playground, arable land and forest land of Agu Awka, Amawbia, Okpuno and Ifite respectively. Physico-chemical properties of the soils were analyzed using standard methods. Analysis of variance and correlation analysis were performed using Genstat Statistical Package Version 18. Results showed that soil properties were significantly ($P<0.05$) influenced by the different anthropogenic activities and were not uniformly distributed down the depths. Soils were dominated by loamy sand and were moderately compacted with low moisture content. The soils were generally acidic (4.47-.5.83) irrespective of depth and landuse.Organic carbon (0.263-0667 %) and total nitrogen (0.028-0.069%) were low and were seriously reduced by human activities. Available phosphorus (6.12-8.91 ppm) was seriously increased in sand mining compared to other land use types, moreover, sand mining activities had impacts on the levels of Ca (5.32-1.99 $cmolkg^{-1}$) and Na (0.020-0.32 $cmolkg^{-1}$). Total exchangeable acidity was reduced in all the land use types apart from playground where there was slight increase (1.57-1.70 $cmolkg^{-1}$). Total exchangeable bases and ECEC followed decreasing pattern of forest > arable land > sand mining > playground. Soil pH had significantly positive association with OC, TN, Ca, Mg, TEB, EEC,%BS, TP and MC. To improve the fertility status of these soils especially arable land, the use of organic and/or inorganic fertilizer is required**.** The regulation of mining activities in the study area was also recommended to protect the soil from further degradation.

1.0 Introduction

Humans have been using land and its resources for centuries in a pursuit of better lives. The way humans have used land and exploited its resources over time is a serious problem (Cieslewicz, 2002) as it has altered land cover and impacted the functioning of the ecosystem. With the advent of agriculture, modern technology, and the rise of capitalist mode of economy, the exploitation of land and its resources has increased dramatically. The management governing utilization of resources is called land use and land use change is any change in the physical, biological or chemical conditions of the resources due to management to satisfy human interests (Quentin *et al*. 2006). This may include conversion of forest to grazing, grazing to cropping, from traditional farming to modern and intensive cultivation, deforestation and planting exotic species, and conversion to non-agricultural uses (Mulugeta, 2014)**.** FAO (2002) noted that forests play an important role in protecting the soil, water resources and ameliorating the environment. Globally, natural events like volcanic eruptions, flooding, fire, climate fluctuations, and ecosystem dynamics may modify the earth‘s land cover but the anthropogenic activities have more influence (Turner *et al*., 1994; Meyer, 1995). Different land use purposes have emerged from previously forest land due to population hike and advent of civilization. According to World Bank (1991), about 60 per cent of the deforestation in the developing world may be attributable to agricultural practices, about 20 per cent to logging operations (including mining) and 20 per cent to household use of fuel wood.

Soils occupy an important place in the ecosystem, it is the interface between the lithosphere, atmosphere, biosphere and hydrosphere. This makes them a very important indicator of former environments as well as presents ones (Dubbin, 2001).Fidaku *et al.*(2012) opined that soils are subject to major change and even destruction by natural forces on the scale of geologic time, the rate and extent of soil degradation through human influence is situation specific. Anthropogenic changes in land use have remarkable effects on the dynamics of soil properties (Ozgoz *et al*., 2013). For example, land use changes from forest cover to cultivated land may hinder addition of litter that enhances nutrient content of soils (Ozgoz *et al*., 2013),lead to increase rates of erosion (Biro *et al*., 2013), result in loss of soil organic matter and nutrient (Saha and Kukal, 2015), and accelerate rate of soil degradation (Barua and Haque, 2013). In addition, land use changes such as deforestation, conversion of rangeland to cropland and cultivation are known to result in changes in soil physico-chemical and biological properties (Houghton *et al*.,

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1999). Impact: of these changes and their magnitude is according to land cover and land management (Baskin and Binkley, 1998; Nardi *et al*., 1996). The increasing anthropogenic influence on physical, chemical and biological processes in soil environments and the impact on soil ecology and biodiversity should not be overlooked (Huang *et al*., 2013).Physical, chemical and biological processes involved in soil development are of fundamental importance in understanding biogeochemical transformations and the impact on environmental quality and ecosystem (Huang 2002, 2008a, 2008b).

Many studies have addressed effects of land-use changes and land management on soil properties, and most of them have analyzed soil properties under different land-use systems (e.g. Hajabbasi, *et al.,* 1997; Doran, 2002; Sadeghi, *et al.,* 2007; Emadi, *et al.,* 2008; Khrsat, *et al.,* 2008; Emadodin, *et al.,* 2009). Chen *et al*.(2001) reported that the conversion of natural forest to other forms of land use can provoke soil erosion and lead to a reduction in soil organic content, lossof soil quality and modification of soil structure. Wang *et al*. (2011) found out that soil organic matter (SOM), total N, available P, pH, exchangeable cations contents and CEC of the soil decreased significantly with conversion of secondary forest to Chinese Fir plantations in subtropical China. Saha and Kukal (2015) found higher bulk density and lower macro-porosity and water retention in cultivated soils than soils of grassland and forests. Soils in transportation and residential areas were characterized by higher pH and bulk density (BD) (Pouyat *et al*., 2007; Zhao *et al*., 2013; Yang *et al*., 2014). Soils in urban forests (Zhao *et al*. 2013) or protected places (Yang*et al.,* 2014) contained higher soil organic carbon (SOC), while soils at industrial sites and in transportation areas were often polluted by heavy metals.

Previous investigations elsewhere undoubtedly suggest significant transformations in human-impacted soil properties as a result of landuse and land cover changes (Mao *et al*., 2014). There is a dearth of such information on effects of different anthropogenic activities on soils of Awka South, Anambra State.

2.0 Materials and methods

2.1. Study area

The study was carried out in four communities viz; Okpuno, Agu Awka, Ifite and Ikpodiaku in Awka South, Anambra State, Southeastern Nigeria. Its land area is 1,774 sq meter 4,844 km^2. The city's population is 4,055,048 (NPC, 2006). It has a humid tropical climate with a marked dry season (December – March), long rainy season (April to November) with double maxima generally in June and September and a high annual rainfall which averages 2000 – 2500 mm throughout the state is normally recorded. Mean annual temperature range from 26^{0}C to 31^{0}C and high relative humidity (above 80%) during the rainy season (Ofomata, 1975). River Niger governs the hydrology of the study area. Boundaries are formed by Delta State to the west, Imo State and Rivers State to the south, Enugu State to the east and Kogi State to the north. The origin of the name is derived from the Anambra River (Omambala) which is a tributary of the River Niger. The indigenous ethnic group in Anambra state are the Igbo (98% of population) and a small population of Olumbanasa people (2% of the population) who live mainly in the north-western part of the state (*Igbofocus.co. uk*., 2013). Sand mining, gravel exploration, hunting, smiths and metal merchants and arable farming are major socio-economic activities. Below are the coordinates of the study locations and the map of the study area showing the sampling points (figure 1).

Location	Latitude	Longitude
Okpuno	6.2473° N	7.0619° E
Agu Awka	6.2127 ° N	7.0720° E
Ifite	6° 10' 0" N	7° 4' 0" E
Amawbia	6.2000° N,	7.0478° E

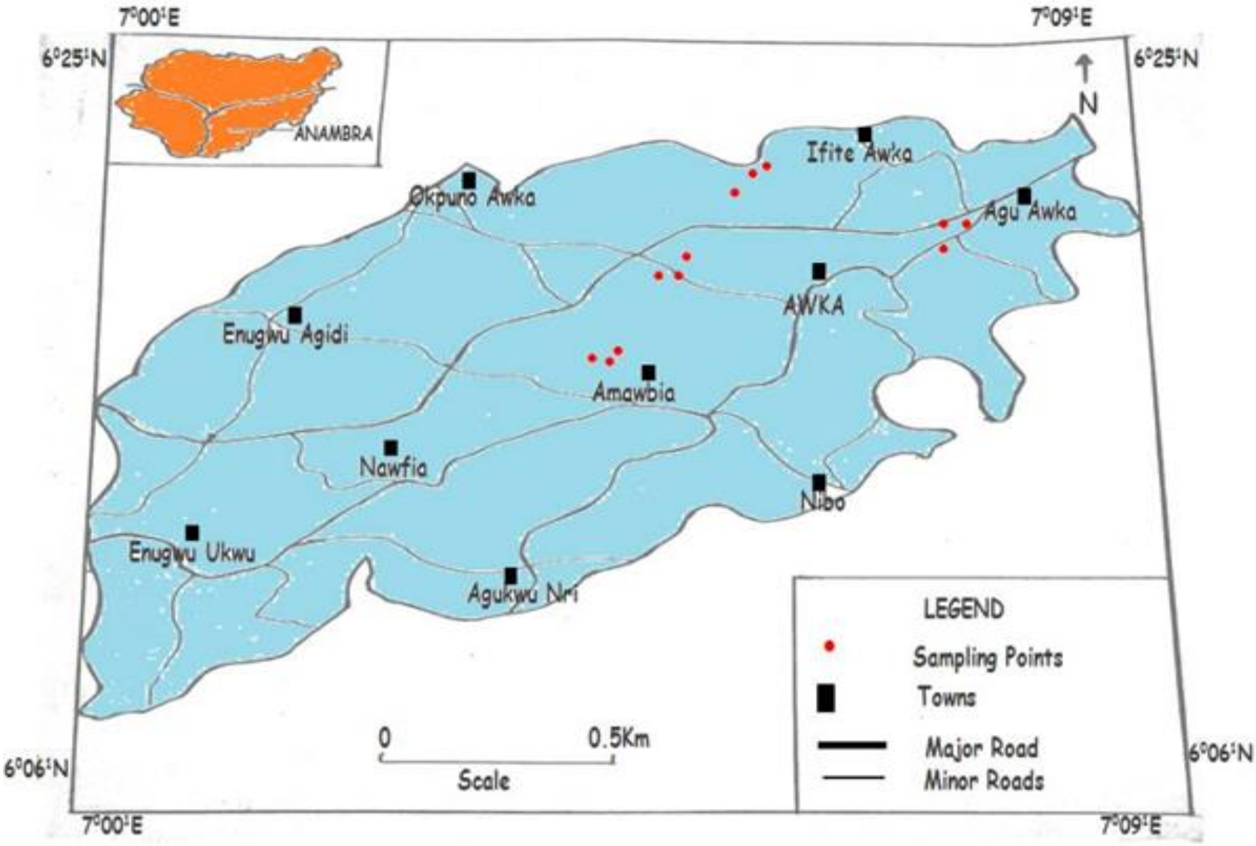

Figure 1. Map showing the study area.

2.2. Geology

The study area is located in an area underlain by Benin Formation. The units are made up of sandy to gravelly sands without any shale or swelling clays. In general, Benin Formation spans from Miocene to Recent. It is the youngest of Niger Delta sediments. Its thickness is about 6,000ft, and very little hydrocarbon accumulation has been associated with the Benin Formation. The Benin Formation comprises the top part of the Niger Delta clastic wedge, from the Benin-Onitsha area in the north to beyond the present coastline (Short and Stauble, 1967). The Benin formation consists of massive continental sands and gravels, it underlain gradationally by the delta front paralic lithofacies. The top of the formation is the recent sub aerially - exposed delta top surface and its base extend to a depth of 4600 feet. The base is defined by the youngest marine shale. Shallow parts of the formation are composed entirely of non-marine sand deposited in alluvial or upper coastal plain environments during progradation of the delta (Nwajide *et al.*, 1996). Although lack of preserved fauna inhibits accurate age dating, the age of the formation is estimated to range from Oligocene to Recent (Short and Stauble, 1967).

2.3. Field Studies

Prior to sample collection, a reconnaissance visit was carried out to identify the areas to be studied. Randomized complete block design (RCBD) was used in the study in which soil auger was used to collect soil samples at 0-15cm, 15-30cm and 30-45cm pre-determined depths. Three (3) soil samples were collected from different anthropogenic impacted soils viz; Okpuno (arable land), Agu Awka (sand mining), Amawbia (playground) and Ifite (forest). Soils were collected in triplicates at each soil depth. Altogether, a total of thirty six (36) soil samples were collected and sent for analysis.

2.4. Determination of Soil Parameters

Bulk density was measured using core method as Grossman and Reinsch (2002) recommended. Total porosity was determined as outlined by Vomocil (1965). Particle Size Distributionwas determined by hydrometer method according to the procedure of Gee and Or (2002) using water and sodium hexametaphosphate (calgon) as dispersant. Moisture content was determined using gravimetric method. Soil pH was determined in water and 0.1kCl using pH meter in soil/liquid suspension of 1:2.5 (Hendershot *et al.*, 1993). Organic Carbonwas determined using the wet oxidation method (Walkley and Black 1934). Available phosphoruswas determined using Bray 2 solution method according to (Olsen and Sommers, 1982). Exchangeable K and Na was extracted using 1N Neutral Ammonium Acetate (NH_4OAC) and determined photometrically using flame photometer (Thomas, 1982). Exchangeable Magnessium and Calcium was determined using ethelene diaminetetraacetic acid (EDTA) (Thomas, 1982). Total Nitrogen was determined by kjehdahl digestion method using concentrated H_2SO_4 and a Sodium Copper Sulphate catalyst mixture (Brenner and Yeomans, 1988). Exchangeable Acidity was determined titrimetrically (Mclean, 1982). Effective Cation Exchange Capacity (ECEC) was calculated from the summation of all exchangeable bases and exchangeable acidity (IITA, 1982). Percentage Base Saturation (%BS)was determined by computation.Heavy metals (Cd, Cu, Cr, and Ni) were determined by standard atomic absorption spectrophotometer method after extracting with double acid (perkin-elmer, 1976).

2.5. Statistical Analysis

Data generated from the laboratory analysis were statistically analyzed with Genstat Statistical Package Version 18 using Analysis of Variance (ANOVA) as outlined by Steel and Torrie (1981), means were separated using Least Significant Difference (LSD) at 5% level of probability. Degree of relationships among selected soil physico-chemical properties and heavy metal concentrations were carried out using correlation at $P \leq 0.05$ probability levels.

3.0. Results

Table 1 showed the physical properties of the soils as affected by anthropogenic activities. Sand particles significantly differed ($P < 0.05$) among the land use types studied. It ranged from 91.35 % at 0-15 cm soil depth in the playground to 67.68 % at 30-45 cm soil depthin the sand mining site. Sand was observed to decrease with depth in all the soils studied. Silt particles on the other hand did not follow any definite pattern down the soil depth apart from

Table 1. Mean result of the effect of anthropogenic activities on physical properties of the studied soils.

Land use (Location)	Depth (cm)	Sand	Silt (%)	Clay	TC	BD (gcm^{-3})	TP (%)	MC (%)
Sand mining	**0-15**	**87.35**	**3.67**	**8.98**	**S**	**1.43**	**44.27**	**6.08**
Sand mining	**15-30**	**69.68**	**7.33**	**22.99**	**SL**	**1.47**	**42.43**	**4.94**
Sand mining	**30-45**	**67.68**	**20**	**11.99**	**LS**	**1.56**	**39.07**	**5.74**
Mean		74.90	10.33	14.65		1.49	41.92	5.59
Playground	**0-15**	**91.35**	**2.67**	**5.99**	**S**	**1.46**	**42.97**	**6**
Playground	**15-30**	**85.68**	**6.33**	**7.99**	**S**	**1.56**	**39.2**	**4.66**
Playground	**30-45**	**78.68**	**1.67**	**19.65**	**LS**	**1.66**	**35.27**	**5.15**
Mean		85.24	3.56	11.21		1.56	39.15	5.27
Arable land	**0-15**	**86.68**	**1.33**	**11.99**	**LS**	**1.2**	**53.27**	**9.72**
Arable land	**15-30**	**78.68**	**4**	**17.32**	**SL**	**1.3**	**49.2**	**11.2**
Arable land	**30-45**	**73.99**	**8**	**17.99**	**SL**	**1.43**	**43.87**	**9.3**
Mean		79.78	4.44	15.77		1.31	48.78	10.07
Forest(control)	**0-15**	**87.01**	**2.33**	**10.65**	**LS**	**1.07**	**58.2**	**10.65**
Forest(control)	**15-30**	**78.68**	**17.33**	**3.99**	**LS**	**1.26**	**50.9**	**11.63**
Forest(control)	**30-45**	**79.01**	**16.33**	**4.65**	**LS**	**1.32**	**48.57**	**11.74**
Mean		81.57	12	6.43		1.22	52.56	11.34
L.S.D (0.05) Location (A)		3.001	3.095	2.728		0.052	2.034	0.654
L.S.D (0.05) Depth (B)		2.599	2.68	2.362		0.045	1.762	0.567
L.S.D (0.05) A*B		5.199	5.361	4.725		0.090	3.523	1.133

Key: TC =textural class, LS =Loamy sand, S=sand, SL=sandy loam,BD =bulk density, TP =total porosity, MC =moisture content, LSD=least significant difference, A= Location B= depth A*B=interaction between location and depth

Table 2. Mean result of the effect of anthropogenic activities on chemical properties of the studied soils.

Location	Depth (cm)	pH (H_20)	OC	TN (%)	AvP (ppm)	Ca	Mg	K	Na ($Cmolkg^{-1}$)	TEA	TEB	ECEC	BS (%)
Sand mining	0-15	4.45	0.373	0.015	5.88	1.46	1.43	0.017	0.03	1.83	2.94	4.77	61.53
Sand mining	15-30	4.41	0.35	0.04	9.35	2.43	3	0.053	0.043	0.81	5.526	7.336	74.93
Sand mining	30-45	4.78	0.157	0.037	11.5	2.09	1.67	0.075	0.022	1.76	3.857	5.617	68.7
Mean		4.55	0.293	0.031	8.91	1.99	2.03	0.048	0.032	1.467	4.108	5.908	68.39
Playground	0-15	4.39	0.43	0.028	6.75	1.71	1.27	0.137	0.026	2.03	3.149	5.182	60.6
Playground	15-30	4.58	0.209	0.026	7.1	2.23	1.2	0.131	0.023	1.41	3.587	4.993	71.7
Playground	30-45	4.43	0.15	0.03	8.06	2.43	2.147	0.05	0.023	1.65	4.664	6.314	73.83
Mean		4.47	0.263	0.028	7.3	2.12	1.539	0.106	0.024	1.7	3.8	5.496	68.71
Arable land	0-15	5.44	0.511	0.07	10.42	5.98	4.417	0.044	0.03	1.34	10.47	11.807	91.3
Arable land	15-30	5.94	0.43	0.036	6.9	5.13	3.06	0.046	0.024	1.563	8.26	9.823	83.9
Arable land	30-45	6.1	0.35	0.029	8.79	5.36	3.12	0.137	0.032	0.94	8.645	9.585	90.4
Mean		5.83	0.43	0.045	8.7	5.49	3.53	0.076	0.029	1.281	9.125	10.405	88.53
Forest(control)	0-15	5.99	0.752	0.087	6.55	3.13	2.68	0.038	0.021	1.64	5.869	7.51	78.27
Forest(control)	15-30	5.72	0.796	0.101	4.87	5.53	3.06	0.023	0.016	1.19	8.634	9.822	87.57
Forest(control)	30-45	5.6	0.453	0.02	6.93	8.8	4.73	0.052	0.022	1.89	13.6	15.49	87.7
Mean		5.77	0.667	0.069	6.12	5.82	3.49	0.038	0.020	1.57	9.368	10.941	84.51
L.S.D (0.05) Location (A)		0.192	0.086	0.015	1.56	1.224	0.403	0.048	0.006	0.233	1.162	1.223	3.624
L.S.D (0.05) depth (B)		0.166	0.074	0.013	1.351	1.06	0.349	0.041	0.005	0.202	1.006	1.059	3.138
L.S.D (0.05) A*B		0.332	0.148	0.026	2.701	2.121	0.698	0.083	0.010	0.403	2.012	2.118	6.277

Key: OC=organic carbon, TN =total nitrogen, AvP =available phosphorus, TEA=total exchangeable acidity, TEB=total exchangeable bases, ECEC=effective cation exchange capacity, %BS=percent base saturation, LSD=least significant difference, A= Location B= depth A*B=interaction between location and depth.

sand mining site where it persistently decreased with depth. Clay particle size was significantly ($P<0.05$) highest (22.99%) at 15-30 cm soil depth in the sand mining site and lowest (3.99%) at 15-30 cm soil depth in the forest (control). The soil texture varied from loamy sand to sandy loam.

Similar to clay, bulk density of the soils generally increased with depth in all the soils studied. Significantly ($P < 0.05$) highest value ($1.66gcm^{-3}$) for BD was recorded at 30-45cm depth of playground. Total porosity (TP) of the soil followed inverse direction with bulk density by decreasing with depth. Significantly ($P<0.05$) highest (58.2%) and lowest (35.27%) values were recorded in 0-15 cm depth of forest and 30-45 cm depth of playground respectively. Moisture content (MC) of the soil did not follow any defined pattern especially in sand mining and arable land. Although significantly ($P < 0.05$) highest value (11.74%) was recorded in 30-45 cm depth of forest compared to other locations irrespective of depths.

Table 2 showed the chemical properties of the human impacted soils. Soil pH significantly ($P<0.05$) differed among the soils and ranged from 4.41-4.78, 4.39-4.58, 5.44-6.1, 5.6-5.99 with mean values of 4.55, 4.47, 5.83 and 5.77 in land mining, playground, arable land and forest (control) respectively. Organic carbon generally decreased with depth in all the sites studied apart from forest soils where there was slight increase. Significantly ($P<0.05$) highest value (0.796%) was recorded in 15-30 cm depth of forest soils. Also, highest (0.667%) mean OC was recorded in forest followed by arable land (0.43%), sand mining (0.293%) and play ground (0.263%). Total nitrogen (TN) like organic carbon differed significantly ($P<0.05$) and followed similar pattern with organic carbon. Highest value (0.069%) of TN was recorded in forest followed by arable land (0.045%), sand mining (0.031%) and play ground (0.028%). Available phosphorus (AVP) concentration of the soil ranged from 5.88-11.5 ppm, 6.75-8.06 ppm, 6.9-10.42 ppm, 4.87-6.93 ppm with mean values of 8.91, 7.03, 8.70 and 6.12 ppm in sand mining, play ground, arable land and forest respectively.

Exchangeable basic cations (Ca, Mg, K and Na) of the soil differed significantly ($P<0.05$) among the soils. Highest ($5.82\ cmolkg^{-1}$) and lowest ($1.99\ cmolkg^{-1}$) mean values of Ca were recorded in forest and sand mining sites respectively while highest ($3.53cmolkg^{-1}$) and lowest ($1.539cmolkg^{-1}$) mean Mg were recorded in arable land and play ground respectively. However, highest ($0.106cmolkg^{-1}$) mean potassium was recorded in play ground compared to lowest ($0.038cmolkg^{-1}$) mean value recorded in forest (control). Moreover, sodium concentration of the soil was highest ($0.032cmolkg^{-1}$) in sand mining site compared to least ($0.020\ cmolkg^{-1}$) mean value recorded in forest (control) site.

There was no defined trend in the distribution of total exchangeable acidity (TEA) down the soil depths. However, TEA varied from 0.81-1.83 $cmolkg^{-1}$, 1.41-2.03 $cmolkg^{-1}$, 0.94-1.563 $cmolkg^{-1}$, and 1.19-1.89 $cmolkg^{-1}$ in sand mining, play ground, arable land and forest respectively (Table 2). On the other hand, total exchangeable bases significantly ($P<0.05$) differed among the soils with highest ($1.36\ cmolkg^{-1}$) and lowest ($2.94cmolkg^{-1}$) recorded in 30-45 cm depth of forest (control) and top soil (0-15cm) of sand mining site, respectively. Generally, highest ($9.368cmolkg^{-1}$) and lowest ($3.80\ cmolkg^{-1}$) TEB were recorded in forest and sand mining sites respectively. Similarly, effective cation exchange capacity (ECEC) of the soils of forest (control) recorded significant ($P<0.05$) highest ($15.49\ cmolkg^{-1}$) compared to other locations studied. Also, highest ($10.94\ cmolkg^{-1}$) mean ECEC was recorded in forest followed by arable land, ($10.405\ cmolkg^{-1}$), sand mining ($5.908\ cmolkg^{-1}$) and play ground ($5.496cmolkg^{-1}$). Consequently, percent base saturation (%BS) of the soils varied significantly ($P<0.05$) among the soils studied. It ranged from 61.53-74.93%, 60.6-73.93%, 83.9-91.3% and 78.27-87.7% with mean values of 68.32, 68.71, 88.53 and 84.51% in sand mining, play ground, arable land and forest (control) respectively.

Results of the association between the physical and chemical properties of the studied soil is shown in Table 3 where most soil properties correlated significantly with each other. Soil pH had significantly positive association with OC ($r = 0.585$), TN ($r = 0.456$), Ca ($r = 0.639$), mg ($r = 0.559$), TEB ($r = 0.645$), EEC ($r = 0.603$), %BS ($r = 0.749$), TP ($r = 0.653$) and MC ($r= 0.865$). However, pH had negative significant association with TEA ($r = -0.485$) and bulk density ($r = -0.653$).

Table 3. Result of Correlation Analysis among the physico-chemical properties of the soils studied.

Properties	pH ($H_2$0)	OC	TN	AvP	Ca	Mg	K	Na	TEA	TEB	ECEC	BS
pH	-	-	-	-	-	-	-	-	-	-	-	-
OC	0.585**	-	-	-	-	-	-	-	-	-	-	-
TN	0.456*	0.775**	-	-	-	-	-	-	-	-	-	-
AvP	-0.075ns	-0.432 ns	-0.113 ns	-	-	-	-	-	-	-	-	-
Ca	0.639**	0.347 ns	0.145 ns	0.069 ns	-	-	-	-	-	-	-	-
Mg	0.552*	0.355 ns	0.232 ns	0.049 ns	0.750**	-	-	-	-	-	-	-
K	-0.114 ns	-0.312 ns	-0.220 ns	0.295 ns	-0.011 ns	-0.246 ns	-	-	-	-	-	-
Na	-0.285 ns	-0.283 ns	-0.360 ns	0.191 ns	-0.104 ns	0.135 ns	0.119 ns	-	-	-	-	-
TEA	-0.485*	-0.181 ns	-0.344 ns	0.045 ns	-0.184 ns	-0.230 ns	0.028 ns	0.147 ns	-	-	-	-
TEB	0.645**	0.365 ns	0.180 ns	0.072 ns	0.974**	0.880**	-0.077 ns	-0.022 ns	-0.211 ns	-	-	-
ECEC	0.603**	0.351 ns	0.145 ns	0.078 ns	0.970**	0.870**	-0.075 ns	-0.006 ns	-0.103 ns	0.994**	-	-
BS	0.749**	0.377 ns	0.380 ns	0.057 ns	0.790**	0.817**	-0.139 ns	-0.058 ns	-0.638**	0.846**	0.790**	-
Sand	-0.080 ns	0.278 ns	0.040 ns	-0.398 ns	-0.095 ns	-0.132 ns	0.020 ns	-0.095 ns	0.145 ns	-0.114 ns	-0.100**	-0.199 ns
Silt	0.125 ns	0.036 ns	0.111 ns	0.032 ns	0.254 ns	0.145 ns	-0.036 ns	-0.233 ns	-0.036 ns	0.230 ns	0.230 ns	0.155 ns
Clay	-0.036 ns	-0.356 ns	-0.162 ns	0.423 ns	-0.152 ns	0.004 ns	0.013 ns	0.356 ns	-0.131 ns	-0.105 ns	-0.122 ns	0.072 ns
BD	-0.653**	-0.799**	-0.596**	0.229 ns	-0.449*	-0.553*	0.286 ns	0.145 ns	0.112 ns	-0.507*	-0.504*	-0.491*
TP	0.653**	0.799**	0.596**	-0.229 ns	0.449*	0.552*	-0.286 ns	-0.146 ns	-0.112 ns	0.507*	0.504*	0.491*
MC	0.865**	0.674**	0.445*	-0.247 ns	0.723**	0.684**	-0.208 ns	-0.312 ns	-0.277 ns	0.750**	0.732**	0.704**

Key:OC=organic carbon, TN =total nitrogen, AvP =available phosphorus, TEA=total exchangeable acidity, TEB=total exchangeable bases, ECEC=effective cation exchange capacity,%BS=percent base saturation, BD=bulk density, TP =total porosity, MC =moisture content, *=significant at 0.05% probability level,**= significant 0.01% probability level, ns=not significant.

Table 4 also revealed that bulk density (BD) and total porosity (TP) correlated significantly negatively and positively respectively with all the parameters studied apart from their association with AVP, K, Na and TEA where weak correlation was revealed. In similar manner with TP, moisture content had significant positive association with all the soil properties studied with the exception of AVP, K and Na where negative and significant relationship was revealed. In addition, organic carbon (OC) had strong positive correlation with TN (r = 0.775). Cacium and Mg concentrations had strong positive association with TEB, ECEC and %BS. Total exchangeable bases, TEB and ECEC also had strong influence with each other and with %BS (r = 0.846 and r = 0.994 respectively). However, total exchangeable acidity (TEA) showed significantly negative influence on %BS (r = -0.638). There was strong negative significant association between ECEC and sand (r = -1.000).

4.0. Discussion

It is widely agreed that the difference in human activities contribute to the variation of soil properties among land use types (Pouyat *et al*., 2007). Unlike sand, clay particles of the studied soils increased with depth in all the soils studied. Naseen (1998) also reported that sand content decreased with increasing soil depth, Nizami *et al* (1997) also reported greater clay content in subsoil than in to soil. According to Idoga and Azagaku (2005), increase in clay with depth may be as a result of eluviations, illuviation process as well as contributions of the underlying geology through weathering. The sandy nature of the soils in the study area indicated that they were prone to excessive leaching and loss of nutrient due to their loose texture. Also, the soils may not provide sufficient mechanical supports for trees (Attoe and Amalu, 2005). The sandy nature especially in sand mining and playground also indicated that soils of the two locations possessed better drainage and aeration constituents.

Similar to clay, bulk density of the soils generally increased with depth in all the soils studied. Other studies (Sintayehu, 2006; Lamenih *et al*. 2005) also found that bulk density significantly varied with land use types due to differences in the land management and land use histories. Total porosity (TP) of the soil followed inverse direction with bulk density by decreasing with depth. The gravimetric moisture content (MC) of the soils was low and could be attributed to the high sand fraction and low porosity which hinders moisture retention. Soils with this property lack adsorption capacity for basic plant nutrients and water retention (Oguike and Mbagwu, 2009).

The soils were generally acidic and this agreed with the findings of Agbede (2008) that the pH in Nigeria derived savannah and forest soils falls within the range of 4.5-7.5. The acidic nature of the studied soils is attributed to the high rainfall resulting in the leaching of some basic cations especially calcium from the surface horizons of the soils (Foth, 2006; Iwara *et al*., 2011). Organic carbon generally decreased with depth in all the sites studied apart from forest soils where there was slight increase. The low (<2 %) organic carbon content observed at all the four sites may be partly due to the effect of arable and land use activities being practiced by the land users,high temperature and relative humidity which favour rapid mineralization of organic matter. Total nitrogen (TN) like organic carbon differed significantly (P<0.05) and followed similar pattern with organic carbon. According to Havlin *et al*. (1999), TN content of the soils are categorized as low (< 0.15%) Prasuna Rani *et al*. (1992) argued that low amount of organic carbon could be the significant factor affecting the amount of available nitrogen. According to Havlin *et al*. (1991), the available P contents of the soils ranged from low to high. The authors rated P as < 3mgkg^{-1} as very low, 4.7mgkg^{-1} as low, 8-11 mgkg^{-1} as medium and > 12 mgkg^{-1} as high. The differences in soil available phosphorus may have resulted from changes in biological and geochemical processes at different depths after human disturbances (Gong *et al*., 2005).

Exchangeable basic cations (Ca, Mg, K and Na) of the soil differed significantly (P<0.05) among the soils. Landon (1991) noted that Na can have a very bad effect on both the plant and the physical properties of the soil if it has very high concentrations compared to the other cations. Hence, the exchange complex that was dominated by Ca followed by Mg, K and Na in all the soils apart from sand mining indicated productive agricultural soils (Bohn *et al*., 2001).

There was no defined trend in the distribution of total exchangeable acidity (TEA) down the soil depths. Exchangeable acidity (0.81-2.03 cmolkg^{-1}) recorded in this study were low when compared with a medium range of 2.1-4 cmolkg^{-1} (Holland *et al*., 1999) but impact of Al^{3+} (a component of TEA) in the soil solution could be significant in terms of influencing the biochemical behaviour in the soils. Nega and Heluf (2013) reported that loss of base forming cations through leaching and runoff generated from accelerated erosion reduces soil pH and thereby increases soil acidity. On the other hand, total exchangeable bases significantly (P<0.05) differed among the soils. Similarly, effective cation exchange capacity (ECEC) of the soils of forest (control) recorded significant (P<0.05) highest compared to other locations studied. According to Landon (1996) ratings for ECEC;> 40 cmolkg^{-1} very high, 25-40 high, 15-25 medium, 5-15 low. Therefore, the soils were generally low in ECEC apart from 30-45 cm depth of forest soil where 15.49 cmolkg^{-1} was recorded. These low values of ECEC is indicative of the low capacity of these soils to retain nutrient elements due to the insufficient amount of organic matter and soil pH chemistry (Smith *et al*., 1994; Williams *et al*., 1996). Consequently, percent base saturation (%BS) of the soils varied significantly (P<0.05) among the soils studied. The percentage base of the soil provides a valuable indicator of the base status, which is often related to the amount of leaching. The low base saturation values (< 99%) by sum of cations (Soil Survey Staff, 1990) can be attributed to Kaolinitic clay content nature of the parent material from which the soils have been formed. According to Ouimet *et al*. (1995), lower base saturation values correspond to higher leaching.

There was strong association between selected physical and chemical properties of the studied soil. Soil pH had significantly positive association with OC, TN, Ca, Mg, TEB, EEC, %BS, TP and MC. This suggests that increase in soil pH, will result in corresponding increase of these soil properties. However, the negative significant association that soil pH had with TEA and bulk density implied that increase in pH will caused the decrease in TEA and BD. The analysis also revealed that bulk density (BD) and total porosity (TP) correlated significantly negatively and positively respectively with all the parameters studied apart from their association with AVP, K, Na and TEA where weak association was revealed. Chaudhari *et al.* (2013); Onweremadu *et al*. (2007) also observed inverse relationship between bulk density and total porosity. This means that increase in bulk density will result in significant decrease in total porosity and moisture content. However, positive significant association between total porosity and moisture content implies that increase in pore spaces results in corresponding increase in soil moisture content. In similar manner with TP, moisture content had significant positive association with all the soil properties studied with the exception of AVP, K and Na where negative and significant relationship was revealed. In addition, organic carbon (OC) had strong positive correlation with TN. Adeyanju (2005) also recorded a strong relationship between organic carbon and total nitrogen N content. Ca and Mg concentrations had strong positive association with TEB, ECEC and %BS. This indicates that increase in these basic cations (Ca and Mg) will result in increase in TEB, ECEC and %BS of the soil. Total exchangeable bases, TEB and ECEC also had strong influence with each other and with %BS. However, total exchangeable acidity (TEA) showed significantly negative influence on %BS. This implies that increase in TEA concentration will result in decrease in base saturation of the soil. However, the strong negative significant association that ECEC had with sand imply that increase in sand will result in significant decrease in effective cation exchange capacity of the soil.

5.0. Conclusion

The study showed that soil properties were significantly (P< 0.05) influenced by the different anthropogenic activities (sand mining, activities in the play ground,farming activities in the arable land and forest activities). Soil compaction rate, total exchangeable acidity and potassium concentration were highest in play ground than other sites while the reverse was the case for total exchangeable bases, and ECEC of play ground soils. The soils were generally acidic irrespective of land use. Organic carbon and total nitrogen (TN) were seriously reduced by human activities. However, available phosphorus concentration was seriously increased in sand mining site compared to other land use types. In addition, sand mining decreased and increased Ca and Na respectively. Inversely to sand mining activities, arable land use type positively improved magnesium concentration.

Based on the findings of this research work, there is need to improve the soil fertility status especially in arable land through organic and inorganic fertilizer application. Sand mining activitiesin the study area should be properly regulated to ensure protection of the environment from soil degradation. There is also need to adopt soil management techniques that will help with erosion control.

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