



Assessment of the Effects of Urban Land Use on Some Soil Properties in Parts of Kaduna Metropolis, Nigeria

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Received: September, 2016

Revised and Accepted: December, 2016

Abstract

Several land use activities have some negative effects on the surrounding soil. This study paper tried to assess the various effects of different land use activities on the physical and chemical properties of soil in part of Kaduna metropolis. Urban land use types such as residential, road side mechanic workshop, dump site, farm land, industrial and wood land were chosen for the study. The main source of data for the study was primary data. Profile pits were dug and 23 samples of soil were collected for laboratory analysis. An undisturbed wood land around the eastern bypass in Maraban Rido was used as the control. The samples were analyzed according to standard method in the laboratory to assess the soil particle size, pH, organic matter, exchangeable bases, exchangeable acidity, available phosphorus, total nitrogen, effective cation exchange capacity (ECEC), and some heavy elements such as Mn, Cu, Ni, Fe, Pb, Zn, and C. The result of the study shows that clay content increases with depth in soils under the various land use, which indicate that urban land use has affected the soils of the area. Organic matter content was found to be relatively high especially in the mechanic workshop and dumpsite, also the ECEC values are higher in soils affected by urban land uses as compared to the control this may be attributed to municipal waste incorporation into the soils. The concentration of heavy metals was generally low as compared to the permissible limit showing that land use types has not affected soil quality significantly. The paper therefore recommends careful use of the soils in the Metropolis to avoid further changes in its quality.

Keywords: Chemical effects; Land use; Physical properties; Soil; Urban.

1.0 INTRODUCTION

Land is one of the vital resources that human beings have exploited for centuries in a pursuit to better their lives. The continuous exploitation of the land is a serious problem as it has altered land cover and impacted negatively on the ecosystem (Cieslewicz, 2002). Soil is everywhere, although generally associated with agriculture, horticulture and forestry, soil also underlies most of our cities and urban hinterland. In urban environment soils may vary

in natural condition, be slightly disturbed or completely disturbed as in the case of man-made landscapes. Soils have always performed a wide range of useful functions. The range of these functions and impacts on the environment has changed considerably in the urban environment as land use is converted from rural to urban. Failure of the soil to function as expected can have significant effect on the urban environment, resulting in serious impacts including damage to buildings and roads, land

slip, ecosystems (Scheyer and Hipple 2005; Hicks and Hird, 2007). Soil is not static; the dynamic nature of soil affects the condition of a specific soil (Karlen *et al.*, 2003). Several land use activities can affect soil stability. Thus, Castro *et al* (2002) are of the view that urban land use influences soil aggregation, aggregate stability and overall soil health.

Soil generally provides the basis for human existence. Both natural and unstable or disturbed soils vary widely in their properties. Unstable soils differ from soils in natural areas because their horizons have been mixed, destroyed or removed. The original soil properties of such unstable soils have changed. Subsoil are exposed or mixed with top soils and compaction may also occur. In such unstable or disturbed soils the natural soils may be buried, chemical and waste materials may have been added. These activities can result in changes in some of the soil properties in site. The natural properties of the soils or the change to their properties can determine whether the soils can carry out the engineering, environmental, hydrological, physical, chemical and biological function required of urban environment (Rimmer, 1998). The importance of soil in sustaining day-to-day urban community activities is often not appreciated and overlooking its importance can have adverse consequences. Thus, Herrick *et al.* (2001) asserts that basic knowledge about soil allows us to use it wisely.

Urban land uses have great influence on some physico-chemical properties such as organic matter, texture and structure, permeability level and leaching, among others. The impact of urban land use on soil often occur gradually but it can affect the distribution and supply of soil nutrients by directly affecting some soil properties such as influencing the biological transformations (Murty *et al.*, 2002; Fraterrigo *et al.*, 2005). Human activities in the urban areas are also known to be an important driver for distribution of soil. These activities influence storm runoff, erosion and sedimentation processes. The coming of modern agriculture, modern technology, and the rise in capitalist mode of economy has increased the demand and exploitation of resources on the land greatly. In the last few decades, land use practices (agriculture, mining, logging, housing and

recreation, among others) have become so intensive and predominant that their impacts can be seen in the forms of uncontrolled development (urbanization and sprawl), deteriorating environmental quality, loss of prime agricultural lands, destruction of wetlands, and loss of fish and wildlife habitats everywhere on the earth. Such impacts have reduced the local capacity of lands to support both ecosystem and human enterprise at global scale, therefore the effect of urban land use is no longer a local environmental problem but a global one (Houghton, 1994).

Urbanization has some number of positive effects on the human wellbeing and the environment in general. The urban growth is associated with declining birth rates, which reduces population pressure on rural land and natural resources. Despite these positive impacts, most cities are still increasingly plagued by human activities such as field clearing, deforestation for firewood and charcoal, bush fire, overgrazing and continuous land use which can lead to adverse change in soil properties. Many cities are adversely affected by traffic congestion, air and water pollution, uncollected and improperly handled solid waste that have serious health consequences. These solid wastes block drainage systems and contaminate groundwater at landfill sites (Butu and Ezeamaka, 2015).

APFED (2003) is of the view that urban growth has several negative impacts on the environment and human well-being. The report further asserts that most major cities in China are increasingly plagued by serious environment problems emanating from various land use activities in the cities. APFED (2003) also stressed that urbanization with associated land use has serious impacts on the local environment and beyond the vicinity and contributes to degradation of natural resources such as soils. Elias and Gbadegsin (2013) also worked on the relationship of urban land use, soils and heavy metals concentration in Lagos Mainland Area and the result shows that most anthropogenic activities generate toxic substances such as heavy metals that are dispersed through diffuse sources and become accumulated in soils, sediment, water bodies and aquatic animals.

Heavy metals are known to be carcinogenic and their bioaccumulation in natural resources such as soil could have adverse effects on the crop and water bodies that are used by humans (Butu and Iguisi, 2012). Butu and Iguisi (2013) are of the view that heavy metals such as manganese (Mn), iron (Fe) and antimony (Sb) that were found in higher concentration in the sediment of River Kabami Zaria were traceable to anthropogenic activities from various land use types such as refuse dumps, farm land, public gutters and effluents from various settlements in the catchment area of the stream. Awotoye *et al* (2013)'s studies in Little Ose Reserve on the soil properties in five different land use types shows that the exchangeable acidity in soil was significantly high in undisturbed soil than in logged over forest and agricultural land. It was also discovered that the agricultural land has the highest concentration of nitrogen (N), phosphorus (P), potassium (K), available phosphorus and magnesium (Mg) were significantly increased at both surface layers in the agricultural lands. Thus, Olowolafe (2008a: 2008b) is of the view that sound knowledge of the relationship between urban land use and soil behaviour (i.e. natural properties) can guide our choice of appropriate land use and soil management practices. Urban sprawl, soil erosion, soil degradation, salinization and desertification among others have also been identified as some of the effects of land use activities (UN Land Degradation and Land Use/Cover Data Sources, 2007).

Soil organic matter storage is also affected by urban land use changes. The ability of soil to function well can be measured by the soil physical, chemical and biological properties of the soil which are known as soil quality indicators (Shukla *et al.*, 2006). Soil properties that can be changed in a short time by land use changes are often referred to as soil quality indicators (Carter *et al.*, 1997). Aminu *et al* (2013) assess the impact of land use types on soil quality in Suleja area of Niger State, Nigeria

the results show that the physico-chemical properties of the soil such as the pH, organic matter and Total Nitrogen did show significant difference. Calcium, cation exchange capacity (CEC), and Available Phosphorus showed a slight difference and were linked with the rapid population growth in Suleja town.

Some studies soils as Abiodun (1974), Baba (1975), Abdullahi (1990), Adindu and Ogbonna, (1998) and Gana (2003) are centred on the effects of agricultural land use on soil there is need to assess some effects of urban land use in parts of Kaduna metropolis because the urban environment is of great importance to the understanding of the earth and its components alongside its impact on sustainable development, natural resources management and a significant understanding of the ecosystem. Therefore, this study tries to assess some effects of urban land use on some properties of soil in parts of Kaduna Metropolis because it is one of the largest cities in Nigeria that is also experiencing rapid urban expansion.

2.0 THE STUDY AREA

Kaduna metropolis is located between latitudes $10^{\circ} 23''\text{N}$ and $10^{\circ} 43''\text{N}$ and longitude $7^{\circ} 17''\text{E}$ and $7^{\circ} 37''\text{E}$. It is the capital of Kaduna State, Nigeria. The city comprised of two main Local Government Areas; Kaduna North, Kaduna South and parts of Chikun and Igabi Local Government Areas as shown on Figure 1. Kaduna state occupies part of the sub-humid agro-ecological zone of north central Nigeria, the state is bounded with Katsina, Zamfara and Kano states in the North, Bauchi and Plateau states in the Eastern part of the country, Nasarawa state and Federal Capital Territory Abuja in the South and Niger state in the Western part (Ajibua and Terdoo, 2013. Kaduna city has since 1967 been the headquarters of the then Northern Region and has remained the centre and administrative headquarters of Northern Nigeria.

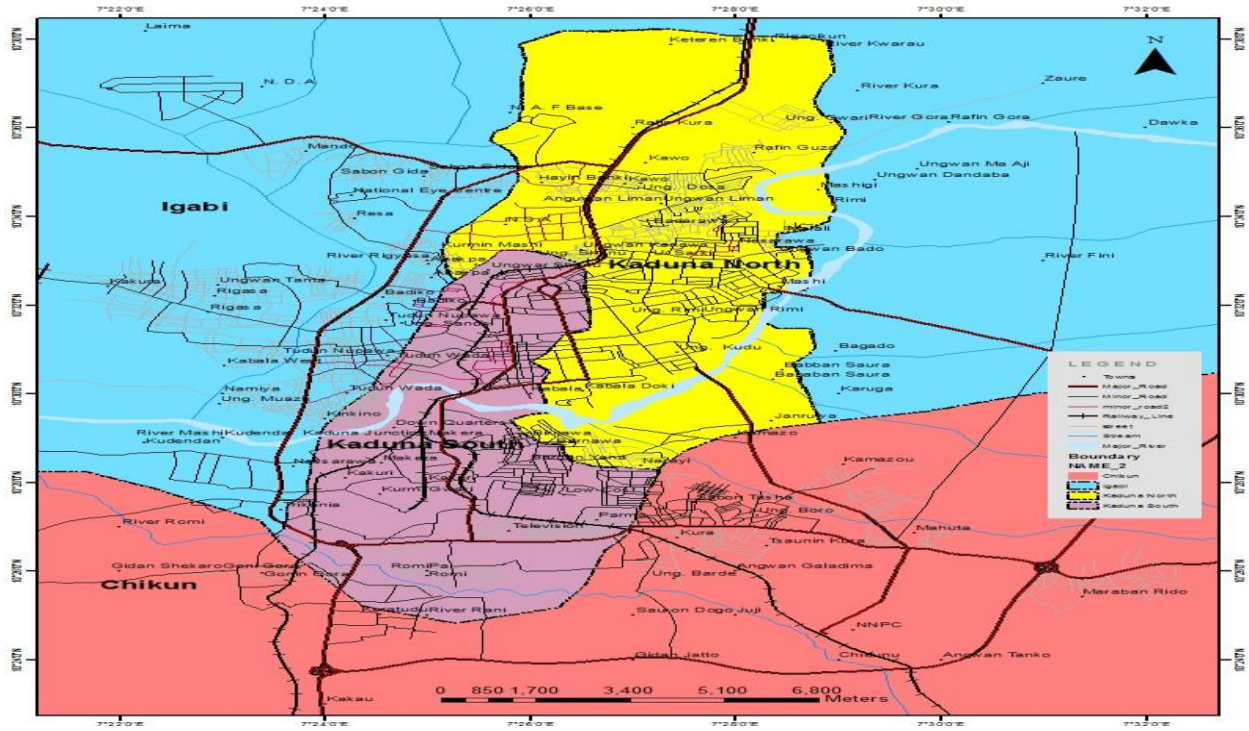


Figure 1: Kaduna Metropolis. Source: Obtained from Department of Cartography, GIS and Remote Sensing Lab, Kaduna Polytechnic (2015).

3.0 MATERIALS AND METHOD

The data for this study was derived mainly from primary sources. The data was generated through field survey involving measurement and observations which was the major data collection tool. Samples were collected from profile pits, surface and subsurface soils. Secondary data were obtained from publications/literatures that are relevant to this work; and also from Base maps, information on land uses and administrative area from relevant Local Government Headquarters which guided the delineation of the study area. Following a careful reconnaissance survey of some parts of Kaduna metropolis, special attention was made on four locations (Barnawa, Kakuri, Sabon Tasha and Maranban Rido) because these are areas that population has increased tremendously and the increase might have affected the properties of soil in the areas.

The study area was divided into seven different land use types as follows; mechanic workshop, farm, residential, dump site, Industrial, Road side and wood land use (which was considered as the control) as shown on Figure 2. The soil samples were collected from the seven different land use types at various depths and put into polythene bags. 23 composite samples were collected from surface and subsurface soils. Seven profile pits were dug and described in the various urban land use areas according to Food and Agricultural Organization (FAO, 2007) Guidelines while the soil was classified in line with United States Department of Agriculture (USDA, 2000) Soil Taxonomy. The collected soil samples were preserved in air-dried container and prepared according to standard methods. The chemical and physical soil properties were analyzed in Soil Science Laboratory of the Ahmadu Bello University Zaria, Kaduna State.

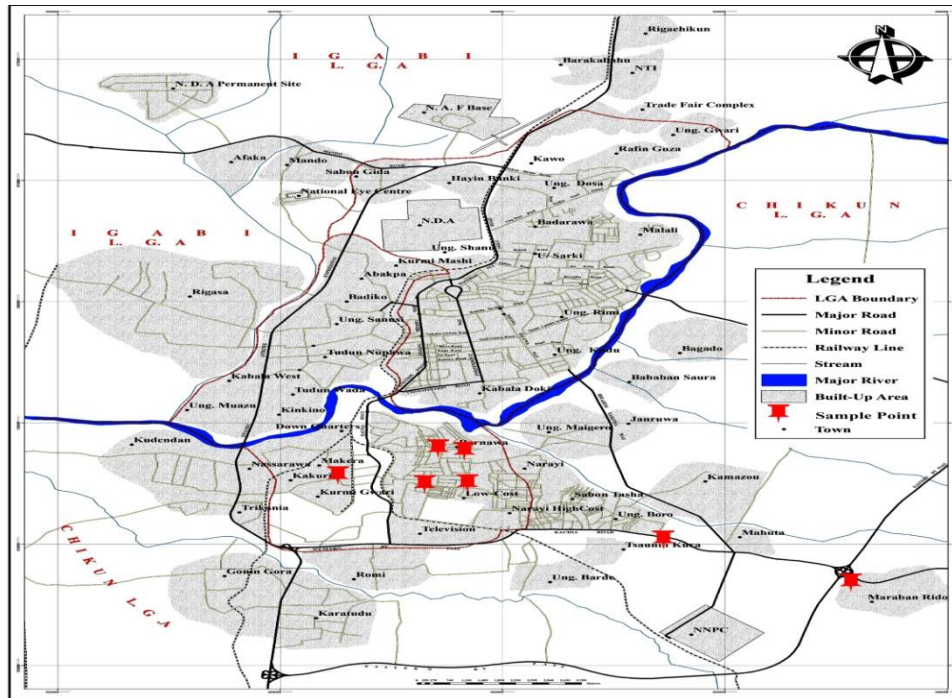


Figure 2: Different Land use Types in some part of Kaduna metropolis. Source: Obtained from Department of Cartography, GIS and Remote Sensing Kaduna Lab, Polytechnic (2015).

3.1 Laboratory Analysis

Standard procedures were employed in the laboratory to determine the following soil properties:

3.1.1 Soil Particle size analysis using the Bouyoucos Hydrometer Method:

To determine the soil particle size, the method employed by Ubwa *et al* (2013) was adopted. Fifty gram of 2mm sieved soil sample was put into a 250mL beaker with 100mL of 50% calgon and stir with a glass rod. About 100mL of treated water was added and mixed and the beaker was allowed to stand for about 30minutes. The mixture was then transfer into a 1000cm³ cylinder while ensuring that all content was completely washed into the cylinder and a 1000cm³ mark with water was made. Before the hydrometer reading was done, the suspended mixture was stirred using long plunger to make sure that the sediment at the bottom is thoroughly mixed. Hydrometer reading was taken at 40 seconds and 2 hours (these are the times recommended by Bouyoucos), then the reading was taken. A blank cylinder was prepared by making 100mL of 50% solution up

to 1 liter mark with water. Blank hydrometer readings of 40 seconds and 2 hours were also taken including the temperature of the suspension and that of the blank. After the last reading the suspension was pour through a 0.2mm sieve. The sand grains retained on the sieve was washed with water and then transfer into a beaker and dried in an oven at 105 °C. Finally the sand was weighed and recorded, these gives the coarse sand fraction. The real hydrometer readings C (g/L) were determined by subtracting the blank reading RL (g/L) from the hydrometer readings in the soil mixture R (g/L) and adding 0.36g/L for every degree after 20 °C.

3.1.2 pH

Twenty millimetre of distilled water was put in a 50ml beaker and 20g of air-dry soil (passed 2mm sieve) was added. The mixture was stirred several times for 30mins with a glass rod. The soil suspension stood for 30mins for all the suspended clay to settle. The electrode of the pH was fixed into the partly settled mixture and the pH was determined. The electrode was not allowed to touch the bottom of the beaker and also the suspension was not stir during

measurement. The reading were taken as the “soil pH measured in water”. The same procedure was repeated using CaCl₂ solution and the reading was taken as “soil pH measured in 0.01M CaCl₂”. The electrodes was rinsed with deionized water and wiped with clean tissue after each reading.

3.1.2 Organic matter (Walkey and Black, 1934 method): Representative sample was taken, grinded to pass through a 0.5mm sieve. 1.00g of soil was weighed out and place in a 250ml flask. 10ml of 1N K₂Cr₂O₇ was pipetted accurately into each flask and swirled gently to disperse the soil. 20ml of conc. H₂SO₄ was rapidly added from a measuring cylinder and the flask was swirl gently until soil and reagent were mixed, then swirl more vigorously for one min. The flask was rotated and allowed standing for 30min. 100ml of distilled water was added after standing for 30minutes and allowed to cool. 3-4 drop of indicator and titrate with 0.5N ferrous sulphate solution on white background was added. It was observed that as the end point approach, the solution takes on a greenish cast and then changes to dark green. The blank determination was made but without soil to standardize the dichromate. The organic matter was obtained by using an equation.

3.1.4 Exchangeable bases (Ca, Mg, Na, and K): Leachates preserved from CEC determination (that is after dilution) was used for the determination of exchangeable bases. Standard readings for different concentrations of each cation was done using graph of absorbance vs concentration (ppm) and Exchangeable bases in meq/100g soil were calculated

3.1.5 Exchangeable acidity (KCl Extraction method): 25ml of KCL extract was pipetted into a 250ml Erlenmyer flask and approximately 100ml of distilled water was added. 5 drops of phenolphthalein indicator was mixed and the titration was done with 0.01M NaOH to a permanent pink end point with alternate stirring and standing. To the same flask, 1 drop of 0.01M HCL was added to bring the solution back to the colourless condition. The value from the milliequivalent of total acidity was subtracted from the first titration to obtain the milliequivalent of exchangeable H.

3.1.6 Available phosphorus using dilute HCl/NH₄F (method of Bray and Kurtz, 1945):

One gram (1g) of air- dried soil was weighed and put in a 15ml tube and 7ml of solution was added. It was put in a mechanical shaker for 1minute and was poured into an acid- washed volumetric flask. Phosphorus was determined in the extract colorimetrically.

3.1.7 Total nitrogen using Kjeldahl (1888) procedure modified by Bremner *et al* (1965):

Two grams (2g) of soil was weighed into kjeldahl flask and 20ml of distilled water was added, and the flask was swirled for few minutes and was allowed standing for 30 minutes. It was heated continuously on a low heat while 3g of catalyst and 20ml of conc H₂SO₄ was added. The flask was allowed to cool and was shook slowly while adding distilled water. The solution was transfer into a clean flask while all the sand particles were retained in the original flask because sand can cause severe bumping during distillation. An addition of 10ml H₃BO₃ solution with 10ml of 40% NaOH was done and the temperature raised until it boils. The % of N content in soil was calculated using a scientific equation.

3.1.8 ECEC was calculated using the summation method:

To calculate the cation exchange capacity (CEC) after the laboratory analysis the following formula was use;

$$CEC \text{ (meq/100g soil)} = \frac{(T - B) \times N \times 100}{W}$$

Where T = Vol of acid used in titration

B = Titre value for blank

N = Normality of acid use

W = Weight of soil used

The exchangeable cation capacity was obtained using the summation method.

3.1.9 Heavy metals: The following heavy metals (Fe, Mn, Cu, Zn, Cd, Pb and Ni) in the soils in parts of Kaduna metropolis were examined. A mixed acid digestion of perchloric, nitric and supheric acid and reading was done with Atomic Absorption Spectrometer (AAS).

4.0 RESULTS AND DISCUSSION

The effects of urban land use on the following properties of soil are presented as follows.

4.1 Physical Properties of Soil

Table 1 shows that the soil type is predominantly in the study area loamy soil. This range from Sandy Clay Loam (SCL) which is 48% of the total soil samples collected from the field to sandy loam (SL) which is 35%, clay loam (CL) 13%, with an exception of Sandy Clay (SC) which is found in Horizon B_{w2} of the dump site land use as reflected. The soil texture shows different variable values of sand, silt and clay. The result shows that clay content of most

of the profile pits e.g. mechanic workshop, farm land and dump site land use were found to increase with depth except for wood land whose surface soil has high percentage of clay content. The increase in clay content with depth on the other land uses could be due to eluviation and illuviation resulting in the translocation and subsequent accumulation of clay in a lower horizon caused by anthropogenic activities.

Table 1 Physical Properties of Soil .Sources: Field Work (2015).

S/n	Land Use Type	Horizon	Depth {cm}	Clay %	Silt %	Sand %	Texture	Colour
1	Mechanic Workshop	A1	0-10	14	10	76	SL	Dark Grey
		A2	10-27	20	10	70	SL	Yellowish Brown
		Bw1	27-45	22	14	64	SL	Dark Brown
		Bt1	45-65	26	18	56	SCL	Dark yellowish Brown
		Bt2	65+	34	16	50	SCL	Dark yellow Brown
2	Farm Land	A1	0-20	16	22	62	SCL	Pale Brown
		Bw1	20-55	28	22	50	SCL	Yellowish Brown
		Bt2	55-105	36	22	42	CL	Brownish yellow
		C	105 +	32	22	46	CL	Light Yellowish Brown
3	Residential Land	A1	0-30	20	14	66	SL	Brown
		Bw1	30-50	28	16	56	SCL	Yellow
		Bt1	50 +	18	8	74	SL	Red
4	Dump Site	A0	0-30	16	12	72	SL	Dark Greyish Brown
		Aw	30-45	26	22	52	SCL	Dark Brown
		Bw1	45-72	22	16	62	SCL	Yellowish Red
		Bwt	72+	24	12	64	SC	Yellowish Red
5	Industrial Land	A0	0-20	18	12	70	SL	Brown
		A1	20-40	24	12	64	SCL	Yellow
		Bt1	40 +	26	12	62	SCL	Reddish Yellow
6	Road Side	A1	0-25	16	16	68	SL	Dark Brown
		Bw1	25+	36	16	48	SCL	Strong Brown
7	Wood Land	A1	0-40	34	26	40	CL	Red
		Bt	40+	26	14	60	SCL	Red

4.2 Chemical Properties of the Soil

Urban land use has greatly affected some chemical properties of soils in the urban area. The soil reaction (pH) is higher in areas affected by urban land uses than their original counterparts and it is a great indicator of the chemical quality of the soil in such an environment. Table 2 shows that the pH of the soil is clearly the same in all land use types. Mechanical land is in neutral state especially in the A Horizon this could be as a result of addition of battery water and other things to the soil. Farm land, residential, dumb site, industrial and road side land uses are all slightly acidic while wood land which serves as the control is moderately acidic. Generally, the soils are neutral to slightly acidic in reaction and this may be due to the nature of soil parent materials which is of complex composition.

pH: The elevation of pH values in these soils could be as a result of application of fertilizers containing calcium or sodium chlorides as sidewalk and street-deicing salts, irrigation of urban soil with water containing calcium, atmospheric droplets, ash and residues often contain calcium too. It could also be from the release of calcium from weathering from bricks, cement, and plaster, among others, or draining of calcium from building facades by polluted acid precipitation and liming of soil to correct deficiencies also raises the pH values. One of the major disadvantages of high pH is that it creates an imbalance with other nutrient ions and may prevent their uptake by roots.

Table 2. Soil Chemical Properties.

S\no	Landuse Types	Horizon	Depth {cm}	pH 1:2.50 H2O	Ratio CaCl2	AP Mg/Kg	OM %	TN %	Exchangeable {Cmol/Kg}			Bases Na		Exch. Acidity {Al+H}	ECEC
									Ca	Mg	K	Na			
1	Mechanic Workshop	A1	0-10	6.9	5.9	18.2	5.54	0.147	10.39	0.61	0.18	0.69	1	12.87	
		A2	10_27	6.8	5.8	74.73	0.29	0.077	7.58	0.55	0.09	0.62	0.8	9.64	
		Bw1	27-45	6.7	6.2	69.48	0.54	0.063	6.45	0.54	0.1	0.66	0.4	8.15	
		Bt1	45-65	6.4	6	3.33	0.48	0.077	8.72	0.58	0.11	0.7	1	11.11	
		Bt2	65+	6.5	5.9	3.85	0.35	0.084	7.27	0.72	0.19	0.69	0.8	9.67	
2	Farm Land	A1	0-20	6.3	6.1	7.18	1.26	0.147	7.14	0.66	0.16	0.82	0.4	9.18	
		Bw1	20-55	6.5	6.2	6.67	0.41	0.063	5.31	0.65	0.11	0.61	0.6	7.28	
		Bt2	55-105	6	5.4	0.88	0.19	0.035	7.51	0.84	0.2	0.67	0.6	9.82	
		C	105 +	6.8	5.9	0.53	0.25	0.035	10.21	0.96	0.11	1.69	0.2	13.17	
3	Residential	A1	0-30	6.3	6.1	5.08	1.41	0.203	8.1	0.63	0.29	0.68	0.4	10.1	
		Bw1	30-50	6.6	6.3	1.58	0.36	0.063	6.51	0.62	0.34	0.66	0.8	8.93	
		Bt1	50 +	6.6	6.2	1.93	0.26	0.042	5.17	0.61	0.47	0.69	0.6	8.08	
4	Dumb Site	A0	0-30	6.4	6.1	87.33	2.1	0.24	15.82	0.82	1.48	1.04	1	20.16	
		Aw	30-45	6.8	6.5	32.55	0.87	0.11	14.77	0.83	2.2	1.04	0.6	19.44	
		Bw1	45-72	6.9	6.6	2.63	0.26	0.07	6.86	0.71	0.71	0.78	0.4	10.13	
		Bwt	72+	6.5	6.3	2.63	0.22	0.07	8.89	0.77	0.77	0.81	0.6	12.96	
5	Industrial	A0	0-20	6.3	6.1	22.58	0.91	0.097	5.9	0.59	0.2	0.87	0.6	8.16	
		A1	20-40	6.5	6.3	5.95	0.46	0.091	4.54	0.58	0.26	0.7	0.4	6.48	
		Bt1	40 +	6.4	6.1	3.15	0.54	0.063	4.48	0.59	0.27	0.79	0.6	6.73	
6	Road Side	A1	0-25	6.4	6.1	7.7	0.83	0.098	4.33	0.6	0.24	0.54	0.4	6.12	
		Bw1	25+	6.5	6.3	1.05	0.22	0.049	4.24	0.74	0.29	0.58	0.4	6.25	
7	Wood Land	A1	0-40	5.9	5.9	0.88	0.12	0.056	2.58	0.68	0.14	0.54	0.6	6.54	
		Bt	40+	5.7	5.7	0.7	0.02	0.049	2.89	0.65	0.11	0.66	0.4	7.71	

Sources: Field Work (2015).

Where AP is Available Phosphorus, OM = Organic Matter Content, TN+= Total Nitrogen, ECEC= Effective Cation Exchange Capacity, Ca= Calcium, Mg= Magnesium, K= Potassium, Na= Sodium.

Organic Matter Content: Organic matter is a carbon-rich material that is made up of plant, animal, and microbial residues in different levels of decomposition. The quantity composition and nature of organic matter vary greatly in different ecosystems. Organic matter is the store house for plants nutrients like nitrogen and it has implication for soil's ability to support growth. The light, porous nature of organic matter helps increase soil water retention capacity, enhance soil structure development and decrease bulk density. It also increases soil's ability to retain contaminants which decreases the chances of offsite movement. Organic matter is primarily of plant origin and it tends to accumulate in urban area with trees or grass cover where decomposition is retarded. Table 2 also shows that organic matter content is relatively high in mechanic and dump site areas, higher than that of the undisturbed soils (wood land) showing that there are high organic activities taking place in the areas, also residential and farm land areas equally have high organic matter content which is likely to be as a result of incorporation of urban waste into the soil with road side having the lowest value. It is also observed that organic matter decreases sharply with increase in depth in all land use types including the control area and this decrease shows the slow rate at which organic matter can leach down within the undisturbed soils.

Available Phosphorus: Phosphorus is one of the essential plant nutrients that are commonly found naturally in most soils. High phosphorus could be either regolith formation or anthropogenic in nature, or both and the amount of available phosphorus from the result is high in soils found in urban areas; with dump site having the highest value of available phosphorus (87.33mg/kg), while residential areas has the least value (5.08mg/kg) as compared to the undisturbed soils of the wood land. Perhaps some urban activities including wastes that contain phosphorus, waste disposal, motor repairs, vehicle panel beating, among others have added significant amount of phosphorus to the soil, making urban soils higher in available phosphorus.

Total Nitrogen: The current fertility status of the granitic soils and the concentration of nitrogen are low, the study shows that the soils

total nitrogen is higher in soils affected by urban land use particularly on the surface soil. Table 2 shows no visible difference in Total Nitrogen (TN) of the soils. Dump site and wood land has the highest concentration of TN (0.24%) and the lowest concentration (0.05%). This connotes that, urban land use has impacted on the total nitrogen on the surface soil. This may be as a result of incorporation of urban waste into the soils or chemical substances as in the case of dump site, residential and mechanical land uses and can also partly account for the increase in organic matter content of the urban soils in some places.

Exchangeable Bases: The result shows that some exchangeable bases show some difference between land use and the control (wood land), while others are normal. Table 2 shows that calcium (Ca) is high in other land uses as compared to wood land (control) with the exception of road side. Industrial and road side are high in magnesium (Mg) and dump site high in potassium (K) and sodium (Na). With an increased amount of exchangeable cations, the more acidity can be neutralized. This explains why soils that are affected by urban land uses have the highest values of ECEC, which could be as a result of town waste incorporating into the soils.

Effective Cation Exchange Capacity (ECEC): Table 2 shows that there is a visible difference between the control (woodland) and other land uses with the exception of road side land use. The soils are generally moderate to high in ECEC, the dump site has the highest (20.16Cmol/kg) and road side with the lowest value of 6.12Cmol/kg. The high ECEC values show that the soils are fertile and this may be attributed to the nature of the clay minerals present. The high ECEC in dump site area, mechanical and residential areas may also be attributed to the moderate level of organic matter in the soils, while the low ECEC in road side may be attributed to clay type and content. The effective cation exchange of soil determines the fertility statues of soils and with the values obtained for the soils, it could be said to be of moderate and high fertility. In general, ECEC can have a great effect on the soil fertility management.

4.3 Effects of urban land use on Heavy Metals

Generally, there are different sources of heavy metals in the soil. These metals could be from geologic formation, atmospheric deposition and the use of synthetic products (e.g. pesticides, paints, batteries, improper stacking of industrial solid waste, and land application of industrial and domestic sludge) and other anthropogenic activities can also result in heavy metals contamination of the urban soils. Heavy metals also occur naturally, but rarely at toxic levels.

Excess heavy metal accumulation in soils can be toxic to humans and other animals. Exposure to heavy metals is normally chronic especially exposure over a longer period of time due to food chain transfer. Immediate poisoning from heavy metals is rare through ingestion or dermal contact but could be possible. Table 3 shows some of the heavy metals in common circulation in the urban areas that are selected for this study.

Table 3. Heavy Metal Content in Soils in some part of Kaduna Metropolis (in mg/kg).

S/no	Land Use Type	Iron	Manganese	Copper	Zinc	Cadmium	Lead	Nikkel
1	Mechanic Workshop	275.22	48.58	35.51	63.84	1.21	103.13	1.96
		121.77	11.94	2.75	13.96	0.48	9.80	0.00
		53.66	15.00	2.23	9.03	0.32	7.13	0.00
		34.70	12.25	2.06	6.72	0.40	9.13	0.00
		39.87	19.56	1.89	7.95	0.40	6.47	0.00
2	Farm Land	128.23	13.32	1.72	9.34	0.4	8.47	0.00
		51.08	2.58	2.66	7.8	0.40	11.13	0.00
		98.92	10.00	2.75	7.8	0.40	11.80	0.00
		75.65	9.69	2.41	7.8	0.40	9.80	0.00
3	Residential	135.13	33.61	2.84	18.5	0.48	14.47	0.00
		28.66	10.44	2.06	8.03	0.40	8.47	0.00
		35.56	7.88	1.28	6.26	0.40	9.13	0.00
4	Dump Site	70.91	37.91	5.51	64.77	0.66	19.13	0.00
		142.89	40.78	6.54	50.60	0.64	19.13	4.02
		76.08	27.07	2.41	14.65	0.48	41.80	0.00
		55.39	12.07	2.58	28.12	0.40	9.13	0.00
5	Industrial	201.08	30.04	71.63	23.97	4.63	39.13	0.00
		57.97	10.44	3.53	7.72	0.64	11.13	0.00
		48.06	7.63	1.97	6.34	0.40	11.8	0.00
6	Road Side	49.78	13.13	1.80	8.18	0.00	10.47	0.00
		22.63	6.20	1.37	7.41	0.00	8.47	0.00
7	Wood Land	39.44	39.22	1.54	5.87	0.00	7.13	0.00
		30.68	4.14	1.20	5.8	0.00	9.80	000

Source: Field work 2015.

The result shows that the concentration of heavy metals has increased in some parts of Kaduna metropolis due to urban activities. Also, the introduction of certain elements into the soil from anthropogenic activities such as municipal waste, sewage sludge, batteries and parent rock materials might have accounted for these differences as follows:

Zinc (Zn): The concentration of Zn ranges from 64.77 to 28.12mg/kg in the dumpsite to 63.84-7.95mg/kg in mechanic workshop, while the control site soil (woodland) has lower concentration of Zn (5.87- 5.80mg/kg) which shows a wide difference between concentration of zinc in urban soil and the control soil. The difference in concentration of zinc in Kaduna metropolis shows the impact of contamination

from anthropogenic activities rather than the geologic formation. The smelting of nonferrous metals, attrition of motor vehicles, and municipal waste are the major zinc sources that contribute to soil and air pollution. The contamination/ or pollution level of Zn on Table 3 is classified into moderate pollution to severe pollution in the various urban land uses locations and so may be harmful to soil organisms, plant and the entire environment if not handled.

Copper (Cu): The concentration of Cu in the soil as shown on Table 3 ranges from 71.63 to 1.97mg/kg in industrial area and 35.51-1.89mg/kg in mechanical workshop, both land uses having the highest values as compared with other land uses while the control site (woodland) has Cu concentration of 1.54 to 1.20mg/kg lower than all the urban land uses. High Cu concentration is an indication of a potential hazard for crops grown on the soil. This is because leaching of Cu down the soil profile will affect ground water reserve. The assessment of contamination or pollution by Cu in the metropolis is placed between slight and severe pollution.

Iron (Fe): The concentration of Fe recorded varies for different land use types, with the highest values recorded at the mechanical workshop area (275.22- 39.87mg/kg) and industrial land (201.08-48.06mg/kg) with the control site having the least value (39.44-30.68mg/kg) as shown on Table 3. The main source of Fe could be from metal scraps in dumpsite and leaching of iron from anthropogenic sources. The ferruginous soil of the study area is also known to contain high level of Fe as can be seen in the control site.

Lead (Pb): Lead in soils shows similar result except for mechanical workshop and industrial land use both having high traces of Pb concentration ranging from 103.13-6.47mg/kg and 39.13- 11.80mg/kg respectively, with the least recorded value obtained at the control site (7.13- 9.80mg/kg) though the Road side is slightly similar to the woodland as shown in Table 3. The presence of traces of Pb in these soils could be from mechanical and industrial waste. Pb is generally low in other land use types and may therefore pose no serious threat to humans and plants. Traces of Pb could be found in the environment from gasoline combustion,

exhaust gasses of petrol engine, battery factories/water, fertilizer impurities, sewage sludge, waste incineration and atmospheric fallout.

Manganese (Mn): Table 3 shows that wood land (control) and mechanical land had the highest value of manganese concentration ranging from 48.58- 19.56mg/kg to 39.22-4.14mg/kg, which could be as a result of their parent rock material while farm land and road side had the least value. Generally, manganese is released into the environment by both natural and anthropogenic processes mostly in the form of coarse particles, through wind erosion, road dusts, agricultural and building activities and quarry processes and in the form of fine particles, it is released into the environment by natural ore smelting, fossil- fuel combustion and from battery water.

Nickel (Ni): Table 3 shows that Ni is only found in mechanical land use and dump site, with the highest value found in dump site and nothing was observed in the other land uses including the control (wood land). Naturally the emission of Ni to the atmosphere is dominated by windblown dust however the anthropogenic sources contributes 65% of all emission sources and are dominated through fossil fuel combustion, waste incineration and nonferrous metal production (Callender, 2007).

Cadmium (Cd): The concentration of Cd in the various land use types was generally similar with an exception of industrial and mechanic workshop land use which had high Cd concentration at the surface soil while there is no traces of Cd found in the control site (woodland) and roadside land use as shown on Table 3. The high amount of Cd found in both industrial and mechanical land use types could be from industrial processes (electroplating, nonferrous metal, iron), fossil-fuel combustion pigments from plastics and paint residues, wear of automobile tyres, lubricants, batteries in the metropolis and parent rock materials in the area. Elias and Gbadegesin (2013) are of the view that the relationship between urban soils and land use is very crucial as they are related to consumptive pattern of the society and that the concentration, distribution and sources of these harmful heavy metals in the urban environment have implications on soils, sediment, and human life

quality and makes this study very important. Goyer (1996) and Elias and Gbadegesin (2013) are of the view that trace amounts of these elements are common and necessary in our environment and diet for good health, however large amount of any of the metals could result in serious and chronic toxicity. Anthropogenic activities affect the natural regolith system and biological redistribution of heavy elements through contamination of the environment which could lead to heavy metals toxicity by allowing it to bio-accumulate in organisms and soils. This bioaccumulation of metals in the food chain has linked to malfunctions of specific organs of the body. Thus, Goyer (1996) and Elias and Gbadegesin (2013) are of the opinion that bioaccumulation could result in damaged or reduced mental and central nervous function, lower energy levels and damage to blood composition, lung, kidneys, liver and other vital organs and long term exposure could also result in slowly progressing physical, muscular and neurological degenerative processes that mimic Alzheimer's diseases, Parkinson's disease, muscular dystrophy and multiple sclerosis. The laboratory analysis of soils under mechanical, residential, industrial, dump site, farm land use shows an increase in heavy metal contents in soils compared to the undisturbed wood land (control). The concentration of these heavy metals in soils may be derived from various sources, such as anthropogenic pollution, weathering of natural high background rocks and metal deposits as it was also stated by Elias and Gbadegesin (2013).

5.0 CONCLUSION AND RECOMMENDATIONS

Soils have always performed a wide range of useful functions. The range of these functions and impacts on the environment has changed considerably in the urban environment as land uses are being converted and failure of the soil to function as expected can have significant effect on the urban environment. The result shows that unstable or disturbed soils differ from stable soils (original soils) because their horizons have been mixed, destroyed or removed. The original soil properties have changed, sub-soils are exposed or mixed with top-soils and compaction may have occurred,

while original soils may have been altered and new materials added. These activities have resulted in great differences in some properties of the soil. These changes determine whether the soils can carry out engineering, environmental, hydrological, physical, chemical and biological functions required for the urban environment. The soil profiles in urban areas have shown sharp changes from one horizon to another depending on the history and background of the soil. This condition is often common in residential construction, because each horizon may completely differ in chemical characteristics. Most of the soils have been disturbed, displaced, or compacted which subject these soils to different types of forces over a period of soil moisture conditions. The study therefore recommends that sustainable management practices that enhance ecosystem services of urban soils be put in place and research on the characteristics of soil at the top and substantially below the surface is needed in metropolitan areas.

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