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PHYSICOCHEMICAL PROPERTIES AND LEVELS OF HEAVY METALS IN TOPSOILS OF SELECTED URBAN AREAS IN AKURE METROPOLIS, NIGERIA.

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ABSTRACT

This research aimed at assessing the physicochemical properties and heavy metal concentration in soils of places visited by a large number of persons. Top soils (0-15 cm) of Shasha market, North Gate motor park, Benin motor park and Ilesha motor park were sampled. The pH of the soil samples ranged from 6.95-7.83 and 5.42 - 8.20,the organic matter ranged from 0.78% - 4.70 and 2.21-5.78%,the CEC ranged from 2.65-3.99meq/100 gm and 3.32 - 5.59meq/100 gm, the electrical conductivity of ranged from 155.00-416.33µS/cm and 150.33- 426.66µS/cm,the particle size determined showed %clay ranging from 8.93 - 22.45 and 9.61-17.36,%silt was 7.44-10.09 and 1.83 - 10.18 and %sand was 68.42 -83.63 and 72.46- 85.45 for control and site samples respectively. The concentration of Pb ranged between 0.04 - 21.45mg/kg and 0.23 - 40.2mg/kg, Cd was 4mg/kg and 3.00 - 6.00mg/kg, Zn was 16 - 66 mg/kg and 35 - 442 mg/kg, Cu was 9 - 25 mg/kg and 13.1 - 145 mg/kg, Mn was 122-420 mg/kg and 137-330 mg/kg, Ni was 1 - 5 mg/kg and 3-9 mg/kg for control sample and site samples respectively. Index of Geo-accumulation (Igeo) and quantification of anthropogenic concentration of metal inferred that the source of pollution was anthropogenic.

Keywords: Soil; Physicochemical properties; Heavy metals; Market; Motor park; Akure

1. Introduction

Heavy metals are inorganic pollutants (elements) which have a density greater than five in their elemental form. Heavy metals usually find specific adsorption sites on organic and inorganic colloids. Although heavy metals occur naturally, their concentration in soils have been elevated by anthropogenic activities. Some heavy metals such as Se, Zn, Mo, Cr and Mn are essential for plants and animals in trace amounts however others like Pb, Cd, and Hg have no known benefit to living organisms. Heavy metals are present in all uncontaminated and unpolluted soils as a result of natural processes like weathering of parent materials but urbanization, production processes, mining, waste disposal and other activities increase the concentration of heavy metals in soils daily (Okrent 1999; Muhammad *et al*., 2014). The toxicity of heavy metals cannot be over emphasized because they can bio accumulate and bio magnify in the food chain (Abrahams, 2002; Mertens *et al.*, 2004; Carrillo-González *et al.*, 2006). In contrast with rural areas, soils in urban environments, particularly in motor parks, open markets, schools, tourist centers and recreational parks have a direct influence on public health not related with production of food. This is due to the fact that human beings can easily get in contact with soils in such areas either directly or indirectly (De Miguel *et al.*, 1997; Mielke *et al.*, 1999). According to the National Population Commission (2010), Akure south local government area is in Ondo state and has a land size of 335.805k/m^2 and a population of 360,268 making it the most inhabited local government area in the state.

The study was aimed at assessing the levels of heavy metals in top soils of selected motor parks and markets in Akure metropolis**.** The specific objectives were to determine the physicochemical properties of the soil samples and the concentrations of Cu, Cd, Ni, Pb, Mn, and Zn in the soil samples.

2. Materials and Methods

2.1 Sampling Areas and Soil Sampling

The study areas are classified into two major groups namely open markets and motor parks (garage). The open market is Shasha market while the motor park is subdivided into three namely FUTA North gate motor park, Ilesha motor park and Benin motor park. All study and sampling areas are within Akure metropolis and are visited by a large number of persons daily. The open market is a major distributor of food items (whole sale market) while the motor parks are places in which persons' board vehicles to other parts of Ondo State and Nigeria. The sampling was carried out on top soil (0-15 cm). The soil samples were collected using a soil auger from each sub division of the major study areas (four subdivisions). Eight composite soil samples were collected in total. Four main site soil samples were collected (one sample from each sub division). Each main sample consisted of six sub samples collected randomly from each subdivision study area (Fig 1). Four composite control samples were collected 70 m away from each main sample collection site. Each control sample for each subdivision consisted of six subsamples collected randomly (Fig 1). The geographical coordinates were obtained using a global positioning system (GPS). The samples were carefully kept in black polyethene bags, tied up and labelled accordingly immediately prior to further analysis.

2.2 Sample Pre-Treatment

The soil samples were spread on trays and air dried for 7 days. The dried samples were passed through a 2 mm sieve (British Standard) to ensure uniformity and a large surface area. The sieved samples were kept in plastic containers until further analysis (Seiler *et al*., 2008; Yuebing *et al*., 2010)

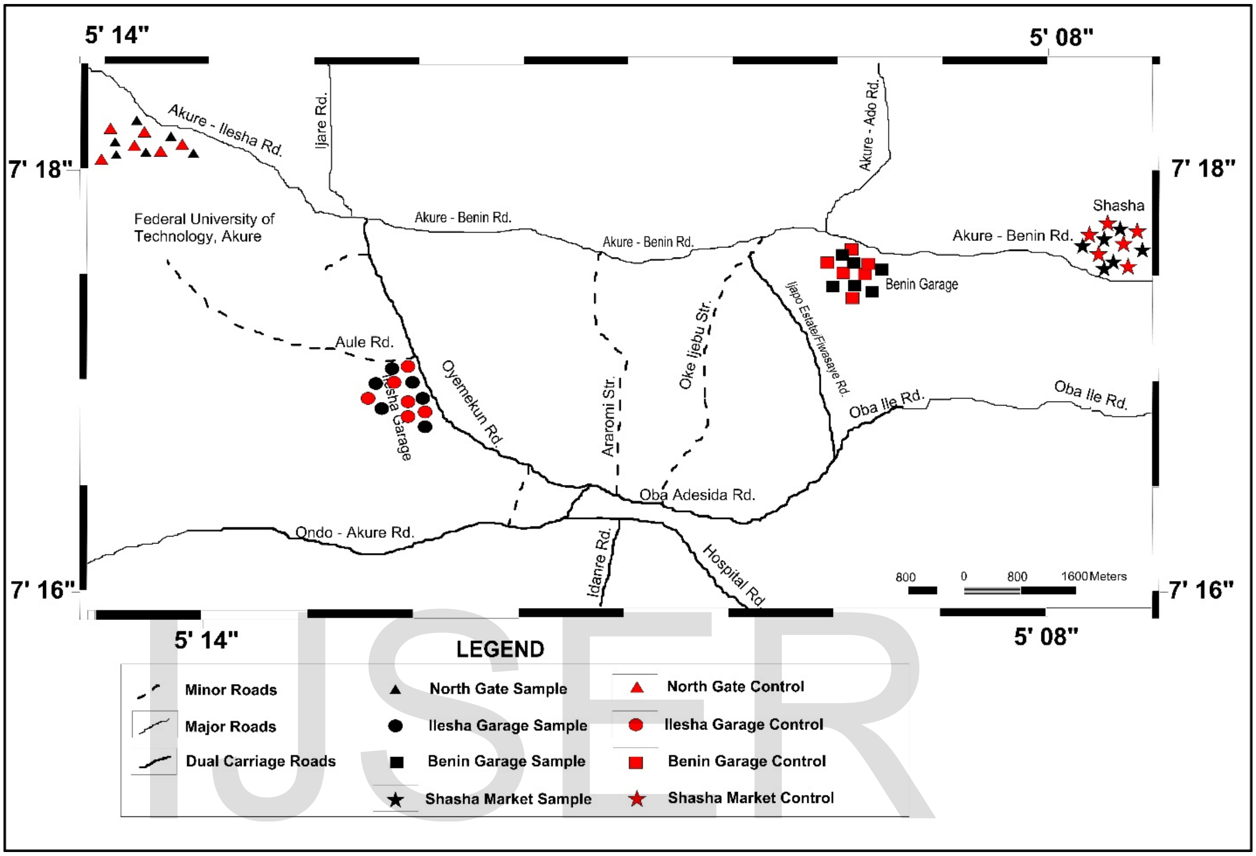

Figure 1: A map showing sampling sites

North Gate Sample – NGS

North Gate Control - NGC

Ilesha Garage Sample – IGS

Ilesha Garage Control – IGC

Benin Garage Sample – BGS

Benin Garage Control – BGC

Shasha Market Sample – SSS

Shasha Market Control – SSC

2.3 Chemical analysis

On the samples were determined: pH measurement using pH glass electrode system model Jenway 3505 (1:2.5 soil:water ratio) (Roslaili *et al.*, 2015), organic matter content (Wakley - Black acid digestion) (Meersmans *et al.*, 2009), particle size (hydrometer method) (Di Stefano *et al.*, 2010), electrical conductivity using a digital electrical conductivity model AVI- 648 manufactured by Labtech (1:2.5 soil:water ratio) (Roslaili *et al.*, 2015) and cation exchange capacity (CEC) (Ibitoye, 2015). The heavy metal content was determined by digesting 0.5 g of soil sample in a digester at 120^0 C using Aqua regia (3:1 of $HCl:HNO_3$) (Imperato *et al.*, 2003) and analysing using Atomic Absorption Spectrometer manufactured by buck scientific model 210 VGP.

2.4 Statistical Analysis

Statistical analysis including one-way analysis of variance (ANOVA) and correlation analysis were performed using statistical package for social sciences (IBM, SPSS 22.0).

3. Results and Discussion

3.1 Physicochemical Properties of Soil Samples

Soil properties such as pH, organic matter (OM), cation exchange capacity (CEC), electrical conductivity (EC) and particle size distribution are known to influence the interactions, adsorption and desorption process of heavy metals within the soil matrix (Aloysius *et al*., 2013). The pH of the soil samples in this work ranged from 5.42 to 8.20 (Table 1). Soil pH ranges was reported by Anietie and Lajide (2015) as follows; < 5.5 (strongly acidic); 5.5-5.9 (medium acidic); 6.0-6.4 (slightly acidic); 6.5-6.9 (very slightly acidic); 7.0 (neutral); 7.1-7.5 (very slightly alkaline); 7.6-8.0 (slightly alkaline); 8.1-8.5 (medium alkaline); and > 8.5 (strongly alkaline). Thus the soils pH can be categorized to range from medium alkaline to strongly acidic pH. Benin motor park sample (5.42) and Shasha market sample (8.20) had the lowest and highest pH values among the site samples while Shasha market control (6.95) and Ilesha motor park control (7.83) had the lowest and highest pH among the control samples. The pH values of the soil samples are also in accordance with the pH values (6.20-7.50) of soil samples reported for motor parks (garage) in Benue state by Dauda and Oboh (2012). Significant variation ($p<0.05$) among the means of the soil pH in the study areas were observed.

Organic matter (OM) in soil immobilizes heavy metals at strongly acidic conditions and mobilizes metals at weakly acidic to alkaline reactions by forming insoluble or soluble organic metal complexes, respectively (Aloysius *et al.,* 2013). The organic matter content of the soil samples ranged from 2.21-5.78% and 0.78-4.70% (Table 1) for site samples and control respectively. This is typical of the range observable in tropical soils (Adedeji *et al*., 2013). The highest value among the site samples was obtained in Benin motor park sample (5.78%) and the lowest value was obtained in North gate motor park sample (2.38%). Benin motor park has little vegetation and this could be the reason why it has higher organic matter content among the motor parks. Shasha market sample also had a relative high organic matter content of 4.79% as compared to other study areas. The relative high organic matter of Shasha market sample is attributable to decaying fruits, vegetables and foods in general which fall to the soil during sales and from baskets used in packaging them. The low organic matter content of North gate motor park may be because of its relatively young age compared to the other motor parks sampled and also has no vegetation growing within on it. Among the control samples, Benin motor park control (0.78%) and Shasha market control (3.59%) had the lowest and highest values respectively among the control samples. Significant variation ($p<0.05$) among the means of the soil pH in the study areas were observed.

The particle size distribution classifies the soils texturally. The soil samples (Table 1) had clay ranging from 9.61-17.36 % and 8.93 – 22.45%, silt (1.83 – 10.18%) and (7.44-10.09%) and sand (72.46-85.45% and 68.42 – 83.63%) for site samples and control respectively. Generally, the soils can be classified as loamy sand, sandy clay loam and sandy loam. The particle size distribution of this research is similar to the range (sand: 70.02 - 89.70%, Silt: 7.05 - 11.10% and clay: 9.95 - 20.20%) reported by Adedeji *et al.* (2013) for roadside soils in emerging urban centers in Ijebu-North Area of Ogun State, Nigeria.

The electrical conductivity is a measure of the concentration of soluble inorganic salts. The electrical conductivity of the soil samples (Table 1) ranged from 150.33– 426.66 μS/cm and 155.00-416.33 μS/cm for site samples and control respectively. North gate motor park sample and Ilesha motor park sample had the lowest and highest values respectively among site samples respectively. Ilesha motor park also serves as mechanic workshops unlike the other study areas and thus regular input of inorganic salts is expected. Ilesha motor park control and Benin motor park control had the lowest and highest values respectively among control samples. Generally, the soil samples can be classified as having medium electrical conductivity. Significant difference was observed between all samples ($p<0.05$) except between Shasha market sample and Ilesha motor park sample. This can be due to the fact that Shasha market sample has minimal sources of inorganic salts as compared to Ilesha motor park sample which has numerous sources of inorganic salts origination from various auto mechanic activities.

The CEC (Table 1) was low generally and ranged from 3.32 – 5.59 meq/100 g and 2.65-3.99 meq/100 g for site and control samples respectively. The CEC values obtained in this research was close to that obtained for top soils (0-5 cm) by Ayo and Olojugba (2014) (4.99 meq/100 g) who researched on the effect of rainfall season on the chemical properties of the soil of a southern guinea savanna ecosystem in Nigeria. Also, Abdulrasoul *et al.* (2011) (3.96 meq/100 g) who worked on the impact of cement dust on some soil properties around the cement factory in Al-Hasa Oasis, Saudi Arabia. Analysis of variance (ANOVA) showed that there was significant difference between all samples ($p<0.05$).

Table 1: Physicochemical Properties of Soil Samples

Sample Code	pH (25 ^{0}C)	EC µS/cm (25 ^{0}C)	% OM	CEC meq/100 g	% clay	% Silt	% sand	Class
SSC	6.95 ±0.02	283.33 ±2.08	4.70 ±0.03	3.59 ± 0.14	8.93^{a} ±0.38	7.44^{a} ±0.20	83.63^{a} ±0.21	Loamy sand
SSS	8.20 ±0.01	424.33^{a} ±2.08	4.79 ±0.01	3.99 ± 0.16	9.61^{ab} ±0.10	4.94 ±0.23	85.45 ±0.13	Loamy sand
IGC	7.83 ±0.03	155.00 ±1.00	4.54 ±0.01	3.32 ± 0.14	22.45±0.03	9.13^{bc} ±0.08	68.42 ±0.05	Sandy clay loam
IGS	7.13 ±0.03	426.66^{a} ±1.15	3.50 ±0.02	3.41 ± 0.15	17.36 ±0.14	10.18^{b} ±0.07	72.46^{b} ±0.18	Sandy loam
NGC	7.32 ±0.02	247.00 ±2.00	2.38 ±0.04	3.46 ± 0.19	18.43 ±0.61	10.09^{b} ±0.85	71.48^{b} ±0.27	Sandy loam
NGS	7.70 ±0.01	150.33 ±1.52	2.21 ±0.01	2.65 ± 0.12	14.41± 0.13	1.83 ±0.43	83.76^{a} ±0.33	Loamy sand
BGC	7.52 ±0.01	416.33 ±1.52	0.78 ±0.02	5.59 ± 0.10	10.05^{b} ±0.02	8.19^{ac} ±0.97	81.76 ±0.97	Loamy sand

BGS	5.42 ±0.02	231.00 ±1.00	5.78 ±0.02	3.69 ± 0.15	16.21± 0.07	8.40^{ac} ±0.13	75.39 ±0.06	Sandy loam

Values are Mean±S.D (n=3)
Means with similar superscript in the same column has no significant difference at $p<0.05$

3.2 Heavy Metal Content

Heavy metals such as cadmium (Cd), copper (Cu), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn) which are often contained as additives in some lubricants and gasoline are non-degradable in the soil. They are also used in making alloys, utilized in the manufacture of a lot of items ranging from cars to household materials.

Lead (Pb), a poisonous metal was present in both control and site samples (Table 2). The concentration of Pb (mg/kg) in the motor parks was 40.20 in Ilesha motor park sample, 2.67 in Benin motor park sample and 0.30 in North gate motor park sample. Ilesha motor park is the oldest motor park among the samples analyzed hence, the highest concentration of Pb. North gate motor park is an upcoming motor park and started its operations when the ban on lead gasoline products was implemented, hence it has the lowest concentration. Lead was not detected in Benin motor park control and this is attributed to the fact that the area is a vegetation with no human alteration. The concentrations of Pb in all control samples was lower than the site samples. The control samples ranged between 0.04 mg/kg - 21.45 mg/kg with Shasha market control having the lowest concentration and Ilesha motor park control having the highest concentrations. The concentration of Pb in all samples was lower than DPR target value of 85.00 mg/kg. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people (Willers *et al*., 2005). It is observed that lead and related metals found on roadside soils, vegetation and nearby surfaces are discharged from automobiles (Olajire and Ayodele, 1997).

Cadmium (Cd), an equally poisonous metal was present in all site samples (Table 2). Cd is used in the manufacture of batteries and in alloys. The concentration of Cd in site samples ranged from 3.00 mg/kg – 6.00 mg/kg with Ilesha motor park sample having the lowest concentration and North gate motor park sample having the highest concentration. Cadmium was not detected in Ilesha motor park control and Benin motor park control. The relatively high concentration of Cd in North gate motor park sample as compared to others may be from the small scale metal welding shops located close to the motor park. The concentration of Cd in samples was higher than control with respect to sample location, the concentration of Cd in all samples was higher than DPR target values of 0.08 mg/kg.

Zinc (Zn) is a ubiquitous metal and was detected in all samples (Table 2). The concentration in mg/kg of Zn in North gate motor park was 35.00, in Benin motor park sample and Ilesha motor park sample was 40.00. The concentration of Zn relative to study area was higher in the site samples than in control samples however, the values were similar. The concentration of Zn in all samples was lower than DPR values except in SSS. Zinc particles may also be derived from industrial sources and the abrasion of tires of motor vehicles (Al-Khashman, 2006; Dauda *et al.*, 2012; Abatyough *et al.*, 2015).

Manganese (Mn) had the highest concentrations among all the elements in all samples (Table 2). Manganese is a naturally occurring substance found in many types of rocks and soil. Ilesha motor park control had the highest Mn concentration. This could be attributed to the fact that Mn naturally has high concentration in Ilesha area. However, in the site samples the concentration of Mn ranged from 137.00 mg/kg - 370.00 mg/kg with Benin motor park sample having the lowest. The concentration of Mn was closely related relative to the sampling site.

The concentration of (Ni) in site samples (Table 2) ranged from 3.00 mg/kg - 9 mg/kg. The highest concentration of Nickel (Ni) was observed in Ilesha motor park sample (9.00 mg/kg). Ni which is used in manufacturing alloys can wear off with time from manufactured products hence, its relative high concentration in Ilesha motor park sample which has several metallic products like vehicles, tire wheels and vehicle spare parts in general. In all samples, the concentration of Ni in control samples were lower than the site samples. The concentration of Ni in control samples was 1.00 mg/kg – 5.00 mg/kg. North gate motor park control having the lowest concentration of Ni could infer that the motor park has not really had negative effect on its surrounding as compared to Ilesha motor park control which has the highest concentration among control samples. Ni was not detected in Benin motor park control because the sample was obtained from areas with little or no anthropogenic influence. The concentration of Ni in all samples was lower than DPR target values (35.00 mg/kg). The concentrations of Ni and Cu in this research is in correlation as reported by Dauda *et al*. (2012). The concentrations of Ni, Cu and Cd in this research were similar to that obtained by Adelekan and Abegunde (2011). According to Iyaka and kakulu (2009) total Cu contents varied considerably from 12.00 mg/kg – 89.00 mg/kg.

Copper (Cu) was detected in all samples (Table 2). The concentration of Cu in mg/kg ranged from 13.10 – 67.00 in site samples and 9.00 – 25.00 in control samples. The concentration of Cu in all samples was lower than DPR target values of 36.00 mg/kg except in Ilesha motor park sample.

The concentrations of metals in soil samples of selected gas and electric welding workshops in Akure, Nigeria was determined by Ajayi *et al*. (2011) and metal concentrations in the control samples obtained was lower than that in this research. This shows that, the concentration of metals increased as a result of anthropogenic factors. However, those areas with less concentrations of metal may be attributed not only to less traffic but it might be due to strong leaching from the topsoil favoured by sandy textured soils predominant in the soil (Odukoya *et al*., 2000, Sha'Ato *et al*., 2000). Onianwa *et al*. (2011) determined the concentrations of Pb, Zn, Cd, Cu, Cr, Co and Ni in topsoil's obtained from vicinities of auto-repair workshops, gas-stations and motor-parks in Ibadan, Nigeria and the levels were elevated above background concentrations in control sites. This indicates that the surrounding areas of auto-repair workshops, gas-stations and motor-parks can be polluted as a result of ongoing activities from such areas. In a research, effect of leaching on heavy metals concentration of soil in some dumpsites at Ikere and Ado Ekiti metropolis, there was a gradual decrease in the concentration of heavy metals (Cu, Mn, Fe, Zn, Cd, Co, Cr, Pb, Ni and Sn) from the centre of the dumpsite to the bottom of the slope (Awokunmi *et al.*, 2010).

Shasha market, which is a whole sale market had heavy metal concentrations in mg/kg as follows: Pb (0.23 and 0.04); Cd (5.00 and 4.00); Zn (442.00 and 66.00); Cu (145.00 and 10.00); Mn (330.00 and 195.00) and Ni (6.00 and 3.00) for site and control samples respectively (Table 2). The high concentration of heavy metals is caused by the pile of metal scarps inside the market. As trucks offload food items, they load in metal scraps. Heavy trucks and vehicles are also parked in front of the market. Also, the market has high influx of vehicles been a whole sale market, these factors in addition to earlier mention reasons are responsible for the high concentration of heavy metals observed. Zinc and cadmium are used for coating iron and steel while stainless steel - an alloy of iron, chromium and nickel may contain manganese and phosphorus as impurities (Judith *et al.*, 1993; Ojo and Ajayi, 2005). Pearson correlation analysis inferred that there is a significance correlation ($p \le 0.01$) between Pb and Mn, Pb and Ni, Ni and

Cu, Mn and Ni, Cu and Zn and significance correlation ($p \leq 0.05$) between Mn and Cu. The heavy metals in discuss are used as alloys mostly, this can be responsible for the observed correlation.

Table 2: Total heavy metal content of soil samples

Sample Code	Pb (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Ni (mg/kg)
BGC	$0.00^{a}\pm0.00$	$0.00^{a}\pm0.00$	$35.00^{a}\pm0.02$	9.00±0.05	122.00±0.01	0.00±0.00
BGS	2.67±0.02	3.52±0.02	$40.00^{b}\pm0.02$	13.10±0.01	137.00±0.15	4.00±0.01
IGS	40.20±0.01	3.00±0.04	$40.00^{b}\pm0.03$	67.00±0.5	370.00±0.09	9.00±0.15
IGC	21.45±0.02	$0.00^{a}\pm0.00$	38.00±0.02	25.00±0.02	420.00±0.01	5.00±0.02
NGC	$0.30^{c}\pm0.01$	$4.00^{b}\pm0.02$	16.00±0.03	$10.30^{a}\pm0.05$	238.00±0.01	1.00±0.02
NGS	10.10±0.02	6.00±0.02	$35.00^{a}\pm0.06$	17.00±0.01	243.00±0.13	$3.00^{a}\pm0.02$
SSC	$0.04^{ab}\pm0.06$	$4.00^{b}\pm0.01$	66.00±0.03	$10.00^{a}\pm0.11$	195.00±0.13	$3.00^{a}\pm0.04$
SSS	$0.23^{bc}\pm0.01$	5.00±0.01	442.00±0.15	145.00±0.35	330.00±1.00	6.00±0.02

Values are Mean±S.D (n=3)
Means with similar superscript in the same column has no significant difference at $p<0.05$

3.3 Quantitative Indices

Various models and indices have been used overtime to quantify and ascertain the source of heavy metals in soils. These models and indices provide information on if the concentration of metals obtained is primarily from anthropogenic or natural sources.

3.3.1 I geo

Index of Geo-accumulation (Igeo) has been used extensively to assess the degree of heavy metal contamination or pollution in soils (Tijani *et al.,* 2009). The Igeo of heavy metals in soils is calculated using the formula (Asaah and Abimbola, 2005; Mediola *et al*., 2008):

Igeo = Log2 [Cmetal/1.5Cmetal (control)]

Where,

Cmetal is the concentration of the heavy metal in the soil sample;

Cmetal(control) is the concentration of the metal in the control sample; and

the factor 1.5 was introduced to minimize the effect of possible variations in control values which may be attributed to natural sources (Mediola *et al.,* 2008). The degree of metal pollution is assessed in terms of seven contamination classes based on the increasing numerical value of the index as follows: (Fagbote and Olanipekun, 2010; Huu *et al.,* 2010).

Table 3: Classes of Index of Geo-accumulation (Igeo)

Class	Value of Soil Quality
<0	unpolluted
0-1	unpolluted to moderately polluted
1-2	moderately polluted
2-3	moderately polluted to highly polluted

3-4	highly polluted
4-5	highly polluted to very highly polluted
>5	Very highly polluted

Table 4: Index of Geo-accumulation (Igeo) of Samples

Sample Area	Pb	Cd	Zn	Cu	Mn	Ni
Shasha Market	1.94	-0.26	2.19	3.27	0.17	0.41
Benin Garage	7.48	7.87	-0.39	-0.04	-0.42	8.06
Ilesha Garage	0.32	7.64	-0.51	0.84	-0.77	0.26
North Gate	4.49	0.00	0.54	0.14	-0.55	1.00

According to the classes of igeo (Table 3), the results (Table 4) showed that Shasha area was unpolluted to moderately polluted for Mn and Ni, unpolluted for Cd, moderately polluted for Pb and moderately polluted to highly polluted for Zn and Cu. Benin Garage area (Table 4) was unpolluted for Zn, Cu and Mn while for Pb, Cd and Ni it was Very highly polluted. Ilesha garage area (Table 4) was unpolluted to moderately polluted for Pb, Cu and Ni while unpolluted for Zn and Mn; Very highly polluted for Cd. North gate area was (Table 4) highly polluted for Pb, unpolluted for Mn, unpolluted to moderately polluted for Cd, Cu and Ni.

3.3.2 Quantification of Anthropogenic Concentration of Metal (QoC)

This model gives information on the percentage of metal concentration inputted by anthropogenic activities. This is calculated using the equation below:

$$\text{Quantification of Anthropogenic Concentration of Metal} = \frac{x - xc}{x} \times 100$$

Where,

x = concentration of the metal in the soil samples; and

xc = concentration of the metal in the control samples (Aloysius *et al.*, 2013).

Table 5: Quantification of Anthropogenic Concentration of Metal of Samples

Sample Area	Pb	Cd	Zn	Cu	Mn	Ni
Shasha Market	82.61	20.00	85.07	93.10	40.91	50.00
Benin Garage	100.00	100.00	12.50	31.30	10.95	100.00
Ilesha Garage	46.64	100.00	5.00	62.69	-13.51	44.44
North Gate	97.03	33.33	54.29	39.41	2.06	66.67

According to QoC results Table (5), the concentration of Pb in all areas were majorly from anthropogenic sources apart from Ilesha garage which had 46.64%. Cd in Benin garage and Ilesha garage were majorly from anthropogenic sources as compared to Shasha market (20%) and North gate (33.33%). Zn in Shasha market (85%) was majorly from anthropogenic sources, partially from anthropogenic sources in North gate (54.29%) and majorly from natural sources in Ilesha garage (5%) and Benin garage (12.5%). Cu in Shasha market (93.10%) and Ilesha garage (62.69%) was majorly from anthropogenic sources as compared to Benin garage (31.30%) and North gate (39.41%). Mn was highest in Shasha market (40.91) and low in all other areas. Ni in North gate (66.67%) and Benin garage (100%) was majorly from anthropogenic sources as compared to 50% in Shasha market and 44.44% in Ilesha garage.

4. Conclusion

This research showed that the physicochemical properties of the soils within the study areas are as reported by previous research although with slight variations.

The concentration of heavy metals in the site samples were all higher than the control samples except IGC. Thus, the study areas were all polluted as a result of anthropogenic activities.

REFERENCES

Abatyough, T. M., Uyeh, D. D., Uttu, J. and Abatyough, B. B. (2015). Distribution and Variation of Heavy Metals and Soil Properties around a Mega Cement Factory in Gboko, Benue State, Nigeria. *International Journal of Science and Technology*, 4(7): 2049 - 7318.

Abdulrasoul, M. A., El-Maghraby, S. E., Mahmoud E. A. N., Ali, M. E. And Salem M. I. A. (2011). Impact of Cement Dust On Some Soil Properties Around the Cement Factory in Al-Hasa Oasis, Saudi Arabia. *American-Eurasian Journal of Agricultural* & *Environmental* Sciences, 11(6): 840 - 846.

Abrahams, P. W. (2002). Soils: Their Implications to Human Health. *Science of the Total Environment*, 291:1–32.

Adedeji, O. H., Olayinka, O. O. and Oyebanji, F. F. (2013). Assessment of Traffic Related Heavy Metals Pollution of Roadside Soils in Emerging Urban Centres in Ijebu-North Area of Ogun State, Nigeria. *Journal* of *Applied Science* and *Environmental Management*, 17(4): 509 - 514.

Ajayi, O. O., Adekeye, E. A. and Ojo, M. A. (2011). Contributions of Metal Welding Workshops To Environmental Pollution in Akure Metropolis, Ondo State, Nigeria. *Journal of Environmental Issues and Agriculture in Developing Countries,* 3:1.

Al-Khashman, O. A., and Shawabkeh, R. A. (2006). Metals distribution in soils around the cement factory in southern Jordan. *Environmental pollution*, 140(3): 387 - 394.

Aloysius, A. P., Rufus, S. and John O. O. (2013). Evaluation of Heavy Metals in Soils Around

Auto Mechanic Workshop Clusters in Gboko and Makurdi, Central Nigeria. *Journal of Environmental Chemistry and Ecotoxicology*, 5(11): 298-306.

Anietie, O. V. and Lajide, L. (2015). Surface Soil Pollution by Heavy Metals: A Case Study of Two Refuse Dumpsites in Akure Metropolis. *International Journal of Scientific and Technology Research*, 4:2277-8616.

Asaah A. V. and Abimbola, A. F. (2005). Heavy metal concentrations and distribution in surface soils of the Bassa Industrial Zone 1, Doula, Cameroon. *The Journal for Science and Engineering* 31(2A): 147 – 158.

Adelekan, B. A. and Abegunde, K. D. (2011). Heavy Metals Contamination of Soil and Groundwater at Automobile Mechanic Villages in Ibadan, Nigeria. *International Journal of the Physical Sciences* 6(5): 1045-1058.

Awokunmi, E. E., Asaolu, S. S. and Ipinmoroti, K. O. (2010). Effect of Leaching On Heavy Metals Concentration of Soil in Some Dumpsites. *African Journal of Environmental Science and Technology*, 4(8): 495 - 499.

Ayo, F. and Olojugba, M. R. (2014). Effect of Rainfall Season On the Chemical Properties of The Soil of A Southern Guinea Savanna Ecosystem in Nigeria. *Journal of Ecology and the Natural Environment*, 6(4): 182 - 189.

Carrillo-González, R. and González-Chávez, M. C. A. (2006). Metal Accumulation in Wild Plants Surrounding Mining Wastes. *Environmental Pollution*, 144:84–92.

Dauda, M. S. and Odoh, R. (2012). Impact of Motor Parks On the Concentration of Heavy Metals In Some Selected Urban Areas of Benue state, Nigeria. *Der Chemica Sinica*, 3(3):737-744.

De Miguel, E., Llamas, J. F., Chacon E., Berg T., Larssen S., Royset, O. and Vadset, M. (1997). Origin and Patterns of Distribution of Trace Elements in Street Dust: Unleaded Petrol and Urban Lead. *Atmospheric Environment,* 31:2733–2740.

Di Stefano, C., Ferro, V. and Mirabile. (2010). Comparism Between Grain Size Analysis Using Laser Diffraction and Sedimentation Methods. *Biosystems Engineering*, 106: 205-215.

Fagbote, E O., Olanipekun, E. O. (2010). Evaluation of The Status of Heavy Metal Pollution of Soil and Plant *(Chromolaena Odorata)* of Agbadu Bitumen Deport Area, Nigeria. *American-Eurasian Journal of Scientific Research,* 5(4):241- 248.

Huu, H. H., Rudy, S. and Van, D. (2010). Distribution a nd Contamination Status of Heavy Metals

In Estuarine Sediments Near Cau Ong Harbor, Ha Long Bay, Vietnam. *Geology Belgica* 13(1-2): 37 – 47.

Ibitoye, A. A. (2015). Practical Manual on Basic Soil and Fertilizer Analysis.

Imperato, M., Adamo, P., Naimo, D., Arienzo, M., Stanzione, D. and Violante, P. (2003). Spatial Distribution of Heavy Metals in Urban Soils of Naples City (Italy). *Environmental Pollution*,124: 247–256.

Iyaka, Y. A. and Kakulu, S. E. (2009). Copper and Zinc Contents in Urban Agricultural Soils of Niger State, Nigeria. *African Research Review*, 3 (3):23-33.

Judith, P. A., Alfred, S. and Christian S. (1993). Contribution of Aluminium from Packaging Materials and Cooking Utensils to The Daily Aluminium Intake. *Zhebenson Unters Forsch*, 197:332 - 341.

Meersmans, J., Van Wesemael, B. and Van Molle, M. (2009). Determining Soil Organic Carbon for Agricultural Soils: A Comparism Between the Walkey-Black and The Dry Combustion Methods (North Belgium). *Soil Use and Management*, 25(4):346-353.

Mediolla, L. L., Domingues, M. C. D. and Sandoval M. R. G. (2008). Environmental Assessment of and Active Tailings Pile in the State of Mexico (Central Mexico). *Research Journal of Environmental sciences* 2 (3): 197 – 208.

Mertens, J., Vervaeke, P., De Schrijever, A. and Luyssaert, S. (2004). Metal Uptake by Young Trees from Dredged Brackish Sediment: Limitations and Possibilities for Phytoextraction and Phytostabilisation. *Science of the Total Environment*, 326:209–215.

Mielke, H. W., Gonzales. C. R., Smith. M. K. and Mielke, P. W. (1999). The urban environment and children's health: soils as an integrator of lead, zinc and cadmium in New Orleans, Louisiana, USA. *Environmental Research*, 81: 117–129.

Muhammad, A. A., Mohd. J. M. and Ismail, Y. (2014). Soil Contamination, Risk Assessment and Remediation.

National Population Commission Abuja, Nigeria. (2010). 2006 Population and Housing Census Priority Table Volume Iii. Population Distribution by Sex, State, Local Government Area and Senatorial District.

Odukoya, O. O., Bamigbose, O. and Arowolo, T. A. (2000). Heavy metals in Top Soils of Abeokuta Dump sites. *Global Journal of Pure and Applied Sciences*, 16 (4): 651 - 653.

Ojo, M. A. and Ajayi, O. O. (2005). Influence of Cooking Wares On Some Mineral Elements Status of Selected Foodstuffs. *Science Focus*, 10 (1):91- 97.

Okrent, D. (1999). On Intergenerational Equity and Its Clash with Intragenerational Equity and On the Need for Policies To Guide The Regulation Of Disposal Of Wastes And Other Activities Posing Very Long Time Risks. *Risk Analysis*, 19:877-901.

Olajire, A. A. and Ayodele, E.T. (1997). Contamination of Road Side Soil and Grass With Heavy Metals. Environmental International, 23(1): 91 - 101.

Onianwa, P. C., Jaiyeola, O. M. and Egekenze, R. N. (2011). Heavy Metals Contamination Of Topsoil in The Vicinity Of Auto-Repair Workshops, Gas Stations And Motor Parks in a Nigerian city. *Toxicological and Environmental Chemistry*, 84(1-4) :33 - 39.

Roslaili A. A., Sahibin A. R., Ismail S. and Wan M. R. I. (2015). Speciation and Availability of Heavy Metals on Serpentinized Paddy Soil and Paddy Tissue. *Social and Behavioral Sciences*, 195:1658 – 1665.

Seiler, T. B., Schulze, T. and Hollert, H. (2008). The Risk of Altering Soil and Sediment Samples Upon Extract Preparation for Analytical and Bioanalytical Investigations - A Review. *Analytical* and *Bioanalytical Chemistry*, 390(8): 1975 – 1985

Sha'Ato, R., Ojanuga, A. G. and Ajayi, S. O. (2000). Forms and Profile Distribution of Potassium

in Typical Soils of the Lower Benue Valley of Nigeria. *Communications* in *Soil* Science and *Plant Analysis,* 31(3-4):437-453.

Tijani, M. N. and Onodera, S. (2009). Hydrogeochemical Assessment of Metals Contamination In an Urban Drainage System: A Case Study of Osogbo Township, SW-Nigeria. Journal of *Water Resource and Protection,* 3:164-173.

Willers, S., Gerhardsson, L. and Lundh T. (2005). Environmental Tobacco Smoke (ETS) Exposure In Children With Asthma-Relation Between Lead And Cadmium, And Nicotine Concentrations In Urine. *Respiratory Medicine*, 99: 1521 – 1527.

Yuebing, S., Qing, Z., Xiaokui, X. and Rui, L. (2010). Spatial, Sources and Risk Assessment of Heavy Metal Contamination of Urban Metal Contamination of Urban Soils in Typical Regions of Shenyang, China. *Journal of Hazardous Material*, 174: 455 - 462.