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Original Paper

Measures of Harm from Heavy Metal Pollution in Battery Technicians' Workshop within Ilorin Metropolis, Kwara State, Nigeria

Henry Olawale SAWYERR[1], Morufu Olalekan RAIMI[1&2*], Adedotun Timothy ADEOLU[1] & Oluwaseun Emmanuel ODIPE[1]

[1] Department of Environmental Health Sciences, School of Health, Allied and Environmental Science, College of Pure and Applied Sciences, Kwara State University, Malete, Kwara State, Nigeria

[2] Department of Community Medicine, Environmental Health Unit, Faculty of Clinical Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

[*] Morufu Olalekan RAIMI, Department of Environmental Health Sciences, School of Health, Allied and Environmental Science, College of Pure and Applied Sciences, Kwara State University, Malete, Kwara State, Nigeria; Department of Community Medicine, Environmental Health Unit, Faculty of Clinical Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria

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Abstract

Soil pollution with Heavy Metals (HMs) has been of much interests lately and is one of the major issues to be faced globally and requires attention because heavy metals above their normal ranges are extremely threatened to both biotic and abiotic life. It was therefore of interest to conduct study to assess the extent of heavy-metal contamination of soils within battery technicians' workshops within Ilorin metropolis, Kwara State, Nigeria. A total of twenty-five composite soil samples were collected from six selected battery charger workshop within Ilorin metropolis and analyzed for the presence of heavy metals using atomic absorption spectrophotometer. Result reveals significant positive relationship between Mn and Fe ($r=0.511^{**}$, $p<0.001$), Mn and Cu ($r=0.565^{**}$, $p<0.001$), Fe and Cr ($r=0.895^{**}$, $p<0.001$), Fe and Cu ($r=0.823^{**}$, $p<0.001$) and between Cr and Cu ($r=830^{**}$, $p<0.001$). Result also shows significant negative relationship between Mn and Cr ($r=-0.679^{**}$, $p<0.001$), Pb and Cu ($r=-0.468^{*}$, $p<0.05$) respectively. The pollution status of heavy metals in soils was evaluated using quantitative indices (pollution index–PI). The result shows that Zn was moderately contaminated while other heavy metals (Pb, Cd, Cr and Cu) had very slight contamination (pollution index<0.1). The

Ilorin metropolis soils of Kwara State were found to have a moderate to very slight contamination respectively. Large variations in PI values of Zn revealed that soil in those areas of the city, which are influenced by anthropogenic activities, have moderate concentrations of Zn resulting in "considerable risk". The findings of this study recommend comprehensive continuous annual monitoring and auditing and further studies on the level of these heavy metals in the near future to ascertain long-term effects of anthropogenic impact is forestalled to protect the men and the environment. This should also involve larger coverage with studies on ground water around such locations. Furthermore, continuous metals speciation should be carried out so that the form and extent of metal bioavailability can be evaluated further.

Keywords

considerable risk, auditing, comprehensive monitoring, eco-environment, metal speciation, pollution, bioavailability, technicians, Ilorin metropolis

1. Introduction

Soil Pollution from Heavy Metal (HM) has become a serious issue in many parts of the world (Chen et al., 1997; Islam et al., 2016; Zhongmin et al., 2018) and also due to its ubiquity natures, trace level toxicity, bioaccumulation and persistence, elevated Heavy Metals (HMs) in soil milieu and thus soil contamination with HMs has been globally attracting much attention (Waseem et al., 2014; Pavlovic et al., 2016). Substantially, HMs that have been accumulated in soils can be release to other environmental media, such as groundwater, rivers, atmosphere and crops, and consequently poses hazard to human beings and ecosystems (Wei & Yang, 2010; Obiora et al., 2016; Cocarta et al., 2016). Heavy Metals (HM) are ubiquitous natural substances in soils, which could be both natural (lithogenic inputs via weathering of parent materials and bedrocks) and anthropogenic in origin (Zhongmin et al., 2018; Islam et al., 2016). Conversely, global enrichments of HMs in soils are primarily due largely to human activities (Luo et al., 2012).

More importantly, naturally occurring metals in the earth's crust, and their contents in the milieu can vary between different parts of the world resulting in spatial variations of concentrations background. The metals distribution in the environment is governed by the properties of the metal and influences of environmental factors (Khlifi & Hamza-Chaffai, 2010; Morufu & Clinton, 2017; Olalekan et al., 2018; Raimi & Sabinus, 2017). Despite the 92 naturally occurring elements, about 30 metals and metalloids are potentially toxic to humans, Be, B, Li, Al, Ti, V, Cr, Mn, Co, Ni, Cu, As, Se, Sr, Mo, Pd, Ag, Cd, Sn, Sb, Fe, Cs, Ba, W, Pt, Au, Hg, Pb, and Bi. Although, quite a number of citizens are exposed primarily to these contaminants in the workplace, the main route of exposure to these toxic elements for most people is through their diet (food and water). The chain of trace metals contamination usually follows a cyclic order such as: industry, atmosphere, soil, water, foods and human. Though toxicity and the resulting public health threat of any contaminant are, of course, a concentration function, it is well established that relatively low levels of chronic exposure to heavy metals and metalloids can cause adverse effects (Agency for Toxic Substance and Disease Registry (ATSDR), 2003a, 2003b, 2007, 2008; Castro-González & Méndez-Armenta, 2008). As a result, there has been increasing apprehension, particularly in the developed world, about exposures, intakes and absorption of heavy metals by humans. Populations are increasingly demanding a cleaner environment in general, and reductions in the amounts of contaminants reaching people as a result of increasing human activities. A practical implication of this trend, in the developed countries, has been the imposition of new and more restrictive regulations (European Commission, 2006; Figueroa, 2008). Despite the subject importance, this paper therefore assesses the soils anthropogenic influences, which has become necessary due to increasing population pressure on soil characteristics. These anthropogenic influences, most often been researched upon in the context of industrial production, transportation, mining, mechanic workshop, construction and manufacturing have resulted in increased heavy metals notably Zinc, Iron, Lead, Cadmium, Chromium, Copper and Manganese in the soils surrounding these activities and ultimately to the biosphere which call for further assessment on soils effects (Johan, 2011; Morufu & Clinton, 2017; Raimi & Sabinus, 2017; Olalekan et al., 2018). Interestingly, biological effects of metal can be beneficial or harmful to humans and the ecosystem. Though, majority of metals (e.g., cadmium, mercury, and lead) in the ecosystem are non-essential and of no importance to biological systems, although some metals (e.g., cobalt, copper, chromium, iron, zinc, and manganese) are essential and are known for important biological functions in humans (Caussy et al., 2003; Odipe et al., 2018). Metal introduction into the soils have been through various natural and anthropogenic sources (Ajmone-Marsan & Biasioli, 2010; Wong et al., 2006; Raimi & Sabinus, 2017; Morufu & Clinton, 2017; Olalekan et al., 2018). The disposal of major anthropogenic sources which include electrical and electronic equipment, paints, pesticides, incineration of domestic waste, atmospheric deposition from industrial processes, and power plants, as well as, traffic-related activities such as fossil fuel combustion, spills of motor oil, and wear and tear of brakes and tires (Ajmone-Marsan & Biasioli, 2010; Wong et al., 2006; Morufu & Clinton, 2017). “Human exposure to metal contaminated soils occurs through inhalation of contaminated dust, ingestion, and dermal contact” (Ng et al., 2015). The total metals concentration in the soil is usually employed as a measured of the soil pollution. But, using total metal content typically overestimates exposure since physicochemical properties of the soil matrix such as pH, texture, and organic matter content can sequester the metal and reduce its bioavailability (Ruby, 2004). Nevertheless, the amount of bioavailability in a contaminant is a function of the absorptive capacity of the body following skin contact, ingestion, or inhalation (Ng et al., 2015).

Heavy metals pollution in aquatic environment is a growing global problem and it has currently reached an alarming rate. Various sources of heavy metals originate from anthropogenic activities like draining of sewerage, dumping of hospital wastes and recreational activities (Morufu & Clinton, 2017). Conversely, the natural occurrence of metals in small amounts may enter into aquatic system through leaching of rocks, airborne dust, forest fires and vegetation. As heavy metals cannot be degraded, they are being deposited continuously and incorporated in water, thus causing pollution of heavy metal in water bodies (Morufu & Clinton, 2017). "The presence of heavy metals in the water may have a profound effect on the microalgae which constitute the main food source for bivalve mollusks in all their growth stages, zooplankton (rotifers, copepods, and brine shrimps) and for larval stages of some crustacean and fish species. Furthermore, bioconcentration and magnification could lead to high toxicity of these metals in organisms, even when the exposure level is low. Under such conditions, the toxicity of a moderately toxic metal could be enhanced by synergism and may cause the population of fish to be declining. Apart from destabilizing the ecosystem, the accumulation of these toxic metals in aquatic food web is a public health threat and thus their potential long-term impact on ecosystem integrity cannot be ignored" (Ogoyi et al., 2011).

2. Battery Charger Workshop

One major anthropogenic source of heavy metals into soil is the disposal of batteries from battery charger workshop. This has become an ever-increasing topic of discussion in the developed countries due to the presence of heavy metals such as lead, mercury, cadmium, copper, zinc, manganese, nickel and lithium. In addition, the chemical composition of the electrolyte is also harmful to the environment if not properly disposed or managed. Lead acid batteries also known as wet cell batteries are most frequently used to power cars, trucks, smaller vehicles and other large pieces of equipment. Lead also known to be a persistent Bioaccumulators Toxic (BBT) chemical with well documented neurological effect in human exposed to vehicular lead-acid batteries which contain a significant amount of lead, 18 to 20 pounds (i.e., about 8.3 to 9kg) in most vehicles. The disposal of lead-acid batteries in a solid waste landfill which is illegally dumped, the lead sulfuric acid tends to seep into the soil affecting the soil nutrient and contaminate ground water. Nigeria with an estimated population of 205 million is a fast-growing developing country and annually, batteries and electronics are used in application more than ever. Daily, consumers, businesses and industry, local state and Federal government agencies generate these battery wastes. Most people in Nigeria are ignorant of battery waste toxicity. As a result, it is important to have some measures of bioavailability of soil-borne contaminant for a more accurate assessment of the associated risk to population health. Importantly, soil ingestion most often is a risk pathway to concentration of contaminant in the soil which is relatively high to other sources (Ng et al., 2015). Thus, the present study goal was to assess the concentrations of heavy metals (Mn, Fe, Cd, Cr, Cu, Pb, Zn) in surface soils in a battery charger workshop within Ilorin metropolis. A secondary goal was to determine the difference in concentration level of heavy metals within the selected sites and thirdly was to assess different methods to determine pollution indexes commonly used in soil pollution. Soils sampling in public places is important because the influence of trace metal pollution on population health, especially battery technicians, is strong and well documented (Simpson, 1996; Dor et al., 1998; Mielke et al., 1999; Sawyerr et al., 2016). Consequently, sampling sites were publicly accessible places such as battery charger workshop where most between humans and soils interaction takes place.

3. Research Methods

3.1 Description of the Study Area

Ilorin is located between Northern and Southern Nigeria on latitude 8^0 3” N and longitude 4^0 35” E with approximation of 100km^2 land mass (Orire et al., 2013). The city comprises of Ilorin west, east and south with a population of 777, 667 (NPC, 2007). The major tribe is Yoruba with Hausa, Fulani and Nupe as minority (Orire et al., 2013). Ilorin is known as Gateway city between Northern and Southern Nigeria (Muhammed, 2006). The major activities in the city ranging from agriculture such as food crop to cloth weaving, leather work, tie and dye, mat making to modern business, industrial and administrative activities (Figure 1).

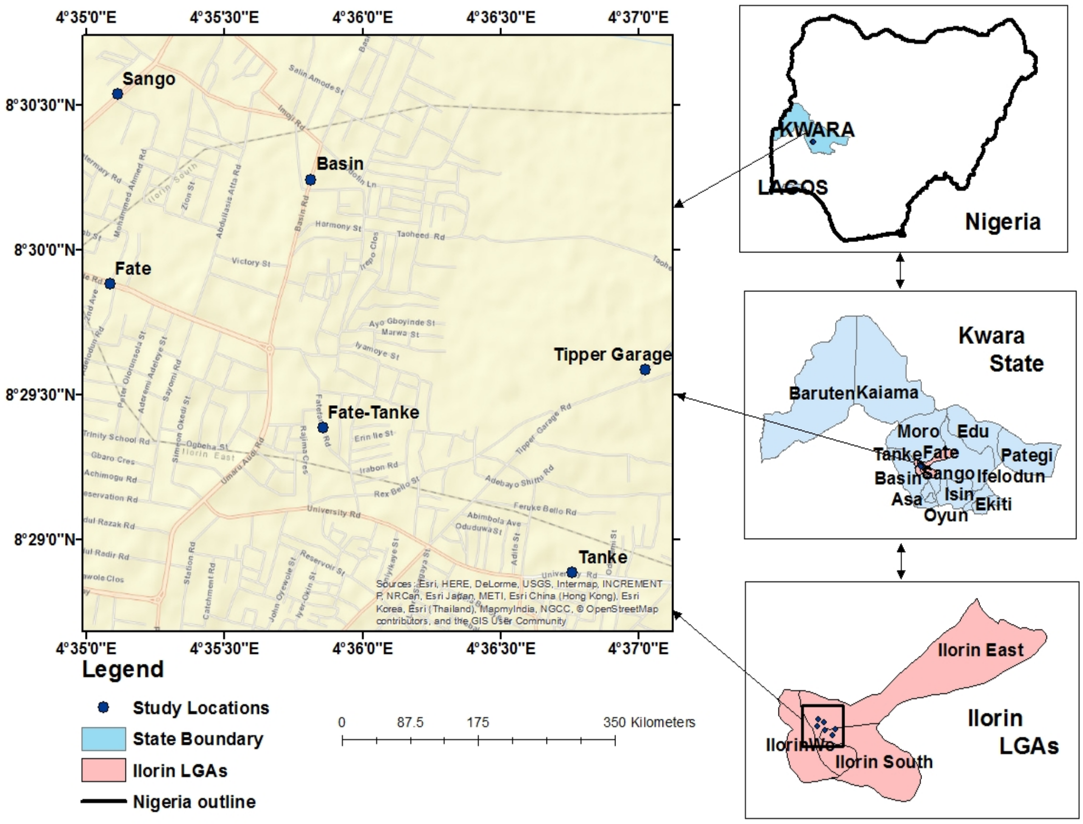

Figure 1. Map of Nigeria Showing the Location of the Study Area

3.2 Sample Collection, Preparation and Analysis

Twenty-five composite soil samples were collected from six selected battery charger workshop within Ilorin metropolis with a soil depth calibrated auger at a depth of 0-15cm representing the topsoil (Table 1 and Figure 1). The soil samples were then air dried, crushed, passed through a sieve, put in clean polythene bags and stored at room temperature for laboratory analysis using standard techniques. 1g of the sieved sample was weighted into a 125ml flask that was washed with acid and rinsed with distilled water. Acid digestion with conc. perchloric acid (4ml), conc. nitric acid (10ml) and sulphuric acid (2ml) was carried out. The content was thoroughly mixed and digested on BIBBY hot plate and heated gently at low temperature of 55^0C. Heating was continued until white dense fume observed. The solution was allowed to cool and 40ml of distilled water was added to it. It was further boiled for about 1 minute at a moderate temperature of 55^0C. The solution was allowed to cool finally and filtered into a 100ml volumetric flask and make up to the mark with doubly distilled water. The digested sample was analysed with ALPHA 4 atomic absorption spectrophotometer (Chem-Tech. Analytical) with EPSON LX-300 printer. Each preparation of sample was repeated in triplicate. This followed standard procedure described in Sawyerr et al. (2016).

Table 1. Soil Samples from Battery Charger Workshop

LOCATION	ZONE	GPS CO-ORDINATE	Latitude
		Longitude	
SITE A	**Tipper Garage**	**4.617128**	**8.493058**
SITE B	**Basin**	**4.596861**	**8.504036**
SITE C	**Sango**	**4.585183**	**8.508949**
SITE D	**Tanke**	**4.612684**	**8.48142**
SITE E	**Fate**	**4.584707**	**8.49803**
SITE F	**Fate-Tanke**	**4.597613**	**8.489728**

4. Method of Data Analysis

Data were analyzed using descriptive statistics correlation and Analysis of Variance. Means and standard error of means were computed for each of the heavy metal and the univariate relationship among heavy metal was done using correlation and differences in heavy metal between the sites were compared using ANOVA. The Statistical Packages for Social Sciences (SPSS version 22.0) was used to enhance data analysis and statistical significance was established at 0.05 level of significance. The p-value<0.05 was considered significant.

5. Results and Discussions

5.1 Results

Table 2. Correlation Matrix Showing the Relationship between the Heavy Metal Parameters

Parameters	**Mn (mg/kg)**	**Zn (mg/kg)**	**Fe (mg/kg)**	**Pb (mg/kg)**	**Cd (mg/kg)**	**Cr (mg/kg)**	**Cu (mg/kg)**
Mn **(mg/kg)**	1						
Zn **(mg/kg)**	-0.220	1					
Fe **(mg/kg)**	0.511**	-0.117	1				
Pb **(mg/kg)**	-0.150	-0.010	-0.124	1			
Cd **(mg/kg)**	0.088	-0.232	0.051	-0.117	1		
Cr **(mg/kg)**	-0.679**	-0.139	0.895**	-0.196	0.236	1	
Cu **(mg/kg)**	0.562**	0.026	0.823**	-0.468*	0.185	0.830**	1

*Significant at 5%, **Significant at 1% ($p<0.0$).

Correlation coefficient is a measure of the linear correlation between two variables and giving a value between +1 and −1. The correlation coefficient data is important in order to deduce the possible sources of the metals in the soil samples. Based on the data, where 1 is total positive correlation, 0 is no correlation, and −1 is the total negative correlation. It is widely used in the sciences as a measure of the degree of linear dependences between two variables. Thus, Table 2 shows the nature and strength of bivariate relationship between any of the physico-chemical parameters. However, the correlation factor for various metals were derived and shown in the table above. As for the metal to metal correlation, result reveals significant positive relationship between Mn and Fe ($r=0.511$**, $p<0.001$), Mn and Cu ($r=0.565$**, $p<0.001$), Fe and Cr ($r=0.895$**, $p<0.001$), Fe and Cu ($r=0.823$**, $p<0.001$) and between Cr and Cu ($r=830$**, $p<0.001$). Result also shows significant negative relationship between Mn and Cr ($r=-0.679$**, $p<0.001$), Pb and Cu ($r=-0.468$*, $p<0.05$). This means that direct relationship exists between these variables which implies that as one of the heavy metal increases, the values of the other heavy metal also increase, and the reverse is the case for negative relationship. The correlation coefficients between the concentrations of the different metals indicate a links between them, which probably reflects their related origin. The wastes which could be indiscriminately disposed within the various workshops are possible sources of these metals.

Table 3. Variation in Heavy Metals across Five Locations

Location	Mn (mg/kg)	Zn (mg/kg)	Fe (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Cu (mg/kg)
Tipper	2.20±0.47[a]	47.13±5.90[a]	3.65±0.54[a]	1.09±0.17[a]	0.00±0.00[a]	2.25±0.32[a]	2.08±0.39[a]
Basin	1.90±0.52[a]	41.38±4.63[a]	3.23±0.39[a]	1.31±0.31[a]	0.13±0.12[a]	2.18±0.35[a]	1.60±0.32[a]
Sango	2.98±0.46[a]	42.40±4.21[a]	3.70±0.54[a]	0.99±0.13[a]	0.01±0.01[a]	2.36±0.35[a]	2.06±0.34[a]
Tanker	2.73±0.69[a]	41.63±4.17[a]	4.15±0.21[a]	0.94±0.17[a]	0.01±0.01[a]	2.53±0.21[a]	2.40±0.58[a]
Fate	2.85±0.33[a]	37.75±2.64[a]	3.74±0.22[a]	0.28±0.83[a]	0.01±0.01[a]	2.29±0.19[a]	1.98±0.21[a]

Table 3 presents variation in heavy metals across five locations (Tipper, Basin, Sango, Tanker and Fate). Result reveals that there is no significant difference in heavy metal between Tipper, Basin, Sango, Tanker and Fate ($p<0.05$).

Table 4. Comparism with Regulatory Guidelines and Other Studies

Heavy Metals	1993 USEPA Standard	Odewande and Abimbola, 2008	(Ghana Kumasi) Godfred *et al.*, 2017	(Addis- Ababa) Demlie and Wohnlich, 2006	Mean	SD
Mn (mg/kg)	-	-	-	-	0.70	0.21
Zn (mg/kg)	6	227	264	85.4	63.50	1.77
Fe (mg/kg)	-	-	-	-	3.70	0.16
Pb (mg/kg)	420	95	97	31.4	1.07	0.07
Cd (mg/kg)	0.5	8.4	0.64	3.22	0.03	0.02
Cr (mg/kg)	30	64	124	64.7	2.32	0.12
Cu (mg/kg)	40	47	75	31.8	2.02	0.13

Table 4 reveals that the concentration of heavy metal obtained in this study were all less than that obtained in Adewara Adesoji Odewande and Akinlolu F. Abimbola (2008), Ghana Kumasi, Addis-Ababa and that of 1993 USEPA standard. However, the present study mean for Zn is more than 10 times higher than the 1993 USEPA standard.

Table 5. Pollution Index

Parameters	Range	Mean	SEM	Remarks
Zn (mg/kg)	0.20-0.45	0.30	0.013	Moderate contamination
Pb (mg/kg)	0.01-0.02	0.01	0.001	Very slight contamination
Cd (mg/kg)	0.000-0.63	0.03	0.02	Very slight contamination
Cr (mg/kg)	0.02-0.04	0.02	0.001	Very slight contamination
Cu (mg/kg)	0.03-0.08	0.06	0.004	Very slight contamination

Pollution index are used to assess the level of soil contamination and/or pollution. Table 5 reveals level of pollution as a result of heavy metal contamination and the result shows that Zn was moderately contaminated while other heavy metals (Pb, Cd, Cr and Cu) had very slight contamination (pollution index<0.1).

5.2 Discussion

Present study was conducted in order to assess the extent of heavy-metal contamination of soils within battery technicians' workshops. As soil pollution is dangerous for both ecosystem and human health, as a result, it is needful to assess the soil quality, as this is a very important issue related to human and environment. For this purpose, this study found significant relationship among some of the parameters. Specifically, the result revealed manganese to be significantly related with Iron (0.511) and copper (0.565), furthermore, the Iron was found to be significantly related with chromium (0.895) and copper (0.823). All these parameters were found to have significant positive relationship with manganese except chromium which had perfect negative relationship. This result implies that as manganese, iron and chromium of the soil increases, copper and chromium increases significantly. Indicating that they were likely contributed simultaneously (closely associated) (Adewara, 2008; Sawyerr et al., 2016). However, for manganese, the reverse was the case such that as the manganese of the soil increases, chromium decreases significantly. Indicating poorly correlated elements might have different geochemical factors influencing their concentrations in the soils (Adewara, 2008). While the result for lead was significantly negative. Perfect negative relationship was obtained between lead and copper revealed significant negative relationship with each other ($p<0.05$). The correlation coefficients between the concentrations of the different metals indicate links between them, which probably reflects their related origin. The wastes which could be indiscriminately disposed within the various workshops are possible sources of these metals. Furthermore, previous research reported excess intake of HMs from soils can result in numerous diseases (Uversky et al., 2001). For example, chronic exposure to Arsenic (As) can lead to dermal lesions, skin cancer, peripheral neuropathy, and peripheral vascular disease (Smith et al., 2006), while chronic ingestion of Cadmium (Cd) can have adverse effects such as prostatic proliferative lesions, bone fractures, kidney dysfunction, hypertension lung cancer, and pulmonary adenocarcinomas (Lin et al., 2013). Excessive intake of Lead (Pb) can damage the skeletal, circulatory, nervous, enzymatic, endocrine, and immune systems (Nieboer et al., 2013). Thus, human health risk *via* direct exposure to soil HMs should not be ignored.

Many studies have shown that urban soils receive loads of contaminants that are usually greater than the surrounding sub-urban or rural areas due to the higher tempo of anthropogenic activities of urban settlement (Adelekan & Alawode, 2011; Sawyerr et al., 2016). This is supported by this study based on the concentrations of the metals investigated. However, the presence of copper in the study area could be a result of several factors including; automobile wastes containing electrical and electronic parts, such as copper wires, electrodes and copper pipes and alloys from corroding vehicle scraps which have littered the surrounding vicinity for a long time, with released metals from the corrosion gradually leaching into the soil (Nwachukwu et al., 2011; Sawyerr et al., 2016). For Manganese, it appears that the levels of Mn in the soils investigated is increasing gradually and need to be closely monitored to prevent any further increase. Because the continuous use of battery workshops pose threat to the health of the users and general public, particularly children and vulnerable people.

In addition, anthropogenic activities have contributed to the presence of zinc from auto mechanic since this element is found as part lubricating oils additives (Abenchi et al., 2010; Sawyerr et al., 2016). However, the concentration of Zn in this study is small compared with many other studies (Nwachukwu et al., 2010; Nwachukwu et al., 2011). Although, when compared with USEPA standard, the present study mean is more than 10 times higher than the standard which call for concern and may be hazardous to health (Morufu & Clinton, 2017). While, for Cd, the results are also in the same range as those reported by other workers in other parts of Nigeria (Abenchi et al., 2010; Adelekan & Alawode, 2011). Furthermore, it is reported that Pb has the highest composition of heavy metals in waste oils (Oguntimehin et al., 2008). Also, the levels of Pb could be elevated by the amount of waste oil, presence of automobile emissions, and expired motor batteries indiscriminately dumped by battery chargers and auto mechanics in the surrounding areas (Sawyerr et al., 2016). This could perhaps be attributed largely to the cluster's nature of activities in the auto mechanic. Nevertheless, it is important to know that there are no soil quality guidelines for heavy metals in soils in Nigeria (Iwegbue et al., 2006; Ipeaiyeda et al., 2007) and hence comparisons were made with those of other countries (Odewande & Abimbola, 2008; Godfred et al., 2017). The concentrations of the metals, however, were relatively low and variation in heavy metals across five locations reveals that there is no significant difference in heavy metal between Tipper, Basin, Sango, Tanker and Fate ($p<0.05$).

Also, trace metal concentrations in the study area do not exceed their respective State (Table 4). The average trace metal concentrations for the study area are several times lower than those for regulatory guidelines and other studies (Table 4). Even compared to cities described as intermediate or by the respective authors (Odewande & Abimbola, 2008; Godfred et al., 2017), the concentrations observed in the study area of the present study remain low (Table 4).

The pollution index was derived by employing the pollution index as defined by Lacutusu (Lacatusu, 2000).

$$\frac{\mathbf{C}\ =\ \textit{Concentration of metal in soil}}{\mathbf{PI}\ =\ \textit{Target value from reference point}}$$

A distinction between soil contamination and pollution range was established by means of the contamination/pollution index C/PI (Table 5). This represents a metal content effectively. C/P index values greater than unities (1) defines the pollution range and when lower than unity the contamination range. The standard employed for interpreting soil heavy metals contamination/pollution index varies from country to country based on the chosen factors (Kestern & Forstner, 1989). The pollution index assessment indicates that most of the metals fall within the "very slight contamination" and "moderate contamination" range in the soil. In all samples, the soil is found to be slightly polluted by cadmium, lead, chromium and copper while Zinc is being found in the "moderate pollution" range. Thus, exposure to lead has been linked to delays in physical or mental development in children. In adults, lead exposure may potentially cause kidney problems and high blood pressure when exposed to levels above the maximum contaminant level for extended period of time. Children, infants and pregnant women are even more susceptible to the damages caused by lead ingestion. Cadmium exposure tend to accumulate in the human body affecting negatively several organs: liver, kidney, lung, bones, placenta, brain and the central nervous system (Morufu & Clinton, 2017; Castro-Gonzalez & Mendez-Arnenta, 2008). Other damages that have been observed include reproductive and development toxicity, hepatic, haematological and immunological effects (Apostoli & Catalani, 2011; ATSDR, 2008; Morufu & Clinton, 2017; Raimi & Sabinu, 2017). For chromium, it has been found to be very toxic and carcinogenic to human and cause eczematous dermatitis, cancer of the lungs, nasal and paranasal sinuses as well as suspected cancer of the stomach and larynx (ATSDR, 2000; Morufu & Clinton, 2017; Raimi & Sabinu, 2017). In addition, studies from Khlifi and Hamza-Chaffai (2010) noted that zinc cause several diseases to humans, fatalities resulting from lung damages caused by inhalation of high concentration of zinc chloride, causes damages to mucus membranes of the nasopharynx and the respiratory tract when ingested since it could cause digestive disorders and constipation.

6. Conclusion

The study identified elevated concentrations of heavy metals including Mn, Cd, Cr, Cu, Fe, Pb, and Zn in surface soils in the commercial hub of Ilorin metropolis in the study area, trace metal concentrations are considerably lower compared to regulatory standard and other studies. This suggests that trace metal concentrations in Ilorin soils are related to the size and activities of the city, presumably because of the more intense land use. Pollution indexes were determined to assess the trace metal pollution level in the area. The contamination indexes led to generally similar conclusions about the proportion of polluted sites, which is relatively low in the study area. This study assessed the extent of heavy-metal contamination in soils within battery technicians' workshops using some pollution indexes. However, the overall pollution indices and carcinogenic risks, incorporating bioaccessibility data, contributed more to the overall risk: Lead is known to affect almost every organ and system in humans (developmental, cardiovascular, reproductive, neurological, ocular, hematological, and renal) while chronic exposure to other heavy metals can result in irritation of the stomach and intestines, blood vessel damage, skin changes, and reduced nerve function (Morufu & Clinton, 2017). It is therefore concluded that continuous use of such battery technicians' workshops may pose a threat to the health of the users and call for the continuous monitoring through agencies of government.

7. Recommendations

Consequent upon our findings, it is recommended that government should intensify on the management of wastes in the battery technician workshops and should carry out comprehensive continuous monitoring and auditing to forestall the effects of waste oil related problems on the environment, particularly on groundwater. In addition, annual continuous monitoring and further studies on the level of these heavy metals should be carried out in the near future to ascertain long-term effects of anthropogenic impact. This should also involve larger coverage with studies on ground water around such locations.

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