Original Research Article

Ecological Risk Assessment of heavy metals in soil of an open dump along old Ikare road Owo, Ondo State, Nigeria.

ABSTRACT

Aims: To investigate the heavy metal concentrations in soil samples collected from an open dumpsite in a rural community (*Aba Idi-Mangoro*) in Owo, Ondo State and to compare the observed values with the regulatory limits, also to determine the pollution levels using tools such as contamination factor, pollution load index and geoaccumulation.
Study design: Field studies.
Place and Duration of Study: Soil samples were collected from *Aba Idi-Mangoro* in Owo, Ondo State, Nigeria between July 2015 and February 2016 to represent the wetand dry seasons.
Methodology:A total of 96 soil samples were collected(6 samples were collected on each visit, while the site was visited twice a month). The samples were taken to the Prof. Julius Okojie Central Research Laboratory at the Federal University of Technology, Akure, Ondo State Nigeria. In the laboratory, samples were air driedto remove the moisture. 2g of the samples weredigested into HNO_3, HCl, HF and $HClO_4$ and AA Spectrophotometer was used to analyse the concentrations of the heavy metals.
Results: Out of the 8 heavy metals assessed, 6 were above the regulatory limits.The order of abundant for the wet season is as follows; Fe>Mn>Zn>Cu>Pb>Ni>Cr>Co>Cd and the dry season is as follows; Fe>Zn>Mn>Pb>Cu>Ni>Co>Cr>Cd. When the mean concentrations of the samples collected during the wet season were compared to the dry season, Mn (0.009), Cd (0.035), Cr (0.044) and Co (0.014) differ significantly ($p<0.05$). No significant difference was found in Fe, Co, Ni and Zn.It was observed from the overall results that the concentrations of heavy metals were higher during the dry season than in the wet season. In all soil sample, the contamination factor (CF), pollution load index and geo-accumulation index values of Fe was extremely high in the two seasons while it varies at different collection times for the other heavy metals.
Conclusion: Due to the high presence of some of the heavy metals found in the soil, the study suggests that water and sediment samples from nearby river(s) within the community should also be examined.

Keywords: rural community, solid waste, heavy metals, pollution tools, ecological risk

1. INTRODUCTION

Solid waste management (SWM) continues to be a leading environmental issue in urban and rural areas of the globe, and this usually affects the ecological balance and the scenery of the environment. Previous studies by Simatele et al, 2017; Simelane and Mohee, 2015; Nzeadibe, 2009 showed that in the past decades, unprecedented population growth has led to increase in the volume and indiscriminate disposal of solid waste in the environment. The implication of this is that as human population increases, waste generation also increases in the communities. The lack of implementation and enforcement of governmental policy, poor funding, differences in political issues, social behaviour, low environmental awareness, poor collection, disposal and management of waste have all contributed to solid waste generation and contamination in the environment(Taherzadeh and Rajendran, 2015). In 2014, Adeyi and Torto, for example, revealed that environmental contamination from solid waste may result to heavy metals pollution which may arise from natural or anthropogenic sources. Pollution from anthropogenic sources may be due to industrial activities, agricultural chemicals or the improper dumping of waste, which is arise from rapid urbanisation, industrialisation and economic development.

High level of heavy metals from anthropogenic sources are deposited daily into the environment from activities like, fossil fuel combustion, quarrying, use of fertilizer and pesticides, smelting and sludge amendment also contaminate the soil. Esakku et al., 2003 observe that during degradation of waste, heavy metals are not biodegradable and this may lead to serious environmental problem that may have severe noxious effects on living organisms. However, when the soils collected from contaminated dumpsites are used to fertilise plants, heavy metals present in the soil might affect the food chain through bioaccumulation leading to serious health issues for human. Igharo *et al*., 2014observe that health issues like blood disorder, kidney destruction, and brain and neurological damage may affect human during exposure. More so, Rasmussen (2014) observes that consumption of dust and soils exposed to heavy metals and metalloid from hazardous waste, leaded petrol, automobiles and industrial waste may also result to some ecological risk health issue. The quality of air in the environment may also be affected by heavy metals from the soil which in turn brings about airborne particles and dust (Cyrys *et al*., 2003; Bandhu, *et al*., 2000). Due to the health issues associated with heavy metals in the environment, Cebula *et al*., (1995) andMerian (1991) are of the opinion that before using of dung or soil for agricultural purpose, the level of heavy metals in soils should be checked as some metals may exceed the standard limit.

Previous studies have further shown that different heavy metals exhibit diverse noxiousness. For instance, contamination of the environment from lead (Pb), copper (Cu), zinc (Zn), arsenic (As), aluminium (Al) and mercury (Hg) affect human gastrointestinal tracts, skin, liver, heart, hematopoietic, respiratory and nervous system. Other signs include depression, convulsion, paralysis, diarrhoea, tremor, haemoglobinuria and pneumonia (Singh *et al*., 2010; Duke*et al.,* 2005; Walcek *et al*., 2003). According to European Union Regulation (2002), the effects of heavy metals can be classified as toxic (severe, chronic or sub-chronic), neurotoxic, mutagenic, carcinogenic and tetragenic. Heavy metal like Pb is severely hazardous and has no significance to life but affects children negatively. It is also associated to postnatal and prenatal neurological health in children(Yilmaz, 2009). Previousstudies on postnatal exposure haveshown the long termimpactsof lead on childhood intelligence quotient, along withawareness and self-consciousness (Ngueta and Ndjaboue, 2013; Plusquellec *et al*., 2010; Lanphear *et al*., 2005). Furthermore, exposure to cadmium in the environment is linked with an increased risk of cancer and heart disease mortality among men whilechronic exposure to it may result indeath and reduce life expectancy(Lanphear *et al*., 2005).

Most studies in the field on solid waste management have only focused on municipal or urban waste management and only a few have examined the rural communities. On the other hand, much of the research up to now in the determination of heavy metal determination in soils and sediments have also been limited to urban areas, leaving an existing gap in this field of study (Adeyi and Babafemi, 2017; Adeyi and Torto, 2014; Zhang *et al.,* 2014)This may be due to the constant rural urban migration in the global south. In many rural communities, open dumping of solid waste is the most common method adopted for the final disposal of waste (Christensen*et al.,* 2001). This is the largest method as many communities lack developed dumpsites and sanitary amenities. However, in this type of method, it can be seen that waste disposal is uncontrolled as different types of waste ranging from hazardous to non-hazardous waste are disposed of to the site which are sometime closer to households and water bodies. Open dumpsites result to serious ecological contamination like underground water and air pollution, and serious public health issues from heavy metals.

In view of the above observations, this paper examines the concentration of heavy metals, in soils collected from the open dumps in a rural community situated along old Owo-Ikare road, Ondo State. Using geo-accumulation index, contamination factors and pollution load index, the contamination level of the soils were evaluated. More so, the level of each heavy metal were compared and evaluated using the World Health Organization (WHO) and the Lagos State Environmental Protection (LASEPA) limits.

2. MATERIAL AND METHODS

2.1 Study Area

The study site *Aba Idi-mangoro*, is a rural community situated along Owo-Ikare old road, in Owo. Owo local government area (LGA) is situated in Ondo North Senatorial District, it lies between latitude 7^0 11´ N and Longitude 5^0 35´ E of Ondo State Nigeria. The town is approximately 150m above sea level and annual rain fall of over 1,500mm(Aribigbola, 2012). It is bounded at the North by Ikare, Akure on the South, Oka and Isua at the East and Ifon on the West. The study site is a non-engineered dumpsite which comprise of different waste materials and it is very close to Owo, LGA Secretariat. It was also observed from the dumpsite that the waste disposed of at the site are not separated and different informal waste collectors were since at the site. These wastes collectors were seen picking and separating the collected waste into metals and non-metals (e.g. glass, plastics, papers, etc.).

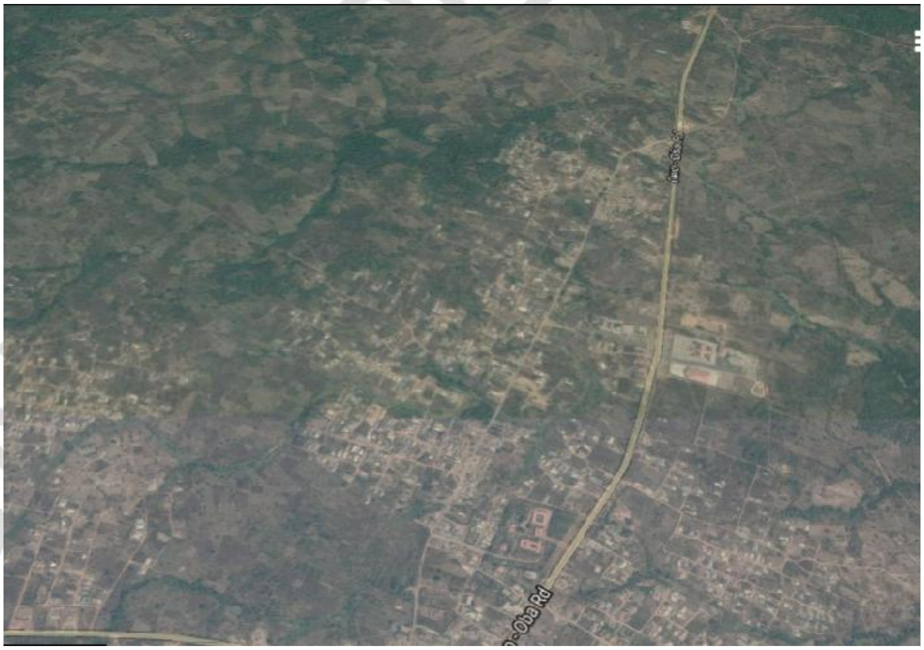

Figure 1: Satellite image of Owo local government council (Google Earth Accessed 13/05/2019)

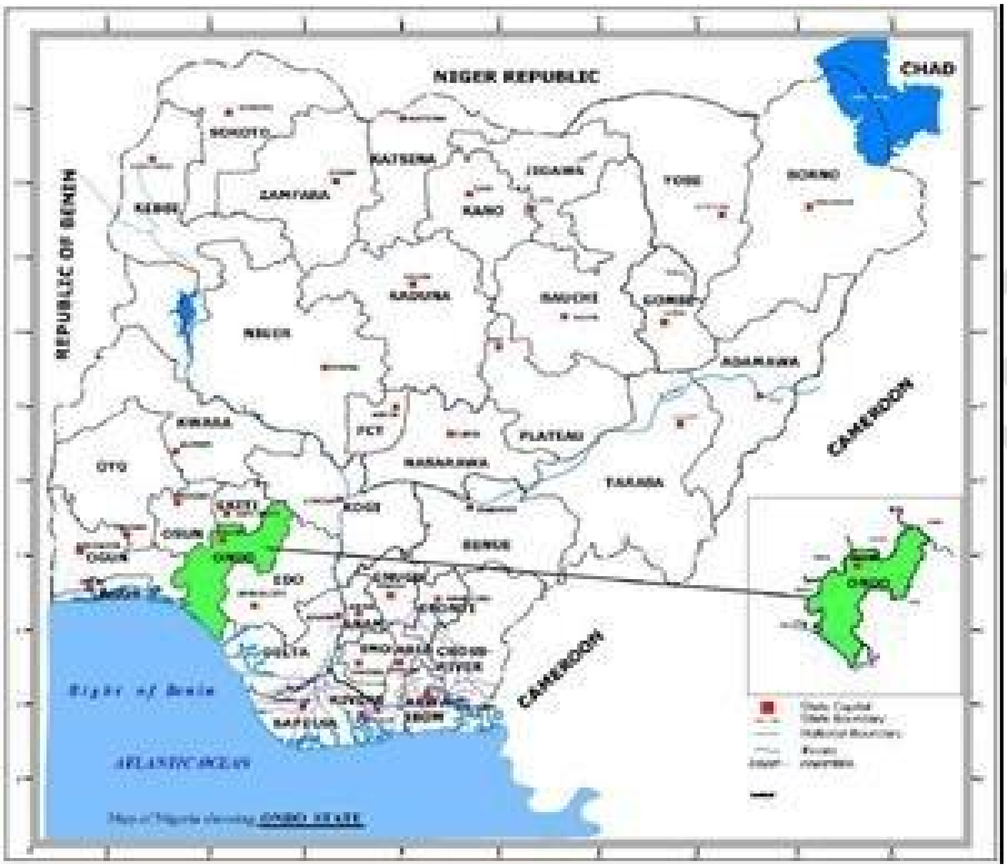

Figure 2a: Map of Nigeria Showing Ondo State Figure 2b: Administrative Map of Ondo State Showing Owo LGA (Oluwagbamila and Samson, 2017**)**

2.2 Soil Sample collection

Soil samples were collected between July 2015 and February 2016 to represent the wet and dry seasons. A total of 96 samples were collected in during this study, 12 samples were collected per month and in triplicate. The surface soil samples were obtained directly from the dumpsites within the depth of 0-10cm using soil auger and trowel. The trowel was used to transfer the soils from the auger into the sample plastic bags. At the end of each collection, the soil auger and trowel were thoroughly cleaned before using it at another point.

2.3 Soil analysis

All soil samples were taken to the Prof. Julius Okojie Central Research Laboratory at the Federal University of Technology, Akure, Ondo State Nigeria. The soil samples were air dried in the laboratory at ambient temperature to remove the moisture. After this, the dried samples were crushed in a pottery mortar and later sifted through a 2-mm mesh size sieve so that the soil can be even and subtle.

Samples for the detection of heavy metal concentrations were weighed and2 g were digested into 70% Nitric acid (HNO3), HCl, $HClO_4$and HFand left in the fume cupboard overnight(Loring and Rantala, 1992). The mixtures were heated continuously at 104^{0}C for 2 hours the next day. The digested mixtures were filtered through a Whatman filter paper into a 50ml standard volumetric flask, and distilled water was mixed with the filtrate. There and then, the solution was poured into bottles for heavy metal analysis using Atomic Absorption (AA) Spectrophotometer by Buck Scientific, model VGP21.

2.4 Data Analysis

2.4.1 Determination of soil contamination

The contamination assessment of the surface soils collected were ascertained by using contamination factor (CF), pollution load index (PLI) and geo-accumulation index (Igeo).

The contamination factor formula was first designed by (Tomlinson et al., 1980) and first used by(Hakanson, 1980) to determine soil contamination status. The contamination factor according to Tomilison *et al*., (1980) is written as:

$CF = C_S/C_B$ **Equation 1**

Where **C_S**refers to the concentrations of trace/toxic heavy metal in the soil samples
$C_B$refers to the baseline or background value.

Nasr et al. (2006) recommend that $CF < 1$ refers to low contamination factor; $1 \leq CF < 3$ indicates moderate contamination factor; $3 \leq CF \leq 6$ shows considerable high contamination factor and; $CF = 6$ implies very high contamination factor

This present study adopts the world shale average background concentration values used by (Onyari *et al*., 2003; Bowen, 1979; Turekian and Wedepohl, 1961). These values were used as there are no background values for heavy metals in Nigeria. Many researchers have utilised the standard background concentration values to measure the contamination factors of soil samples.

The Pollution Load Index (PLI), was first used by (Tomlinson et al., (1980))to determine the magnitude of heavy metal contamination in sediment. In this study, the Pollution load index for each position was evaluated using the equation below:

PLI=(CF1xCF2xCF3x.......CFn)1/n **Equation 2**

Where: **n** = the number of contamination factors and site, respectively.
According to (Chakravarty and Patgiri, 2009), the PLI value > 1 is polluted while PLI value < 1 indicates no pollution.

The geo-accumulation index (Igeo) was first defined and used by (Müller, 1969) to access the metal pollution concentrations in sediment and developed global standard shale values (Praveena et al., 2007). This index is expressed as:
$Igeo = \log_2 (Cn/1.5Bn)$ **Equation 3**

Where **Cn** = the measured concentration of the element in soil;
Bn = the geochemical background value and the constant **1.5** is introduced to analyse natural variations of the background values in the environment and to detect very small anthropogenic impact.(Müller, 1969) defined the seven classes of Igeoas: $I_{geo} \leq 0$, class 0, unpolluted; $0 < I_{geo} \leq 1$, class 1, from unpolluted to moderately polluted; $1 < I_{geo} \leq 2$, class 2, moderately polluted; $2 < I_{geo} \leq 3$, class 3, from moderately to strongly polluted; $3 < I_{geo} \leq 4$, class

4, strongly polluted; $4<I_{geo}\leq 5$, class 5, from strongly to extremely polluted; and $I_{geo}>5$, class 6, extremely polluted.

3. RESULTS AND DISCUSSION

The heavy metals concentrations for the wet and dry seasons are presented in Table 1 below. In both seasons, iron (Fe) was the most abundant metal found in the soil while cadmium (Cd) was the least. The order of abundance for the wet season is as follows; Fe>Mn>Zn>Cu>Pb>Ni>Cr>Co>Cd and the dry season is as follows; Fe>Zn>Mn>Pb>Cu>Ni>Co>Cr>Cd. It can also be seen from the table that the concentrations of heavy metals were higher during the dry season than what was obtained in the wet season. Fe ranged between 30098.00 to 7046.67 and 7032.83 to 29699.00 mgkg-^{1}, Mn 83.00 -245.33 and 169.00 -327.50 mgkg-^{1}, Cd 0.00-4.00 and 0.00, Cr 6.67 to 16.00 and 1.17 to 5.00, Cu 0.00-295.33 and 3.67 and 112 mgkg-^{1}, Pb 0.00-39.33 and 0.00-144.33 mgkg-^{1,} Co 0.67 to 6.67 and 3.00 to 10.67 mgkg-^{1}, Ni 6.67 to 23.33 and 8.67 to 15.00 mgkg-^{1}, Zn 4.33-360.67 and 20.00-453.00 mgkg-^{1} in the wet and dry seasons respectively. When the mean concentrations of the samples collected during the wet season were compared to the dry season, Mn, Cd, Cr and Co differ significantly ($P<.05$). No significant difference was found in Fe, Pb, Ni and Zn. It was observed from the overall results that the concentrations of heavy metals were higher during the dry season than in the wet season.

Although no previous study has been conducted in this study site, however, the results corroborate some previous finding done within and outside Ondo states, Nigeria (Adeyi and Babafemi, 2017; Ololade, 2014; Adeyi and Torto, 2014;Aikpokpodion*et al.*, 2010). Since heavy metal are not easily biodegradable, there is every tendency that the metals will keep increasing in the soil if waste disposed on the site is not properly managed (Zhang et al., 2014) which may later bio-accumulate in the systems of any living organism residing around the study site.

Table 1. Mean concentration from the study sites during the wet and dry seasons***Mean±SE****M = Mean values ± Standard error of means*

Months	Fe	Mn	Cd	Cr	Cu	Pb	Co	Ni	Zn
1st									
Mean	30098.00±3265.49	245.33±33.59	0.00±0.00	5.00±5.00	98.66±85.68	28.67±18.41	6.67±1.76	6.67±5.70	60.66±13.28
Max	36562.00	306.00	0.00	20.00	53.00	75.00	14.00	18.00	84.00
Min	26058.00	190.00	0.00	0.00	4.00	0.00	8.00	4.00	38.00
2nd									
Mean	7046.67±938.82	83.00±44.17	6.00±3.46	10.00±4.16	112.00±30.51	144.33±55.12	5.33±1.76	23.33±9.40	360.67±145.53
Max	8440.00	160.00	12.00	16.00	173.00	249.00	8.00	42.00	616.00
Min	5260.00	7.00	0.00	2.00	80.00	62.00	2.00	12.00	112.00
3rd									
Mean	6935.33±538.66	106.66±41.86	0.00±0.00	16.00±4.16	0.00±0.00	0.00±0.00	2.00±0.00	10.67±1.76	24.00±9.86
Max	7474.00	190.00	0.00	24.00	0.00	0.00	2.00	14.00	40.00
Min	5858.00	58.00	0.00	10.00	0.00	0.00	2.00	8.00	6.00
4th									
Mean	5766.66±1186.61	108.67±26.44	4.00±1.15	10.00±2.00	10.00±10.00	8.67±5.21	0.67±0.67	12.00±2.31	4.33±4.33
Max	8040.00	160.00	6.00	14.00	30.00	18.00	2.00	16.00	13.00
Min	4040.00	72.00	2.00	8.00	0.00	0.00	0.00	8.00	0.00
				Concentration (mg/kg) Dry season Mean ± S.E					
1st									
Mean	29699.00±16871.00	272.00±131.8 8	0.00±0.00	5.00±5.00	32.00±14.57	27.67±23.78	10.67±1.76	11.33±4.05	340.33±167.26
Max	62699	508.00	0.00	15.00	53.00	75.00	14.00	18.00	579.00
Min	7099	52.00	0.00	0.00	4.00	0.00	0.00	0.00	18.00
2nd									
Mean	18032.33±1877.57	327.50±26.21	0.00±0.00	3.97±1.79	112.00±30.51	144.33±55.12	9.00±1.73	14.33±1.76	453.00±89.49
Max	20249.00	356.00	0.00	7.30	173.00	249.00	12.00	17.00	700.00
Min	14299.00	275.00	0.00	1.30	80.00	62.00	6.00	11.00	390
3rd									
Mean	18865.67±7662.53	258.33±17.27	0.00±0.00	1.17±0.92	25.00±12.50	10.33±10.33	7.67±1.45	15.00±6.03	146.67. ±134.18
Max	34099.00	285	0.00	3.00	50.00	31.00	10.00	27.00	415.00
Min	9799.00	226	0.00	0.00	12.00	0.00	5.00	8.00	9.00
4th									
Mean	7032.83±847.71	169.00±19.62	0.00±0.00	9.33±3.17	3.67±0.33	0.00±0.00	3.00±2.00	8.67±0.67	20.00±14.50
Max	8049.50	203.00	0.00	15.00	4.00	0.00	7.00	10.00	49.50
Min	5349.50	135.00	0.00	4.00	3.00	0.00	1.00	8.00	5.00
WHO limit	5mg/kg	0.2mg	0.3mg	0..15	6.00mg/kg	5mg/kg			<1

Table 2 below shows the contamination factor (CF) values of the heavy metals for the two seasons. It can be seen from the table that during the wet season, the results show that the CF of Fe was very high for all collections, as the values were greater than 6, this result corroborates(Adeyi and Torto, 2014). More so, cadmium (Cd) was very high during the 2nd and 4th collections at the same time Pb was very high during the 2nd collection. Meanwhile, during the 1st and 2nd collections, it was observed that the CF of Cu was moderate during the first, second and the overall average collection. In addition, the CF of Zn for second and third collections show that the metal was high because the values were greater than 3. This is shown in the result analysis section. All other metal showed low contamination factor during the two season. This result implies that the soils sample were contaminated at various point of collection which may be due to some of the activities carried out in the area, which is majorly cassava processing.

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Table 2: Contamination factor (CF)

Metal (Wet Season)	Fe	Mn	Cd	Cr	Cu	Pb	Ni	Zn
1st collection	752.32	0.27	0.00	0.05	2.19	1.43	0.10	0.64
2nd collection	176.17	0.09	6.00	0.11	2.49	7.22	0.08	3.80
3rd collection	173.38	0.12	0.00	0.17	0.00	0.52	0.03	0.25
4th collection	101.00	0.12	4.00	0.11	0.22	0.00	0.01	4.56
CF for overall mean	311.54	0.15	8.33	0.12	2.24	0.96	0.19	1.18
Dry Season								
1st collection	742.47	0.50	0.00	0.05	0.71	1.38	0.17	3.58
2nd collection	450.81	0.36	0.00	0.04	2.49	0.72	0.21	4.77
3rd collection	471.64	0.29	0.00	0.01	0.55	0.00	0.22	1.53
4th collection	175.82	0.19	0.00	0.10	0.08	0.43	8.67	0.21
CF for overall mean	460.19	0.28	0.00	0.05	0.96	2.28	0.19	2.77

The result of pollution load index, a tool that is use for the comparison of pollution status in soil is presented in Table 3. The PLI for all heavy metals were generally low but Fe, Cu and Zn were greater one (> 1) in the dry season while Fe and Zn were > 1 in the wet season. Meanwhile all other metals showed no value for the two seasons.

Table 3: Pollution Load Index

Metals	Wet season	Dry season
Fe	219.49	408.17
Mn	0	0
Cd	0	0
Cr	0	0
Cu	0	1.77
Pb	0	0
Ni	0	0.51
Zn	1.29	1.53

The Igeo is used to measure the degree of pollution in soils and it comprises of seven different grades as classified by (Müller, 1969). The Igeo results are presented in Table 4. These results show that the heavy metal pollution varied at diverse collection times from the study site. Using the classification grade created by Muller, the soil samples were extremely contaminated with Fe during the wet and dry seasons. Also, Cd was extremely high during the 2nd and 4th collections in the wet season while Zn was moderately contaminated during the 2nd collection in the wet and dry seasons. The soil was slightly polluted with Pb in the wet season during the second collection. However, the soils remain uncontaminated with Mn, Cr, Cu and Ni in the two seasons while Cd was not contaminated in the dry season. These hazardous metals may be present in the soil due to industrial activities from JOF oil industry and the various agricultural activities.

Table 4: Geo-accumulation index for studied heavy metals in the dumpsite

Metal	Fe	Mn	Cd	Cr	Cu	Pb	Ni	Zn
(Wet Season)								
1st collection	8.97	-2.47	0	-4.64	0.55	-0.06	-3.93	-1.23
2nd collection	6.88	-0.41	13.33	-3.84	0.73	2.27	-4.26	1.34
3rd collection	6.85	-3.84	0	-3.06	0	-1.54	-5.67	-2.57
4th collection	6.07	-3.64	8.89	-3.84	-2.75	0	-7.25	1.60
Dry Season								
1st collection	8.95	-2.32	0	-4.64	-1.08	-0.12	-3.17	1.26
2nd collection	8.23	-2.06	0	-5.06	0.731	-1.07	-2.83	1.67
3rd collection	8.30	-2.40	0	-6.64	-1.43	0	-2.76	0.034
4th collection	6.87	3.06	0	-3.84	-4.20	-1.79	-3.55	-2.83

Pollution assessment of the study site

From this study, soil pollution was determined by comparing the concentration values of the heavy metals with some regulatory heavy metal limits, pollution load index and the contamination factor. From Table 1 it can be seen that metals like Fe, Mn, Pb, Zn, Cd and Cr were higher than the regulatory limits depending on the time of collection. It should be noted that heavy metals do not degrade but rather they easily bioaccumulate in and pose ecological risk or threats to human health and other ecological lives in the environment (Onjefu *et al.,* 2017). In addition, many previous studies have shown some of the health effects associated to heavy metal (Kacholi and Sahu, 2018; Onjefu *et al.,* 2017; Ayangbenro and Babalola, 2017). Metal toxicology assessment shows that it can interrupt the structures and functions of enzymes by attaching itself with thiol and protein groups, or by substituting co-factors in prosthetic groups of enzymes.

It is therefore important to note that the indiscriminate dumping of waste and some other illegal activities might have contributed to the high values recorded in the contamination factors of the heavy metals. However, from Table 2, it can be seen that the CF values were greater than 6 for Fe, Cd and Pb as proposed by (Hakanson, 1980). In addition to this, the present study site is contaminated with Fe, Pb and Cd and this agrees with the suggestion by Hakanson (1980) and Tomlinson (1980). It may therefore be said that the site is contaminated. Mores so, the pollution load index only indicate that Fe, Pb and Zn are the only metals that pollute the study site. This is so when compared to the PLI value proposed by Chakravarty and Patgiri (2009). Furthermore,Angulo (1996)observed that due to leaching in the wet season, PLI value is usually higher in the dry season. Although, Nigeria does not have a baseline value, this present study conforms toAngulo (1996) as the PLI dry season values were higher than what was observed in the wet season.

Environmental Risk Assessment

According to Phillips and Subasinghe (2009),environmental assessment studies access the probability and cost of pollution on floras, faunas and the entire ecological units whereas, ecological risk assessment investigates the threats associated to faunas and human health. From the heavy metal concentration results, it could be seen that Fe and Cd were above the WHO limits during the wet season while Fe was higher in the dry season than in the wet. This may be due to leaching of heavy metals which occurs in the wet season. More so, this present study shows that not all the heavy metals present in the soil were significantly hazardous. The high presence of Fe may be associated to the parent soil in the study location, these results agreed with the findings of Angulo (1996). In addition, the presence of Fe and Zn in the soil may be due to dumping of different waste which include agricultural waste, fertilizer, waste from passers-by and passing cars because the study site is closer to a major market where only food items from other rural settlements are sold, this is also consistent with the studies ofIsimekhai*et al.*, (2017) and Kananke*et al.*, (2015). The presence of Pb and Cu may be due to the release of pollution of vehicle exhaust from nearby traffic, because Nigeria uses only leaded petrol and diesel and the presence of waste released by the vegetable oil industry located close to this study site. Many previous studies have shown that the availability of Cd in soil could make the soil very toxic and it is of a great concern, these results are in agreement withIsimekhai*et al.*, (2017). As a result of some the heavy metals that exceeded the regulatory limits, it shows that the study site was polluted.

From the PLI, it can be inferred from the study that Fe and Zn are the major pollutants found in both seasons and Cu was only polluted in the dry season. The PLI was determine using Chakravarty and Patgiri (2009) proposed standard which shows that PLI value > 1 is polluted while PLI value < 1 shows no pollution. Mn, Ni, Pb, Cr and Cr showed values no pollution in the soil samples. Since Fe shows the highest potential risk, it implies that the underground water around the study area may as well be affected. This result is similar to Adeyi and Babafemi (2017) andAdeyi and Torto (2014). Igeo result also shows that the soil is extremely high with Fe and Zn.

4. CONCLUSION

The study has revealed the presence of some of the most hazardous heavy metals at a level that is above the WHO limits for soil in Nigeria. It is therefore, imperative for the Ministry of Environment to embark on a sensitization programme to stop indiscriminate disposal of waste and the use of open dump sites. Also, there should be provision of a better alternative to rural communities.

Further studies can also be carried out to assess heavy metal concentration level in some nearby sources of potable water, as leachate from this dumpsite can easily contaminate the underground water which sometimes are not treated before drinking by resident of the area.

ETHICAL APPROVAL (WHEREEVER APPLICABLE)

The leader of this team sought permission from Ondo State Waste Management Board before the sample were collected and it was granted.

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