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Ecological Risk Assessment of the Soil around Odo Iya-Alaro (Iya Alaro River) at Ojota, Lagos States, Nigeria

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ABSTRACT

Human developmental activities always result to waste generation; that invariably pollute the environment, if not properly managed. The aim of this study is to determine soil quality around Odo Iya-Alaro at Ojota, Lagos. A total of 12 soil samples were collected from 0 -15 cm and 15- 30 cm at three different spots of 100 and 500 m (control) away from the bank of the river. Samples were analysed for pH, EC, NO3, TOC; Zn, Na, K, Ca, Mg, Cu, Fe, Cd, Cr, Ni, and Pb using standard analytical methods. The results were subjected to both differential and inferential statistics using statistical package (SPSS 22.0 version). Subsequently, the data were compared with Earth crust values. The soil pollution was evaluated using pollution, ecological risk, and geo-accumulation index. Cr (50.43), Ni (29.47), and Cu (104.10) mg/kg at 100 m were higher than their controls; (12.09), (8.14), and (86.06) mg/kg respectively, but lower than their respective Earth crusts; (100), (80) except (50) mg/kg. The soil was moderately polluted with pH (1.15), Na (3.00), K (2.11), Mg (1.87), Ca (1.26) and Cu (1.21); considerably polluted with EC (3.82), TOC (3.39), and Ni (3.62); and very highly polluted with Fe (8.26). Fe (711.73) had a very high ecological risk. The Geo – accumulation index was moderately - strongly polluted with Zn (2.61), and very strongly polluted with pH (5.37), EC (14.90), NO3 (9.66), Na (15.41), K (11.31), Mg (9.51), Ca (17.08), Fe (15.32), Cu (12.54), Cr (8.67), and Ni (7.32). The soil was polluted. and urgently needs reclamation for Garden Park (relaxation).

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INTRODUCTION

Waste is inevitable in any economy but ability to manage it; is what distinguished between developed and developing economy. However, a lot of waste are being generated by various anthropogenic activities, such as industries, commerce and agriculture, that contain a lot unwholesome materials which are very detrimental to the human health and environment, if released to water bodies untreated (Barzegar *et al.*, 2018; Mgbenu and Egbueri, 2019). Many wastes produced in the cities have been reported to be sources of heavy metals contamination to the soil and water (Egbueri, 2018; Barzegar *et al.,* 2019). Water and soil resources were contaminated with excess heavy metals that can cause health risks (Adamu *et al.,* 2014; Vandervoet *et al*., 2013). Furthermore, heavy metals enter the plant, animal, and human body via soil and water through direct and indirect consumption (USEPA 2017; Thanomsangad *et al.,* 2019; Barzegar *et al.,* 2019). Industrial waste waters are one of the major carriers of heavy

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metals that contaminate various water and soil (Yakovlev 2022; Ukah *et al.,* 2019). Although some heavy metals like copper, zinc, selenium, etc., in small quantities, are generally good for human body, but only their excessive accumulation in the body is a big threat to human health (Ukah *et al.,* 2019; Toth *et al*., 2016).

The major challenge of waste water discharge is the contamination of soil and it is alarming. According to Omole and Isiorho (2011), they reported that 80% of the industries discharged their waste waters without treating them. However, soil is a natural absorber and reservoir of these various contaminants, whether emptied into the water or soil directly (Chen *et al.*, 2022; Zhou *et al.*, 2020; Rosca *et al.*, 2019). In addition, automobile emissions also adds to the contamination of heavy metals; such as zinc, copper, iron and cadmium through wires, petrol and tyres of the vehicle released on the road side soil through mechanical tear and wear (Finch *et al.,* 2015). However, since all these products are not biodegradable, they persist and accumulate in the soils, thus polluting the environment (Zhou *et al.* 2019).

Most urban and industrial runoff contains a component of trace and heavy metals in the dissolved or particulate form (Hassan, 2022 a; Talovskaya *et al.*, 2018). Moreso, the toxicity of heavy metals on the environment is due to the ability to persist and bioaccumulate in the living and non - living component of the environment (soil and water) (Truchet *et al.,* 2020; Szynkowska *et al.,* 2018; Omole *et al.*, 2016; Huang *et al.,* 2016). Heavy metals in the environment are usually taken from non - living component (soil and water) by some living things in the environment through their feeding habit and stored more than what they can metabolize (Osakwe, 2014).

In addition, higher concentration of heavy metals in the soils, is a major source of concern in many countries in the world today (Hassan, 2022 b; Omole *et al.* (2016)). There are many studies on soil heavy metals focusing on heavily populated city, industrial areas as well as waste landfills areas (Omole et al., 2016). Osakwe (2014) studied the heavy metals contents in soils in the automobile workshop in Abraka, Delta State, Nigeria. Inobeme *et al*. (2014) also carried out similar study on the soil around paint industries in Kaduna (Nigeria). Khan *et al.,* (2018) investigated the effect of using waste water to irrigate farmland in Pakistan.

Various researchers have asserted that there is need for continuous monitoring of the concentration of heavy and trace metals in soil; because of their implications on the various component of the environment. The individual early researcher has investigated the pollution of soil by a certain sector of economy or development at a particular study area. However, the pollution that occurred at Odo Iya-Alaro caused by pollution from various sectors of economy and development; such as vehicular emission, waste water from different types of industry, farming (the river is used to irrigate the farms), automobile workshop, domestic waste; many but to mention a few were emptied daily into the river. The aim of this study is to determine the quality of the soil around the Odo Iya-Alaro at Ojota, Lagos.

MATERIAL AND METHODS

The samples for this study were collected from the bank of Odo Iya-Alaro situated at Ojota suburb (Kosofe Local Government Area) LGA, Lagos State, Nigeria. It is on coordinate 6. 581116 ̊N and 3.376258 ̊E. The river is dark in colour with bad odour; which are signs of being polluted with all sorts of waste (human, domestic, and industrial). There are two vehicular bridges runs across the river; joints Kosofe and Ikeja LGA. Ikeja LGA is highly industrialised; has the majority of company in Lagos State. Lagos State being industrial and commercial hub of Nigeria. The industrial wastewaters are discharged some kilometers away from Ikeja into a rectangular-shaped concrete canal, which eventually empties into Odo Iya-Alaro (a natural river). However, at the bank of the river a lot of human activities are going on such as weaving of cane furniture, food hawking, vegetable farming; mechanic workshop etc. Figure 1 shows

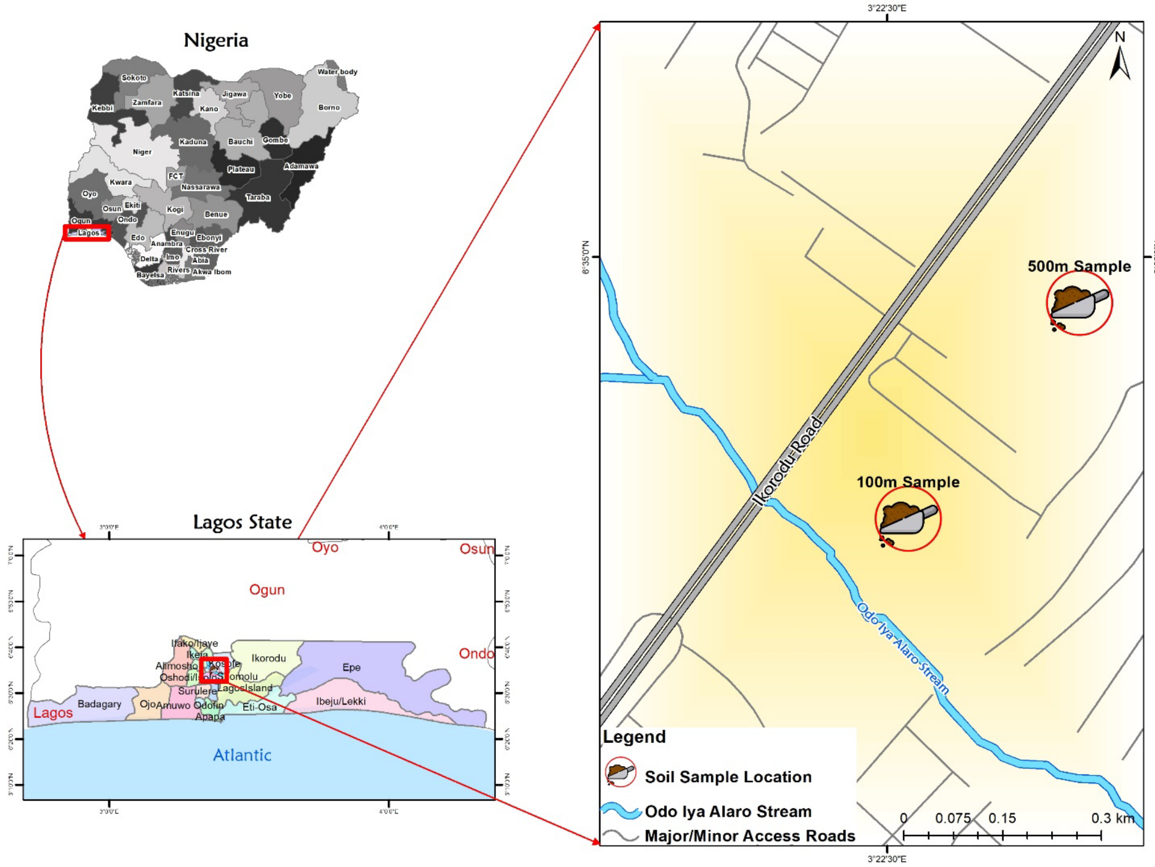

Figure 1: Map of Odo Iya - Alaro (Collection Site)

the sample collection site.

The soil samples were collected at the other side of the bank of the river where there was no extension of human activities; toward the neighboring hinterland. Soil auger was used to excavate soil out from 0 -15 cm (Topsoil) and 15 – 30 cm (Subsoil) at three different spots at sphere of 100, and 500 m (control) away from the bank of the river. At each distance, a total of six soil samples (3 topsoil and 3 subsoil) were collected and labelled accordingly. Subsequently, samples were taken to laboratory for analysis. The soil samples were analysed for the following;

Physico-chemical; pH, electrical conductivity (EC), total organic carbon (TOC) and nitrate (NO_3).

Trace metals: zinc (Zn), calcium (Ca), sodium (Na), magnesium (Mg), and potassium (K).

Heavy metals: copper (Cu), iron (Fe), cadmium (Cd), chromium (Cr), nickel (Ni), and lead (Pb)

The mean and standard deviation of each parameter in all six soil samples (topsoil and subsoil) at each distance were calculated.

Ten (10) grams of the air dried soil were weighed into 100 mL beaker and 20 mL of distilled water was added. The mixture was allowed to stand for 30 minutes with occasional stirring with glass rod. An electrode from calibrated pH meter was inserted into the partially settled suspension and the pH of the soil was measured. Conductivity meter (Jenway 4520 model) was used to determine electrical conductivity of the soil samples. The meter was calibrated with a solution of 0.01M KCl having a conductance of 1413 mS/cm at 25 °C. Nitrate standards were prepared in the range 0.1–1.0 mg/LN diluting 1.00, 2.00, 4.00, 7.00 and 10.0 mL standard nitrate solution with 10 mL of distilled water. Add 10 mL sample or a portion diluted to 10 mL

Table 1. Classification Ladder for Pollution Index(Olatunde *et al.*, 2020; Maanan *et al.*, 2014)

Value	Pollution level
$Pi \leq 1$	Low
$1 < Pi \leq 3$	Moderate
$3 < Pi \leq 6$	considerable
$Pi > 6$	very high

Table 2. Classification Ladder for Ecological Risk Index (Kolawole, *et al.*, 2018)

Value	**Ecological risk level**
$Eri < 40$	Low
$40 \leq Eri \leq 80$	Moderate
$80 \leq Eri \leq 160$	Considerable
$160 \leq Eri \leq 320$	High
Eri 320 >	very high

to the test tube. Place the tube in a cool water bath and add 2 mL NaCl solution and mix well. Add 10 mL of H_2SO_4 solution and again mix well and allow to cool. The reaction test tube was then placed in a cool water bath and add 0.5 mL brucine-sulphanilic acid reagent. Swirl the tubes and mix well and place the tube in boiling water bath at temperature 95 °C. After 20 minutes, remove the samples and immerse it in a cool water bath. The samples were then poured into the dry tubes of spectrophotometer; however, the standards and sample against the reagent blank at 410 nm were read.

CALCULATION

$$\text{Nitrate N in mg/L} = \frac{\mu g\ NO_3^- - N}{\text{mL of sample}}$$

$$NO_3 \text{ in mg/L} = \text{mg/L nitrate N} \times 4.43 \quad (1)$$

Total organic carbon (TOC) was analysed; by 1 g of soil sample placed inside a block digester tube followed by addition of 5 mL of potassium dichromate solution and 7.5 mL of concentrated H_2SO_4. The tube was placed in a pre- heated block at 145 - 155 °C for 30 minutes. Thereafter, removed and allowed to cool. The digest was transferred into a 100 mL conical flask and followed by the addition of 0.3 mL of Ophenanthrene- ferrous complex (ferroin) indicator solution, then stirred and mixed properly using magnetic stirrer. The digest was titrated with ferrous ammonium sulphate solution with end point indicating a change from green to brown colour. The organic carbon content was expressed in percentage as follows and was based on 77 % recovery factor

$$\%\ \text{Organic C} = \frac{N\ (T - B)}{W} \times 0.390 \quad (2)$$

Where N = Normality of KMnO4;
T = Volume of KMnO4 used in titration of soil;
B = Volume of KMnO4 used in titration of blank; and

W = Weight of soil in gram

The soil sample was air dried, grinded and sieved and 1 g of the sample was weighed into 250 mL conical flask. About 10 mL of distilled water was added to the soil sample. Five (5) mL of hydrochloric acid (HCl) was added to the mixture followed by 1 mL of nitric acid (HNO_3). The mixture was placed on hot plate and heated continuously; until it started to boil. The heating is continued with occasional addition of distilled water to prevent it from drying out until the Brown fume of the content was no longer detectable. The mixture was allowed to cool and then filtered into a 100 mL measuring cylinder and made up to the volume with distilled water. The filtrate was aspirated into the Atomic Absorption Spectrophotometer (AAS).

The result of the laboratory analysis were subjected to mean, and standard deviation, t – test using statistical package (SPSS 22.0 version) and compared with earth crust values (Alloway, 1995). In addition, the possibility of occurrence of health and environmental hazard of the surrounding soil were evaluated using the following indices: pollution index (PI), geo-accumulation index (GI) and ecological risk index (ERI)

The level of metal pollution (contamination) in the soil around the river were determined by comparing metal concentrations in soils at the sampling point away from the bank of the Odo –Iya Alaro river with the control point (geochemical background) obtained from an uncontaminated location 500 m away (Maanan *et al.,* 2014). The mean values of the parameters (topsoil and subsoil) are calculated so as to compare the calculated mean with the guideline value. The level of pollution was assessed using the pollution index (*Pi*), geo-accumulation index *(I geo)* and the ecological risk index *(Eri)*. However, the means of topsoil and subsoil values for each sampling area (100 and 500 m) were found and used to calculate the indices

Pollution index is equal to the division of the means of concentration of each parameter in the soil (top soil and subsoil) by means of the concentration of the same parameter in the control (topsoil and subsoil) value (Olatunde *et al.*, 2020; Maanan *et al.*, 2014).

$$Pi = C\,i / B \tag{3}$$

Where $C\,i$ is the mean concentration of the metal in the soil (topsoil and subsoil) sample and B is the mean of the concentration of the metal in the control (topsoil and subsoil) sample (i.e. the concentration of the metal in the perceived unpolluted sample). The level of metal pollution is rated using four pollution classes based on the value of the index.

The ecological risk index *(Eri)* evaluates the potential ecological risk posed by heavy metal pollution as regard the toxicity of individual heavy metals:

$$\mathrm{E\,i} = \mathrm{T\,i\,r} * P\,i \tag{4}$$

Eri is the individual potential ecological risk factor and *Pi* is the pollution index.

T i r is the toxic response factor, characterizing the potential of metal pollution by representing the toxicity of metals. The normalized toxic response factor suggested for Zn, Cu, Pb, Cr, Cd and Ni have toxic response factors of 1,5, 5, 2, 30 and 5 respectively (Kolawole et al., 2018; Nouri and Haddioui 2016). The degree of metal pollution is rated using five pollution classes based on the value of the index (Kolawole, et al., 2018)

The geo-accumulation index (I geo) is used to evaluate the amount (degree) of element pollution in soils by balancing the present with background (control) concentrations.

$$I\,geo = \mathrm{Log}_2\,(C\,i / 1.5\,B) \tag{5}$$

Where $C\,i$ is the concentration of the metal in the soil sample and B concentration of the metal in the control (unpolluted sample).

The degree of metal pollution is rated using seven pollution classes based on the value of the index (Huu, 2020) as in Table 3

Table 3. Classification Ladder for Geo-Accumulation Index (Huu, 2020)

Value	Geo-accumulation level
I geo < 0	Unpolluted
0 < Igeo < 1	unpolluted - moderately polluted
1 < Igeo < 2	moderately polluted
2 < Igeo < 3	moderately - strongly polluted
3 < Igeo < 4	strongly polluted
4 < Igeo < 5	strongly - very strongly polluted
I geo ≥5	very strongly polluted

Table 4. One Sample t-test of the Physiochemical Content of Surrounding Soil (N=3)

Parameter	100		Control (m)				
	TS	S S	TS	SS	Mean ± Std	t-stat	P-value
pH	8.38	8.52	7.44	7.20	8.45±0.02	33.93	0.02
EC (μS/cm)	425.00	411.00	120.4	98.6	418 ±9.99	44.36	0.99
NO3 (mg/kg)	22.86	28.00	50	45	25.43±3.63	-0.22	0.86
TOC (%)	2.49	2.25	0.8	0.6	2.37±0.17	8.83	0.07

Source: Result from Field Survey 2020
TS = top soil; SS = sub soil;

Table 5. One Sample t-test of the Trace Metals of the Surrounding Soil (N =3)

Parameter	100		Control (m)				
(mg/kg)	TS	SS	TS	SS	Mean ± Std	t-stat	P-value
Na	448.87	437.26	243.06	52.35	443.07±8.21	52.36	0.01
K	89.36	89.69	49.53	35.33	89.53±0.23	250.33	0.00
Mg	45.08	45.29	25.19	23.13	45.19±0.15	23.12	0.01
Ca	495.66	528.12	411.89	402.12	511.89±22.34	22.12	0.14
Zn	0.04	0.22	127.5	13.46	0.13±0.12	-873.46	0.00

Table 6. One Sample t-test of Heavy Metals of the Surrounding Soil (N =3)

Parameter (mg/kg)	100		Control (m)		Mean ± Std	t-stat	P-value
	TS	SS	TS	SS			
Fe	714.71	708.74	80.64	91.65	673.13± 46.65	1.65	0.20
Cu	106.65	111.54	70.82	101.29	107.82±8.98	0.28	0.80
Cr	46.89	53.97	13.50	10.68	33.50±20.04	1.69	0.19
Pb	0.00	0.00	0.00	0.00	0.00±0.00	0	1.00
Cd	0.00	0.00	23.00	110	0.00	0	1,00
Ni	27.06	31.88	9.47	6.8	29.47±3.41	6.81	0.09

RESULTS AND DISCUSSION

The one Sample t-test of physicochemical content of the soil (Table 4) shows that the pH (TS = 8.38) and (SS =8.52) samples around Odo –Iya Alaro was significantly different from control (TS = 7.44 m/kg) and (SS = 7.20 m/kg) samples, while EC, NO_3 and TOC of the topsoil and subsoil at 100 m away from the river are not significantly difference from the control experiment at 5% Significance level. This was in agreement with the result of Hassan (2022b). The fertility of the soil is being determined by a lot of soil variable such as by pH, total organic carbon, NO_3, cation exchange capacity etc. The pH values of topsoil and subsoil samples are slightly alkaline; 8.38 and 8.52 respectively. However, with mean value of 8.45; hence, averagely okay for the soil; because pH of soil is very vital because metal accessibility is low when the pH is neutral (Hassan, 2022 b; Olatunde *et al.,* 2020). However, depending on the contaminants present in the Odo Iya - Alaro, as the contaminants therein come from all facets of anthropogenic activities; thus could nourish or be harmful to the soil content (Truchet *et al.,* 2020; Khan *et al.,* 2018; Szynkowska *et al.,* 2018; Omole *et al.*, 2016; Huang *et al.,* 2016) . The higher the NO_3, TOC and EC levels in the soil, the higher the nutrients content of the soil. However, among the three parameters, only NO_3 is lower than the control. This is as a result of vigorous farming embarked upon on the surrounding soil (100 m). Thus, the soil around Odo Iya - Alaro demonstrates a reasonable level of fertility and are comparable with the results of (Hassan, 2022 b; Zhou *et al.*, 2019).

Table 5 shows the trace metal content (one Sample t-test) of the surrounding topsoil and subsoil near the river; with Zn, Na, K and Mg are significantly different from the control (topsoil and subsoil), while there is no significant difference between the Ca content of the surrounding topsoil (495.66 mg/kg) and subsoil (528.12 mg/kg) near the river and the control (topsoil = 411.89 mg/kg and subsoil = 402.12 mg/kg) at 5% significance level (Egbueri, 2018; Barzegar *et al.,* 2019). In addition, with the exception of Zn, other trace metals (Na, K, Mg and Ca) are higher in the soil around the river than the control site. Hence, shows that the soil was polluted with these trace metals. However, this is good for the soil, as the trace metals are essential to the plant growth; if invariably, such plants are consumed by man; they provide these essential elements for proper functioning of human metabolic processes.

Table 7. Comparison of Mean Values of the Top Soil and Subsoil of the Parameters with Earth Crust Values

Means Values of Topsoil and Subsoil			
Parameter (mg/kg)	**100**	**Control (m)**	**Earth crust (mg/kg) (Alloway, (1995)**
pH	8.45	7.32	
EC,µS/cm	418.00	109.5	
NO_3	25.48	47.5	
TOC	2.37	0.7	
Na	443.07	147.71	
K	89.53	42.43	
Mg	45.19	24.16	
Ca	511.89	407.01	
Fe	711.73	86.15	–
Zn	0.13	70.48	75
Cu	104.10	86.06	50
Cr	50.43	12.09	100
Pb	0.00	0.00	14
Cd	<0.001	66.50	0. 1
Ni	29.47	8.14	80

Table 8. Pollution (Parameters), Ecological Risk (Heavy Metals) and Geo-Accumulation (Parameters) Indices of the Soil around Odo Iya – Alaro

Means Values of Topsoil and Subsoil in the Location			Pollution Index	Ecological Risk	Geo-accumulation
Parameter (mg/kg)	100	Control (m)			
pH	8.45	7.32	1.15		5.37
CND (µS/cm)	418.00	109.5	3.82		14.90
NO_3	25.48	47.5	0.54		9.66
TOC (%)	2.37	0.7	3.39		0.15
Na	443.07	147.71	3.00		15.41
K	89.53	42.43	2.11		11.31
Mg	45.19	24.16	1.87		9.51
Ca	511.89	407.01	1.26		17.08
Zn	0.13	70.48	0.00	0.00	2.61
Fe	711.73	86.15	8.26	711.73	15.32
Cu	104.10	86.06	1.21	6.05	12.54
Cr	50.43	12.09	4.17	8.34	8.67
Pb	0.00	0.00	0.00	0.00	0.00
Cd	0.00	66.50	0.00	0.00	0.00
Ni	29.47	8.14	3.62	18. 1	7.32

The one Sample t-test of heavy metals (Table 6) shows that Fe, Cu, Cr, Cd and Ni contents of the topsoil and subsoil around Odo Iya - Alaro are significantly different from corresponding control (topsoil and subsoil). However, except Pb, where there is no significant difference between 100 m (top soil = 0.00 mg/kg; subsoil = 0.00 mg/kg) and the control (topsoil =0.00 mg/kg and subsoil = 0.00 mg/kg). The implication is that Odo Iya - Alaro affects the heavy metal (Fe, Cu, Cr, Cd and Ni) content of the surrounding topsoil and subsoil at 5% Significance level (Yakovlev 2022; Ukah *et al.,* 2019). Furthermore, with the exception of Pb, all other heavy metals (Fe, Cu, Cr, Cd and Ni) were higher in the soil nearer to the bank of the river, than the control. However, this has a lot of implications on the health of man, if any food crop grown on this soil is consumed. However, ingestion of Cr by human can impair the liver and kidney functions, high concentration of Ni affects the human reproductive system and immune system. Pb at a very small concentration can cause neurological disorder even in children (Thanomsangad *et al.,* 2019; Barzegar *et al.,* 2019; Mgbenu and Egbueri, 2019).

Table 7 shows the comparison of the determined parameters with the Earth crust values; Zn (0.13 mg/kg) 100m was lower than the control (70.48 mg/kg); however both were lower than the earth crust (75 mg/kg). Cr (50.43 mg/kg) at 100 m was higher than the control (12.09 mg/kg) but both were lower than the earth crust (100 mg/kg). Pb at 100 m and the control were (0.00 mg/kg) and lower than the earth crust (14 mg/kg). In addition, Cd of the Earth crust (0. 1 mg/kg) was higher than the 100 m Cd (<0.001 mg/kg) but lower than the control soil (66.50 mg/kg). The Cu (104.10 mg/kg) at 100 m was higher than the control soil (86.06 mg/kg), but both were higher than the Earth crust (50 mg/kg). Ni (29.47 mg/kg) at 100 m higher than the control (8.14 mg/kg) but both were lower than the Earth crust (80 mg/kg) (Hassan, 2022b; Ukah et al., 2019; Toth et al., 2016; Adamu et al., 2014; Vandervoet et al., 2013).

The pollution index of the determined parameters in Table 8 illustrates that the soil within the sphere of 100 m was lowly polluted with NO_3 (0.54), Zn (0.00), and Pb (0.00). In addition, the soil was moderately polluted with pH (1.15), Na (3.00), K (2.11), Mg (1.87), Ca (1.26) and

Cu (1.21). The Odo Iya - Alaro considerably pollutes the soil with EC (3.82), TOC (3.39), Ni (3.62) at 100 m away from the blank of the river. The soil was very highly polluted with Fe (8.26).This agreed with the works of Olatunde *et al.* (2020); Maanan *et al.* (2014). Similarly, Table 5 demonstrates that Zn (0.00), Cu (6.05), Cr (8.34), Pb (0.00), Cd (0.00) and Ni (18. 1) in the soil (100 m) did not pose any ecological risk to the soil. However, with the exception of Fe (711.73) that posed very highly ecological risk to the soil. Furthermore, the Geo – accumulation index shows that the soil was polluted with every determined parameter; as none of them has value lesser than zero. The soil was unpolluted - moderately polluted with Pb (0.00), Cd (0.00) and TOC (0.15). The Zn (2.61) was moderately - strongly polluted in the soil. Moreover, the soil (100 m) was very strongly polluted with pH (5.37), EC (14.90), NO_3 (9.66) Na (15.41), K (11.31), Mg (9.51) Ca (17.08), Fe (15.32), Cu (12.54) , Cr (8.67), and Ni (7.32).The results were comparable to Kolawole *et al.* (2018) and Nouri and Haddioui (2016) that examined the ecological risk of the mining site soils and sediments of the industrial area in Southwestern Nigeria and AIT Ammar abandoned Iron mine soil in Morocco respectively.

CONCLUSION

This study has revealed the quality of the soil around Odo Iya - Alaro (100 m); the pH was significantly different from control, while EC, NO_3 and TOC are not significantly different from the control. The pH values of soil are slightly alkaline. The Zn, Na, K and Mg are significantly different from the control. With the exception of Zn, other trace metals (Na, K, Mg and Ca) are higher than the control site. The Fe, Cu, Cr, Cd and Ni were significantly different from corresponding control. The pH, EC, TOC, Fe, Cu, Cr, and Ni were higher in the soil (100 m) than the corresponding controls, while NO_3, Zn and Cd were lower than their corresponding controls.

The pollution index of the determined parameters in the soil within the sphere of 100 m were lowly polluted with NO_3, Zn, and Pb. The soil samples were moderately polluted with pH, Na, K, Mg Ca and Cu. The Odo Iya - Alaro considerably pollutes the soil with EC, TOC, Ni. The soil was very highly polluted with Fe. In addition, Zn, Cu, Cr, Pb, Cd and Ni (100 m) did not pose any ecological risk to the soil; with the exception of Fe that posed very high ecological risk. The geo – accumulation index revealed that, the soil was unpolluted - moderately polluted with Pb, Cd, and TOC. The Zn (moderately - strongly polluted). Moreover, the soil was very strongly polluted with pH, EC, NO_3 Na, K, Mg Ca, Fe, Cu, Cr, and Ni.

In view of the findings revealed by this study, it is recommended that;

There is need for the treatment of the effluents by the industries and waste from the immediate surroundings into a non - toxic state before discharging them into the water body.

Solid waste should be discouraged from being emptied into the river or canal. However, Lagos State Waste Management Agency (LAWMA) should be up to her tasks through Private Sector Participation (PSP) by trying to get to any nook and corner of Lagos State to collect solid waste.

Efforts should be made by the regulatory agencies such as National Environmental St&ards and Regulation Enforcement Agency (NESREA) and Lagos state Environmental Protection agency (LASEPA) to monitor where people are cooking, selling, and hawking food, use as work shop etc.

The Odo Iya - Alaro should be cleared off of all the makeshifts near the river because of ecological risk involved in residing or working around the place.

Farming should be discouraged at bank of the river, particularly Odo Iya - Alaro where all sorts of waste are emptied into by concerned agencies because of the health and safety of the people and environment.

GRANT SUPPORT

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CONFLICT OF INTEREST

The author declare that there is no any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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