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# Ecological and Health Risk Assessment of Heavy Metals Contamination Solid Waste Dumpsite Soil in Igando, Lagos State

**[1*]Chioma Vivian Abiaziem, [1]Sosanya Peter, & [1]Islamiyat Adenike Ojelade**
[1]Department of Science Laboratory Technology, The Federal Polytechnic Ilaro
**Corresponding Author:** chioma.abiaziem@federalpolyilaro.edu.ng

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## Abstract

*Indiscriminate disposal of municipal solid wastes poses serious risk of pollution in the neighboring soils. Hence, this work targeted to determine the ecological and health risk assessment of some designated heavy metals; As, Cd, Cr, Cu, Pb, Zn, Ag and V in solid waste dumpsite in Igando. Five soil samples were collected from different points of the study site while the control sample was collected about 1 km away from the study site from a depth of 0-15 cm. The sample was digested using 3:1 ratio of $HNO_3$ and HCl and was analyzed using inductively coupled plasma-optical emission spectrophotometer (ICP-OES). The mean concentration of the heavy metals recorded in the soil samples were; 20.09 ± 35.97 Cd, 38.17 ± 24.83 Cr, 42.06 ± 50.41 Cu, 57.40 ± 40.93 V, 63.24 ± 37.60 As, 161.57 ± 145.8 Pb and 1865.7 ± 24 mg/kg for Zn, respectively, silver was not detected. Pb and Zn were exceeding the tolerable limits reported by WHO while other metals were within the WHO limits. The ecological risk assessments; contamination factor, degree of contamination, geo-accumulation index, pollution load index, and the ecological risk index were calculated and was indicated to be low contamination aside for Zn whose concentration was moderate risk; the health risk assessment which includes average daily dose through ingestion, inhalation and dermal, hazard quotient, hazard index and cancer risk were also calculated and it indicated a low risk of contamination. Hence, there is a necessity for continuous checking and sanitizing of the dumpsite before using the dumpsite for water and agricultural purposes.*

**Keywords:** Carcinogenic, contamination, health risk, heavy metals, ecological risk, solid waste

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## Introduction

Metals with a specific gravity of more than 5g/cm are referred to as heavy metals. Chromium, lead, cadmium, Copper, nickel, mercury, and iron are the most prevalent heavy metals. If they are present in low concentrations, certain heavy metals, such as iron and nickel, are necessary for the survival of all forms of life (Leah & Johnny, 2014). However, even in low concentrations, heavy metals like lead, cadmium, and mercury are poisonous to living things. They also abnormally affect an organism's metabolic processes, especially in higher doses (Manahan, 2001). Auto repair shops, chemical factories, building weathering and pavement surfaces, urban effluents, pesticides, fertilizers, pharmaceuticals, batteries, and tyre wear particles are anthropogenic sources of heavy metals (Wei & Jiang, 2010). The chemical make-up of the waste, its physical attributes, the type of vegetables grown, and the degree of ingestion all have an impact on the health concerns. By way of inhalation, eating, and manual handling, heavy metals from the polluted soils reach the plants and then eventually the tissues of people (Ekere et al., 2020). The metals can attach to crucial biological elements including structural proteins and prevent them from working properly. Extended exposure to heavy metals can lead to cancer; affects the central and peripheral nervous system (Ekere et al., 2020)

The Igando solid waste dumpsite is well for the disposal of solid/metropolitan waste. The dumpsite is located close to residential areas with the leachates running into underground water. The procedures of improper disposal of hazardous parts contaminates the environment as an upshot of the discharge of heavy metals and other toxic substances into the Igando dumpsite posing human and ecological risk (Vincent, Klaus, Sampson, Doris & Benjamin, 2018). However, there is very little known about the contamination and health risk related with heavy metals measured from Igando.

Heavy metals such as arsenic, lead and mercury that do not have any identified natural purposes, while chromium, manganese and iron among others which have organic function to life entities but could be harmful when the permissible limits go beyond. Most heavy metals have the ability to persist in the environment for long period of time. Human health risk assessment factors have been used to determine whether the exposure to heavy metals on solid waste dumpsite soil could cause adverse effect to both adults and children. Thus, this study estimated the ecological risk assessment consisting of the degree of contamination, contamination factor, pollution index, geo accumulation index and ecological risk index while the human risk assessment constitute of the average daily dose through ingestion, inhalation and dermal, hazard quotient, hazard Index and cancer risk.

Hence, this work was meant to evaluating the levels of arsenic, chromium, cadmium, copper, vanadium and zinc around solid waste dumpsite in Igando, Lagos using ICP-OES and assessing the ecological and health risk of these metals in both adults and children.

## Materials and Methods

### Area of Study

Igando is a suburb area of Alimosho Local Government Area of Lagos State South-west, Nigeria at 6º 53′ 59° N, 3º 24′ 83° E in the South of the area; it has a longitude of 3° 15' 0" E and latitude of 6° 32' 60" N. The solid waste dumpsite at Igando is around residential areas and business offices. Due to lack of strict legislation and regulation, these solid wastes are indiscriminately disposed at the dumpsite releasing heavy metals and other contaminants into the environment in large quantities via leachate.

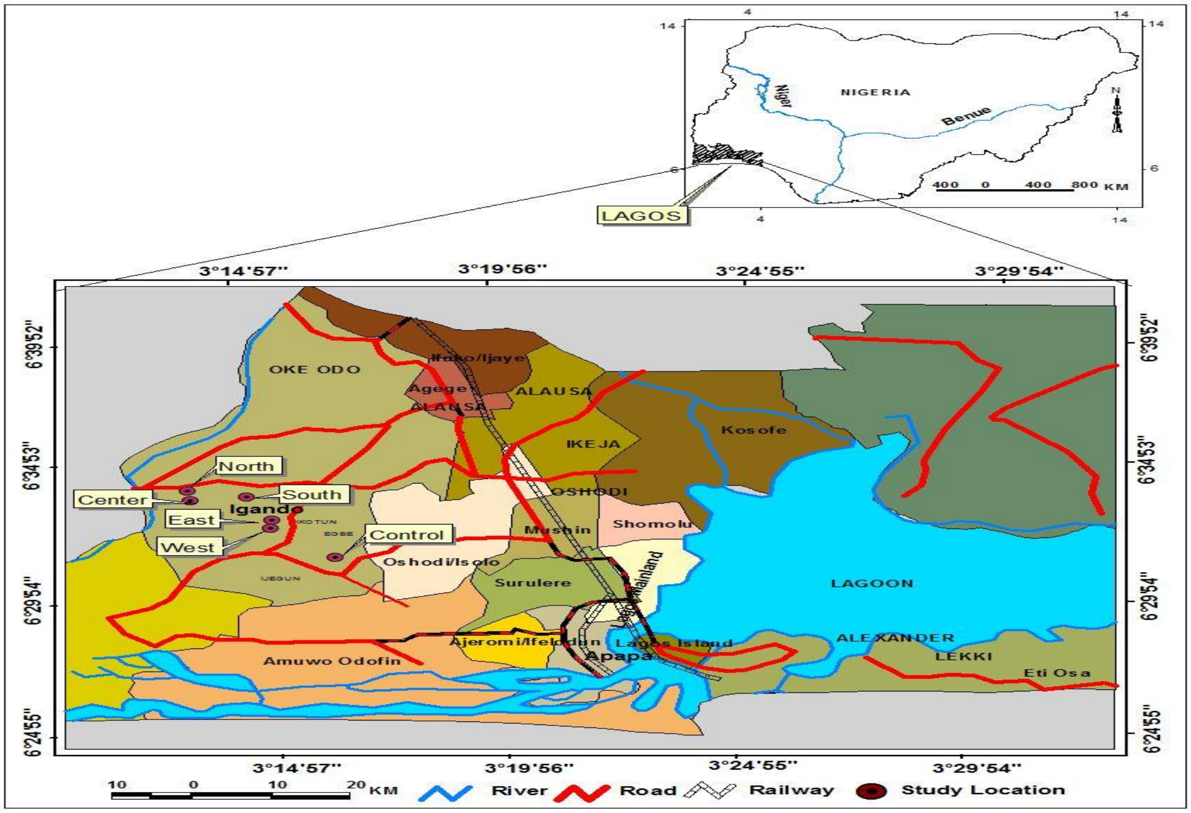


Figure1: Map of sample location in Igando, Lagos State

**Collection and Treatment of Sample**

Soil samples were collected at the main point and designated distance of 100 m apart from East, West, North and South around the dumpsite using a measuring tape. The control soil sample was taken at about 1 km away from the study site. The identified soils were sampled using a hand trowel at 0-15 cm soil depths. The samples were kept in a polyethylene bag and labeled accordingly. The soil samples were further air-dried at 25$^{o}$C for 7 days in the research lab, crushed with mortar and pestle and passing through 2 mm sieve mesh. All reagent used were of analytical grade and from which standard solutions were prepared, apparatus were thoroughly washed with detergent and cleaned with deionized water.

**Sample Digestion**

According to Environmental Protection Agency (EPA) 3050B method, 1 g each of the treated soil sample was measured and conveyed into a beaker, 1:3 ratio of nitric acid and hydrochloric acid were added. The digestion was done on a heating block in a fume cupboard with the temperature not beyond 90$^{o}$C for about an hour. The beakers were left to cool and 2 mL of hydrogen peroxide was put into different beaker and heated for 10 minutes. After digestion was completed, the digested volume of each sample was measured. About 10 mL of ultra-pure deionized water was added into 0.5 mL of the digest and the digestate was filtered. Designated metals such as; As, Cd, Cr, Cu, Pb, V, Ag and Zn were determined from the filtrate using ICP-OES Agilent 720 ICP-OES.

**Ecological Risk Assessment Parameters**

**Ecological Risk Factor (ERF)**

To evaluate the ecological effects of human activity and protect the ecosystem, an ecological risk assessment is conducted. Using the following equation, the ecological risk factor quantifies the possible ecological risk of a specific pollutant:

$$Erf = Tr \times CF \qquad (1)$$

Where Erf is the ecological risk factor, Tr is the toxic-response factor for a given substance and CF is the contamination factor (Romaric et al, 2019).

**Contamination Factor (CF)**

This is a quantitative measure used to define the concentration trend of metals in soil. It is expressed by;

$$CF = \frac{Cm}{Bm} \qquad (2)$$

Where Cm is the mean concentration of metal M in soil and Bm is the background concentration (value) of metal M, taken from literature. Cf < 1 indicates low contamination; 1 < Cf < 3 indicates moderate contamination; 3 < Cf < 6 indicates considerable contamination; Cf> 6 indicates very high contamination (Isaac, Timi & Erepamowei, 2018).

**Degree of Contamination (DegC)**

Degree of contamination was obtained by applying the equation:

$$DegC = \sum_{i=1}^{n} Cf \qquad (3)$$

Where Cf signifies a one element index which shows contamination of a single element, n is the number of analyzed heavy metals. DegC values are characterized as follows: DegC<8, low degree of contamination; 8<= DegC, moderate degree of contamination; 16 <= DegC < 32, high degree of contamination; Deg>32; very high degree of contamination (Hakanson, 1980).

**Geo accumulation Index (Igeo)**

The geo-accumulation index (Igeo), as described by Lokeshwari and Chandrappa in 2006, has been extensively utilized to gauge the level of heavy metals pollution in both land and water ecosystems.

$$Igeo = In\ (Cm / 1.5 \times Bm) \qquad (4)$$

Cm stands for the average amount of heavy metal in soil, Bm for background concentrations, and 1.5 for potential variations in background levels brought on by lithological differences. Igeo is sub divided into seven descriptive categories: 0 = Unpolluted, 0-1 = from Unpolluted to Moderately Polluted, 1-2 = Moderately Polluted, 2-3 = from Moderately to Strongly Polluted, 3-4 = Strongly Polluted, 4-5 = from Strongly to Extremely Polluted, and >6 = extremely Polluted (Lokeshwari & Chandrappa, 2006).

**Pollution Load Index (PLI)**

The assessment of pollution load index (PLI) of dumpsite soil was achieved with the expression:

$$PLI = N\ \sqrt{(Cf1 \times Cf2 \times Cf3 \times \ldots\ldots\ldots\ldots Cfn)} \qquad (5)$$

Where n is the number of heavy metals under investigation and Cf is the contamination factor for each metal determined by ratio of the concentration of each heavy metal in soil to the concentration of each metal in background soil. A PLI value larger than 1 is regarded as polluted, whereas one less than 1 is regarded as unpolluted.

**Health Risk Assessment Parameters**

A health risk valuation was carried out to evaluate the category and extent of the exposure likened to the chemical elements existing in soil. The chronic daily intakes (CDI) through the three pathways were estimated.

**Ingestion of Soil**

$$CDI = (Cs \times IRs \times EF \times ED) / (BW \times AT) \qquad (6)$$

**Dermal Contact with Soil**

CDI = (Cs x SA x FE x AF x ABS x EF x ED)/(BW x AT) (7)

**Inhalation of Particulates Emitted from Soil**

CDI = (Cs x PEF x IN x EF x ED) / (BW x AT) (8)

Where SA is the exposed skin surface area, FE is the dermal exposure ratio, AF is the soil to skin adherence factor, ABS is the dermal absorption factor, PEF is the particulate emission factor, IN is the inhalation rate, EF is the exposure frequency, ED is the exposure duration, BW is body weight, and AT is the average time of exposure. Where Cs is the concentration of the heavy metal in soil.

**Hazard Quotient (HQ)**

HQ = CDI / RfD (9)

Where CDI is the total chronic daily intake of a toxic substance conveyed in mg/kg/day from diverse paths, i.e., soil, water, subcutaneous, and air, and RfD is the chronic reference dose for the toxic substance stated in mg/kg/day, the non-cancer hazard quotient is a unitless number which is expressed as the possibility of a distinct having to suffer an adversative effect..

**Hazard Index (HI)**

The hazard index (HI) was designed to evaluate non-carcinogenic risk from the total paths.

HI = ∑HQingestion + HQinhalation + HQdermal (10)

**Cancer Risk**

The carcinogenic risk (CR) was assessed applying the equation.

$$LADD_{inh} = \frac{C \times ExFr}{PEF \times AT} \times \left(\frac{R_{InhChld} \times ED_{Child}}{BW_{Child}} + \frac{R_{InhAdults} \times ED_{Adults}}{BW_{Adults}}\right) \quad (11)$$

CR = $LADD_{Inh}$ × CSF (12)

Where CSF is the cancer slope factor of a metal (Ismiat et al., 2019).

## Results and Discussion

### Mean Concentration of Heavy Metals

The detailed standards of metal at Igando solid dumpsite are presented in Table 1 This study shows that zinc was the highest in concentration with the value of 340.76 mg/kg followed by vanadium (101.11 mg/kg), chromium (66.19 mg/kg), lead (65.89 mg/kg), arsenic (55.76 mg/kg), copper (2.74), cadmium (0.54) and silver which is not detected. The highest level of zinc could be attributed to organic waste; zinc concentration of control sample was also high and reported to be 1865.7 mg/kg. This result was in accordance to the study done by Lawan et al., (2012) but lower the findings done by Leah and Jonny, 2014. The mean concentration of vanadium was reported to be 57.40±40.93 mg/kg. There was variance between the level of concentration in the dumpsite soil and the control sample which was recorded to be 367.36 mg/kg and lower than the concentration of the dumpsite soil due to the presence of oil refining, mining, combustion of coal. Presence of vanadium in the soil is due to weathering of rocks. The result indicated high toxicity.

The mean concentration of chromium was recorded to be 38.17±24.83 mg/kg. There are variance between the levels of Cr in the dumpsite soil and the control sample which was recorded to be 126.47 mg/kg (high toxicity). This is a clear indication of build up or buildup of heavy metals in the control sample which could be due to the presence of electronic waste. However, chromium level in this work was greater related to that reported by Oladuni et al., (2013).

The mean concentration of lead was reported to be 65.89 mg/kg. There was a huge variance between the levels of lead in the dumpsite soil and the control sample which was reported to be 253.86 mg/kg. This could be attributed to the indiscriminate dumping of waste materials comprising of batteries, food packaging materials and Polyvinylchloride materials (PVC) (Twumasi et al., 2016). This study goes in line with the study done by Nwankwoala & Ogbonna (2013) who reported lead concentration to be at the series of 50 to 300 mg/kg.

**Table 1: Mean concentration of heavy metals in soil (mg/kg)**

| HM | South | North | East | West | Center | Mean/SD | Control |
|---|---|---|---|---|---|---|---|
| Cd | 83.33 | 0.54 | 0.56 | 0.21 | 15.84 | 20.09 ± 35.97 | 3.35 |
| Cr | 56.78 | 66.19 | 34.32 | 2.54 | 31.02 | 38.17 ± 24.83 | 126.47 |
| As | 73.64 | 55.76 | 94.29 | 1.81 | 90.71 | 63.24 ± 37.60 | 34.78 |
| Pb | 270.69 | 65.89 | 112.21 | 5.14 | 354.48 | 161.57 ± 145.8 | 17.62 |
| V | 84.52 | 101.11 | 24.76 | 4.68 | 71.93 | 57.40 ± 40.93 | 367.36 |
| Cu | 117.57 | 2.74 | 70.96 | 2.34 | 69.66 | 42.06± 50.41 | 2.33 |
| Ag | ND. | ND. | ND. | ND. | ND. | ND. | ND. |
| Zn | 6031.9 | 340.76 | 760.39 | 39.58 | 2155.9 | 1865.7 ± 2466 | 253.86 |

Note: HM = Heavy Metals, ND = Not detected, SD = Standard Deviation

The mean concentration of arsenic was reported to be 55.76 mg/kg. There are slight variance between the levels of arsenic in the dumpsite soil and the control, sample which was reported to be 34.78 mg/kg. Presence of arsenic in soil may be due to the disposal of electronic appliances that are dumped in the soil.

The mean concentration of copper was recorded to be 2.74 mg/kg. There was a slight variance between the levels of copper in the dumpsite soil and the control sample, which was reported to be 2.33 mg/kg. Presence of copper in the site could be a sign of the migration of leachate rich in copper into the nearby soils. The average level of cadmium was recorded to be 0.54 mg/kg and the control sample was recorded to be 3.55 mg/kg. Presence of cadmium in the soil may be due to leachate.

**Ecological Risk Assessment**

**Contamination Factor (CF):** The values of the contamination factor are presented in Table 3. Cadmium, chromium, arsenic, lead, copper and vanadium were; 0.08, 0.13, 0.22, 0.55, 0.15 and 0.19, respectively, which is within the classification; CF < 1 signifying low contamination, whereas, zinc was reported to be 6.25 which indicates high contamination which may be due to the presence of zinc materials dumped in the soil, silver was not detected. In the control sample, the contamination factor detailed for cadmium, chromium, arsenic, zinc, lead, copper and vanadium were; 3.96, 1.49, 4.11, 0.05, 2.99, 2.76 and 2.09 respectively. The high values of the control sample compared to the sample site could be due to presence of these elements from anthropogenic activities at the control sample site These values indicates moderate contamination and silver was not detected which may be due to no presence of silver materials in the soil.

**Degree of Contamination (DC):** The degree of contamination ranged from DC < 8 (low risk), 8 ≤ DC < 16 (moderate risk), 16 ≤ DC< 32 (considerable risk), CD > 32 (very high risk) according to Bhutiani et al., (2017). Table 2 showed that both the values of the dumpsite sample and the control sample indicated low risk contamination aside for zinc in both dumpsite sample and control sample which indicated moderate risk.

**Table 2: Degree of Contamination (DC)**

| HM | DS | Summary | CS | Summary |
|---|---|---|---|---|
| Cd | 0.08 | Low risk | 3.96 | Low risk |
| Cr | 0.13 | Low risk | 1.49 | Low risk |
| As | 0.22 | Low risk | 4.11 | Low risk |
| Pb | 0.55 | Low risk | 2.99 | Low risk |
| V | 0.19 | Low risk | 2.09 | Low risk |
| Cu | 0.15 | Low risk | 2.76 | Low risk |
| Ag | ND | ND | ND | ND |
| Zn | 6.25 | Moderate risk | 0.05 | Low risk |

HM = Heavy metals, DS = Dumpsite Sample, CS = Control Sample

**Geo-accumulation index (Igeo):** The values of the geo-accumulation index are presented in Table 3. The Igeo value recorded for chromium was 3.49, 3.16, 2.76, 1.37 and 2.23 for copper, vanadium, lead and zinc, respectively, the result was as; 2<Igeo< 3 which signifies that the study area was moderately to heavily polluted. Arsenic was recorded to be -2.76 and cadmium -4.36 indicating that the site was not polluted with arsenic and cadmium. While values for all the control samples were recorded to be negative, this indicated that the soil was unpolluted with the heavy metals. These results were in accordance to Odukoya (2015) who reported moderate to heavily polluted for abandoned dumpsites in Lagos.

**Ecological risk index (ERI)**: ERI values are presented in Table 4. The ERI value for cadmium was recorded to be 602.7, 76.34, 632.4, and 807.85, respectively. Copper and zinc were found to be; 210.3 and 1865.7, respectively, indicating extremely high contamination. Vanadium and silver were not detected indicating low contamination. While the control samples were recorded to be; 100.5, 252.94, 347.8, 88.1, 11.65 and 253.86 for cadmium, chromium, arsenic, lead, copper and zinc, respectively, which indicated extremely high contamination. This could be due to anthropogenic activities at the control site.

**Table 3: Geo-accumulation index (Igeo)**

| HM | DS | CS |
|---|---|---|
| Cd | -4.36 | -6.92 |
| Cr | 3.49 | -1.69 |
| As | -2.76 | -3.63 |
| Pb | 1.37 | -4.36 |
| V | 2.76 | -0.17 |
| Cu | 3.16 | -7.48 |
| Ag | ND | ND |
| Zn | 2.23 | -0.69 |

HM = Heavy metals, DS = Dumpsite Sample, CS = Control Sample

**Table 4: Ecological Risk Index (ERI)**

| HM | DS | CS |
|---|---|---|
| **Cd** | 602.7 | 100.5 |
| **Cr** | 76.34 | 252.94 |
| **As** | 632.4 | 347.8 |
| **Pb** | 807.85 | 88.1 |
| **V** | ND | ND |
| **Cu** | 210.3 | 11.65 |
| **Ag** | ND | ND |
| **Zn** | 1865.71 | 253.86 |

HM = Heavy metals, DS = Dumpsite Soil, CS = Control Sample

**Health Risk Assessment**

Average Daily Dose for all the exposure route (Ingestion, dermal and inhalation) were presented in Table 5. **Ingestion values** for adults were recorded as follows; 27.5E-6, 52.2E-6, 84.2E-6, 221.3E-6, 78.6E-6, 57.6E-6 2555.7E-6, for cadmium, chromium, arsenic, lead, vanadium, copper, zinc, respectively, indicating low contamination which was less than 1. Silver was not detected. Thus, ingestion values for children were also less than 1 indicating low contamination. This report was in line with the study done by Vincent et al. (2018) on informal e-waste in Ghana; they reported that the average daily ingestion to be of low contamination owing to the low contamination of heavy metals present in the work site.

**Inhalation values** for adults were recorded as follows; 5.5E-6, 10.4E-6, 17.3E-6, 44.3E-6, 15.7E-6, 11.5E-6, and 511.2E-6; for cadmium, chromium, arsenic, lead, vanadium, copper and zinc respectively, indicating low contamination, indicating below the USEPA guide level of HI<1. However, silver and zinc were not found. The values for the control samples were below the reference dose value and also indicated low contamination. Inhalation values for children were also less than 1 indicating low contamination. These shows that, there were no-non carcinogenic risks after the selected metals in both adults and children; this assertion was similar to that reported by (Shahla et al., 2021).

**Dermal values** for adults were recorded as follows; 0.8E-6, 1.7E-6, 2.4E-6, 6.2E-6, 2.2E-6, 4.6E-6 and 71.5E-6, for cadmium, chromium, arsenic, lead, vanadium, copper and zinc, respectively, indicating low contamination, which was less than 1, whereas silver was not detected. The control samples were below the reference dose values and also indicated low contamination whereas silver was not detected. For children, the values were also less than 1 signifying low contamination.

**Table 5: Average daily dose (ingestion, inhalation and dermal) of heavy metals concentration in adult and children of Igando dumpsite**

| HM | MC | $ADD_{ing}$ | $ADD_{inh}$ | $ADD_{derm}$ | $ADD_{ing}$ | $ADD_{inh}$ | $ADD_{derm}$ |
|---|---|---|---|---|---|---|---|
| | | | Adult | | | Children | |
| **Cd** | 20.09 | 27.5E-6 | 5.5E-6 | 0.8E-6 | 256.9E-6 | 9.8E-6 | 7.3E-6 |
| **Cr** | 38.17 | 52.2E-6 | 10.4E-6 | 1.7E-6 | 486.9E-6 | 18.6E-6 | 13.9E-6 |
| **As** | 63.24 | 84.2E-6 | 17.3E-6 | 2.4E-6 | 808.6E-6 | 30.7E-6 | 23.1E-6 |
| **Pb** | 161.57 | 221.3E-6 | 44.3E-6 | 6.2E-6 | 2065.8E-6 | 78.5E-6 | 58.9E-6 |
| **V** | 57.40 | 78.6E-6 | 15.7E-6 | 2.2E-6 | 733.9E-6 | 0.03E-6 | 20.9E-6 |
| **Cu** | 42.06 | 57.6E-6 | 11.5E-6 | 4.6E-6 | 537.8E-6 | 20.5E-6 | 15.3E-6 |
| **Ag** | ND | ND | ND | ND | ND | ND | ND |
| **Zn** | 1865.71 | 2555.7E-6 | 511.2E-6 | 71.5E-6 | 23853E-6 | 906.5E-6 | 679.9E-6 |

HM = Heavy metals, MC = Mean Concentration, $ADD_{ing}$= Average Daily Dose Ingestion, $ADD_{inh}$= Average Daily Dose Inhalation, $ADD_{derm}$= Average Daily Dose Dermal.

**Hazard quotient (HQ):** The hazard quotient value was presented in Table 6. All the heavy metals in this study indicated low contamination for both adult and children aside for arsenic and lead that was 2.69 and 5.91 respectively, at ingestion of soil for children. Silver was not detected. A similar report was represented by Vincent et al. (2018) on e-waste in Ghana, indicating a moderate contamination of some heavy metals in the study site due to low activities on the site.

**Hazard Index (HI):** These values are presented in Table 8 for both adult and children. The adult values indicated no adverse effect (HI < 1) as indicate by USEPA (2001). Whereas, the children values were also in the same trend as the adult except for arsenic and lead that were reported to be 2.88 and 6.31 respectively, indicating moderate contamination and extremely high contamination. Silver was not detected, this could be attributed to the presence of arsenic or lead materials disposed in the soil and it could also be as a result of leachate. Therefore, proper investigation should be done so as to control the levels of arsenic and lead in the soil.

**Table 6: Hazard Quotient of heavy metals concentration for Adult and Children**

| HM | $HQ_{ing}$ | $HQ_{inh}$ | $HQ_{derm}$ | $HQ_{ing}$ | $HQ_{inh}$ | $HQ_{derm}$ |
|---|---|---|---|---|---|---|
| | | Adult | | | Children | |
| **Cd** | 0.03 | 4.24E-3 | 6.0E-4 | 0.19 | 7.52E-3 | 5.64E-3 |
| **Cr** | 0.02 | 3.17E-3 | 4.46E-6 | 0.15 | 5.63E-3 | 3.99E-3 |
| **As** | 0.28 | 0.06 | 8.1E-3 | 2.69 | 0.11 | 0.08 |
| **Pb** | 0.64 | 0.13 | 0.02 | 5.91 | 0.23 | 0.17 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **V** | 0.02 | 2.25E-3 | 3.16E-4 | 0.11 | 4.28E-6 | 2.98E-3 |
| **Cu** | 1.56E-3 | 3.11E-3 | 1.25E-4 | 0.02 | 5.51E-4 | 4.13E-4 |
| **Ag** | ND. | ND. | ND. | ND. | ND. | ND. |
| **Zn** | 7.75E-3 | 1.55E-3 | 2.17E-4 | 0.08 | 2.75E-3 | 2.07E-4 |

HM = Heavy metals, $HQ_{ing}$= Hazard Quotient Ingestion, $HQ_{inh}$= Hazard Quotient Inhalation, $HQ_{derm}$= Hazard Quotient Dermal.

**Table 7: Hazard Index of heavy metals concentration for Adult and Children**

| HM | HI Adult | HI Children |
|---|---|---|
| **Cd** | 0.04 | 0.21 |
| **Cr** | 0.03 | 0.16 |
| **As** | 0.35 | 2.88 |
| **Pb** | 0.79 | 6.31 |
| **V** | 0.73 | 0.12 |
| **Cu** | 0.004 | 0.02 |
| **Ag** | ND | ND |
| **Zn** | 0.009 | 0.09 |

HM = Heavy metals, HI = Hazard Index

**Cancer risk (CR)**: The cancer risk values were presented in Table 8 for both adult and children. All the values reported were low risk (CR<1), they were below the USEPA (2001). Hence, the soil is safe from cancer for both adults and children. A related outcome was stated by Vincent et al. (2018) and Ismat et al. (2019) who specified cancer risk to be of low value which may be due to low activities of the heavy metals assessed at the dumpsite.

**Table 8: Cancer risk of heavy metals concentration for Adult and Children**

| CM | Adult | Children |
|---|---|---|
| **Cd** | 4.3E-6 | 8.9E-5 |
| **Cr** | 0.233 | 2.2E-8 |
| **As** | 0.014 | 1.1E-7 |
| **Pb** | 4.0E-7 | 1.6E-6 |

HM = Heavy Metals

## Conclusion

The indiscriminate disposal of solid waste in Igando area of Lagos has led to the discharge of high amounts of heavy metals in the immediate soil. This study assessed the ecological and health risk of heavy metals around solid waste dumpsite in Igando Lagos State. From the six samples collected, heavy metals concentrations were measured, contamination factor, degree of contamination, geo accumulation index, pollution load index and ecological risk index were estimated and they were within the acceptable limits recommended by WHO. More so, the health risk assessment which are the average daily dose (ingestion, inhalation and dermal), hazard quotient, hazard index and cancer risk were calculated for each of the metals and indicated low contamination for both adults and children.

Soil around this waste dumpsite could be recycled for agricultural purposes on condition that the risk of ecotoxicology is properly considered, and land reclamation events embarked upon. Therefore, the Lagos State Government should advance stringent waste disposal guidelines to avert the unpleasant approach of the public in regards to waste disposal and fencing of dumpsites should also be encouraged.

## References

Bhutiani, R., Kulkarni, D. B., Khanna, D. R., & Ashutosh, G. A. (2017). Geochemical Distribution and Environmental Risk Assessment of Heavy Metals in Ground water of an Industrial Area and its Surroundings in India. *Energy Ecological Environment, 2*(2), 155-167.

Dirisu, C. E., Biose, E., & Aighewi, I. T. (2019). Heavy Metal Contamination of Ewhare Dumpsite Environment in Niger Delta, Nigeria. *SCIREA Journal of Environment, 3*(2), 30-45.

Ekere, N. R., Ugbor, M. C., Ihedioha, J. N., Ukwueze, N. N., & Abugu, H. O. (2020). Ecological and Potential Health Risk Assessment of Heavy Metals in Soils and Food Crops Grown in Abandoned Urban Open Waste Dumpsite. *Journal of Environmental Health Science and Engineering*, *18*(7), 11–721.

Hakanson. L. (1980). An Ecological Risk Index for Aquatic Pollution Control, A Sedimentological Approach. *Water Resources Journal, 14*(18), 975-1001.

Isaac, U., Timi, T., & Erepamowei, Y. (2018). Assessment of Heavy Metal Pollution in Soils within and around some Municipal Solid Waste Dumpsites in Sapele Town, Delta State, Nigeria Department of Chemical Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, PMB 71, Yenagoa, Bayelsa State. *International Journal of Agriculture, Environment and Bioresearch*, *3*(6), 2-15.

Ismat, H. A., Saifeldin, E. S., & Abubakr, M. I. (2019). Contamination and Human Health Risk Assessment of Heavy Metals in Soil of a Municipal Solid Waste Dumpsite in Khamees Mushait, Saudi Arabia. *Journal of Toxin Review*, *2*, 1-25.

Lawan, I. B., Stephen, S. H., Goni, A. D., & Muhammad, T. (2012).Study of Vertical Migration of Heavy Metals in Dumpsites Soil. *ARPN Journal of Science and Technology*, *2*(2), 340-345.

Leah, A. S., & Johnny, A. C. (2014). Heavy Metal Concentration of Dumpsite Soil and Accumulation in *Zea Mays* (Corn) Growing in a Closed Dumpsite in Manila, Philippines. *International Journal of Environmental Science and Development, 5*(1), 1-2.

Lokeshwari, H., & Chandrappa, G. T. (2006). Impact of Heavy Metal Contamination of Belladur Lake in Soil and Cultivated Vegetables. *Current Science Journal, 91*(5), 150-157.

Manahan, S. E. (2001). Fundamentals of Environmental Chemistry, 2nd Edition CRC Press, Limited Liability Company (LLC) Boca Ralton, Florida. p. 853-861.

Nkop, R. E. J., Ogunmolasuyi, A. M., Osezua, K. O., & Wahab, N. O. (2016). Comparative Study of Heavy Metals in the Soil around Waste Dumpsites. *Applied Science Resources Journal, 8*(3), 11-15.

Nwankwoala, H., & Ogbonna, V. (2013). Water Quality Surveillance of Boreholes Around

Landfill Site in Eligbolo-Eliozu, Obio/Akpor Local Government Area, Rivers State, Nigeria. *Journal of Environmental Toxicology, 2,* 29-34.

Odukoya, A. M. (2015). Contamination Assessment of Toxic Elements in the Soil within and Around Two Dumpsites in Lagos, Nigeria. *Ife Journal of Science, 17*(2), 351-361.

Oladunni, B. O., Tejumade, A., & Otolorin, A. O. (2013). Heavy Metal Contamination of Water, Soil and Plants around an Electronic Dumpsite, Nigeria. *Pollution Journal of Environmental Studies, 22*(5), 1431-1439.

Shahla, K., Sakine, S. & Gholamreza, M. (2021). Health and Ecological Risk Assessment and Simulation of Heavy metal-contaminated Soil of Tehran landfill. *Royal Society of Chemistry Advances, 14*: 8080-8095.

Twumasi, P., Tandoh, M. A., Borbi, M. A., Ajoke, A. R., Owusu-Tenkorang, E., Okoro, R., & Dumevi, R. M. (2016). Assessment of the Levels of Cadmium and Lead in Soil andVegetable Samples from Selected Dumpsites in the Kumasi Metropolis of Ghana. *African Journal of Agricultural Resources, 11*, 1608-1616.

USEPA (US Environmental Protection Agency). (2001). Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. *93*(55), 4-24.

Uzoekwe, A. S., & Richard, G. (2020). Level and Ecological Risk Assessment of Heavy Metals in Old Landfill in Bayelsa State, Nigeria. *Journal of Environmental Chemistry and Ecotoxicology, 12*(1), 2-6.

Vincent, N. K., Klaus, G., Sampson, M. A., Doris, A., IJ, K. A., & Benjamin, S. C. (2018). Contamination and Health Risk Assessment of Exposure to Heavy Metals in Soils from Informal E-Waste Recycling Site in Ghana. *Emerging Science Journal, 2*(6), 16.

Vinod, J., Jeevan, S. S., & Natalija, M. (2014). Assessment of Geo-accumulation Index of Heavy Metal and Source of Contamination by Multivariate Factor Analysis. *International Journal of Hazardous Materials, 2*(2), 18-22.

Wei, B., & Jiang, F. (2010). Heavy Metals Induced Ecological Risk in the City of Urunqi, China.*Environment Monitoring Assessment Journal, 160,* 33-45.

WHO., FAO., & IAEA. (1996). Trace Elements in Human Nutrition and Health. World Health Organization. Geneva, Switzerland. 6-10.