# Surface Soil Pollution By Heavy Metals: A Case Study Of Two Refuse Dumpsites In Akure Metropolis

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**ABSTRACT:** Heavy metals can be harmful to the biota and human beings when present above certain tolerable levels in the ecosystem. This lead to the study of the accumulation, contamination and pollution of these metals in soils of two refuse dumpsites within and outskirts of Akure Township, capital city of Ondo State, Nigeria. The dumpsites are where wastes such as industrial wastes, automobile wastes, municipal wastes, agricultural wastes, etc were dumped. At each site, soil samples were collected randomly from nine different points of about 1m part at depth of about 0-30cm and analyzed for heavy metals and pH. The metals analyzed include Zn, Fe, Co, Cu, Ni, As, Ba, Pb, Cr and Cd using Atomic Absorption Spectrophotometer (AAS) with HF/Aqua regia wet digestion method. The pH of the soils ranged between 7.49 and 8.66. The results revealed heavy metal presence and implicated wastes as the major sources of the heavy metals in the soils of the dumpsites. All the metals were detected in all the soil samples except Arsenic that was not detected in three points at site A. Fe had the highest concentrations, while Ni had the least concentration in both sites. The trend in concentration was Fe > Zn >Pb> Cu> Cd> Co> Cr >As>Ba>Ni in site A, While the trend in concentration was Fe> Cr> Zn> Cu >Pb>Cd> Co> As > Ba> Ni in site B. The mean metal concentrations were compared with Department of Petroleum Resources (DPR) Standard values for soils in Nigeria, all the metals except Cr and Cu are below the DPR target values while Cd and Arsenic are above the DPR intervention values for the two sites, and this calls for immediate remediation.

**Keywords:** Contamination,Dumpsites, Ecosystem,Heavy metals,Pollution, Remediation, Surface soil, Wastes.

## INTRODUCTION

Heavy metals are individual metals and metal compounds that can impact human health. These are all naturally occurring substances which are often present in the environment at low levels. In larger amounts, they can be dangerous;generally, humans are exposed to these metals by ingestion (drinking or eating) or inhalation [1]. The major sources of heavy metal pollution in urban areas of Africa are anthropogenic, while contaminations from natural sources predominate in the rural areas. Anthropogenic sources of pollution include those associatedwith fossil fuel and coal combustion, industrial effluents, solid wastedisposal, fertilizers and mining and metal processing. At present, the impact of these pollutants is confined mostly to the urban Centre's with largepopulations, high traffic density and consumer-oriented industries. Natural sources of pollution include weathering of mineral deposits, bush burning and windblown dusts [2]. Commonly encountered heavy metals are chromium, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, antimony, mercury, thallium and lead. More specific definitions of a heavy metal have been proposed; none have obtained widespread acceptance [3].Criteria used to define heavy metals have included density, atomic weight, atomic number, or periodic table position [4]. Density criteria range from above 3.5 $g/cm^3$ to above 7 $g/cm^3$. The occurrence and activities of heavy metals on soil, vegetation and the environment has been reported by many workers [5], [6], [7], [8], [9], [10], [11], [12]. This paper describes the effect of municipal refuse dump on surface soil and also evaluates the extent of pollution of the surface soil of the dumpsites by heavy metals.


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## MATERIALS AND METHODS

### Sample collection and preparation

The soil samples used for this study were collected in the year 2014 from two different refuse dumpsites located at two different extremes of Akure Town, the Ondo State capital in Nigeria. At each site, nine different points were randomly chosen for sampling at about 1 meter apart and soil samples were collected from each point using a standard hand auger at one depth in the soil profile of about 0-30cm. The collected soil samples were carefully transferred into black high density polyethylene bags, properly labelled and transported into the laboratory. The soil samples were air-dried for a period of two weeks in a well ventilated laboratory; the well dried samples were ground with laboratory mortal and sieved using a 212um mesh size. The sieved samples were used for the pH determination, soil moisture content and total heavy metals determination.

### Soil Moisture Content Determination

The soil moisture content was determined by the method of [13] in order to express the analytical results on dry weight basis.

### Soil pH Determination

The soil pH was determined as described by [14] method, using a digital pH meter (Jenway 3015 model).

**Total Heavy Metals Determination**

The total heavy metals concentrations were determined after wet digestion of the soil samples with a mixture of concentrated Hydrofluoric acid and Aqua regia using flame atomic absorption spectrophotometer (Buck Scientific 200 model). The mean, standard deviation and the coefficient of variation were calculated using the Statistical Package for Social Scientists (SPSS) 15.

## RESULTS AND DISCUSSIONS

Table1 shows the PH values for the two Dumpsites Soils coded as Site A and B. The pH ranged from 7.96 to 8.33 for site A, while site B pH ranged from 7.49 to 8.66. The values obtained in this measurement agreed well with pH values of between 5.79 and 8.55 obtained by [10] in his study of some soils in Akure. Soil pH ranges was given by [15]as follows;< 5.5 = strongly acidic; 5.5-5.9 = medium acidic; 6.0-6.4 = slightly acidic; 6.5-6.9 = very slightly acidic; 7.0 = neutral; 7.1-7.5 = very slightly alkaline; 7.6-8.0 slightly alkaline; 8.1-8.5 = medium alkaline; and > 8.5 = strongly alkaline. From the above pH ranges, it can be said that the dumpsite soils are alkaline. The two sites have similar pH ranges in spite of their distance apart. Soil pH is the measure of the level of acidity or alkalinity of a particular soil [15]. Table2shows the moisture content values for the two Dumpsites Soils coded as Site A and B.The moisture content ranged from 2.04 to 3.13 for site A, while site Bmoisture content ranges from 2.04 to 3.23. The results showed that the soils were very dry with minimal moisture content. Table 3 shows the mean metal concentration for site A and site B. All the metals were present in all the soils except Arsenic which was absent at three borings at site A. The content of theheavy metals in these sites would depend on the age of the site, that is, the duration of wastes disposal on each land, the type of waste disposed on each site, the volume of the waste on each site and on the geological features of the area. Table4 shows the comparism of the two dumpsites soils with that of the Department of Petroleum Resources(DPR, 2002) targets and intervention values. On comparing of the mean metal concentrations with the[16]standard values for soil, it was found that all the individual metal concentrations in site A were below the DPR target values except Cadmium and Arsenic which had higher values than the DPR targets values. Also, in site B, Copper, Arsenic, Cadmium and Chromium were above the DPR target values. As shown in Table 4, Cadmium and Arsenic were the prominent metals that recorded values higher than the DPR target and intervention values. As for these heavy metals that had attained DPR intervention values, effective soil remediation techniques must be employed to treat these polluted soils.All other heavy metals having concentrations above the DPR target values must be monitored effectively and continuously before they attain the DPR intervention values, in order to prevent further soil pollution by these metals. There was no DPR target and intervention values for iron perhaps because of its high concentration and distribution in natural or unpolluted soils. Although, when iron is present above certain concentrations, it becomes toxic to the soil plants and animals.

## CONCLUSION

The two dumpsites studied coded as site A and B in Akure had revealed that indiscriminate disposal of wastes such as Municipal wastes, industrial wastes, agricultural wastes, etc are major sources of soil contamination and pollution by heavy metals. The presence of heavy metals in the environment represents one of the most important environmental hazards. A knowledge of the total concentration of these heavy metals through soil analysis (as indicator) could be considered as a starting point for evaluating the degree of pollution as investigated in this study. The cadmium and Arsenic metals concentrations in the analyzed dumpsite soils are at a critical level, that is, they are above the DPR target and intervention values, while other metals concentrations were below the DPR target value except Copper and Chromium concentrations which were above the DPR target values at site B only. It can be concluded that Site B is more polluted than site A and that the indiscriminate disposal of wastes on these land had contributed to the increment in concentrations of these metals in the land. The high levels of Cadmium, Arsenic obtained in this study coupled with other heavy metals contamination of these soils, make the soils and its environment unsafe and unhealthy for human activities such as living, farming and grazing by animals.

## APPENDIX

**Table 1 PH of Dumpsites Soils for Site A and B.**

| Site No | pH Value | Site No | pH Value |
|---|---|---|---|
| $A_1$ | 8.19 | $B_1$ | 8.27 |
| $A_2$ | 8.15 | $B_2$ | 7.87 |
| $A_3$ | 8.31 | $B_3$ | 7.49 |
| $A_4$ | 8.09 | $B_4$ | 8.66 |
| $A_5$ | 8.18 | $B_5$ | 8.37 |
| $A_6$ | 8.33 | $B_6$ | 8.37 |
| $A_7$ | 8.08 | $B_7$ | 8.25 |
| $A_8$ | 8.18 | $B_8$ | 8.33 |
| $A_9$ | 7.96 | $B_9$ | 8.16 |
| Mean | 8.16 | Mean | 8.20 |
| StandardDeviation | 0.11 | Standard Deviation | 0.34 |
| Coefficient of Variation | 1.40 | Coefficient of Variation | 4.11 |

**Table 2 Moisture Content (%) of the Dumpsite Soils**

| Site No | Moisture content (%) | Site No | Moisture content (%) |
|---|---|---|---|
| $A_1$ | 2.04 | $B_1$ | 2.04 |
| $A_2$ | 2.84 | $B_2$ | 2.10 |
| $A_3$ | 3.07 | $B_3$ | 3.13 |
| $A_4$ | 2.94 | $B_4$ | 1.57 |
| $A_5$ | 2.86 | $B_5$ | 2.33 |
| $A_6$ | 3.13 | $B_6$ | 3.23 |
| $A_7$ | 2.37 | $B_7$ | 1.55 |
| $A_8$ | 2.93 | $B_8$ | 1.92 |
| $A_9$ | 2.12 | $B_9$ | 1.53 |
| Mean | 2.70 | Mean | 2.16 |
| Standard Deviation | 0.41 | Standard Deviation | 0.64 |
| Coefficient of Variation | 15.26 | Coefficient of Variation | 29.77 |

**Table 3 Mean Metal Concentration (mg/kg) for Site A and B.**

| | Zn | Fe | Co | Cu | Ni | As | Pb | Cd | Cr | Ba |
|---|---|---|---|---|---|---|---|---|---|---|
| Site A | 86.29 $\pm$6.95 | 213.97 $\pm$15.22 | 8.33 $\pm$7.41 | 31.34 $\pm$21.41 | 1.16 $\pm$1.33 | 6.24 $\pm$5.52 | 56.16 $\pm$16.22 | 28.56 $\pm$17.95 | 6.71 $\pm$2.96 | 5.47 $\pm$1.01 |
| Site B | 95.28 $\pm$7.30 | 185.57 $\pm$28.55 | 18.08 $\pm$13.72 | 52.48 $\pm$26.63 | 0.65 $\pm$0.26 | 5.43 $\pm$2.22 | 40.66 $\pm$9.38 | 40.17 $\pm$18.21 | 132.65 $\pm$69.10 | 4.83 $\pm$1.12 |

**Table 4 Comparing of mean metal concentrations of the sites with the DPR target and intervention values for normal soils (mg/kg)**

| Metals | Mean metal conc. In site A | Mean metal conc. In site B | DPR target values | DPR intervention values |
|---|---|---|---|---|
| Zinc | 86.29 | 95.28 | 140 | 720 |
| Iron | 213.97 | 185.57 | - | - |
| Cobalt | 8.33 | 18.08 | 20 | 240 |
| Copper | 31.34 | 52.48 | 36 | 190 |
| Nickel | 1.16 | 0.65 | 35 | 210 |
| Arsenic | 6.24 | 5.43 | 1.0 | 10 |
| Lead | 56.16 | 40.66 | 85 | 530 |
| Cadmium | 28.56 | 40.17 | 0.8 | 12 |
| Chromium | 6.71 | 132.65 | 100 | 380 |
| Barium | 5.47 | 4.83 | 200 | 5000 |

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