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ASSESSMENT OF HEAVY METALS CONCENTRATIONS IN SOILS OF SHAGAYA ESTATE DUMPSITE, ILORIN, SOUTHWESTERN NIGERIA.

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Abstract
Indiscriminate dumping of domestic wastes has been known to adversely affect the environment and ultimately the health of humans thus leading to the study of various dumpsites in Nigeria. This study was aimed at assessing the concentration of some heavy metals within the Shagaya Estate dumpsite, Ilorin, Southwestern Nigeria to determine their level of contamination and/or pollution. Twenty representative soil samples were obtained from the dumpsite at about 20cm depth, air dried, pulverized, sieved to <63μm and analyzed for concentrations of Cadmium (Cd), Lead (Pb), Mercury (Hg), Arsenic (As), Selenium (Se) using Atomic Absorption Spectrometry (AAS). The results from the analysis were compared with average crustal value to determine level of enrichment; Geo-accummulation factor (Igeo) and Contamination Factor were calculated to determine their contamination level while Pollution Index (PI) was done to understand the pollution level of these heavy metals within the study area. Concentration ranges for selected heavy metals were; Pb (14.6-77ppm), As (0.46-1.38ppm), Cd (0.04-0.13ppm), Hg (0.04-0.13ppm) and Se (0.06-0.13ppm) which revealed the concentration of heavy metals in the order of Pb <As < Cd <Hg< Se with Pb, Hg and Se having higher concentrations when compared with average crustal values; Igeo values indicated that all samples were uncontaminated with As, Cd and Hg while Pb and Se were moderately contaminated; CF calculations showed moderate contamination of Pb (2.87), Hg (1.07) and Se (2.04) while PI had a value of 2.25 indicating that the study area is currently heavily polluted. These results showed that the dumpsite is moderately contaminated and heavily polluted which is not safe as there are residential houses around the dumpsite.

INTRODUCTION

The menace of environmental pollution has been haunting the world since early times and is still growing due to increasing population and economic development in developing countries. Municipal solid waste (MSW) normally termed as "garbage" or "trash" is an inevitable byproduct of human activity especially in the Urban areas which will continue to grow with increasing human civilization (Abdul, 2009; Ogunrinola and Adepagba, 2011). In majority of countries, the smaller units do not have any specific technique of managing these wastes leading to indiscriminate dumping on land, groundwater and surface water bodies which pose a threat to both the environment as well as human health (Pattnaik and Reddy, 2009). In Nigeria, waste management is at its lowest in most cities and towns with numerous refuse heaps left unattended, recycling of waste is almost unknown while methods of collection and final disposal are very unsatisfactory.The alarming rate at which heaps of solid waste continue to occupy cities, coupled with the fact that 87% of Nigerians use disposal method adjudged unsanitary, has not only contributed to visual blight and odor, but has also encouraged the breeding of rodents, mosquitoes, and other pests raising serious concerns over public health (Odukoya 2015). This could also lead to introduction of heavy metals into the environment beyond acceptable limit which could be toxic to both humans and animals (Caylak and Tokar, 2012). It is therefore imperative to study the impact of this indiscriminate dumping on the environment and humans by assessing the heavy metal distribution in an open dump site of Shagayi Estate, Ilorin, Southwestern Nigeria.

STUDY AREA DESCRIPTION

The dumpsite of interest is situated within the Shagaya Estate, Ilorin, Kwara State with GPS coordinates of 8°31′18′′N and 4°35′21′′E (Fig 1, 2) covering about 190 by 60meters. The area of study has a climate characterized by two seasons: the raining season and the dry season. The raining season starts from around march and ends in October within the average rainfall of 1600mm to 1800mm. while the dry seasons starts around November and ends in march with an average maximum temperature of about 30 °C. The dumpsite is surrounded by house so there are no vegetation.



Fig 1: Satellite imagery of the study area with insert of the dumpsite



Fig 2: Aerial view of the dumpsite.

MATERIALS AND METHODS

Twenty representative soil samples were collected at about 20cm depth 30 meters apart (Fig 3) throughout the dumpsite in well-labeled, pre-cleaned polythene bags; samples were air-dried, pulverized, sieved to <63μm and 10g of each sieved sample was analyzed for concentrations of Cadmium (Cd),Lead (Pb), Mercury (Hg), Arsenic (As), Selenium (Se) using Flame Atomic Absorption Spectrometry (FAAS) analysis (Fig 4a, b, c). Results from the analysis were first compared with Average Crustal Values (ACV) and interpreted using Geo- accumulation Index (Igeo), Contamination Factor (CF) and Pollution Index (PI) to determine contamination and pollution levels of these heavy metals within the study area.

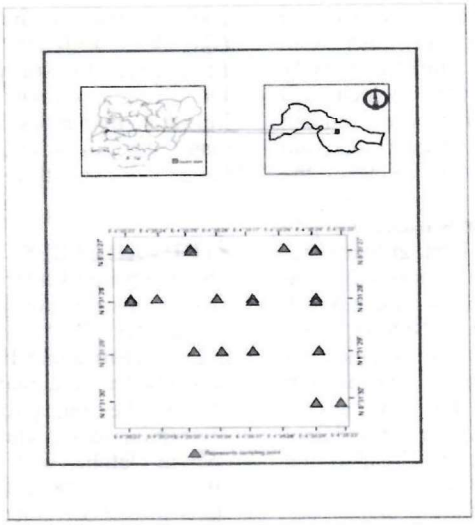


Fig 3: Soil sampling point location within the study area.



(B_n)

Fig 4: a) sample collection at about 20cm depth
b) Sieve analysis using a sieve shaker during sample preparation
c) Flame Atomic Absorption Spectrometry analysis been carried out on the samples.

INTERPRETATION

The results from the FAAS analysis were first compared with the Average Crustal Values proposed by Taylor 1964 to determine level of enrichment for each of the heavy metals, Index of geoaccummulation (Igeo) and Contamination Factors (CF) were calculated to ascertain the contamination level while Pollution Index was used to determine level of pollution.

Index of geoaccummulation (Igeo)

Muller (1981) proposed the assessment of quality of clays using the formula below and calculated values were interpreted in accordance with Table 1;

$$Igeo = \log_2 Cn / 1.5 * Bn \quad \ldots\ldots\ldots\ldots (1)$$

Where C_n is the measured concentration of the metal of interest,

B_n is the background concentration of the metal, and

1.5 is a constant introduced to minimize the effect of possible variations in the background values (B_n) attributable to lithogenic variations in clays

Table 1: Muller's I_{geo} classification (1981)

I_{geo} values	Class	Quality
Igeo< 0	0	Uncontaminated
0<Igeo< 1	1	Uncontaminated to moderately contaminated
1 <Igeo< 2	2	Moderately contaminated
2<Igeo< 3	3	Moderately to heavily contaminated
3<Igeo< 4	4	Heavily contaminated
4 <Igeo< 5	5	Heavily contaminated to extremely contaminated
Igeo> 5	6	Extremely contaminated

Contamination Factor (CF)

Contamination of the stream sediments were calculated using the formula below and interpreted as proposed by Hakanson, 1980 in Table 2;

$$CF = \frac{C^{i}_{(0-1)}}{B_n} \quad \ldots\ldots\ldots\ldots$$

Where CF is the contamination factor, $C^{i}_{(0-1)}$ is the mean content of metal of interest from at least 5 sampling sites, B_n is the background concentration of the metal,

Table 2: Levels of Contamination Factor and Contamination Degree (Hakanson, 1980)

Level	CF value	Contamination level
1	CF < 1	Low
2	1 ≤ CF < 3	Moderate
3	3 ≤ CF < 6	Considerable
4	CF ≥ 6	Very high

Pollution Index (PI)

The Pollution Index was further used to determine the level of pollution of the areas studied by the PHEs using the relation proposed by Muller 1981:

$$PI = \sqrt{\frac{(CF_{Average})^2 + (CF_{Max})^2}{2}} \quad \ldots$$

Where PI is Pollution Index

$CF_{Average}$ is mean value of contamination factors

CF_{Max} is maximum contamination factor value

And

PI < 0.7: unpolluted

0.7 < PI < 1: slightly polluted

1 < PI < 2: moderately polluted

2 < PI < 3: heavily polluted

PI > 3: severely polluted

RESULTS AND DISCUSSION

Comparison between the concentrations of each heavy metal analyzed with the Average Crustal Values (Taylor, 1964) showed higher values of Pb in all samples; Hg was enriched in samples S5- S12 and S14-S17; Cd had all values below the ACV value, Se had higher values in all twenty samples while As had values lower than the ACV in all samples (Table 3). Igeo calculations showed no contamination of all samples by As, Cd and Hg(except a samples S6 and S7 which was uncontaminated to moderately contaminated); Se was uncontaminated in samples S16, S17 and S19, uncontaminated to moderately contaminated in samples S1-S11, S13-S15, S20 while S12 showed moderate contamination; Pb was uncontaminated in S16, uncontaminated to moderately contaminated in S2-S4, S6-S8, S10, S14, S15, S17, S19, S20 and moderate contamination at S1. S5, S9 and S11-S13 (Fig 5). CF further confirmed results gotten from Igeo as there was no contamination of As (0.50) and Cd (0.44) in all sample while Pb (2.87), Hg (1.07) and Se (2.04) showed moderate contamination (Fig 6). The result of PI was 2.25 indicating that the study area was heavily polluted (Fig 7).

Table 3: Elemental concentrations in soil samples of Shagaya Dumpsite compared to Average Crustal Values (Taylor, 1964)

Samples	Pb	Hg	Cd	Se	As
S1	**65.16**	0.066	0.0526	**0.08**	0.52
S2	**55.7**	0.044	0.064	**0.12**	0.6
S3	**45.84**	0.044	0.12	**0.124**	0.5
S4	**57.2**	0.068	0.11	**0.084**	0.48
S5	**75.8**	**0.11**	0.136	**0.12**	0.52
S6	**56.4**	**0.12**	0.086	**0.1**	0.46
S7	**53.72**	**0.134**	0.108	**0.12**	1.1
S8	**49.8**	**0.1**	0.078	**0.128**	1.38
S9	**71.4**	**0.098**	0.08	**0.1**	0.98
S10	**55.8**	**0.09**	0.116	**0.1**	1.08
S11	**75.8**	**0.108**	0.092	**0.14**	0.66
S12	**77**	**0.098**	0.12	**0.152**	1.34
S13	**71.4**	0.072	0.098	**0.08**	1.08
S14	**45.2**	**0.084**	0.092	**0.106**	0.6
S15	**52.9**	**0.092**	0.076	**0.088**	0.9
S16	14.6	**0.088**	0.108	**0.06**	1.32
S17	**53.8**	**0.086**	0.048	**0.062**	1.06
S19	**55.6**	0.08	0.044	**0.07**	1.12
S20	**57.6**	0.05	0.06	**0.108**	1.3
MEAN	54.415	0.085	0.878	0.104	0.909
STD	7.976	0.307	0.235	0.338	1.002
MAX	77	0.134	0.136	0.152	1.38
MIN	14.6	0.44	0.44	0.06	0.46
MEDIAN	55.8	0.09	0.116	0.1	1.08
CV	**20**	**0.080**	**0.20**	**0.05**	**1.8**

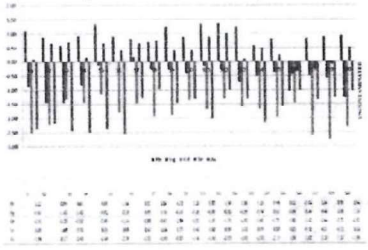


Fig 5: Index of Geoaccumulation (Igeo) indicating the level of contamination in soil samples of Shagaya Dumpsites.

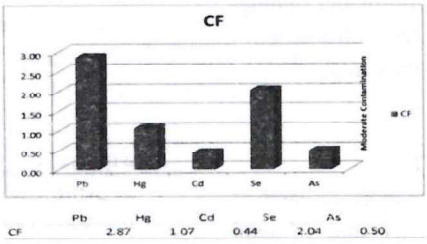


Fig 6: Contamination Factor (CF) values showing moderate contamination of Pb, Hg and Se for the study area.

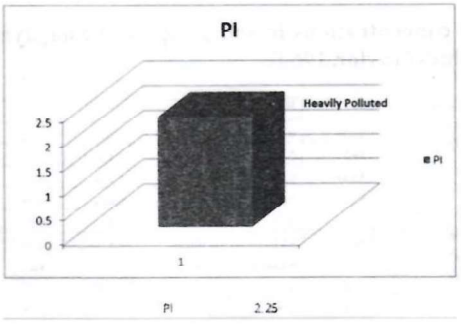


Fig 7: Pollution Index value indicating heavy pollution in soils of Shagaya Dumpsite

CONCLUSION.

Assessment of heavy metal concentrations within the dumpsite of Shagaya Estate was done by comparism of the heavy metal concentrations with the Average Crustal Values, Index of Geoaccummulation, Contamination Factor and Pollution Index. The ACV comparism showed enrichment of Pb and Se in all samples while Hg was enriched in 12 samples; Igeo indicated uncontaminated to moderately contaminated values of samples in Hg and Se while Pb showed mostly moderate contamination; CF further confirmed moderate contamination of the study area with Pb, Hg and Se while PI value indicated that the Shagaya Dumpsite is heavily polluted. This study represents a reference report on assessment of heavy metals of Shagaya Estate Dumpsite, Ilorin and findings would be useful for further research and policy making for the sustainable management of the dumpsite.

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DECLARATION OF INTEREST

The authors hereby declare that there is no conflict of interest to the best of their knowledge.

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