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Assessment of Metals Accumulation in Selected Dumpsites of Oyo Township, Southwestern Nigeria

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Abstract
Dumpsoil samples from nine refuse dumps and one control site in Oyo Township were analysed for Lead (Pb), Zinc (Zn), Cadmium (Cd), Iron (Fe) and Chromium (Cr). Samples were obtained at depths of 0-0.5m, 0.5-1m, 1-1.5m and 1.5-2.0m. The values of concentration of Pb, Zn, Cd, Fe and Cr in the dumpsite soil samples in mg/l ranged from 0.01-3.20, 0.01-3.72, 0.01-3.37 and 0.001-3.16 respectively. The concentrated trend recorded in the analyses is in the order of Pb<Zn<Cd<Fe<Cr. The concentration of metals at the dumpsoils and control sampled site showed that there was remarkable of increase in the concentration of trace metals from sampled dumpsoils compared to the sampled soil at the control site. It is observed that these values of the observed in view of high concentration require an urgent attention. It is recommended that the refuse dumps should be relocated outside Oyo township and appropriate remedial measures soils should be initiated at the dumpsites locations to map up the leachates.
Keywords: Dumpsites, Soils, Heavy Metals, Oyo Township, Remediation

Introduction

The disposal of wastes generated by human activities within a municipality is generally an urban problem (Odukoya and Abimbola 2010). After some years, a dumpsite undergoes biologically, chemically, geologically, and hydro geologically mediated changes resulting in a weathering process. Consequently, it becomes point source of pollution of the aquiferous units close to them (Manjunathan *et. al,* 2001). When rainfalls, the rain leaches pollutants from the waste disposal site, thus introducing toxins and contaminations into the soil, surface and groundwater and eventually plants that grow within the vicinity of the dumpsite (Awofolu *et. al.,* 2007; Daka *et. al.,* 2007). Improper management of solid wastes is one of the main causes of environmental pollution and degradation in many cities, especially in developing countries. Many of these cities lack solid waste regulations and proper disposal facilities.

Solid wastes are all the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted. The indiscriminate dumping of municipal wastes are common in Oyo town. (Plate 1). The Oyo waste dump sites have been in use since 1940s and illegal local dumping of mostly market wastes is still continuing till date. Sabo waste site is surrounded by residential buildings to the southeast and northwest. The general trend of this waste generation in Oyo is increasing each month. The solid waste composition is highly biodegradable mainly composed of an organic fraction with moisture. Food waste, plastic, paper, rubber, leather, wood, glass, metal and textile are the common waste components.

The physical composition of waste varies according to consumer patterns, life style and economic status.The physical composition of waste varies according to consumer patterns, life style and economic status. The detailed composition of solid wastes from selected street in Oyo revealed that it is dominated by food waste 41-61% filled by paper 4-25% plastic 3.6-28%. The per capital generation rate in Oyo metropolis is high as in other towns in Oyo State. This is definitely due to the high influx of commercial activities in the study area.The poor disposal and handling of waste thus lead to environmental degradation ,destruction of the ecosystem and poses great risks to public health.

This study is therefore undertaken on the waste disposal sites in Oyo township SouthWestern, Nigeria with the aim of evaluating the impact of heavy metals in the waste disposal sites and relate them to the attendant environmental problems. Heavy metal pollution is a problem associated with areas of intensive industry. However, roadways, areas of dumpsites and automobiles now are considered to be one of the largest sources of heavy metals. (Tijani et al, 2004). Human existence on earth is almost impossible without the heavy metal. Even though important to mankind exposure to them during production, usage and their uncontrolled discharge into the environment has caused lots of hazards to man, other organisms and the environment itself (Jarup, 2003).

Local Geology

Oyo township lies on the Basement Complex area of southwestern Nigeria, comprising undifferentiated Gneiss – migmatite complex (Oyawoye, 1972). Rock exposures in the Oyo Township is generally underlain by quartzite, undifferentiated schist, magmatic gneiss and migmatite (Figure 1). The minor rock is pegmatite. The quartzites

occur as long elongated ridges trending NW-SE and are mostly massive. Schistose quartzites with micaceous minerals alternating with quartzo-feldsparthic ones are common in the southern part of the town. The gneisses are the most dominant rock type. They occur as granite gneisses and banded gneisses with coarse to medium grained texture. Noticeable minerals include quartz, feldspar and biotite. Pegmatites are common as intrusive rocks occurring as joints and vein fillings.

Location and Accessibility

Oyo township lies in the coordinates of N07° 47' 02" – N07° 62' 01" and E03° 52' 01" – E04° 00' 00" (Figure 2). Oyo is well accessible as there are well developed road networks in the town. The study area is low lying which is controlled by the topography. The dumpsites include Ilora, Akinmorin, Sabo, kaara, Sado, Ara-Oyo, Idode, Awe, Laaka and Iyalamu in the central part of the study area . The rocks are highly fractured both at the surface and at depths making the drainage to be fracture controlled. The study area is relatively rugged with undulating topography. The study area falls within the humid and sub-humid tropical climate of southwest Nigeria. The study area experiences two seasons, the rainy season which runs from March to October and dry season which runs from early November to February. Precipitation in the study area is usually common in the form of rainfall.

Methodology

Ten municipal refuse dumpsites located at the central part of Oyo Township were randomly selected for investigation. An uncontaminated site was used as control. Soil samples were obtained in triplicates at each site from depths of 0m-0.5m; 0.5m-1.0m; 1.0m-1.5m; and 1.5m-2.0m using a depth calibrated soil auger. Each sample was immediately placed in a fresh plastic bag and tightly sealed. All the samples were transported to the Laboratory for analyses. The soil was spread on a clean plastic sheet placed on a flat surface and airdried in open air in the laboratory under room temperature conditions for three weeks. The soil was sieved using a 0.5mm sieve. 0.5g was weighed from the sieved soil of each sample and put into a pyrex beaker. 10 ml of nitric acid mixture ratio 1:2 was added to the soil samples. The beaker was then covered with a lid and placed on a hot plate at 105^0C for 30 minutes in a fume cupboard for digestion.After the 30 minutes period, the beaker containing the digested solution was brought out of the fume cupboard and allowed to cool. After cooling, the mixture was transferred into a 25ml volumetric flask and made to 25ml mark with distilled water. The 25ml solution was used for the determination of Cr,Zn, Cd, Pb and Fe . Determination of the concentration of heavy metals was done using an Atomic Absorption Spectrophotometer(AAS). .

Result and Discussion

The summary of trace metals and sampling points of dumpsoil in Oyo Township was presented in Table 1 and 2. Cadmium concentration ranged between 0.02-3.72 mgl^{-1} in the layers of the dump soil (Figure 3). Relatively low values were obtained in all layers of Traverse 5. Highest value (3.72mg/l) was detected in 0.5 to 1.0m layer of transverse 4.

Figure 1:Local Geology of the Study Area.

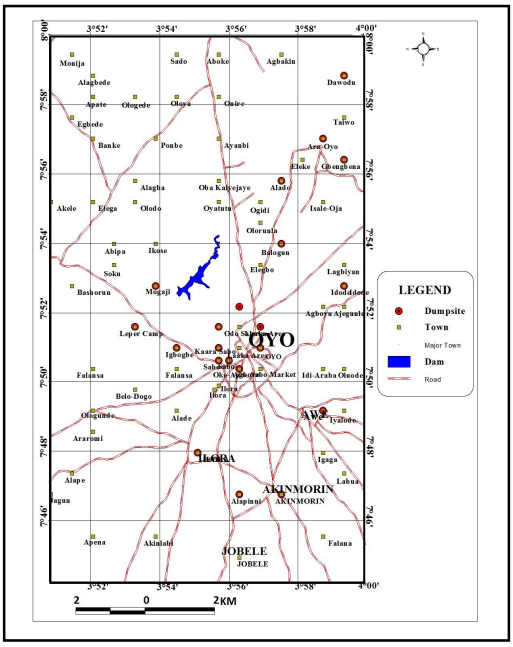
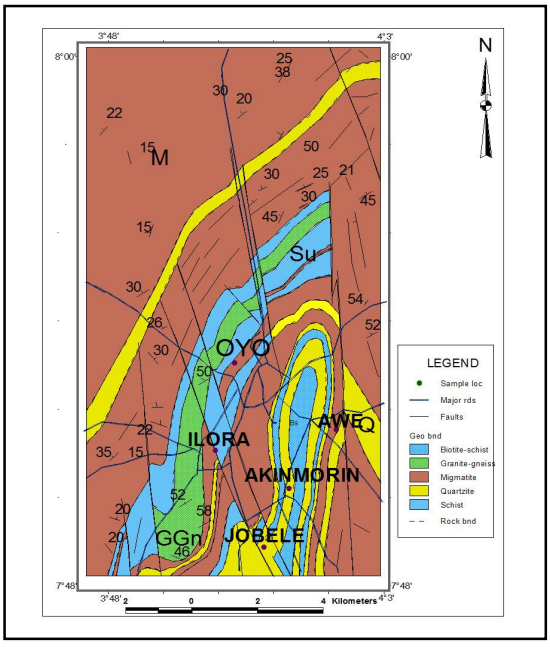


Figure 2: Location Map of Oyo Township



The high trend of cadmium observed in this present study corroborates with the submission of Al-Tvrki and Helal, (2004) and Ren *et al.,* (2005) that Cd is anthropogenic metal that is always abundant in upper layer of soils once there is external interference. The objectionable concentrations of Cd recorded in this study could be traced to the long years deposition of wastes in the site without check hence the elemental bioreaction culminated into high cadmium .Likewise the high concentration could also be traced to the presence of cadmium in the lubrication oils and tyres at the dump (figure 3). Pb concentration ranged between 0.001-3.37 mgl^{-1} in the layers of the dump soil (Figure 4). Relatively low values were obtained in all layers of Traverse 5. Highest value (3.37mg/l) was detected in 1.0 to 1.5m layer of transverse 1. At this layer, most other transverse recorded high Pb level. Pb exposures can cause seizures, mental retardation and behavioural disorders in human beings (Sobolev and Begonia, 2008).The variability in the concentration of Pb in the traverses specifically the high concentration recorded in Traverse 1 is a confirmation of the anthropogenic point source inputs. Cr concentration in the dump soil ranged from 0.01-0.81mgl^{-1}. Most of the values obtained in this study did conform to the acceptable limit of WHO (Figure 5) . The relatively high concentration recorded in Transverses 3 and 9 could be associated with the indiscriminate deposits of different load of wastes that might probably have Cr as precursor. Adelekan and Alawode (2011) likewise submitted that the high concentration of Cr in dumpsites could be ascribed to deposited wastes which contained high concentrations of Cr. The Cr was reported to be one of the heavy metals whose concentration in the environment is steadily increasing due to industrial growth especially the development of metal, chemical and tanning industries. Likewise Adelekan and Alawode (2011) opined that Cr pollution could also be traced to water erosion of rocks, liquids fuels and industrial and municipal waste.

Chronic cadmium exposures could results in kidney damage, bone deformity and cardiovascular problems (Goyer and Clarkson, 2001). The pattern depicted by concentration of iron (Fe) at different depth of the dump soils revealed a marked deviation from the permeable point set by WHO (2011) for soil except the Traverse 5. The relatively high concentration of iron observed could be attributed to the concentration of Fe in the leachate as a result of the deposition of sewage and agricultural wastes. A confirmation of the submission of Gabriel and Stephen (2009) that dumpsite is a significant source of Fe. (Figure 6). Generally, the concentration of Zn in depths of the dump soil fell below the permissible limit. Zinc cannot be regarded as one of the prominent contaminants in the dump soil. These could be due to the chemical constituents of the wastes of the dump sites and the anthropogenic factors **(** Figure 7**) .**

Table 1: Summary of Metal Content (mg/l) of Soils at four Depth at Dumpsites in Oyo Township

Dumpsite	0.0m – 0.50m	0.50m – 1.00m	1.00m – 1.50m	1.50m – 2.00m
TR1	**0.81 – 1.62**	**0.62 – 2.31**	**0.04 – 3.37**	**0.14 – 1.63**
TR2	**0.25 – 1.72**	**0.03 – 2.99**	**0.53 – 195**	**0.18 – 1.12**
TR3	**0.67 – 1.96**	**0.32 – 2.55**	**0.13 – 1.81**	**0.52 – 1.55**
TR4	**0.11 – 2.06**	**0.02 – 3.72**	**0.51 – 1.48**	**0.21 – 3.16**
TR5	**0.002 – 0.66**	**0.01 – 0.15**	**0.001 – 0.09**	**0.001 – 0.11**
TR6	**0.01 – 3.20**	**0.03 – 1.31**	**0.01 – 2.06**	**0.03 – 1.28**
TR7	**0.03 – 1.92**	**0.01 – 3.07**	**0.03 – 0.32**	**0.38 – 2.31**
TR8	**0.28 – 1.18**	**0.26 – 1.69**	**0.07 – 1.69**	**0.06 – 2.15**
TR9	**0.04 – 0.73**	**0.01 – 1.05**	**0.31 – 3.19**	**0.02 – 2.33**
TR10	**0.01 – 1.04**	**0.07 – 1.32**	**0.11 – 2.32**	**0.44 – 2.14**

Table 2: Sampling point Descriptions of Oyo Dumpsites

S/N	Locaion	Dumpsites	Longitude	latitude	Elevation (m)
1	TR1	Ilora	07^0 48.740[1]	03^0 53.958[1]	305.5
2	TR2	Akinmorin	07^0 47.665[-1]	03^0 56.246[1]	289
3	TR3	Sabo	07^0 55.600[1]	03^0 56.200[1]	253.3
4	TR4	Sabo kaara	07^0 52.219[1]	03^0 56.299[1]	295.8
5	TR5	Sado	07^0 56.415[1]	03^0 57.719[1]	893.0
6	TR6	Ara-oyo	07^0 57.172[1]	03^0 58.606[1]	288.1
7	TR7	Idode	07^0 51.203[1]	03^0 55.863[1]	995.0
8	TR8	Awe	07^0 49.642[1]	03^0 57.975[1]	322.1
9	TR9	Laaka	07^0 50.952[1]	03^0 56.031[1]	294.0
10	TR10	Iyalamu	07^0 51.623[1]	03^0 56.560[1]	278.3

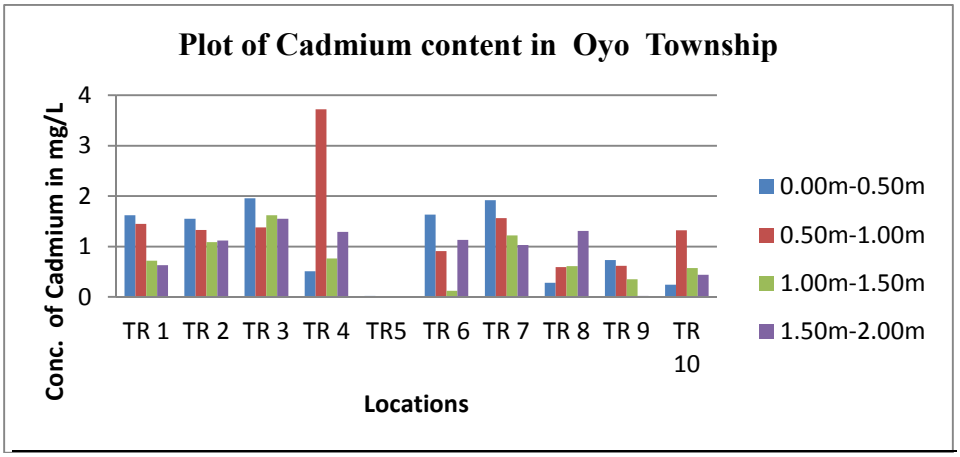


Figure 3: Cadmium content of Dumpsoils in Oyo Areas

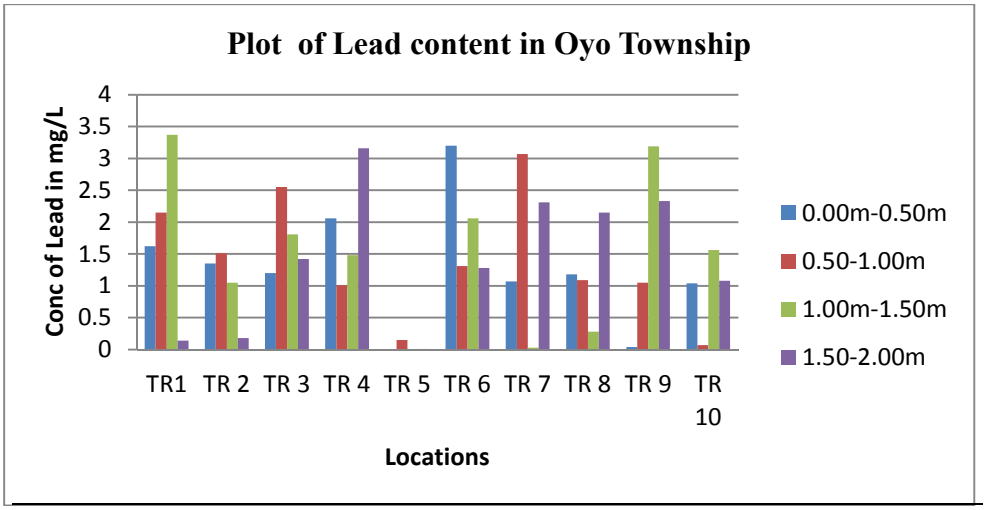


Figure 4: Lead content of Dumpsoils in Oyo Areas

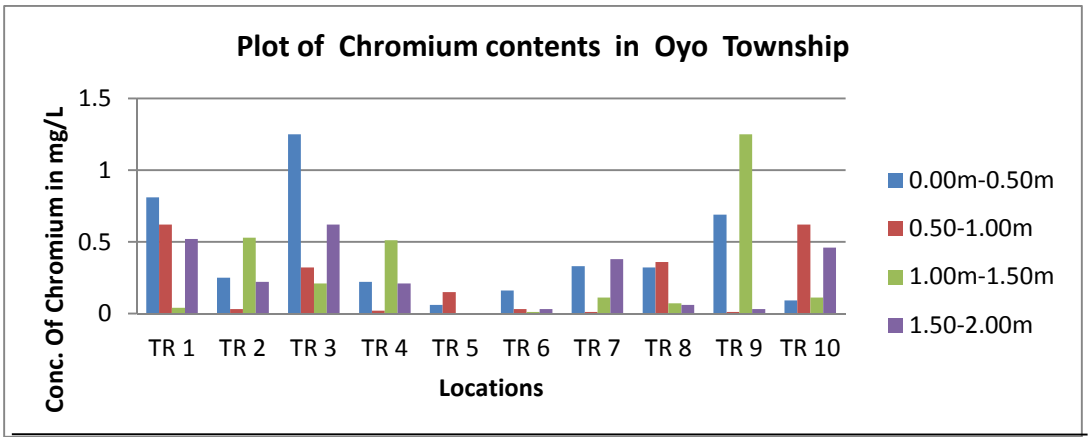


Figure 5: Chromium content of Dumpsoils in Oyo Areas

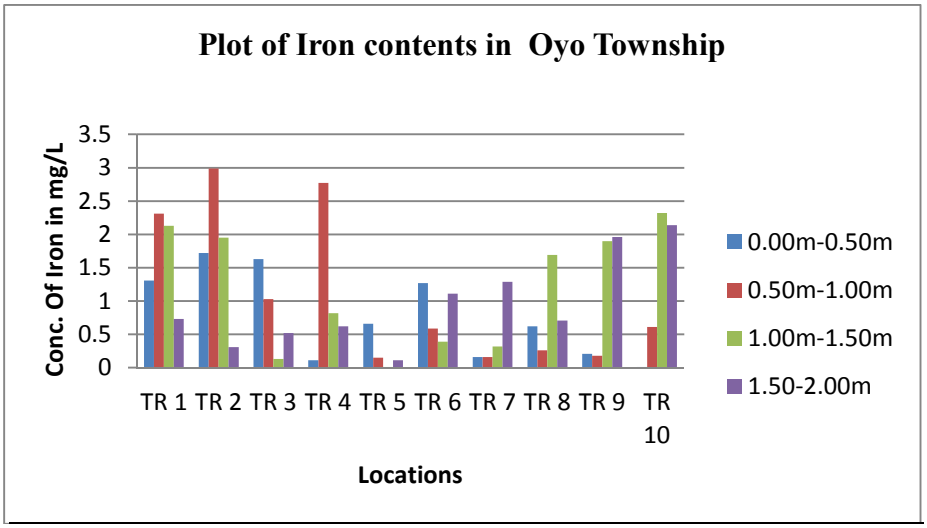


Figure 6: Iron content of Dumpsoils in Oyo Areas

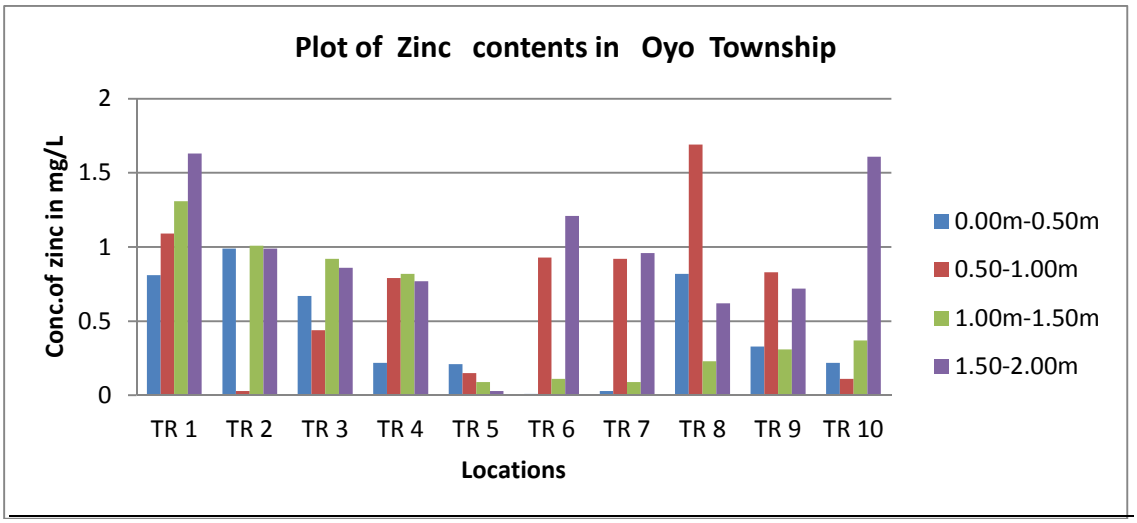


Figure 7: Zinc content of Dumpsoils in Oyo Areas

Conclusion

In the study area Lead, Zinc, Cadmium, Iron and Chromium exhibited elevated values in soils at the refuse dumpsites when compared to control samples. Lead (Pb) was found to be generally high in all the soil layers a situation that may cause high blood level that inhibit irritation, mental, retardation. While Cr was found to have low concentrations which may cause bleeding of the gastrointestinal tract cancer of the respiratory tract and cancers of the skin and mucus membrane. The order observed for the study is Pb >Zn > Cd > Fe > Cr. The values of Pb obtained from the study area raised significant concern for safety of the environment and health impacts on the inhabitants. These waste dumps should be relocated outside Oyo township and appropriate remediation measures to map up contaminated soil especially in respect of Pb should be initiated at the dumpsite locations.

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Plate 1: Disposal of Wastes close to Residential Areas in Oyo Township