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Original Research Article

Heavy Metal Concentrations in Soil of Ogbomoso and its Environs

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Abstract

Monitoring the level of accommodation of the heavy metals in soil is of great importance, since the continuous deposition in the soil can cause severe environmental degradation and toxicity. This work, therefore investigated the degree of heavy metal pollution in the soil of Ogbomoso, which is one of major cities in Nigeria. Soil samples were collected from three different locations within Ogbomoso. The locations are an auto-mechanic workshop near the stadium, a motor park within a residential area and from university farms. The samples were collected at distances of 50 metres and 100 metres away from the point of location of the study sites. The soil samples were air-dried in the laboratory for about fourteen days. After drying, the samples were collected and sieved. 0.5 mm particle size was selected in order to obtain fine particles. The concentrations of investigated metals were determined using the atomic absorption spectrophotometer. The results of investigation revealed that there was heavy pollution of Manganese (Mn) in all the three sites, while the lead (Pb) pollution was observed in the mechanic workshop and the motor park. Nickel (Ni), Copper (Cu) and Zinc (Zn) pollution was only found in the mechanical workshop, while the only metal that was within the recommended safe limit in all three sites was Cadmium (Cd). The study concluded that, the less polluted site was the university farms and that vehicular traffic as well as repairs and maintenance of automobiles, were the major sources of soil pollution in Ogbomoso and by extension Nigeria.

Keywords: Concentration, Heavy metal, Pollution, Soil

INTRODUCTION

The term "heavy metal" refers to any metallic chemical element that has a density that is greater than 5.0 g/cm^3 and occurs naturally as ore in soil and it is usually toxic or poisonous even at low concentration (Adeniyi et al., 2002). Typical examples of heavy metals include: Mercury (Hg), Cadmium (Cd), Arsenic (As), Chromium (Cr), Lead (Pb) and so on. Heavy metals are of considerable environmental concern due to their toxicity and accumulative behaviour in humans. At normal concentrations, they are important in several ways and many are used industrially in technologically advanced countries. Some are physiologically essential for plant and animal and thus have a direct bearing on health and agricultural productivity, while many are significant as pollutants of ecosystems throughout the world (Nriagu, 1996). The most contaminated soils are in the proximity of the motorway and streets with high traffic flows (Imperato et al., 2003). Technological advancement in most developed countries has immensely reduced the discharge of trace metals such as cadmium into the environment. However, in the developing nations, the pollution of the environment by trace metals through industrial emissions, effluent discharges, solid waste disposal, usage of agro-chemicals and sewage sludge in agricultural practices and automobile activities is evident (Rossini and Fernández, 2007; Manta et al., 2002;

Boularbah et al., 2006). Furthermore, the extraction, refining and processing of crude oil have become the major source of energy globally and currently generates over 90 % of Nigeria's total revenue (Obanijesu et al., 2007a). However, these activities go along with the deposition of heavy metals such as copper, lead and cobalt amongst others (Obanijesu et al., 2007b). These metals and hydrocarbons can contaminate the soil and the water by altering the pH thereby making the ecosystem unsafe for various agricultural activities.

There are so many metals that can be found in the soil and there is a need to control the discharge of these metals into the soil so that their concentration will not increase beyond normal proportion because failure to control their emission can result into contamination of water in wells, ponds and if such water is continually taken, it can cause serious health problem to the victim and also affects crops been cultivated on the affected farm lands.

Many researchers had carried one kind of investigation or the other as regards soil pollution by heavy metals. For example, Aremu et al (2007) [9] investigated the levels of pollution and various likely environmental havocs. Samples of processed food, unprocessed food and river waters were taken from three locations, processed and analyzed for hydrocarbon and heavy metal contents. The result showed a linear correlation of the concentration of the hydrocarbon and heavy metals content with the sites of crude oil processing. They concluded that various oil processing activities affect the environment through the release of trace elements and hydrocarbons, which may adversely affect the health of the indigenes. It is therefore advisable for the oil producing companies operating within Niger-Delta region of Nigeria to minimize the waste generation as much as possible and in the event of waste generation, the waste (in whatever form of production) should be properly treated before disposal into the environment.

Onawumi et al (2007) carried out study on lead pollution in soil of a battery making factory at two separate times. Atomic Absorption Spectrometer (AAS) was employed in the estimation of lead content in the soil samples for the two periods. The result of the study showed that significant changes were noticed in the level of lead in the soil samples between the time of active production and the downtime.

Monitoring the level of the heavy metals in soils is of great importance, since the continuous deposition in the soil can cause severe environmental degradation and toxicity. The main objective of this study was to evaluate the degree of heavy metals pollution in three different locations in Ogbomoso. A good knowledge about the changes in the concentration of the soil in chosen locations would assist in environmental management. This paper focussed on analysing the soil concentration of six different heavy metals in three different locations in Ogbomoso, Nigeria. The metals tested for were cadmium (Cd), zinc (Zn), copper (Cu), lead (Pb), nickel (Ni), and Manganese (Mn).

MATERIALS AND METHODS

Soil samples were collected from three different locations within Ogbomoso. These locations are an auto-mechanic workshop near the stadium, a motor park within a residential area and from university farms. The auto-mechanic workshop was chosen considering the fact that various auto repairs are done in the workshop which make the site suitable and appropriate for this study. This is because metals like Cu, Ni, Zn and Pb get into the soil through many repair works such as panel beating, repair of engine parts and painting being done on vehicles. Oil spillage is prominent in the mechanic workshop and motor park soil. The motor park site was chosen because it is situated around residential houses and as a result of which heavy metals can get into the soils through oil spillage and other minor repairs usually carried out within motor parks. The university farms were also used as a case study as they are located within residential areas. The farms also engaged in mono-culture farming system over the years, which is unnatural, as such practice depletes the soil of nutrients, allows diseases and pests to spread and in short bring into play the use of chemical substances foreign to the environment. On application of these chemicals, the land can be said to be exposed to heavy metals as most composition of the chemicals contain metals.

The samples were collected at distances of 50 meters and 100 meters away from the point of location of the study sites. The top soils were collected from a uniform depth of between 7.5 cm to10 cm into the ground. The soil samples were air-dried in the laboratory for about fourteen days. After drying, the samples were collected and sieved. 0.5 mm particle size was selected in order to obtain fine particles. The sieved soil was properly ground using an agate mortar to enhance oxidation of the soil samples. 1 g of the finely ground soil was accurately weighed, then transferred to an evaporating dish and 30 ml of the acid mixture (4 parts H_2SO_4, 2 parts HCL and 1 part HNO_3) was added. The mixture was heated gradually at first and then more strongly until white fumes were no longer evolved. The viscous mass was mixed with hot dilute HCL acid and filtered in line with works of Adeniyi (2001) and Anderson (1991). The insoluble fraction, which consists of unchanged mineral and the silica liberated from the silicates, was washed with diluted HCL acid and hot water. The filtrate was made up to 100 ml in volumetric flasks before being transferred to a well labelled 120 ml bottles. The same procedure was repeated for the remaining soil samples. The concentrations of elements of interest (Cd, Cu, Ni, Pb, Mn and Zn) were determined using the atomic

Table 1. Heavy metal concentration at auto-mechanic workshop

Distance (m)	Concentration of Elements (µg/g)					
	Cd	**Ni**	**Cu**	**Mn**	**Pb**	**Zn**
0	16.45	89.60	535.10	293.80	219.50	125.20
50	10.76	70.43	339.30	246.30	201.60	105.80
100	2.78	51.10	143.50	203.90	193.50	110.78
Mean	**9.90**	***70.38***	***339.00***	***248.00***	***204.87***	***113.90***

Table 2. Heavy metal concentration at motor park

Distance (m)	Concentration of Elements (µg/g)					
	Cd	**Ni**	**Cu**	**Mn**	**Pb**	**Zn**
0	2.78	89.50	377.60	361.40	196.80	53.50
50	1.97	56.70	248.30	266.10	131.90	39.72
100	1.14	28.20	151.70	200.80	66.90	22.30
Mean	**1.96**	**58.13**	**259.00**	***276.10***	***131.86***	**38.50**

Table 3. Heavy metal concentration at the university farms

Distance (m)	Concentration of Elements (µg/g)					
	Cd	**Ni**	**Cu**	**Mn**	**Pb**	**Zn**
0	2.61	31.00	247.80	556.28	64.80	22.00
50	2.10	21.60	193.40	299.40.	46.60	20.30
100	1.50	12.00	139.60	156.54	24.80	18.70
Mean	**2.07**	**21.50**	**193.60**	**337.40**	**45.40**	**20.33**

Table 4. Comparison of concentration of elements at 3 locations

Metal	Mean value of concentration of elements (µg/g) at			Recommended safe value (µg/g) *[13]
	Mechanic workshop	**Motor park**	**University farms**	
Cd	9.90	1.96	2.07	10.10
Ni	70.38	58.13	21.50	66.90
Cu	339.00	259.00	193.60	283.00
Mn	248.00	276.10	337.40	172.00
Pb	204.87	131.86	45.40	81.00
Zn	113.90	38.50	20.33	101.30

*Source- Chen et al., (2005)

absorption spectrophotometer.

RESULTS AND DISCUSSION

The results of heavy metals investigated are presented in Tables 1- 4.

It can be seen in Table 4, that concentration of cadmium (Cd) is highest in the auto-mechanic workshop with a mean value of 9.90µg/g, which is still within the safe limit. It was also noticed that the cadmium concentration has a gradual decreasing trend from the sample taken from auto-mechanic workshop to the sample from a motor park and the least value was gotten from the university farms sample. The presence of Cd in motor oil and car tyres probably explains its accumulation in mechanic workshop soil and motor park soil.

The auto mechanic workshop has the highest concentration of nickel. The mean value of 70.38 µg/g obtained is higher than the recommended safe limit of 66.9 µg/g as recommended by (Chen et al., 2005). The primary source of nickel pollution is from diesel fuel, gasoline and lubricating oil coming in contact with soil. The value of nickel for the university farms sample was however low with an average value of 21.50µg/g. The mechanic workshop soil has a significant amount of Ni as a result of different activities being done on the site.

The highest concentration of Cu was obtained from the sample collected from the auto-mechanic workshop with a mean value of 339.3µg/g, followed by 264.7µg/g

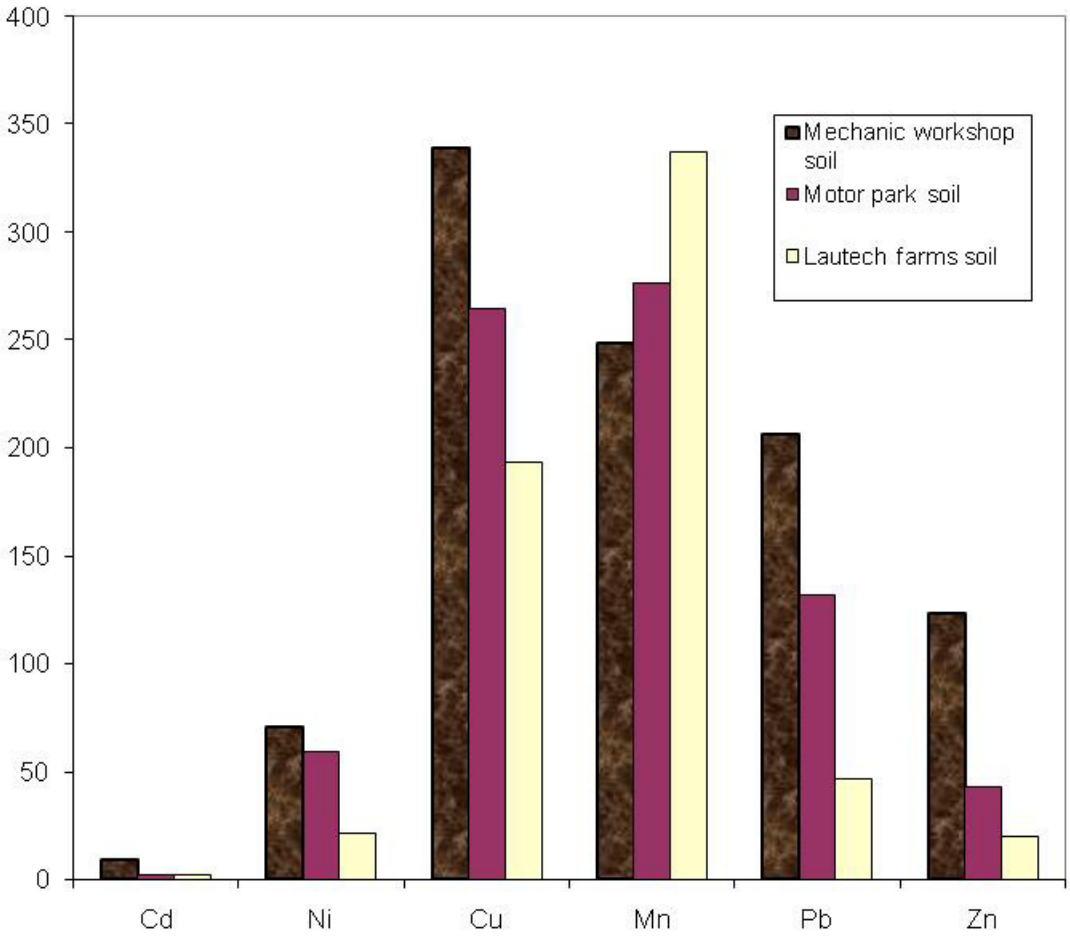

Figure 1. Cd, Ni, Cu, Mn, Pb and Zn levels in mechanic workshop soil, motor park soil and the university farms soil in Ogbomoso

from motor park sample, while the least mean value of 193.4µg/g was obtained from the university farms sample. The copper content within the mechanic workshop was too high and far above the recommended safe value and this might be due to the fact that copper is a constituent of most alloys used in automobile parts and when discarded as scraps. These parts rust or corrode and then copper is deposited into the soil.

Manganese is a very important micro-nutrient in the soil as it is a co-factor of various enzymes and is utilized in photosynthesis. It can be seen that the university farms sample has the highest mean concentration of Mn with an average value of 337.4 µg/g followed by motor park sample with 276.1 µg/g, while the least mean value of 248.9 µg/g in mechanic workshop sample. The highest concentration of Mn at the university farms might not be unconnected with the use of fertilizers, pesticides, fungicides and insecticides being used on the farms to increase yield. The mean values of Mn concentration obtained in all the three locations are not satisfactory, because, they were all found to be above the recommended safe limit of 172µg/g (Chen et al., 2005).

For the lead content, Pb, the highest concentration value obtained was 204.87µg/g from mechanic workshop sample, next to it is motor park sample with 131.86µg/g, while the least is from Lautech farms with a mean value of 46.6µg/g. The mean value obtained from mechanic workshop and motor park soil is greater than recommended safe value of 81µg/g (Chen et al., 2005). Highest concentration in mechanic workshop soil could be attributed to the presence of lead used as anti-knocking in fuel for vehicles, tyre wear, lubricating oil and grease, bearing wear in which any of the components of these materials may come in contact with the soil, used fuels and oils are spilled carelessly and then enter the soil. The motor park soil which account for the second largest concentration of lead is due to the fact that some repair works are also done in most, if not all of our motor parks causing oil spillage. Tyre wear from moving cars on the road and vehicle exhaust are other predominant sources.

The highest concentration of zinc (113.90µg/g) was found in mechanic workshop sample. The average values of zinc in the motor park and the university farms soils,

which are 38.50µg/g and 20.33µg/g respectively, are satisfactory and are within the recommended safe limit of 101.30µg/g (Chen et al., 2005). The high concentration of zinc at the mechanic workshop might be attributed to oil leakage, which is a pathway of Zn into the soil, as motor oil tends to accumulate metals as it comes into contact with surrounding parts of the engine as it runs. Little zinc content at the university farms soil may come from rusting of disposed metallic poultry feeders, poultry nets, containers of vaccines and probably from brake emission from vehicles that comes around the farm.

It was observed that, the concentration level of every metal examined was high at the centre of the site and reduced as the distance increased from the centre. Generally, from the analysis carried out, the highest heavy metal concentration levels were discovered to be at the auto-mechanic workshop site and this could be attributed to various repairs and maintenance activities being carried out on daily basis. In the similar manner, the motor park soil accounted for the second largest concentration of these metals considering the fact that most drivers had turned themselves to mechanics, thereby turning motor parks into mechanic workshops. However, the portion of the university farms soil being considered under this study did not have much heavy metals accumulation, except for manganese, which has the highest concentration in this sample, which could be traced to use of fertilizers, pesticides, fungicides and insecticides being used to increase yield. One would have expected, farmland at the university farms to be more polluted than motor park soil but investigation conducted revealed that application of fertilizer at the farms is to the barest minimum. Figure 1 shows Cd, Ni, Cu, Mn, Pb and Zn levels in all the three sites examined.

CONCLUSION

From the results obtained in this study, the following conclusions among other were drawn:-

i. The soil within the mechanic workshop has the highest metal pollution, while soil within the university farms has the least concentration of heavy metals. However, the university farms have the highest concentration of magnesium.

ii. The concentration of heavy metals is highest at the centre and decreases at various distances away from the centre.

iii. Vehicular traffic as well as repairs and maintenance of vehicles are major sources of soil pollution in Nigeria.

iv. The application of fertilizers, pesticides, fungicides and insecticides being used on the farms to increase yield is primarily responsible for higher concentration of manganese [Mn] at the university farms.

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