JASEM ISSN 1119-8362

Full-text Available Online at
www.ajol.info and
www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *June 2014*
Vol. 18 (2) 263-265

Heavy Metal Distribution in the Vicinity of Automobile Scrap Sites in Agbor, Nigeria

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KEYWORDS: Vehicle scrap, heavy metals, soil concentration, Nigeria

ABSTRACT: Surface soil in the vicinity of automobile scrap sites were studied for heavy metal level. The result revealed that the concentration of heavy metals in the various sites exceeded those of the control sites. The mean concentration ranges (mg kg^{-1}) for heavy metals in these sites were 4.00 – 11.55 for Cd; 6.22 – 977 for Pb; 0.34 – 1.26 for Cu; 0.72–1.59 for Cr and 12.21 – 93.31 for Fe. However, the concentrations compared well with those found in normal agricultural soil and were below environmental quality criteria for soil for agriculture, residential and industrial purposes except for cadmium. The accumulation pattern for the metals followed the order Fe > Cd > Pb > Cr > Cu. Cadmium represented a contamination hazards in these sites. © JASEM

http://dx.doi.org/10.4314/jasem.v18 i2.17

*Introduction***:** Soil pollution occurs in several ways, including application of herbicides, fertilizers, pesticides and industrial effluent. Other major sources including indiscriminate disposal of dry cell batteries, papers, textiles, oil and grease and metal scraps from mechanic workshops (Odukoya and Bamgbose, 2001). Toxic metals content in soil, leads to groundwater contamination while some may be absorbed by crops or washed into nearby streams and rivers through runoff (Nyle and Well, 1999).

Contamination of heavy metals in the environment is of major concern because of their toxicity and threat to human life and the environment (Iwegbue et al., 2006). Contrary to other pollutants, heavy metals are not biodegradable and tend to persist as metal atoms or the speciation may change overtime. Moreover, unexpected rapid mobilization of heavy metal could result in environmental catastrophe, menacing human health and welfare by poisoning water sources and food sources (Stiglini and Anderberg, 1993).

Like other major cities in Nigeria, automobile mechanic workshops are found scattered all over Agbor town and occupied almost every vacant lot among the major roads. Wastes were indiscriminately dumped on every available space and all categories of urban wastes ranging from lubricating oil films, junked cars to tires were found to litter along streets and major roads (Iwegbue et al., 2006).

Automobile mechanic works has been implicated for elevated concentration of heavy metals (Cd, Cr, Cu, Pb, Ni and Zn) in soil profile in the vicinity of automobile mechanic waste dumps (Iwegbue et al., 2006). Assessing the concentrations of heavy metal in these sites provides information on guidance for redevelopment, extents of contamination and choice of possible remediation or clean-up techniques. The primary objective of the present study is to determine the characteristic
levels of iron, copper, chromium, lead and cadmium in soil in the vicinity of automobile scrap sites in Agbor town.

METALS AND METHODS

Description of study area: Agbor town lies between the latitude 5.10^o – 6.2^o N and longitude 6.10^o – 6.2^o E. The town drains into the Ologodo River. The major industrial activities in this town are medium scale industries, steel and automobile mechanic works.

Sampling and analysis: Scrap sites were divided into 50 m x 50 m quadrant and each quadrant was further subdivided into 25 sampling cells with an area of 10 m x 10 m each. Soil samples were collected from each cell at depth of 0 – 30 cm using a soil auger. A total of nine sites were examined with sites 03, 06 and 09 as the control sites. These sites do not have any known history of automobile waste dump. In our laboratory, the samples were air-dried, and sieved to pass a 2 mm nylon mesh. The samples were stored in plastic container at 4 ^{o}C prior to analysis. Five grams of the air-dried samples were digested with mixture of aqua-regia (Radojevic and Bashkin, 1999). The clear digest was diluted to 100 ml mark using nanopure water. The solution was subsequently analyzed for Fe, Cu, Cr, Pb, and Cd using a graphite furnace atomic absorption spectrophotometer equipped with D_2 background correction device (GBC scientific equipment Sensa X 1175, Australia).

Quality control was assured by the analyzed procedural blank replicates and spikes. All reagents used (HCl, HNO_3) were of analytical grades. The spike recovery for each metal was greater than 93.5 %.

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RESULTS AND DISCUSSION

Table 1 presents the concentrations of heavy metals in surface soils in the vicinity of automobile scrap sites in Agbor metropolis. The mean±SD is presented and range in parenthesis. The values below the means value represent the concentration range at each sites. Analysis of variance (ANOVA) ($P \geq 0.05$) represents significant spatial variation in the concentration of heavy metals in all sites. Each site shows significant higher concentration of Cd, Pb, Cr, Cu and Fe than of the control sites. Control sites are devoid of automobile scrap wastes and other anthropogenic activities hence low levels of the studied metals. This further suggested that elevated concentrations of metals found in these sites were due to the contributions from the automobile scraps.

The concentrations of heavy metals were within the normal concentration ranges of these metals in most agricultural soils, except for Cd. According to the review by Lindsay (1979), Kabata-pendias and Pendias (1992), and Alloway (1995), normal concentration range of these elements in soil are 0.01- 0.7 $mgkg^{-1}$ for Cd; 1.00 -10.0 $mgkg^{-1}$ for Cr; 2 - 250 $mgkg^{-1}$ for Cu, 0.4 - 1000 $mgkg^{-1}$ for Ni; 50 - 300 $mgkg^{-1}$ for Pb and 1 - 900 $mgkg^{-1}$ for Zn. In comparison, the concentrations of heavy metal in the soil samples were generally lower than those found in the soil profiles of automobile mechanic waste dumps in Port Harcourt (Iwegbue et al., 2006) and soil in the vicinity of municipal solid waste dump in Southwestern Nigeria (Bamgbose et al., 1999) and levels reported for concentrated sites elsewhere in the world (Ma and Roa, 1997; Kabala and Singh, 2001; Szerzen et al., 1993).

The accumulation pattern of the heavy metals in the soil follows the order Fe > Cd > Pb > Cr > Cu. This order is justified by the fact that iron constitutes about 80% of total content of the scraps dumped on the soil. The elevated level of lead found is due to used lead battery cells. In Nigeria, guideline and standards for redevelopment of contaminated soil is lacking hence most comparison shall be made with international guidelines.

The levels of metals found in these sites are below threshold values for each metal under the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) scheme used in the United Kingdom (ICRCL, 1987, 1988). This implies that the concentration of these metals should cause a problem. In other word, it does not need any form of remedial action before any form of chosen development can proceed on such land. However, the levels of Cd exceeded the Canadian interim environmental quality criteria for agriculture and park lands/residential purposes (CCME, 1991). Such sites require remedial action for Cd before it can be used for either agricultural or residential purposes. Cadmium consist a serious contamination hazards in these sites. Cadmium can be easily mobilized in these sites because of the academic nature of soils in Southern Nigeria (Odu et al., 1987; Isirimah, 1987; Iwegbue et al., 2006). They may eventually contaminate the groundwater or nearby surface water or absorbed by plants which will finally get into human food chain.

*Conclusion***:** The concentrations of heavy metals from this study were within concentrations found in normal agricultural soil and below the ICRCL threshold values and Canadian interim environmental quality criteria for agricultural, residential and industrial purposes except for Cd. The results revealed that soil in these sites requires some remedial action for Cd before such land can be used for any form of chosen development.

Table 1: Mean ± S.D and range (in parenthesis) of heavy metal concentration in mg/kg dry weight from soil number**.**

Sample		Fe	Cu	Cr	Pb	Cd
01	25	64.44±2.58^{a} (60.20 – 56.40)	0.29± 0.03^{b} (0.19 – 0.41)	0.72±0.09^{b} (0.64 – 0.90)	9.77±1.47^{b} 8.30 – 10.75)	8.44±1.01^{b} 0.04 – 9.00)
02	25	93.31± 4.67^{b} (90.40 – 98.60)	0.34 ± 0.05^{b} (0.24 ±0.04)	1.18 ± 0.15 (0.84 – 1.32)	7.11±1.13^{b} (6.00 – 8.22)	1.55 ±1.39^{a} (11.05 – 12.60)
03	25	3.00± 0.15 (1.95 – 3.50)	0.1±0.01 (0.09 – 0.22)	0.21 ± 0.02 (0.08 – 0.43)	44 ±0.08^{b} 44 – 0.07^{b}	1.77 ± 0.14^{b} (1.10 – 1.95)
04	25	67.80 ± 3.39^{b} (62.00 – 70.50)	0.66 ± 0.07^{b} (0.44 – 0.90)	1.44 ± 0.19^{b} (1.22 – 1.96)	6.22 ± 0.31^{b} (5.96 – 6.66)	9.77 ± 1.27^{b} (8.99 – 10.86)
05	25	90.00 ± 4.50^{b} (85.00 ± 100.05)	1.38 ± 0.01 (1.08 – 1.68)	1.59 ±0.23^{b} (1.40 – 2.09)	8.88 ± 1.48 (7.84 – 0.91)	7.55 ± 0.91^{b} (6.95 – 8.65)
0.6	25	35.66 ±2.14^{b} (3.40 – 38.92)	0.31 ± 0.13^{b} (0.09 – 0.43)	0.31 ± 0.06^{b} (0.11 – 0.50)	1.77 ± 0.20^{b} (1.28 – 1.99)	ND
07	25	12.21 ± 0.97^{b} 10.21 – 14.08)	0.74 ± 0.9^{b} (0.64 – 0.92)	1.31 ±0.23^{b} (0.01 – 1.52)	8.00 ± 1.12^{b} (6.95 – 9.05)	4.00± 0.60^{b} (3.80 – 4.88)
08	25	78.91 ± 3.95^{b} (69.0 – 80.91)	1.26 ± 0.16^{b} (1.06 – 1.48)	1.8 ±0.18 (1.00 – 1.38)	9.33 ± 1.30^{b} (7.86 – 10.00)	4.88±0.78^{b} (4.06 – 5.50)
09	25	23/31 ± 1.41^{b} (20.01 – 26.51)	0.09 ±0.01^{b} (0.04 – 0.15)	0.91 ± 0.439 (0.62 – 1.20)	0.44 ± 0.09^{b} (0.22 – 0.66)	1.33 ±0.35^{a} (1.10 – 1.65)

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