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ORIGINAL ARTICLE

Levels Of Heavy Metals in Soil as Indicator Of Environmental Pollution in Maiduguri,Borno State, Nigeria

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ABSTRACT
Levels of some heavy metals (Mn, Ni, Co, Cr, Cd, Cu, Fe, Zn and Pb) were investigated in Soil to serve as indicator of environmental pollution in Maiduguri Metropolitan council, Borno State, Nigeria. Concentration levels of the metals were determined using Perkin-Elmer Analyst 200 Atomic Absorption Spectroscopy (AAS). Soil samples were collected monthly for three months from three different locations (Bama station, Bulumkutu and Post office areas designated as S1, S2 and S3 respectively) at distances of 50m and 100m each from the main roads, and 250m to serve as control. The results showed that the concentrations of analysed heavy metals ranged from 1.04±0.06- 2.53 ± 0.03 µg/g Mn; 2.11±0.05-8.70 ± 0.30 µg/g Fe; 0.34±0.01-1.40±0.03 µg/g Zn; 0.01±0.01-0.46 ± 0.01 µg/g Co; 0.09±0.09-0.80 ± 0.02 µg/g Pb and 0.08±0.01-1.19 ± 0.13 µg/g Cr whereas, the concentrations of Ni and Cd were not detected at S3(control) and Cu at S1(50M) and S2(50M) of the study areas. Variations of the metals in the soil samples were in the order: Fe>Mn>Pb>Cr>Zn>Cd>Co>Ni>Cu. Analysis of Variance (ANOVA) confirmed significant differences (p<0.05) between the levels of heavy metals within the soils from the three sampling points. The concentrations of some of the metals in the three sampling points were lower than that of their corresponding control.Thus, the soil does not only indicate pollution due to vehicular traffic activities but also other anthropogenic activities.
***Key words**: Pollution, Environment, Road Side Soil, Heavy Metal, Borno.*

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INTRODUCTION

Heavy metals are chemical elements with a specific gravity that is at least 5 times the specific gravity of water. [1]. Heavy metals are important group of pollutants. They are non-biodegradable, hence are not readily detoxified and removed by metabolic activities once they are available in the environment. This may subsequently lead to their build up to toxic levels or bioaccumulation in ecosystem. Bioaccumulation of these heavy metals in man, animals and plants result in metal poisoning[2]. Environmental heavy metal pollution is mainly of anthropogenic origin and results from activities such as fossil fuels, vehicular emissions, industrial emissions, landfill leachates, fertilizers, sewage and municipal wastes [3,4,5,6]

Heavy metals in soils continue to receive increasing attention due to the greater understanding of their toxicological importance in ecosystems, agriculture and human health (while it is vital to consume small amounts of many metals to maintain good health, some metals cause particular concern if exposure is above the recommended limit), the growing scientific and public awareness of environmental issues and the development of even more sensitive analytical techniques to measure their concentrations accurately. [7]

Heavy metal concentrations in soil are associated with biological and geochemical cycles and are influenced by anthropogenic activities such as agricultural practices, industrial activities and waste disposal methods [8, 9, 10].Contamination of roadside soils with heavy metals arises from various sources such as vehicles, road wear, and slipperiness control industries. Trace metal concentrations, such as Cd, Cu, Zn, and particularly Pb in surface soils have been the focus of many investigations. Accumulation of these metals in surface soil is greatly influenced by traffic volume and motor vehicles, which introduce a number of toxic metals into the atmosphere[11,12]

Manganese is a common and rich element in soils and is an essential nutrient for organisms. The major sources of manganese in soil are fertilizers, sewage sludge and ferrous smelter. [13] Some reports showed that traffic activities enriched the roadside soil Manganese content[14], but [15] concluded that enrichment was attributed to natural sources. Nickel is an essential element for animals and some plants. Some reports found it was enriched in roadside soils but there was no direct evidence to conclude that enrichment came from the traffic activities [14, 15], although it was found in fossil fuel emissions. Cobalt is beneficial for humans because it is a part of vitamin B12, which is essential for human health. Cobalt is used to treat anemia in pregnant women, because it stimulates the production of red blood cells. However, too high concentrations of cobalt may damage human health. Chromium is a trace element in most soil. It is not an essential nutrient of plant but is a trace essential element for animal and people. The problems that are associated with chromium involve skin rashes, stomach ulcer, kidney, liver damages, lungs cancer and ultimate death. [13]. [14] investigated Chromium concentration in soil beside the busy road and found no correlation with the traffic activities. Cadmium has been one of the most concerned heavy metal pollutant and some previous studies indicates that it is associated with motor traffic [12]. There is no strong evidence to prove that Cadmium pollution by the roadside soil was mainly from the traffic activities[14, 15]. Lot of literatures showed strong evidences that traffic activities is one of Copper pollution source on roadside soil [14]. However, whether the drift of the particulate can reach so high an altitude (201-400m altitude) is not proved. This is a good support for the Copper pollution from the traffic activities but we still cannot ignore pollution from the fertizer and manure [16]. Some reports have shown that traffic activities enrich the roadside soil iron content [14]. However, [15] concluded that the enrichment of iron in roadside soil was attributed to the natural sources. Zinc is an essential nutrient for all organisms. It is a common component in leaded petrol, diesel oil, and even in unleaded petrol and in tyre wear and brakes. Inevitably, Zn is a pollutant of traffic activities on roadside soils [14, 15]. Lead has been used in leaded petrol, diesel oil, even in unleaded petrol (<0.015 g L^{-1}) and there has been concerns that it is the main pollutant from traffic activities[14, 15]. The pollution of Pb from the fertilizers was minor when compared to the atmospheric deposition [16].

Soil can be considered as a good indicator of environmental quality of heavy metals [17]. In Maiduguri, the Environment has undergone irreparable damage due to the population growth and its subsequent requirements in terms of housing and traffic density.Maiduguri (Lat. 11°50′N, Long 13°10′E) is located in Borno State, Nigeria. It is underline by the sediments of Lake Chad basin. Temperature ranges between 22 and 28°C, with means of the daily maximum exceeding 40°C before the onset of the rainy season, of March, through May. During the winter (December through February) the temperature falls to 12°C. It has an estimated population of 1,197,497[18]. The objectives of this study is to measure environmental level of the concentrations of heavy metals such as Cu, Co, Mn, Ni, Pb ,As, Cd, Cr and Fe in soil samples at Post Office, airport junction and Bama Station areas of Maiduguri Metropolis.

MATERIALS AND METHODS

Sample Collection

Soil samples were collected at distances of 50meters and 100meters from roadsides in various locations within Maiduguri, Borno State, Nigeria. Sample collections were carried out according to the methods described by Radojevic and Bashkin[19]: samples were collected using hand auger. Samples were put into a precleaned polyethylene bags and transported to the laboratory. Sampling points were designated as S1, S2 and S3.Point S1 is located at Bama motor park, Point S2 were Air port Junction and Point S3 at Post Office Areas. For each of the sampling points, soil samples were also collected at 250meters away from the main road to serve as controls. The samples were collected monthly from the designated and control points for a period of three months from December, 2012 to February, 2013.

Sample Preparation

Each of the Soil samples was dried separately in an oven at 105°C for 72 hours until they became brittle and crisp [20]. A portion (1g) of dried, disaggregated and sieved samples were placed separately in 50ml beakers and were digested with 10ml of HNO_3–$HClO_4$–HF(in the ratio of 9:4:1) to near dryness at 80 to 90˚C on hot plate. The digested samples were filtered separately into a 50ml volumetric flask using Whatman No. 42 filter paper and made up to $100cm^3$ mark with deionised water [19].

Sample Analysis

The digested samples were used to determine the concentration of some heavy metals such as Cu, Co, Mn, Ni, Zn, Cd, Cr, Fe and Pb using Atomic Absorption Spectrophotometer (Analyst 200 Pelkin Elmer).

Data Analysis

Data obtained was statistically analyzed using SPSS 16.0. Analysis of variance (ANOVA) with Turkey post-hoc test was used to determine the level of significance of variations between the samples. Results were considered statistically significant ($P<0.05$).

RESULTS AND DISCUSSION

Table 1 showed the heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Bama Station area; table 2 showed heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Bulumkutu area and table 3 showed heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Post office area in Maiduguri metropolis

The results showed that the level of some of the heavy metals analyzed was higher at 100m and at the controls when compared with their corresponding 50m. Analysis of Variance (ANOVA) also confirmed significant differences ($p<0.05$) between the levels of heavy metals in soil from different distances within the same locations with the exception of Manganese and chromium in Bama station and Cadmium, Iron and Lead in Bulumkutu and Cadmium and Iron in Post office areas which shown no significant differences. Therefore, the higher concentration of the heavy metals at 100m and at the control points might not only due to traffic pollution but also due to geographical status or leaching and runoff. This is in support of the work of Aslan*et al*. [21].in which the concentration of selenium in lichen increase with increase in distance. It was concluded that the higher selenium content of the lichen was due to the geographical area. Many researchers have notified that heavy metals contents were higher in plants samples collected near a main road [22]. Some reports have shown that traffic activities enrich the roadside soil metals content [14]. However, Oliva and Espinosa [15] concluded that the enrichment of some metals in road soil was attributed to the natural sources.

Table 1: Heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Bama Station area in Maiduguri metropolis

DISTANCE	Mn	Ni	Co	Cr	Cd	Cu	Fe	Zn	Pb
50m	$2.23^{a} \pm 0.06$	$0.03^{a} \pm 0.01$	$0.33^{a} \pm 0.01$	$0.83^{a} \pm 0.04$	$0.65^{ab} \pm 0.03$	N.D	$6.44^{a} \pm 0.34$	$0.34^{a} \pm 0.01$	$0.67^{a} \pm 0.01$
100m	$1.59^{a} \pm 0.01$	$0.04^{b} \pm 0.01$	$0.43^{b} \pm 0.02$	$0.97^{a} \pm 0.06$	$0.82^{a} \pm 0.08$	0.02 ± 0.01	$7.97^{b} \pm 0.21$	$0.71^{b} \pm 0.02$	$0.80^{b} \pm 0.02$
Control	$2.53^{b} \pm 0.03$	$0.03^{a} \pm 0.01$	$0.36^{c} \pm 0.01$	$1.19^{b} \pm 0.13$	$0.60^{b} \pm 0.04$	0.02 ± 0.01	$8.70^{c} \pm 0.30$	$1.40^{c} \pm 0.03$	$0.74^{ab} \pm 0.01$

The above values are means of replicate values (n=3). Within column, for similar samples means with different alphabets are statistically different ($p<0.05$). Control=250m away from each point and N.D= Not Detected.

Table 2: Heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Bulumkutu area in Maiduguri metropolis

DISTANCE	Mn	Ni	Co	Cr	Cd	Cu	Fe	Zn	Pb
50m	$1.53^{a} \pm 0.03$	0.01 ± 0.01	$0.09^{a} \pm 0.01$	$0.42^{a} \pm 0.02$	$0.32^{a} \pm 0.04$	N.D	$4.53^{a} \pm 0.12$	$0.50^{a} \pm 0.01$	$0.52^{a} \pm 0.02$
100m	$1.33^{b} \pm 0.04$	0.02 ± 0.01	$0.46^{b} \pm 0.01$	$0.49^{ab} \pm 0.01$	$0.36^{a} \pm 0.01$	$0.09^{a} \pm 0.01$	$4.14^{a} \pm 0.01$	$0.63^{b} \pm 0.01$	$0.56^{a} \pm 0.01$
Control	$2.25^{c} \pm 0.02$	0.02 ± 0.01	$0.23^{c} \pm 0.01$	$0.61^{b} \pm 0.01$	$0.49^{a} \pm 0.11$	$0.01^{b} \pm 0.01$	$6.81^{b} \pm 0.10$	$0.61^{a} \pm 0.03$	$0.74^{b} \pm 0.01$

The above values are means of replicate values (n=3). Within column, for similar samples means with different alphabets are statistically different ($p<0.05$). Control=250m away from each point and N.D=Not Detected.

Table 3: Heavy metal concentrations (μg/g) in the Samples at vary distances from the main roads in Post office area in Maiduguri metropolis

DISTANCE	Mn	Ni	Co	Cr	Cd	Cu	Fe	Zn	Pb
50m	$2.34^{a} \pm 0.04$	0.04 ± 0.01	$0.34^{a} \pm 0.01$	$0.68^{a} \pm 0.02$	$0.71^{a} \pm 0.12$	0.03 ± 0.01	$4.96^{a} \pm 0.01$	$0.96^{a} \pm 0.01$	$0.72^{a} \pm 0.02$
100m	$1.61^{b} \pm 0.02$	0.04 ± 0.01	$0.40^{b} \pm 0.01$	$1.08^{b} \pm 0.04$	$0.70^{a} \pm 0.04$	0.01 ± 0.01	$5.07^{a} \pm 0.10$	$0.59^{b} \pm 0.02$	$0.78^{b} \pm 0.02$
Control	$1.04^{c} \pm 0.06$	N.D	$0.01^{c} \pm 0.01$	$0.08^{b} \pm 0.09$	N.D	0.02 ± 0.01	$2.11^{b} \pm 0.05$	$0.63^{b} \pm 0.01$	$0.09^{c} \pm 0.09$

The above values are means of replicate values (n=3). Within column, means with different alphabets are statistically different ($p<0.05$). Control=250m away from each point and N.D= Not Detected.

CONCLUSION

Generally, the concentrations of the metals was in the order of Fe>Mn>Pb>Cr>Zn>Cd>Co>Ni>Cu in the soil samples. The Results showed that the level of some of the heavy metals analyzed was higher at 100m and at the controls when compared with that at 50m. Analysis of Variance (ANOVA) also confirmed significant differences ($p<0.05$) between the levels of heavy metals in soil from different distances within the same locations. These showed that geographical status and traffic densities vary from one point to another. Therefore, traffic activities can partly contribute to heavy metals pollution in these areas and actually, the main contributors of heavy metals accumulation in this area might due to mobility of the metals through leaching and runoff. This finding suggests that the soilscan be used as indicator of Environmental Pollution in Maiduguri.Therefore, further studies should be conducted using soil to indicate the levels of other environmental pollutants.

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