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# HEAVY METALS ENVIRONMENTAL POLLUTION ASSESSMENT AT THE FEDERAL POLYTECHNIC MUBI, NIGERIA

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ABSTRACT

*Heavy metals environmental pollution has been a serious cause for concern to man worldwide because of their persistency, toxicity and threat to human life and environment. However, the problem is even worse in developing countries due to lack of political will by governments to put in place concrete outfits for environmental monitoring and systematic information collation on pollutants. Available literature on heavy metals environmental pollution as it relates to our area of interest at Federal Polytechnic Mubi furnished no data. Thus, the outcome of this research will in no doubt alleviate the paucity of extant literature on the targeted elements: manganese, copper, chromium, zinc, nickel, iron and cadmium. Soil samples of three soil profiles from four selected sites of major*

**Introduction:**

Heavy metals environmental pollution is mainly due to anthropogenic and volcanic eruptions inputs into the environment (Alloway, 1990). The former source is one of the legacies of the past and present industrialization and urbanization waste disposal activities coupled with the degree of chemical usage (Alloway, 1990, Pratt, 1993; Jivendra, 1995; Ma et al., 2019). One can hasten to add natural sources or emissions other than volcanic eruptions, such as source as geochemical activities (for example, earthquakes, landslides, debris flow) wild forest fire, windblown dust and biogenic sources (Olade, 1987; Cope 2004; Ming-Hoa,



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*road verges at the Federal Polytechnic Mubi were collected and atomic absorption spectrometer (Buck scientific 210 Model) was used to determine the environmental pollution load of the aforementioned elements. On the whole, the soil profile distribution of Ni, Cu, Pb, Mn, Fe. Zn and Cr showed marked variations within the same site and between different sites. The overall mean values recorded for these elements were 1.64, 1.08, 0.34, 267.27, 35.74 and 1.22 mg/kg, respectively. Cadmium was not detected in any of the soils. The very low concentration values of the metals obtained notwithstanding, these elements do not remain stationary in the soil profile as erosion and other agents can transport them to the farming areas within the campus. Thus with time, these pollutants in the environment may accumulate unnoticed to toxic levels. And via food chain transfers, increases the elemental toxicological load and pose adverse health effects. There is therefore, the need to formulate workable strategies to continuously monitor these pollutant elements in the soils at definite intervals as well as establish a databank of geochemical background values of pollutant elements in agricultural soils, urban road dust, and others; which is a desideratum for comprehensive assessment of contamination status of a given soil medium in Nigeria.*

***Keywords:*** *Heavy metals, Environmental pollution load, Assessment, Spectrometric method, Major Road, Federal Polytechnic Mubi.*

2005; European Union/World Health Organization (EU/WHO), 2007; Ma et al., 2019) to the aforementioned dual causes of the said environmental pollution types. Thus, these activities can lead to potential increase in the focused metals in this present study.

Heavy metals such as cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni). lead (Pb) and zinc (Zn) are delivered in large quantities to the ecosystem globally via atmospheric deposition (Olade, 1987; Alloway, 1990; European Environmental Agency (EEA), 2007; Wafen, Ibrahim & Lawal, 2009; Negrel & Roy, 2012; Lindgren, 2007 as cited in Oghuvwu, Ojanomore, &

Omiosigho, 2014). Amongst the anthropogenic emissions, the main sources of heavy metals into the atmosphere are mining and non-ferous metal smelting plants which emit Cd, Cu, Ni, Pb, selenium (Se) and Zn (Neira, 2006; Blacksmith Institute, 2012). Others include combustion of fossil and leaded-petrol fuels which mobilize Cr, Pb and Zn into the atmosphere (Ogugbuaja, Schwazer, & Wilson, 1984; Ademoroti, 1996).

According to (Khuhawar, Mizra, & Jahangir (2012); Owamah, 2013), exploration, production and refining of crude oil and soil spillage are some other sources of release of Ni, V, Fe, Zn, Cu, Pb and Hg increases the toxicological load to the environment. A review contribution from Campel and Nikel (2006) noted that environmental sources of lower levels of Ni include tobacco smoking, dental or orthopaedic implants, inexpensive jewellery and stainless kitchen utensils. Still, other sources include, agro-allied practices through the application of phosphatic fertilizers, pesticides, organic manure (Mengel, Kirkby, Kosegarten, & Appel, 2006; Dara, 2008; Wuana, & Okieimen, 2011) and sludge (Salem, Badaway, & El-Dweeb, 2002) which contains various heavy metal contaminants either as impurities or active constituents, contribute their unfair share of heavy metals such as Cd, Cr, mercury (Hg), Ni, Pb and Zn into the soil. The effluents from crude oil refineries and steel plants also compete as if it were, with the above- mentioned sources in the discharge of cobalt (Co), Cr, Cu, Fe, Ni and V into the ecosystem (Okuo & Lyasele, 2004). To crown it all, it is pertinent to mention a novel and intriguing source of heavy metals dispersal into the environment in Nigeria: The electronic-waste (e-waste) dumping of fairly used electronic gadgets or parts thereof, like transistors or integrated circuits (ICs) panels, massively imported into the country but failed to get ready buyers (Oketola, 2009; Sowunmi, 2009). And therefore, disposed in dumpsites or open dustbins in urban settlement or abandoned on the verges of the highways. Besides the indispensability of these metals, their compound as well as the alloys in nations growth (Nriagu, 1988), some of them Co, Cr (III), Cu, Fe, Mn, Mo and Zn are essential nutrients in human diet (Goyer et al., 2004) and hence, man's existence would have been almost impossible without them (Laniyan, Philips, & Elesha, 2011).

But their presence in high concentration has toxic effects due to their ability to cause oxidative stress by free radical formation (Khayazade & Abasi, 2001).

Their long half-lives and hence, persistency in the environment (John. Jacquillet, & Unwin, 2010) results in human exposure to heavy metals even at low concentrations and can cause adverse effects because of their ability to bioacummulate and biomagnify in body tissues and organs (Subukola, Aderniran, Odedairo, & Kafinhausa, 2011). The aforementioned attribute coupled with high toxicology of these elements in the environment have made them to be recognized as priority pollutants (Owamah, 2013). The seriousness of these metals types contamination is further underscored by the fact that they are water-soluble, non- degradable, vigorously oxidizing and strongly bonded to many biochemicals, inhibiting their functions (Sangare, Trived, & Mishara, 2012). Water-solubility on the other hand, predisposes the metals to the formation of ions and thus, is the sole factor influencing bioavailability and absorption of metals and their compounds (Goyer et al., 2004). Heavy metals such as Cr (VI), Ni, and Cd have been well-established as human carcinogens in one form or another or in particular routes of exposure (National Toxicology Programme [NTP], 2000). Furthermore, some exhibit adverse effect on reproductive system and unfavourably impact on nutrition by displacing more biologically useful metals such as calcium (Ca) and Zn (American Herbal Products Association [AHPA], 2009).

According to Wei and Yang (2010), Wuana and Okieimen (2010) and Ma et al. (2019) in urban areas, these elements enter human body via pathways such as direct inhalation of contaminated air, ingestion of food, drinking contaminated water and via the food chain (soil- plant human or soil- plant-animal-human). With time the level of these toxic species which bioaccumulate, especially in adipose tissues and organs in the body may pose health problems as exemplified in the case of adverse health consequence upon the consumption of Cd-contaminated rice produced in the region of Tamaya city, Japan in the 1960s (Titus, 2003; Nishijo et al., 2017).

Some adverse health effects of Pb, Cu, Cd, Fe, Zn, Cr, Mn and Ni in humans are presented infra vide: Pb is a soft, ductile and malleable bluish grey post 5d transition metal (Prakash, Busu, Tuli, & Madu, 2006). It is commonly found in many consumer products such as some variants of lead- based paints (http://www.chm.bris.ac.uk .rnotrn/leadtet/leadh.htm). as well as air, contaminated soil, house-hold dust, food, lead-glazed pottery and drinking water, but it is harmful to human health if inhated or ingested (Minnesota Department of Health, 2008; Martin & Griswold, 2009). Pb is also deliberately added as tetraethyl lead (TEL) to petrol to improve its octane number. And during combustion, PbO is formed (http ://www.chmbris.ac/.uk/motm/leadtet/leadh.htm; Kareni & Akinbode, 2003; Wallington, Kaiser & Frarelly, 2005) which reacts with the co-additives (1,2 — dibromethane and others — alkyl halides) to form $PbCl_2$, $PbBr_2$ etc and subsequently released to the environment as pollutants emission via the exhaust (Ademoroti, 1998). When inhaled by humans the lead-derived pollutants bioaccumulate in the body system over time resulting in anaemia and if acute, death ensues (http://www.chm.bris.ac-uk/motm/leadtet/Leadh.htm; Ademoroti, 1998). Children are more vulnerable to Pb toxicosis and blood level lead (BLL) above 10 µg/dl is labelled as poison (Indian National Academic [INSA], 2011). Furthermore, excess toxicity can cause abnormal cognitive functions in children (Minnesota Department of Health, 2008; INSA, 2011).

Cu is a ductile and malleable reddish-brown 3d transition metal with atomic number 30. The human body has an innate regulation mechanism for maintaining the proper level of Cu. However, infants and people with Wilson's disease are more prone to its toxic effect; Despite this natural Cu regulating mechanism mentioned supra vide, drinking water containing excess of it over a short period of time could experience adverse health problems, characterized by vomiting, diarrhoea and stomach cramps. Cu also causes liver and kidney damages and eventually death (Minnesota Department of Health, 2008).

Zn is a ductile, malleable and lustrous bluish white 3d "transition metal" (Callender, n.d). ZnO and some other compounds of Zn are used as

accelerator and additives, respectively in the manufactures of tyres in the automobile industry (Akeem & Akinbode, 2003). Zn species are released to the atmosphere in traffic related emission (EEA, 2007). The harmful effects of Zn include nusea, diarrhea vomiting and general malaise (Akeem & Akinbode, 2003).

Cd is a soft, ductile malleable and silvery-white 5d transition metal with atomic number 48 (World Bank Group, 1998). Tobacco smoke is a major source of Cd exposure in humans but not food (Ming-Hoa, 2005; Figueroa, 2008; INSA, 2011). Tobacco smoke contains an appreciable amount of this metal. Because its absorption from the lungs is much greater than from gastrointestinal tract, smoking contributes significantly to the total burden (Ming-Hoa, 2005; Figueroa, 2008). As stated elsewhere, it has been established as a human carcinogen. Cd is a cumulative toxicant that affect kidney, bone metabolism and reproductive tract as well as endocrine system. Excessive exposure to Cd causes skeletal demineralization as calcium excretion is increased; which probably can lead to increase in bone fragility and risk of fractures (Wu, Jin, Wang, Ye, Kong, & Nordeberg, 2001). Cd excessive accumulation in the human body can also cause cardiovascular, nervous and bone diseases (WHO, 1971). According to Oliver (1997), serious health problems can ensue as a consequence of increased dietary Cd accumulation in the human body as was reported elsewhere. About 100 people died from Cd poisoning caused by consumption of rice grown in Cd-contaminated soil. The symptoms were described as “Itai itai”. meaning it hots, it hots or ouch-ouch in Japaneses (Titus, 2003; Dara, 2008). It can also cause sterility in male humans (Higgin & Bums, 1975).

Fe is a hard, brownish 3d transition metal with atomic number 26. In the form of its alloys, Fe is used in the manufacture of body parts of automobiles, viz, engine blocks, piston and cylinder and tyres (EPA 1997; Akeem & Akinbode, 2003). The wear and tear of the aforementioned automobile body parts. couple with rust from abandoned decaying vehicle parts are the primary sources of Fe to the environment. Secondary sources of it are supplements, drinking water. Fe purpose cookingware. Excessive

accumulation of Fe can affect liver, cardiovascular system and kidney in humans (Botha & Davison, n.d), diabetes mellitus and skin promentation (Skinke & Cook, 1987). And it is also credited with pathological events such as the deposition of Fe oxides in Parkinson's disease (Candelaria, Gracia-Arias, Cetina, & Dulnas Gonzalez, 2006 as cited in Mudgal, Madaan, A. Mudgal, Signh, & Mishra, 2010). In addition to its role in health and disease, dietary $Fe^{3+}/Fe^{2+}$ ions are specifically implicated in the free radical theory of ageing as they are credited with oxidatixe stress (Mudgal, Madaam, A. Mudgal, Singh, & Mishra, 2010).

Cr is a lustrous silvery grey 3d transition metal with atomic number 24 (Wuana & Okieimen. 2010). In its maximum oxidation state, Cr compounds are human carcinogens. When in contact with the skin it can cause ulceration and dermatitis. Furthermore, inhalation of this form of the metal causes ulceration and perforation of the mucous membrane of the nasal septum and irritation of some related organs of the respiratory tract, as well as asthmatic bronchitis and bronchidspasm characterized by coughing and wheezing which is accentuated by shortness of breadth and nasal itching. Long-term exposure of Cd can cause damage to liver and kidney (Martin & Griswold, 2009; Wuana & Okieimen, 2011). Mn is a pinkish grey 3d transition metal with atomic number 25. In excessive concentrations in the human body, it accumulates in the kidney, liver and bones resulting into "manganese psychosis" — an irreversible brain damage. The characteristic symptoms are uncontrollable laughter and sexual excitement; culminating into impotency (Mengel, Kirkby, Kosegarten, & Appel, 2006). The probable reason for the manifestation of the health condition might not be unconnected with the fact that when Mn is inhaled, it is conveyed directly to the brain unmetabolized (Oghuvwu, Ojanomore, & Omosiogha, 2014).

Ni (atomic number 28) is a silvery white 3d transition metal (Callendar, n.d). It occurs in the environment at very low concentration and when inhaled or ingested in excess of the maximum tolerable amount. Ni has adverse health effects resulting into the development of various cancer types (Wuana & Okieimen, 2011).

Recently, there is an upsurge of interest in environmental pollution studies in some urban areas in Nigeria (Kareem & Akinbode, 2002; Nkwocha, 2004; Oluseyi, Olayinka, & Adeleke, 2012; Abidemi, 2013; Oghuvwu, Ojanomare, & Omosigho, 2014). However, a critical perusal of available literature revealed that the scientific results generated furnished no data on Mubi and The Federal Polytechnic Mubi, Mubi in particular.

The area of interest is the major road at The Federal Polytechnic Mubi, about 3.1 km long. The institution has witnessed a phenomenal increase in automobiles plying the road as well as increase in the human population and road repairs works within the last three decades, more vehicular traffic and related emission, and waste-generation. The consequence of the above is, the concomitant increase in the emission of pollutants from vehicular exhausts, wear and tear of tyres, abrasions of engine parts, borings, brake linings, asphalt coatings, (EEA, 2007; WHO, 2007) and possible decay of abandoned automobiles body parts. The inceneration of solid wastes on campus also augments the level of emissions mentioned above.

It is therefore, imperative to investigate the level of selected heavy metals in the roadside soils of the major road, since soil is a major sink or reservoir for heavy metals released into the environment by the aforementioned anthropogenic activities (Wuana & Okieimen, 2011).

## MATERIALS AND METHOD

### Study Area

Mubi is located between latitude $10^0$ $11^1$ $30^{11}$ and $10^0$ $22^1$ $30^{11}$ N and between longitude 13° 13’ 0011 and 13° 30’ 00”E (Uba Topographic Sheet 156, Edition 1, 1974).

It is a fast growing urban conglomerate in North-Eastern Nigeria and houses three institutions of higher learning and The Federal Polytechnic Mubi is but one. As stated in the introductory section, the study area is the major road and also, the longest in the institution and transverses the entire length of the campus from the main gate, meandering close to the

"Sambisa Forest" Hostel and finally to the "End-of-the Road"-the termination of the tarred road.

At The Federal Polytechnic Mubi, over 1,000 cars ply this road on work days as witnessed in the current 2017/2018 academic session in comparison with the solitary 10 cars that plied the same route in the mid l980s. The volume of traffic is high in the early hours of the day. This increased traffic means greater combustion rate. The consequence of the above is the cocomittant or commensurate increase in traffic emission of pollutants with their attendant negative health effects. Not only has the fleet of cars increased astronomically over the past three decades, the human population has also increased about 10-fold with its associated twin waste- generation problem. This indiscriminate solid refuse incineration near the said road sides on campus is a common sight, which also augments the traffic emission mentioned previously.

## Sampling and Laboratory Procedure

The method as described by Zaku (2006) was adopted for sampling. Three samples each from four sites, viz., Sport Complex ("A"), Sambisa Forest Hostel ("B"), Mass Communication Department ("C") and Food Science and Technology Department ("D") close to the major road were collected in a zigzag manner trasversing versing the major road, and each spot separated by 50 metres. A total of 12 samples were collected using stainless auger and stored in labelled plastic bags. The choice of the range of the sampling depth is predicated on the fact that the applied fertilizer in farms should be available within 20 cm of the surface soil for maximum growth as 80 - 95 per cent of the roots of the crops are found within this depth (Beyronth, Wells, Norman, Mamel, & Pillow, 1998).

Foreign objects were removed from the homogenized field samples and air-dried for seven days, crushed and sieved through a 2 mm - aluminium sieve. A test sample was obtained from the representative sample by conning and quartering method (Campos-M & Campos-C, 2017).

## Digestion Procedure and Metal Content Determination

A definite amount (0.25 g) of each test sample was placed in a Kjedahl digestion flask, followed by a 20 $cm^3$ mixture of concentrated $HNO_3$ and HCI (5:1). The digestion flask was then heated on a beating mantle in a fume cupboard until white fumes were observed. The solution was then cooled and 10 $cm^3$ de-ionized water was added and resultant mixture was filtered using Whatman filter paper into a standard volumetric flask and made up to mark with the de-ionized water (Zaku. 2006). The concentration of Cd, Cr, Cu, Fe, Mu, Ni, Pb and Zn, in each sample solution was determined in triplicate on atomic spectrometer (Buck Scientic 210 Model).

## RESULTS AND DISCUSSION

The mean concentrations of Ni, Cu, Pb, Mn, Fe, Zn, Cr and Cd obtained from the different sites of the major road verges at The Federal Polytechnic Mubi are presented in
Table 1.1.

### Zinc (Zn):

The main Zn contains of soil in sites “A” “B” “C” and “D” ranged from 21.34 — 64.17 mg/kg (Table 1.1). The concentration values of Zn in the soil showed marked variation between different sites. The mean contents were within the recommended range of 5 — 100 mg/kg by Alloway (1990).

### Nickel (Ni):

There was a marked variation in the distribution of Ni in the soils from different sites but similar metal contents values were obtained within the same site. The overall mean concentration of 1.64 mg/kg was far below the lower critical limit for normal plant growth as reported by Saxena (1990).
Iron (Fe): Fe has the highest concentration values in all the sites in comparism with the other pollutant elements. These high values of Fe cannot be unconnected with the massive presence of haematite and Fe oxides in the soils as characterized by the very deep brownish colour.

### Manganese (Mn):

Mn was not detected in one sampling point in sites "A" and "B", respectively. Its concentration ranged from 0.004 — 1.33 mg/kg which was far below the upper critical limit of 604 mg/kg recommended by International Atomic Energy Agency [IAEA] 2000).

### Chroniurn (Cr):

The soils from all the sites were poor in Cr content with a mean range of 1.14 — 1.32 mg/kg. This was far below the lower critical limit of 49 mg/kg recommended by IAEA (2000) for normal plant growth. This low content of Cr portends non-contamination of the studied area by this metal.

### Cadmium (Cd):

Cd was not detected in any of the soils of the area of interest. This might be due to:

i. Its slow natural abundance
ii. Scavenging abilities of Mn and Fe for Cd in the soils (Alloway, 1990 as cited in Zaku, 2006);
iii. Its concentrate on was below the detection limit of the instrument (Atomic absorption spectrometer — Buck Scientific 210 Model used for its determination in the soils;
iv. Extensive leaching of this metal to levels below the maximum sampling depth; and
v. Extensive teaching out of Cd from the topsoil profile during heavy rains and subsequent transportation to other areas by runoffs.

### Lead (Pb):

Pb was only detected in site "A" with mean concentration value of 0.002 mg/kg. The reasons proffered for the non-detection of Cd in the studied area might be applicable to this element in sites "B", "C" and "D".

Heavy metals status of roadside soil samples collected from Akpakapara Road in Benin City were determined by Oghuvwu, Ojanomare and

Omosigho (2014). Fe, Zn, Pb, Mn, Cr, Cd, Cu and Ni were found to be the pollutants with mean values of 201.96, 311.94, 2.78, 3.17, 0.19, 4.54, 4.08 and 24.90 mg/kg, respectively. The concentration of these elements were by far higher than those obtained in this present study with then exception of Zn. These higher concentration values were attributed to the higher traffic volume on the road with its attendant traffic and related emissions into the environment and soil being a mojor sink for these pollutants.

In another related study, Akeem & Akinbode (2003) also analyzed heavy metal, contents of roadside soil samples from major highways and road junctions in Benin City. Fe, Zn and Pb were quantified in concentrations 12824, 1280, 1176 mg/kg and 13648, 1384, 1200 mg/kg respectively for Benin — Warri and Benin — Lagos roads. The metal contents were by far higher than those obtained by Oghuvwu, Ojanomane, & Omisigho (2014) at Akpakpapawa Road in the same city. This Road is a very less busy road in comparison to Benin — Warri and Benin — Lagos Roads respectively. Akeem and Akinbode attributed their very high values to very high traffic volumes of these roads due to the peculiar location of Benin City in relation to Lagos, the economic nerve centre of the nation and gateway to both South and South Eastern states with their attendant traffic volumes and emissions.

## Degree of Contamination of Heavy Metals in Retrospect

The geochemical Index (Igeo) introduced by Muller in 1969 can mathematically be expressed (Wei & Yang, 2010; Ma et al., 2019) as:

$$Igeo = Iog_2 (Cn/1.5\ Bn) \qquad 1$$

Where:

Cn = measured concentration of the element in the environment.

Bn = geochemical background values in soils.

1.5 = constant that accounts for natural fluctuations in the concentration of a given species as wells as anthropogenic influences in the environment.

Igeo index has been widely employed in Europe trace metal studies. It gives a vivid picture of the degree of contamination of the study area:

i. Igeo $< 0$ is uncontaminated;
ii. $0 <$ Igeo $\leq 1$ uncontaminated to moderately contaminated;
iii. $1 <$ Igeo $\leq 2$ moderately contaminated;
iv. $2 <$ Igeo $\leq 3$ moderately to heavily contaminated;
v. $3 <$ Igeo $\leq 4$ heavily contaminated;
vi. $4 <$ Igeo $\leq 5$ heavily to extremely contaminated; and
vii. Igeo $> 5$ extremely contaminated.

We were unable to use this more embracing concept of Muller in this study due to lack of geochemical background values of the elements examined.

## Enrichment Factor (EF)

EF is a double-barelled tool often used to evaluate the extent of metal enrichment in soil and as a discriminant between the sources of the metals from natural and anthropogenic activities (Kowalka et al., 2010 and Paloxic et al., 2019 as cited in Ma et al., 2019). It is mathematically expressed as in Equation (2):

$$EF = \frac{(C_m/C_{Ti})s}{(C_m/C_{Ti})Bn} \qquad 2$$

Where

$C_m/C_{Ti}$ = Concentration ratio of metal to the reference element (Ti) in the sample and geochemical background values and Bn as explained in Equation (1) supra vide (Ma et al., 2019).

According to Liu, BaO, Yao, Yemg., & Wang (2018, conservative elements such as aluminium (Al), Fe, Mn and calcium (Ca) can be used as reference standard; the EF values obtained from analysis are often interpreted as follows:

a. As a discriminant (1) EF value $< 1.5$; the element originates from the earth's crust or through natural weathering;
b. As an indication of degree of metal enrichment in the soil.

i. EF values $< 1$; indicates zero enrichment;
ii. EF values of 1 – 3; indicate minor enrichment;

iii. EF values between 3 – 5 indicate moderate enrichment;
iv. EF values ranging from 5 – 10; an indication of moderately severe enrichment;
v. EF values of 10 – 25; an indication of severe enrichment; and
vi. EF values > 50; an indication of extremely severe enrichment.

It is pertinent to note that the Igeo and EF values are complementary in the interpretations of measurement results.

## CONCLUSION

The concentration values of the metals obtained in this study were far below the critical values recommended by Alloway (1990), Saxena (1990) and IAEA (2000) for normal plant growth. The heavy metals concentrations of the targeted elements reported in this study have an abundance trend in the order :

$$Fe > Zn > Ni > Cr > Cu > Mn > Pb$$

In the interim, the results of this study can serve as beachmark for future investigations. The studied area is therefore not contaminated by the elements investigated.

## RECOMMENDATIONS

Although, the concentration of the pollutant metals examined were far below the authenticated upper critical limits, it is worthy of note that soils are not only medium for plant growth and primary reservoir of pollutants but also a transmitter of many pollutants species to the immediate environment and even beyond. And hence, accumulated pollutants in the topsoil can be easily be transported to the different environment components (Dennis, Essien & Udoh, 2013) including the farming areas within the campus via runoffs and / or erosion or leaching out during heavy rainfall. With time, they accumulate within the soil profile and may pose adverse health problems via the food chain. Muller's concept of

geochemical index which is a more comprehensive approach than the one adopted could not be used in the description of the contaminated status or otherwise of the studied area due to non-availability of geochemical data on the background values of the elements investigated. In the light of the above therefore, there is the need for :

i. The establishment of a databank of geochemical background values of elements found in agricultural soil, urban road dust and enrichment factor values;
ii. Continuous monitoring of the studied area for pollutant metals at definite intervals.
iii. The studies need to be extended to dry season soil samples in order to compare the variation in the status of the heavy metal pollution load with results of georeferenced rainy season samples in the studied area.

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Table 1.1: Concentrations (in mg/kg) of Ni, Cu, Pb, Mn, Fe, Zn, Cr and Cd in the Studied Area

| Sample | Points | Ni | Cu | Pb | Mn | Fe | Zn | Cr | Cd |
|---|---|---|---|---|---|---|---|---|---|
| A | A1 | 2.92 | 0.92 | 0.001 | ND | 331.01 | 64.41 | 1.04 | < 0.01 |
| | A2 | 2.92 | 0.95 | 0.004 | 0.01 | 336.52 | 62.61 | 1.24 | < 0.01 |
| | A3 | 2.77 | 0.95 | 0.002 | 0.04 | 335.72 | 65.50 | 1.14 | < 0.01 |
| | X | 2.84 | 0.94 | 0.002 | 0.017 | 354.42 | 64.17 | 1.14 | < 0.01 |
| | ±S | 0.076 | 0.07 | < 0.08 | 0.02 | 2.98 | 1.46 | 0.10 | < 0.01 |
| B | B1 | 2.25 | 0.15 | < 0.08 | 0.003 | 322.64 | 23.20 | 1.24 | < 0.01 |
| | B2 | 1.05 | 0.15 | < 0.08 | 0.001 | 140.32 | 22.44 | 1.10 | < 0.01 |
| | B3 | 1.05 | 0.15 | < 0.08 | ND | 140.61 | 23.62 | 1.32 | < 0.01 |
| | $\bar{X}$ | 1.45 | 0.15 | < 0.08 | 1.333 | 204.52 | 23.09 | 1.22 | < 0.01 |
| | ±S | 1.05 | < 0.005 | < 0.08 | 0.002 | 110.95 | 0.60 | 0.11 | < 0.01 |
| C | C1 | 1.81 | 0.99 | < 0.08 | 0.019 | 143.60 | 21.25 | 1.22 | < 0.01 |
| | C2 | 0.30 | 1.00 | < 0.08 | 0.018 | 144.21 | 21.32 | 1.08 | < 0.01 |
| | C3 | 0.22 | 0.99 | < 0.08 | 0.015 | 144.60 | 21.46 | 1.66 | < 0.01 |
| | $\bar{X}$ | 0.78 | 0.99 | < 0.08 | 0.017 | 144.14 | 21.34 | 1.32 | < 0.01 |
| | ±S | 0.90 | 0.006 | < 0.08 | 0.002 | 0.50 | 0.11 | 0.30 | < 0.01 |
| D | D1 | 0.78 | 1.30 | < 0.08 | 0.001 | 336.00 | 34.42 | 1.21 | < 0.01 |
| | D2 | 1.75 | 1.21 | < 0.08 | 0.004 | 335.00 | 34.00 | 1.21 | < 0.01 |
| | D3 | 1.92 | 1.21 | < 0.08 | 0.001 | 337.00 | 34.64 | 1.21 | < 0.01 |
| | $\bar{X}$ | 1.48 | 1.24 | < 0.08 | 0.002 | 336.80 | 34.34 | 1.21 | < 0.01 |
| | ±S | 0.62 | 0.052 | < 0.08 | 0.002 | 1.00 | 0.32 | 0.00 | < 0.01 |
| | $\bar{\bar{x}}$ | **1.64** | **1.08** | **0.002** | **0.34** | **267.27** | **35.27** | **1.22** | **ND** |

**Key:**

$\bar{\bar{X}}$ = Mean of means

ND = Not detected

< = Limit of detection