



Analysis of Pollution Levels of Heavy Elements Using Fractionation Pattern of Street Soils of Langtang North, Plateau State, Nigeria

Lungfa Collins Wuyep^{1*}, U. F. Hassan¹, A. A. Mahmoud¹, T. M. Gudam¹, M. Siman¹, Lumi Zakka² and Habila Yusuf Thomas³

¹Department of Chemistry, Abubakar Tafawa Balewa University, Bauchi, Bauchi State, Nigeria.

²Centre for Geodesy and Geodynamics Toro, National Space Research and Development Agency, Nigeria.

³Department of Nuclear Energy, Federal University of Pernambuco, Pernambuco-Brazil.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJOCS/2021/v10i419100

Editor(s):

(1) Dr. SungCheal Moon, Korea Institute of Materials Science, Korea.

Reviewers:

(1) Theo Davies, Mangosuthu University of Technology, South Africa.

(2) Dodo Juliet Dingtsen, University Of Jos, Nigeria.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/76432>

Original Research Article

Received 21 August 2021
Accepted 31 October 2021
Published 02 November 2021

ABSTRACT

Soil Pollution is a serious environmental challenge around the world today. Anthropogenic activities and population explosion have continued to pose great danger to our environment most especially land resources which are fixed. It is against this backdrop that this study assessed the levels of some selected heavy elements (As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn). To achieve this, various fractions of exchangeable bound metals, carbonate bound metals, manganese oxide bound metals, iron/manganese bound metals, organic/sulphide bound metals and residual bound metals in soils of Bala, Gantang, She-for, Walang and Yangang Streets as well as Intorok Street which serves as control, Langtang North, Plateau State, Nigeria were assayed using Atomic Absorption Spectrophotometry. The results show that the bioavailable/soluble fractions ranges in (mg/kg) are for: As (BDL – 34.00), Cd (3.00 - 45.00), Co (BDL – 70.00), Cr (42.00 – 155.00), Cu (47.00 – 73.00), Fe (48.00 – 116.00), Mn (46.00 – 119.00), Ni (42.00 – 108.00), Pb (30.00 – 292.00) and Zn (45.00 – 207.00) in all the Streets investigated. The residual/ insoluble fraction ranges in (mg/kg) are for: As

*Corresponding author: E-mail: wuyepzhar1991@gmail.com;

(BDL – 5.00), Cd (1.00 – 11.00), Co (BDL – 25.00), Cr (9.00 – 56.00), Cu (11.00 – 19.00), Fe (11.00 – 28.00), Mn (10.00 – 25.00), Ni (10.00 – 21.00), Pb (11.00 – 68.00) and Zn (9.00 – 47.00). The residual fraction is associated with minimal toxicity since migration and transformation of this fraction under general conditions are limited because of being tightly bound to Fe and Mn oxides and hydroxides. The bioavailable fraction is generally observed to be predominant in all the soil, it is usually associated with anthropogenic factors. Higher heavy element concentrations in these streets were recorded in points where there are evidences of organic load discharge and domestic effluents as in the case of Gantang, Yangang, and Bala streets. The fractionation pattern for the six streets assayed showed the northern (hill) part of Langtang North has no potential risk of contamination. However, the plain or southern part of the study area showed high potential risk that if not monitored will result in serious contamination. Topography plays an important role in the risk factor of heavy element contamination in the study area. The overall results showed evidence of some heavy metal pollution in all the Street soils assayed with possible cumulative effect over time.

Keywords: Fractionation; atomic absorption spectrophotometry; heavy elements; bioavailable fraction; residual fraction and pollution.

1. INTRODUCTION

Pollution is a global environmental problem which various countries around the world are suffering from. The problem is ranked among the most significant environmental challenges worldwide which requires evaluation and urgent solution to overcoming the negative impacts [1-2]. Soil is a heterogeneous mixture of organic and inorganic substances in which the binding mechanism of metals varies with the composition of the soil. Accumulation of heavy elements in soils is of great concern due to the probability of food contamination through soil root interface. Soil, water and atmosphere represent a growing environmental problem affecting food quality and human health, [3]. Though heavy elements cadmium, chromium, cobalt and lead are not essential elements, they are readily taken up accumulated in plants in toxic forms. The ecological effects of heavy elements in soil are closely related to the distribution of species in the solid and liquid phase of the soil. The presence of heavy elements in soil is of great ecological significance owing to their toxicity at certain concentrations [4]. Heavy Element pollution in soil has become serious with rapid industrialization and urbanization over the first two decades [5-6]. The toxic heavy elements entering the ecosystem may lead to geo – accumulation and bio – accumulation [7].

Pollution is the cause of many diseases, which affect not only the old, but also the young and energetic as well as all animals and plants [8]. Surface soil may act as carriers and possible sources of pollution, since the mobility of these elements is such that they remain in the upper

layers without regard to type of soil. The elements are not permanently fixed and can therefore be released by changes in climatic or environmental conditions such as rainfall and soil pH [9]. WHO report pointed out that twenty million children worldwide suffer from pollution which has become critical because of over-population [10]. The presence of heavy elements at trace level and essential elements at elevated concentration causes toxic effects if exposed to human population [11]. The most important source of heavy elements in the environment are the anthropogenic activities such as road construction, mining, smelting procedures, steel and iron industries, chemical industries, traffic, agriculture as well as domestic activities [12].

1.1 Evaluation of Heavy Elements in Roadside Soils

Abechi *et al.* [13], studied the Evaluation of Heavy Elements in Roadside Soils of Major Streets in Jos Metropolis. Results indicate the decreasing order of the average total metal content for the studied elements: Fe > Zn > Mn > Pb > Cd > Cu. Except for Cd, all metals are lower than the levels of those reported in other studies. The absence of Co and Ni indicate no pollution due to these elements. Correlation analysis between elements and the traffic volume (V) indicates significant positive correlation ($p < 0.05$) between Pb, Cd and Mn, and V.

A study of heavy element concentrations in soils, plant leaves and crops grown around dump sites in Lafia Metropolis, Nasarawa State, Nigeria by Opaluwa. [4] using digestion and Atomic Absorption Spectrophotometer methods (AAS)

showed the concentration of metals in soil samples in mg/kg from site 'A' determined were As = 0.66, Cd = 0.48, Co = 0.58, Cu = 0.91, Fe = 0.63, Ni = 0.31, Pb = 0.49, and Zn = 0.38 while that of site 'B' were As = 0.55, Cd = 0.84, Co = 0.63, Cu = 0.82, Fe = 0.64, Ni = 0.42, Pb = 0.53, and Zn = 0.40.

The metal concentrations in plant leaves and crops showed high level of Co = 0.33 and Fe = 0.32 in roselle leaves; Cu = 0.71 and As = 0.37 in groundnut; Cu = 0.48 and As = 0.28 in maize grains; As = 0.36 and Co = 0.32 in spinach leaves; and Cu = 0.36 and Co = 0.32 mg/kg in okra. The values of all the metals analyzed for samples from dumpsites were higher than those from the control site suggesting possible mobility of metals from dumpsites to farmlands through leaching and runoffs, but were below values recommended by the World Health Organization (WHO). Abechi *et al.* [13].

Level of heavy elements in soil Samples from farmlands along highways in parts of Owerri, Nigeria was evaluated by Okereke *et al.* [14]. The research was designed to ascertain the concentrations of heavy elements (Cu, Pb, Zn, Ni, Cd) in soil samples from farmlands along highways in parts of Owerri. Soil samples were collected from cassava farms along three major roads with high traffic density and a rural road that served as control location. The results revealed that the mean concentrations of metals in soil samples in mg/kg ranged from 3.00 – 6.31 for Cu; Pb, 0.09 – 4.00; Zn, 3.97 – 8.59; Ni, 0.001 – 0.96; and Cd, 0.31 – 0.79. The overall results showed evidence of some heavy element pollution on the soils with possible cumulative effect over time.

Heavy element concentrations in plants and soil along heavy traffic roads in North Central Nigeria was studied by [15]. Plant and soil samples were analyzed to determine the heavy elements (Cd, Zn, Cu, Cr, Pb and Ni) along major roads in Kwara State, Nigeria. Control plant and soil samples were obtained from Kwara State University (KWASU). Eight soil and plant samples were collected. One sample each of soil and plant was collected from Kwara State University as the control sample. Three plant species (*Kyllingapumilamichx*, *Kyllingasquamulatathanm ex vahl*, *Cenchrus biflorusroxb*) on which animals feed were collected along major roadsides. The samples were digested using wet method and heavy elements were analyzed using Atomic Absorption

Spectrophotometry Technique. Lead concentration in plants from the sites was found between 24-142 mg/kg and 24-157.667 mg/kg in soil samples. Copper was found between the ranges of 28.55-115.2 mg/kg and 7.70-80.13 mg/kg in plant and soil samples respectively. Zinc ranges from 13.00-120.45 mg/kg and 30.8219.23 mg/kg in plants and soil respectively. Cadmium was between BDL-0.400 mg/kg and BDL-0.366 mg/kg in plants and soil. Chromium was detected between BDL-53.65 mg/kg and 10.57-77.10 mg/kg in plants and soil respectively. Nickel was between 1.65-11.85 mg/kg and 1.83-14.87 mg/kg in soil and plants samples. Heavy elements (Cd, Zn, Cu, Cr, Pb and Ni) in the control samples were found to be 0.35, 40.00, 88.55, 0.65, 238 and 0.65 mg/kg for Cd, Zn, Cu, Cr, Pb and Ni in plants respectively. The soil samples were between 0.066, 9.50, 4.83, 55.63, 33.667, 4.33 mg/kg, Zn, Cu, Cr, Pb and Ni respectively. Based on this study, plant and soil along road sides were found with high concentration of heavy elements [15].

The ecological risk assessment of some heavy elements in roadside soils at traffic circles in Gombe, Northern Nigeria was reported by Sulaiman. (2018). This study evaluated the levels of some heavy elements in the roadside soils at different traffic circles using geo-accumulation index, ecological risk and Hakanson method to assess the overall ecological risk and identify ecological potential risk of heavy elements pollution. The metals concentrations were found to be higher in the soil samples from edge due to high traffic volume and human activities, and there was significantly decrease in concentration with increase in roadside distance.

Evaluation of some Heavy Elements in Soils along a Major Road in Ogbomoso, South West Nigeria was reported by Taofeek. [16]. Evaluation of the concentration of soil elements (Pb, Cd, Cr, Zn, Mn, Cu, Fe, and Ni) from selected sites (Odo Oba, Sabo and General Areas) along a major road in Ogbomoso was made in comparison with control site, LAUTECH Campus (LC) based on contamination factor and pollution indices. The metal levels in the sites revealed that: General > Sabo > Odo Oba > LC for the analyzed metals except Fe of which highest value was obtained in the control site. Further investigation is highly necessary to study the concentrations and health implications of these metals in residents of the linear settlements along this major road in Ogbomoso.

2. DESCRIPTION OF STUDY AREA

This study was carried out in Langtang North Local Government Area of Plateau State, Nigeria. (Fig. 1). The study area is located at 9°08'00"N 9°47'00"E/9.13333°N 9.78333°E. It has an area of 1,188 km² and a population of 140,643 based on 2006 Census (Wikipedia, 2019).

The inhabitants are synonymous with farming and commerce. It is the administrative capital and the commercial nerve center of the LGA and is the most densely populated area in the Local Government according to the 2006 Nigerian census result. It has the highest number of aging automobiles plying its roads compared to any part of the Local Government Area which contribute greatly to the source of heavy elements in the environment. Six sampling sites of Bala, Gantang, She – For, Walang, Yangang Streets and Intorok Street were selected, with Intorok Street used as control. At each sampling point, 500.00 g of soil was collected over a depth 0-10 cm using a stainless-steel sampler. Soil samples along roads were collected at a distance of 1.00 m away from the road and within an area of 1.00 m². Three (3) samples were collected from each point, thoroughly mixed in a clean plastic container to obtain a representative

sample, dried, crushed, sieved with a 2 mm mesh, kept in polyethylene bags and labeled prior to the analyses. The soil samples were labeled according to the regions from which they were obtained.

3. MATERIALS AND METHODOLOGY

The GPS coordinate of each point where soil sample was taken was recorded.

To assess the concentration of each metal in the sampled soil in the laboratory, reagents were used. The reagents used throughout this study are sodium ethanoate solution, hydroxylamine hydrochloride, 25.00 % (v/v) ethanoic acid, mol/dm³ trioxonitrate (V) acid, 30.00 % (v/v) hydrogen peroxide, aqua regia, ammonium ethanoate solution, 20.00 % (v/v) trioxonitrate (V) acid, 10.00 % (v/v) trioxonitrate (V) acid, and oxalate buffer.

3.1 Fractionation of Heavy Elements

The elements were fractionated using the methods of Tessier *et al.* [17] and Elsokkary [18] adopted by [19] [20]. The elements species were classified into six (6) fractions as shown in Table 1.

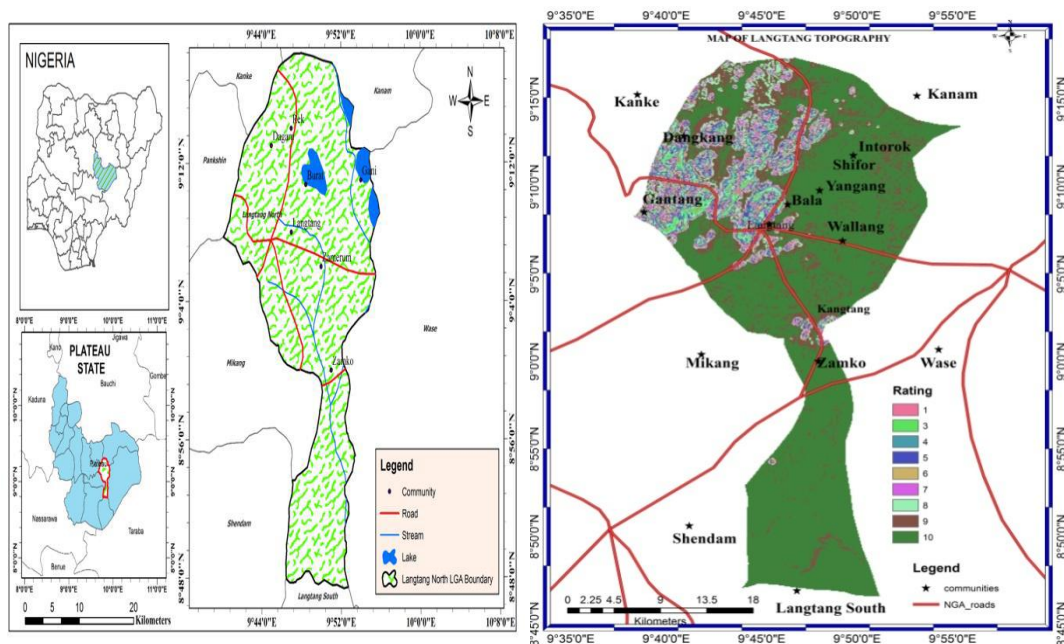


Fig. 1. Geographical and topographical Map of Langtang North, Plateau State - Nigeria
Source: Centre for Geodesy and Geodynamics, 2021

Table 1. Classification of element species into six fractions

Fractions (Soil and Control)	Symbols
Exchangeable bound metals	F1
Carbonate bound metals	F2
Manganese oxide bound metals	F3
Iron-manganese oxides bound metals	F4
Organic/sulphide bound metals	F5
Residual bound metals	F6

Table 2. Mean metal concentrations in soils from the study areas

Mean Metal Concentrations (mg/kg)										
Fractions	As	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Bala	0.00	6.00	15.83	35.17	13.50	24.00	21.33	10.83	21.50	20.50
Gnagtang	2.50	8.33	3.50	8.67	15.33	11.00	11.17	21.50	60.00	42.33
She-for	0.83	2.83	2.50	9.00	9.67	10.00	9.67	8.67	6.83	9.00
Walang	6.17	0.67	1.50	9.83	10.00	22.50	10.83	8.50	21.83	15.33
Yangang	2.33	8.83	0.00	12.17	12.67	22.17	24.00	12.67	42.17	11.67

3.1.1 Determination of exchangeable bound metals

Soil sample (1.00 g) was weighed into a 250 cm³ conical flask and 10.00 cm³ of 1.00 mol/dm³ sodium ethanoate solution was added. The pH was adjusted to 8.7 by the addition of 25.00 % ethanoic acid. The mixture was agitated for 2 hours using an orbital Shaker SOI, filtered into a 100 cm³ volumetric flask using Whatman Filter Paper Number 1. The filtrate was made up to mark with water. The metals were determined using (AAS) Model 210 VGP and the residue was reserved for further fractionation [19-20].

3.1.2 Determination of carbonate bound metals

The residue from the exchangeable bound metals was leached for 3 hours with 1.00 mol/dm³ sodium ethanoate solution and the pH adjusted to 5.0 using 25.00 % dilute ethanoic acid. The leachate was filtered into a 100 cm³ volumetric flask and made up to the mark with water. The leachate was analyzed for: As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn at their respective wavelengths using (AAS) Model 210 VGP and the residue reserved for further analyses [19-20].

3.1.3 Determination of manganese oxide bound metals

The residue from the carbonate bound soil was leached with 10.00 cm³ of 0.10 mol/dm³ hydroxylamine hydrochloride and 0.01 mol/dm³ trioxonitrate (V) acid (adjusted to a pH of 2.0 with 25.00 % ethanoic acid) after shaking for

3 hours using an orbital Shaker SOI. The leachate was quantitatively filtered into a 100 cm³ volumetric flask and made up to the mark with water. The leachate was used to analyze : As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn using (AAS) Model 210 VGP. The residue was reserved for further analyses [19-20].

3.1.4 Determination of iron-manganese oxide bound metals

The residue from the manganese oxide bound soil was extracted using 10.00 cm³ of pH 3.0 oxalate buffer solution after shaking for 12 hours in a water bath. The extract was filtered into a 100 cm³ volumetric flask and water was added to mark. The sample solution was also analyzed for: As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn using (AAS) Model 210 VGP at their respective wavelengths. The residue was reserved for further analyses [19-20].

3.1.5 Determination of organic matter/ sulphide bound metals

The residue from the iron-manganese oxide bound soil was extracted by shaking with 100.00 cm³ of 30.00 % hydrogen peroxide solution. This was adjusted to a pH of 2.0 by the drop-wise addition of 20.00 % trioxonitrate (V) acid and heated for 6 hours at 90°C in a water bath. This was re-extracted at room temperature with 10.00 cm³ of 1.00 mol/dm³ ammonium ethanoate solution and the pH was maintained at 2.0. After shaking for three (3) hours, the first extract of the mixture was filtered using Whatman Filter Paper Number 1 into a 100 cm³ volumetric flask and

water was added to mark. The analyte was analyzed for: As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn using (AAS) Model 210 VGP and the residue reserved for further analysis of residual metals [19-20].

3.1.6 Determination of residual metals

The residue from the organic matter/sulphide bound soil was digested using 10.00 cm³ of aqua-regia by heating in a digestion tube at a temperature of 250°C. The clear digest was decanted and allowed to cool, filtered using Whatman Filter Paper Number 1 into a 100 cm³ volumetric flask. This was made up to mark with water. The analyte was analyzed for: As, Cd, Co, Cr, Cu, Fe, Mn, Ni and Zn using (AAS) Model 210 VGP [19-20].

4. RESULTS

The fractionation patterns of some heavy elements and their mean concentrations (mg/kg) in soils taken from Bala, Gantang, She – For, Walang and Yangang Streets as well as Introk Street (Control) of Langtang North Local Government Area, Plateau State, Nigeria are presented in the Table below.

The total metal concentrations of soil were broadly aggregated into the exchangeable, carbonate, reducible manganese oxide, iron/manganese oxide (reducible), organic/sulphide (oxidizable) and residual bound metal content. The concentrations of bioavailable As in the street soils in the five streets ranged from 0.00 - 34.00 mg/kg and the values are below the targeted value (200.00 mg/kg) and intervention value (625.00 mg/kg) of soil, [21]. However, the values obtained for the residual fraction ranged from 0.00 – 5.00 mg/kg. The bioavailable fraction is observed to be predominant in all the soils. The soil in the study area may receive As from a variety of anthropogenic sources, including municipal, commercial waste and pesticide/herbicide use. The cumulative sum of As analyzed is also below the targeted regulatory standards of heavy elements in soil 20.00 – 40.00, 43.00 and 76.00 mg/kg reported by EPMC, 2015, EPA, 2007 and USEPA, 2002, respectively. Based on the values obtained, it is evident that As will not pose any health hazard to the inhabitants of the studied area. As in the environment is not immediately dangerous.

The concentrations of Cd ranged from 3.00 mg/kg (found in walang Street) to 45.00 mg/kg

(yangang street). This is lower than 75.00 mg/kg assayed by Nduka *et al.* [22] but is much higher than 0.66 mg/kg found in irrigation farm Railway Quarters, Bauchi [20]. The presence of Cd may be as a result of anthropogenic activities such as the application of artificial phosphate fertilizers that can contribute to the level of Cd in the roadside soil samples within the study area. Cd is toxic at low exposure levels and has acute and chronic effects to health.

Co concentrations in the five streets spread from 0.00 mg/kg (yangang street) to 70.00 mg/kg (bala street). The 70.00 mg/kg agrees with the threshold limit of 100.00 mg/kg [23]. Building materials and hospital waste may act as sources of Co in these streets in the study area. Co is used in chemical industries as drying agents for paints and tiles, using these products in the study area can also contribute to the level of cobalt in the road side soil samples.

The concentration of Cr assayed in the five street soils ranged from 42.00 mg/kg (found gantang street) to 155.00 mg/kg (found in bala street). These values are greater than the value (100.00 mg/kg) of Cr reported by Iwegbue *et al.*, [24], as well as 150.00 µg/g (mg/kg). European Union Standard [25]. However, Cr concentration in soils varies up to as high as 350.00 mg/kg [26]. Cr has been identified in at least 1,127 to 1,699 waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) [27]. Most of the Cr in the study area is found naturally in soil and dump sides (bioavailable fractions). Cr is an essential trace element because small amounts of Cr is necessary for human health, it is use for Cr deficiency, diabetes and high cholesterol in form of supplements. Breathing high levels of Cr can cause irritation to the nose and throat, but pure Cr has no adverse effect on humans [28].

The bioavailable Cu in all the streets soil samples assayed ranged from 47.00 mg/kg (she-for) to 73.00 mg/kg (gantang). this is higher than the permissible limits of 36.00 mg/kg [21] and less than 100.00 mg/kg set by FAO/WHO, 2001. The residual Cu spread from 11.00 mg/kg to 19.00 mg/kg as recorded in all the Streets. The Residual fraction is associated with minimal toxicity due to the difficulty in its migration and transformation under general conditions. The soluble fraction is observed to dominate in all the soils assayed in all the Streets, it is usually associated with anthropogenic factors. Cu may be present in the soil through natural sources

such as windblown dust and anthropogenic sources (phosphate fertilizer production, wood production and metal pollution such as burnt vehicles and electrical appliance along this street because Cu is commonly found in electrical wirings.

The cumulative sum of soluble Mn determined in the five street soils spread from 46.00 mg/kg assayed in she-for Street to 119.00 mg/kg carried out in yangang Street. The insoluble Mn spread from 10.00 mg/kg to 25.00 mg/kg as conducted in all the Streets. The insoluble fraction is related with minimal toxicity due to the difficulty in its movement and transformation under general conditions. The soluble fraction is observed to dominate in all the soils assayed in all the Streets, it is usually associated with anthropogenic factors. The observed values carried out are below the threshold limit of 850.00 mg/kg of soils set by DPR [21] and 2000.00 mg/kg established by FAO/WHO [29]. Mn may be available in the soil as solids, small particles in water and dust particles in air of fossil fuels [28].

Bioavailable Ni in the five street soils spread from 42.00 mg/kg (she-for) to 108.00 mg/kg (gantang). Residual Ni spread from 10.00 mg/kg to 21.00 mg/kg all the Streets studied. The soluble fraction is observed to be dominant in all the soils analyzed in all the Streets, it is usually associated with anthropogenic factors. The assayed values are within the maximum tolerable level of 75.00 – 150 mg/kg proposed by joint FAO/WHO [30]. However, it is below the intervention value (210 mg/kg) of soil [21]. Small quantities of Ni is essential, but when the uptake is too high it can be a dangerous to human health, it can cause respiratory failure, birth defects, heart disorder and asthma. Atmospheric deposition is the main source of Ni in the soil within the study area.

The soluble Pb obtained in this study spread from 30.00 mg/kg assayed in she-for street to 292.00 mg/kg assayed in gantang street. The soluble Pb ranged from 11.00 mg/kg to 68.00 mg/kg all the Streets assayed. The soluble fraction is observed to be predominant in all the Streets soils analyzed. The values reported for both soluble and insoluble fractions fall between the maximum tolerable level of 250 – 500 mg/kg in dry soil proposed by joint FAO/WHO [30]. However, these values are lower than 530.00 mg/kg [31] and 1000.00 mg/kg [32]. The high concentration of Pb observed could be

associated to Pb particle from the combustion of gasoline which settles on street soil around mechanic stands. Domestic waste is one of Pb emission sources, along with superficial drainages and atmospheric deposition. Based on the results obtained in all the fractions it is evident that Pb might pose health risk to the inhabitants of Gantang Street if not checked and controlled.

The concentrations of Zn analyzed in the five streets range from 45.00 mg/kg (she-for) to 207.00 mg/kg (gantang). The residual Zn spread from 9.00 mg/kg to 47.00 mg/kg as recorded in all the Streets. The Residual fraction is associated with minimal toxicity due to the difficulty in its migration and transformation under general conditions. The soluble fraction is observed to dominate in all the soil sediments assayed in all the Streets, it is usually associated with anthropogenic factors. The values obtained are higher than the permissible limit of 50.00 mg/kg ([30]. However, this is much lower than the level of Zn (832.00 mg/kg) determined in soil of locality in the former mining area of rudnany, [33], 600.00 mg/kg [32], 500.00 mg/kg [34], 720.00 mg/kg [35] and. 1100.00 mg/kg [31]. Low Zn levels can increase a person's risk of disease and illness, Zn plays an important role in maintaining healthy skin, people with long-term wounds often have low Zn levels, Zn has antioxidant properties, some researchers have suggested that maintaining adequate Zn levels could possibly offer some protection against COVID-19. Zn is naturally present in all soils in typical background concentrations 10.00 – 100.00 mg/kg [36]. Human activities have enriched the top soils with Zn through the applications of manure or inorganic fertilizers and sewage sludge in the study area.

5. CONCLUSION

The presence of heavy elements (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were observed in the soil sediments in all the streets. Higher heavy element concentrations in these streets were recorded in points where there are evidences of organic load discharge and domestic effluents as in the case of Gantang, Yangang and Bala streets. The results found in this study show that heavy elements levels in the streets are relatively low compared to the referenced permissible limit values reported by WHO. [29] DPR. [21] WHO/FAO. [30] USEPA. [31] EPAA [32] EPMC. [37] CME. [34] EEA. [35] as well as Adagunodo *et al.* [23,38-39]. This study showed the northern

(hill) part of Langtang North has no potential risk of contamination. However, the plain or southern part of the study area showed high potential risk that if not monitored will result into serious contamination. It is therefore evident that topography plays an important role in the risk factor of heavy elements contamination. The overall results showed evidence of some heavy elements pollution in all the Street soils assayed with possible cumulative effect with time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kutty AA, Al-Mahaqeri SA. An Investigation of the Levels and Distribution of Selected Heavy Metals in Sediment and Plant Species Within the Vicinity of Ex-Iron Mine Bukit Besi. *Journal of Chemistry*. 2016;20:43-56.
2. Mafuyai GM, Eneji IS, Shaato R, Nnamonu LA. Heavy Metals Concentration in Soil Irrigated with ex-tin mining Pond Water, Bokkos L.G.A, Plateau state, Nigeria. *African Journal of Environment of Natural science research*. 2019;2(3):13-28.
3. Mafuyai GM, Shaopera U, Ayuba SM. Enrichment and Geo-accumulation of Pb, Zn, As, Cd, Mn and Cr in Farm Soils Around Tin Mines Areas in Plateau state, Nigeria. *African Journal of Environment and Natural Sciences*. 2020;3(2):22-31.
4. Opaluwa OD, Aremu MO, Ogbo L, Abiola KA, Odiba IE, Abubakar MM, Nweze NO. Heavy Metal Concentrations in Soils, Plant Leaves and Crops Grown around Dumpsites in Lafia Metropolis, Nasarawa State, Nigeria. *Advances in Applied Science Research*. 2012;3 (2):780-784.
5. Teng Y, Wu J, Lu S, Wang Y, Jiao X, Sung L. Soil and Soil Environmental Quality Monitoring in China. A review. *Environment international*. 2014;68:177-199.
6. Li XN, Jiao WT, Xiao B, Chen WP, Chang AC. Soil Pollution and Site Remediation Policies in China A review. *Environmental Reviews*. 2015;23: 263-274.
7. Henry MU, Ogenyi RA, Henry UI, Dogun O. Assessment of Heavy Metal Concentration in Water Soil and Vegetable in ex-mining ponds, Jos South L.G.A, Plateau state, Nigeria, *International Journal of Scientific and Research Publications*. 2018;8(8):840-845.
8. Kanmony C. *Human Rights and Health Care*". Mittal Publication, New Delhi, India. 2009;73-76.
9. Ajibola VO, Ozigis I. Partitioning of Some Heavy Metals in Kaduna Streets Soils. *Journal of Chemical Society of Nigeria*. 2005;30(1):62-66.
10. Pain A. *A Brief Look at Life: One Man's View Predicament*". Troubador Public Limited, Leicester, United Kingdom. 2008;81-84.
11. Fong F, Seng C, Azan A, Tahir M. Possible Source and Pattern Distribution of Heavy Metals Content in Urban Soil at Kuala Terengganu Town Centre. *The Malaysian Journal of Analytical Science*. 2008;12:458 - 467.
12. Ruqia N, Muslim K, Muhammad M, Hammeed UR, Surraya S, Nosheen A, Muhammad S, Molub U, Muhammad R, Zeenat S. Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and analysis of physics chemical parameters of soil and water wheeled from Tauda Dam Kohat. *Journal of pharmaceutical science and Research*. 2015;7(3):89-97.
13. Abechi ES, Okunola OJ, Zubairu SMJ, Usman AA, Apene E. Evaluation of heavy metals in roadside soils of major streets in Jos metropolis, Nigeria. *Journal of Environmental Chemistry*. 2010;2(6):98-102.
14. Okereke JN, Nduka JN, Ukaoma AA, Ogidi IO. Levels of Heavy Metals in Soil Samples from Farmlands along Highways in Parts of Owerri, Nigeria. *World Journal of Innovative Research*. 2019;7(1):1-7.
15. Ogundele DT, Adio AA, Oludele OE. Heavy Metal Concentrations in Plants and Soil along Heavy Traffic Roads in North Central Nigeria. *Journal of Environmental and Analytical Toxicology*. 2015;5(6):334-335.
16. Taofeek AY, Tolulope OO. Evaluation of Some Heavy Metals in Soils along a Major Road in Ogbomoso, South West Nigeria. *Journal of Environment and Earth Science*. 2012;2(8):71-79.
17. Tessier A, Campbell PGC, Bisson M. Sequential Extraction Procedure for the Speciation of the Particulate Trace Metals. *Analytical Chemistry*. 1979;51:844 – 851.
18. Elsokkary IH. Selenium Distribution, Chemical Fractionation and Adsorption in

- Some Egyptian Alluvial and Lacustrine Soils. *Z. Pflanzenernaehrung und Bodenkunde*. 1980;143(1):74-83.
19. Hassan UF, Hassan HF, Musa ZA, Hassan AF, Mohammad M, Ushie OA. Determination of Some Heavy Metals Speciation Pattern in *Typha domingensis* Invaded Soil in Bauchi Metropolis, Nigeria. *ATBU, Journal of Science, Technology and Education*. 2019;7(1):140-169.
 20. Adebayo RK, Hassan UF, Adamu HM, Hassan HF, Baba Haruna, Ajiya DA. Comparative Evaluation of Speciation of Heavy Metals in Irrigation Farm of Railway Quarters, Bauchi State, Nigeria. *International Journal in Applied Science*. 2020;5(3):2454-6186.
 21. Department of Petroleum Resources – DPR. Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (revised edition). Department of Petroleum Resources, Ministry of Petroleum and Natural Resources, Abuja, Nigeria; 2002.
 22. Nduka O, Ifeanyi O, Chidinma N. X-Ray Fluorescent Determination of Potentially Toxic Elements in Quarry Dust from Umuoghara Industrial Crushing Sites. *Leonardo Journal of Science*. 2014;31-42.
 23. Adagunodo TA, Sunmonu LA, Emetere ME. Heavy Metals Data in Soils for Agricultural Activities. *Data in Brief*. 2018;18:1847-1855.
 24. Iwegbue CMA, Bassey FI, Tesi GO, Nwajei GE, Tsafe AI. Assessment of Heavy Metal Contamination in Soils around Cassava Processing Mills in Sub-Urban Areas of Delta State, Southern Nigeria, *Nigerian Journal of Basic and Applied Science*. 2013;21(2):96-104.
 25. Singh KP, Mohan D, Singh VK, Malik K. Studies on Distribution and Fractionation of Heavy Metals in Gomti River Sediments-a Tributary of the Ganges, India. *Journal of Hydrology*. 2005;312:14-27.
 26. Ertani A, Mietto A, Nardi S. Chromium in Agricultural Soils and Crop. *A Review of Water, Air and Soil Pollution*. 2017;228: 190-191.
 27. HazDat. HazDat Database; Agency for Toxic Substances and Disease Registry. Toxicological – ATSDR. Profile for Chromium; 2007. Available:<http://www.atsdr.cdc.gov/toxprofiles/tp23.html> Accessed 3/5/2021.
 28. Lenntech. Chemical Properties of Cobalt-Health and Environmental Effects of Cobalt; 2019. Available:<https://www.lenntech.com/periodic/elements/as,htm>). Date accessed: 16/10/2019.
 29. World Health Organisation and Food and Agricultural Organisation - WHO/FAO (2001). *Soil Testing and Plant Analysis*, Bullentin. No 38/1, Food and Agriculture Organization, Rome, Italy. 2009;7-12.
 30. World Health Organisation and Food and Agricultural Organisation - WHO/FAO. *Soil Testing and Plant Analysis*, Food and Agriculture Organization, Rome, Italy. 2007;45-52.
 31. United States Environmental Protection Agency - US EPA, (2014). *Cleaning up the Nation's Hazardous Wastes Sites*. Available:<http://www.epa.gov/superfund>.
 32. Environment Protection Authority of Australia - EPAA. Classification and management of contaminated soil for disposal. *Information Bulletin 105*. Hobart, TAS 7001 Australia; 2012.
 33. Lenka A, Danica F. Contamination of the Soil and Water Environment by Heavy Metals in the Former Mining Area of Rudňany (Slovakia). *Soil and Water Resources*. 2014;9(1):18–24.
 34. Canadian Ministry of the Environment - CME. *Soil, Ground Water and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act*; 2009.
 35. European Environmental Agency - EEA, *Progress in management of contaminated sites (CSI 015/LSI 003)*; 2007. Available:<http://www.eea.europa.eu/data-and-maps/indicators>
 36. Mertens J, Smolders E. Heavy Metals in Soils. *Journal of Environmental Pollution*. 2012;22:465-493.
 37. Environmental Protection Ministry of China -EPMC. Standards of soil environmental quality of agricultural land. Huangbanhang 69: Office of Environmental Protection Ministry of China, Beijing, China; 2015.
 38. Environmental Protection Agency – EPA. *Drinking Water Health Advisory for Mn*. Accessed; 2007. Available:<http://www.epa.gov/safewater/>. Date accessed; 17/4/2021.
 39. United States Environmental Protection Agency - US EPA. Supplemental guidance

for developing soil screening levels for superfund sites. Office of Solid Waste and Emergency Response, Washington, D.C;

2002.
Available:<http://www.epa.gov/superfund/health/conmedia/soil/index.htm>

© 2021 Wuyep et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<http://www.sdiarticle4.com/review-history/76432>