Concentrations of Heavy Metals in Farmland Soils from selected Oil Bearing Communities in Gokana, Rivers State, Nigeria

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Abstract: **- Human intervention into the natural environment in order to better humanity has both negative Local Government Area of the Rivers State. The communities where the samples were collected were Yeghe, Bodo, B-Dere and K-Dere. The samples were subjected to laboratory treatment and and positive components. Soil samples were collected from selected farmlands from Gokana finally analyzed for heavy metals concentrations in both soil and the cassava parts. The result showed that the mean concentrations of the heavy metals in the soil from the communities were; 1.501±0.142, 2.685±0.382, 4.185±0.740, 4.021±0.540, 174.914±28.497 and 3.809±0.596 mg/Kg for cadmium (Cd), lead (Pb), chromium (Cr) copper (Cu), iron (Fe) and nickel (Ni) respectively. The order of concentrations of the heavy metals in the soil was, Fe > Cr > Cu > Ni >Pb> Cd. Analysis of the pollution levels of the soils from the farmlands using some pollution indices indicated that contamination factor analysis showed that the soils were all severely polluted with Cd, but were uncontaminated with all the other metals. Pollution index revealed that all the soils fall within the range of slight contamination, contamination degree and modified contamination degree assessment indicated that the soils were uncontaminated with the metals.**

Keywords: **Heavy metals, soil, contamination, pollution index, contamination degree, modified contamination degree.**

I. INTRODUCTION

Exploration and exploitation procedures have created considerable wastes. Discharging of onshore and offshore oil and gas wells can have negative environmental and social impacts if not properly managed, including land use impacts, soil and groundwater contamination, and erosion (Nwanyanwu *et al*., 2015).Humanoid activities have produced a considerable upsurge in the discharge of heavy metals into soils (Salim and Spark, 2001;Haung *et al*., 2002). The cumulative concentration of heavy metals present in the soil is frequently used to point to the amount of contamination or pollution by heavy metals.

Apart from activities emanating from natural causes, virtually all anthropogenic activities possess the capacity to influence in the production of heavy metals within the environment. Although, the event of production of heavy metals from these activities may have resulted as byproducts of most human activities, yet they contribute immensely to the total input or output of heavy metals burden of an environment. In the event of release of heavy metals into the environment (as contaminants or pollutants), they migrate through one source or the other to areas where they were not initially present and thus may gradually accumulate to non-tolerable levels (Gaur and Adholeya, 2004).

The aftermath of human activities within an area is accompanied with the release or output of different chemicals into the environment. One of the chief chemicals discharged into the environment is heavy metals, which have either direct or indirect consequence on humans, other animals and plants. This has given rise to the study of the levels of pollution or contamination of different environments such as water, soil, sediment, air and plants with heavy metals (Edori and Kpee, 2017).

Extreme quantities of heavy metals may possibly occur in the environment as an outcome of typical geographical occurrences like the nature of ore formation, decaying/disintegration of rocks, and leakage (Osam *et al*., 2013). Further activities that might add to disproportionate is charge of these metals into the environs comprise of incineration of remnant fuels, manufacturing and releases of industrial, agronomic, home and careful use of pesticides. Other Anthropogenic sources of heavy metals contributions include searching for crude oil and mining activities and oil spillages are also major sources of these metals (Osuji and Onojake, 2004).

The contamination of heavy metals in the soil is becoming worrisome and giving a warning signal to the world. Moreover, it is also creating avenues for debate on food security and its safety all around the globe (Al Saad *et al*., 2019).

This Study therefore examined the concentrations of heavy metals in soil from selected farmlands in different Gokana communities.

II. MATERIALS AND METHODS

Collection of Soil Samples

Soil samples were collected from a depth of 0 -15 cm below the surface of the soil with soil auger. The samples were collected randomly within the sample area and pooled together to form aggregate samples. The samples were transferred into polyethylene bags initially washed in dilute nitric acid. The soil samples were taken beneath the cassava plant used for the same experiment.

Preparation of Soil Samples for Analysis

The soil samples were taken to the laboratory and was air dried for two weeks. Thereafter, the samples were weighed and further dried to constant weight for another week. The dried samples were crushed with a pestle and mortar to powder. The dried soil samples were sieved in a 2mm mesh. The homogenized soil samples were stored in acid pre-cleansed glass bottles and kept preserved in the laboratory until digestion.

Digestion of Soil Samples

Precisely weight of 2 g of soil were weighed from each soil sample and placed in digestion bottles. Then 6 ml of concentrated nitric acid, 2 ml of hydrofluoric acid and 2 ml of hydrogen peroxide with reagent purity of 70, 48 and 35% respectively were added to the vessels. All the vessels were firmly sealed and transferred to the digester.

All vessels were firmly sealed and placed in a steam bath operated at a temperature of 60 ^{o}C. The vessels were heated for one and half hours for a clear colour of the digest to appear. Thereafter, 20 ml of water was added and heated for 30 minutes. The vessels were removed from the digester and the digested samples were allowed to cool. They were then transferred to 50 ml volumetric flasks. Then appropriate volume of de-ionized water was added to 50 ml mark. The digested samples were filtered using whatman filter paper into 50 ml plastic sample bottles. These were stored in a refrigerator maintained at 4 ^{o}C until time for analysis.

Analysis of Soil Samples for Heavy Metals

The preserved solutions of the digests were determined using atomic absorption spectrometry (AAS), model 71906. Triplicate measurements were done for all the samples.

Determination of Contamination Factor

The contamination factor of the individual metals in the soil was calculated from the formula adopted by other authors (Edori and Kpee, 2017; Marcus *et al.*,2017; Nwineewii *et al.*, 2018) as;

$$CF = \frac{Cm}{Cb}$$

Pollution Index, Contamination Degree and Modified Contamination Degree

The pollution index (PI) was calculated based on the formula of Hakanson (1980), as;

$$PI = n\sqrt{CFI\ x\ CF2\ x\ CF3\ x \ldots\ldots\ldots.x\ CFn^{n}}$$

The contamination degree CD and modified contamination degree were calculated from the Hakanson equation as;

$$\text{Cd} = \sum_{i=1}^{n} C\,F$$

and

$$\text{mCD} = \frac{1}{N}\sum_{i=1}^{N} CFI$$

Where, CF = contamination factor, n = number of metals, Cm = metal concentration in polluted water or sediments, Cb = background value of the metal or maximum recommended value of the metal in water, sediment or soil.

nor N = the number of the heavy metals investigated

III. RESULTS AND DISCUSSION

Heavy metals in Soil

The results of the heavy metals in soils from the different locations or stations are shown in Table 1. The concentrations of cadmium (Cd) in the soils from the examined stations varied from 1.397 – 1.746 mg/Kg with an average value of 1.501±0.142 mg/Kg. The observed values from the different stations were higher than the world average value (0.3 mg/Kg) of Cd in shale. The concentrations of Cd in soil observed in this work were higher than those of Idodo-Umeh and Ogbeibu (2010), in soil samples from petroleum impacted area at Olomoro, Delta State, Nigeria, where Cd was not detected from the soil samples. The value of the present study was also higher than those of Asia *et al*., (2007) in soil samples from Mayuku area of Benin, Edo State, whose values ranged from 0.23 – 0.95 mg/Kg, but within the same range of the values observed in soils along Benin River exposed to lubricating oil factory effluents, where values ranged from undetected – 4.5 ± 4.0 mg/Kg (Akporido and Asagba, 2013).

The high value of Cd in the soil from sampled stations may be associated with human input sources. Anthropogenic sources of Cd within any terrestrial environment are; quarrying and production of metal ores, burning of fossil fuel and manufacture of phosphate fertilizers. Cd is part of rechargeable Ni-Cd batteries which are discharged inappropriately on land surfaces (Challa and Kumar, 2009). Other sources of environmental Cd include lubricating oils, additives, tyre vulcanization practices and technology based productions and activities (Jaradat and Momani,1999). Cd metal is extensively used in plating, colourings, plastics, electrical stabilizers and battery industries (Mehbrahtu and Zerabruk, 2011). Toxicity of Cd is very pronounced at high concentrations and is known to cause numerous circumstances of food poisoning in man. Very little amount of Cd can lead to adverse changes in blood vessels of the human kidney. When consumed by man, it replaces zinc through some biochemical reactions and thus causes hypertensive conditions and damage to the kidney (Mehbrahtu and Zerabruk, 2011).The observation on the presence of Cd in the soil indicates potential pollution concerns related with Cd, that likely originated from the burning of fossil fuel in the area over a long period of time (Qing *et al*., 2015), too much of gas flaring and disposal of unprocessed waste (Benson *et al*., 2016).

The concentrations of lead (Pb) in the sampled soils from the different oil bearing communities varied from 2.118 – 3.194 mg/Kg. The mean value observed from the stations was 2.685±0.382 mg/Kg. The value was lower than the world average value of 20 mg/Kg. The concentrations of Pb observed in this study were lower than the values obtained by Marcus *etal*. (2017), in soils from different dumpsite in Port Harcourt, Rivers State, Nigeria, but higher than those of Edori and Kpee (2017) in soils within the vicinity of abattoir in Port Harcourt metropolis.

The leading source of lead in the environment arise from the addition of tetraethyl lead to gasoline as additive, lead-acid accumulators (lead batteries) discarded as waste, bullets, materials for the protections of wire, dyes, household furniture, paints and burning of fuel for vehicles (Fardiaz, 1992).Pb is not an important heavy metal when considering the human biological system. Pb has the ability to cause oxidative stress in animals and add to the origin of the initial stages of pathogenic Pb poisoning through the disruption of antioxidant balance of the mammalian cells. Elevated concentration of Pbarising from its buildup or accumulation in the human body leads to different physiological imbalance or diseases such as; anemia, stomachache, headache, intellect disorder, damage to the brain and central nervous system malady (Rehman *et al*., 2013).

The negative implications of Pb in children and adults is well documented as reduction in physical growth (causes dwarfism) and mental growth, reduction in learning capacity, kidney damage, headache, hearing impairment, talking complications, signs of prickliness and tiredness (Simeonov *et al*., 2010). Higher rate of barrenness problems, abortion and still births are experienced amongst pregnant women exposed to Pb metal (Ediin *et al*., 2000).Pb toxicity has several effects on biochemical systems which include the capability to deactivate enzymes, contend with calcium for assimilation into bones and restrict nerve transmission of impulse and brain growth (Ediin *et al*., 2000).

Pb is known to have a valency of four, but prefers the oxidation state of +2 instead of the +4 state. This is because only two of the four electrons in the outermost shell ionize freely. The different salts of Pb^{2+} possess low solubility characteristics in water. Soil and plants are easily contaminated by Pb fumes from different industrial sources. Even at low concentrations, Pb^{2+}has the capacity to cause toxicity to humans, plants, animals and microorganisms. This toxicity is due to the fact that it is not subject to biodegradation, but continuously become accumulated when constantly consumed of produced in the environment (Pehlivan *et al*., 2009).

The concentrations of chromium (Cr) from the different sampled stations varied within the range of 3.007 - 4.894 mg/Kg. The observed mean value for Cr in the study areas was 4.185±0.740 mg/Kg. The world average value of Cr is known to be 90 mg/Kg, which is higher than the observed value in the present work. However, the values Cr in the present research is very low when compared to those of Shah *et al*. (2013), in soils collected from polluted and non-polluted areas of the Karak, Khyber Pakhtunkhwa District, Pakistan, whose concentrations were as high as 32 mg/Kg.

Cr is a very important element in the breakdown of lipids, fat, and glucose. Lack of Cr leads to hyperglycemia, increased level of fat in the body, low sperm content in semen fluid, but may be toxic and carcinogenic at elevated concentrations (Chishti *et al*., 2011). Cr controls carbohydrate, nucleic acid, and lipoprotein breakdown, absorption or uptake and increases the action of insulin in human system (Yap *et al*., 2010). Besides, Cr stimulates the activities of numerous enzymes. However, prolong contact with Cr can lead to possible damage to the liver, kidney and lungs. When there is a lack of Cr in the blood, the effectiveness of insulin in maintaining proper sugar and cholesterol level come under challenge and thus lead to elevated level of both in the human blood. This further leads to insulin resistance, weakens glucose acceptance, and probably play the role of risk factor of atherosclerotic diseases (Sheded *et al*., 2006).The most abundant species of Cr in the environment is Cr VI and Cr III (Hilgenkamp, 2006).

Cr III is required in the human and animal diet and it is the specie that is responsible for the build-up of energy based molecules and fat or protein molecule, while Cr VI is a cancer causing agent (Chernoff, 2005).Sources of Cr in the environment include industrial activities, most notably the chemicals and tanning industries (Adeleken and Abegunde, 2011). Other sources of environmental Cr are cement, leather, plastics, dyes, textiles, paints, printing ink, cutting oils, photographic materials, detergents and wood preservatives (Hilgenkamp, 2006), nature of rocks or soil origin, power generating plants, liquid fuels, brown and hard coal and wastes from industries and public settlements. Cr is not subject to biodegradation and so is persistent in the environment. When Cr is mixed with soil, it is transformed into different species which are transferred to either soil or sediment which are the natural environmental sinks (Adeleken and Abegunde, 2011).

The concentrations of Cu observed in the soil of the sampled areas were in the range of 3.321 – 4.722 mg/Kg, with and average value of 4.021±0.540 mg/Kg. These values are lower than the world average value in shale, which is 45 mg/Kg. The concentrations of Cu observed in the present work is higher than those of Idodo-Umeh and Ogbeibu (2010) in petroleum impacted soils in Olomoro, Delta State, Nigeria, but lower than the values obtained in soils used for artisanal crude refining works in parts of Gokana Local Government Area, Rivers State, Nigeria (Njoku *et al*., 2016).

Cu is very important to both plants and animals. Cu develops the effective functioning of metabolic processes in plants and supports the DNA ailment opposition mechanism in humans. Deficiency of Cu in animals impedes growth (Anderson, 1997), results in cardiovascular injuries and myelination of the spinal cord, blemishes in skin-color, bone and connective tissue formation and reproduction (Buck, 1978). It has been observed that lack of Cu in animals causes negative effects on the brain and spinal cord, membrane enzymes, kidney and liver tissues and plasma/serum blood receptacles. However, when the concentrations of Cu in human animal body are very high or in excess requirement, human and animal health is at risk (Howell and Gawthorne, 1987). This is based on the fact that it inhibits or inactivates enzymes activities, cause anemia, hemolysis and icterus when it is freed unexpectedly into blood from the liver where it is stored. Other biological systems affected by Cu are enzymes such as the aldotase, alkaline phosphodiesterase, pepsin, lipase adenosine triphosphate, and aminoacyl RNA (Owen, 1981).

The observed concentrations of iron (Fe) varied from139.811 - 216.114 mg/Kg, while the average value for the examined stations was 174.914±28.497 mg/Kg. The observed values from the different stations were lower than both the DPR and world average value in shale which are 38000 and 47000 mg/Kg respectively for soil and sediment.

According to Nwaugo *et al*. (2006) and Akubugwo *et al* (2009), the major reasons for high concentrations of Fe in a media is due to the redox conditions between Fe^{3+} to Fe^{2+}. This condition is always favorable in situations of oil spill, where Fe (iii) readily reduces to Fe (ii). When this happens, more Fe (ii) is made available in the soil and so the soil becomes more toxic to plants and therefore causes growth retardation in plants (Osam*et al*., 2013).

Iron (Fe) is come next to aluminum and silicon when considering natural concentration in the earth's crust. It is a very important macro element for both plants and animal growth and well-being, but at very high concentration in the soil constitutes deleterious effect to some plants, namely; rice and sugarcane. The presence of Fe in plant and animal at the required concentration is very important because it is required for normal body metabolism and mechanism. In living creatures, it plays dual purposes of acting both as a donor and acceptor of electrons depending on the types of ions present in the environment, thus acting as a regulatory agent against excessive intake of some metals into living systems. However, the presence of free Fe in animal system is detrimental because it catalyzes the conversion of H_2O_2 into the formation of free radicals that has the capacity to finally destroy the cell through harmful breaking of its arrangement and configuration. However, this condition of cell damage is regulated by the binding of Fe to proteins to form the heme-protein block, thus creating a balanced cell system and structure.

The concentrations of nickel (Ni) in the examined soil samples from the different stations varied from 3.037-4.711 mg/Kg, with and average value of 3.809±0.596 mg/Kg. The values observed for Ni in the study area were lower than the 45 mg/Kg value, the world average concentration in shale.

Ni is the 24th most abundant element in the earth's crust. It is utilized in the production of stainless steel and also in the making of alloys, where it is combined with Fe, Cu, Cr and Zn. These alloys are converted to different products such as heater, jewelry and coins. Compounds of Ni found use in the manufacturing of battery, colouring agents for ceramics and catalytic agents in chemical reactions.

Intake of high concentration of Ni has been identified to cause severe health implications on laboratory animals and has the propensity to cause mortal lung disease that can in dogs (ASTDR, 2005). Allergic responses have been observed in humans exposed to Ni and in life-threatening circumstances resulted in deteriorating respirational ailment that shows deadly. Workers at obvious risk of Ni toxicity are those working in metal producing industries that produces Ni dust and are inhaled for a long period of time. Contact with Ni is presently regulated within a value not exceeding 0.05 mg/cm^3 in Ni equivalents per 40-hour work-week). Ni dust and many other Ni combinations, complexes or compound are also alleged to be cancer causing agents (ASTDR, 2005).

Table 1: Heavy metals in Soil from Some Communities in Gokana L. G. A

Heavy Metals (mg/Kg)	Stations				Mean±SD
	Yege	Bodo	B-Dere	K-Dere	
Cd	1.436	1.746	1.423	1.397	1.501±0.142
Pb	2.714	3.194	2.714	2.118	2.685±0.382
Cr	4.112	4.894	4.728	3.007	4.185±0.740
Cu	3.321	4.324	4.722	3.715	4.021±0.540
Fe	216.114	184.113	139.811	159.617	174.914±28.497
Ni	4.711	3.774	3.712	3.037	3.809±0.596

Contamination Factor of Heavy Metals in Soils from Sampled Locations

The contamination index or factor of the individual metals examined at the various stations is given in Table 2. The contamination factor values for Cd varied from 4.657 – 5.820. The values obtained for contamination factor for Cd in the examined soils were higher than those of Edori and Kpee(2017) in selected slaughter soils in Port Harcourt, Rivers State, Nigeria, but lower than the values observed in leachate contaminated soil close to dumpsites within Port Harcourt City, Nigeria (Marcus *et al*., 2017) and either lower or higher than the contamination factor values for Cd observed in selected agricultural soils in industrial areas of Tangail district, Bangladesh (Proshad *et al*., 2019). From the range of values observed for the contamination factor for CD in the soil within the area showed that all the soils were severely polluted with Cd.

The contamination factor values for Pb in the soil from the sampled stations varied from 0.106 – 0.160. The range of values observed for Pb indicated that the soils from the selected areas fall within slight contamination. The observed values of contamination factor in the present work is lower than those of Marcus *et al*. (2017), in a soil contaminated with dumpsite leachate within Port Harcourt metropolis and those of Salman et al. (2019) in soils from Orabi farms, El Obour, Egypt, but higher than the values observed in abattoir soils situated in different parts of Port Harcourt, Nigeria (Edori and Kpee, 2017).

The contamination factor values for Cr in the soil of the examined stations varied from 0.033 - 0.054. The calculated contamination factor values for Cr in the examined farmland soils were slightly higher than the values of Sulaiman *et al*. (2019), in soils from unrestrained quarrying location at Dareta community, Zamfara, Nigeria and those of Edori and Kpee, (2017), in soils contaminated with animal dungs in Port Harcourt, Nigeria. However, these values were lower than the values observed in leachate contaminated soil (Marcus *et al*., 2017), and those of Proshad *et al*. (2019), in cultivated soils in the industrialized regions of Tangail neighborhood, Bangladesh. The interpretation of the values of contamination factor of Cr in this work based on the intervals of contamination/pollution as proposed by Lacatusu, (2000), showed that the soils were uncontaminated with Cr.

The contamination factor values for Cu in the soil samples from the examined stations varied from 0.074 - 0.105. The range of values of contamination factor for Cu from this work is lower than those of Sedghi *etal*, (2019) in soils around power plant station in Neka Mazandaran Province, Iran, those of Salman *et al.* 2019) in Orabi farmlands, El Obour, Egypt, those of Proshad *et al*. (2019), in agronomic farmlands soils near engineering areas of Tangail neighborhood, Bangladesh, those of Marcus *et al* (2017) in dumpsite leachate contaminated soils in Port Harcourt City Metropolis and those of Edori and Kpee (2017) in Abattoir soils in Port Harcourt, Nigeria. The values for Cu indicated uncontamination of the soil with Cu metal.

The contamination index (factor) of Fe in the soil from the different stations examined varied from 0.003 – 0.005. The contamination index values for Fe were higher than the values of observed in some abattoir soils in Port Harcourt (Edori and Kpee, 2017) and soils obtained from inhabited areas and amended soils of unrestrained metal excavating location in Daretasettlement, Zamfara, Nigeria (Sulaiman *et al*. (2019). However, the values of the present work were either lower or within the range of values observed by Marcus *etal*. (2017) in soils contaminated with leachate from waste dumps. The levels of Fe contamination factor calculated showed that the farmland soils were not contaminated with Fe

The contamination factor analysis for Ni in the soil from the different station investigated showed a range of 0.045 – 0.069. The value range of contamination index for Ni in the selected farmland soils in the present work were lower than those of Marcus *et al*, (2017), in leachate contaminated soils, those of Sedghi *et al*. (2019), in soils nearby electricity generating power station in Neka Mazandaran Province, those of Proshad *etal*. (2019), in agrarian woodlands soils nearby production regions of Tangail locality, Bangladesh, but within the range of values observed in soils from abattoir with Port Harcourt, Rivers State (Edori and Kpee, 2017) and higher than the values observed in soils from mining areas of Dareta rural community, Zamfara, Nigeria (Sulaiman *et al*., 2019).

Table 2: Contamination Factor of Heavy Metals in Soils from the Sampled Areas

Heavy Metals	Stations			
	Yege	Bodo	B-Dere	K-Dere
Cd	4.787	5.820	4.743	4.657
Pb	0.136	0.160	0.136	0.106
Cr	0.046	0.054	0.053	0.033
Cu	0.074	0.096	0.105	0.083
Fe	0.005	0.004	0.003	0.003
Ni	0.069	0.056	0.055	0.045

Pollution Index, Contamination Degree and Modified Contamination Degree of Heavy Metals in Soils from Sampled Locations

The pollution index, contamination degree and modified contamination degree of the soils from the selected area are shown in Table 3. The pollution index (PI) of the examined soils were within the range of 1.304 – 1.355. The lowest value was observed in K-Dere Soil, while the highest value was observed in soil from Bodo. The range of values observed from the present work when interpreted on the basis of intervals of contamination and pollution proposed by Lacatusu (2000), falls within the category of slight pollution. This implies that all the examined farmland soils were slightly polluted with heavy metals. The observed PLI values in the present work were either higher or within the range of values observed in top soil from Paspanga, Burkina Faso (Bambara *et al*., 2015), but within the same value range in top soils from Orabi farms, El Obour, Egypt (Salman *et al*., 2019). However, these values were lower than those of Nwankwoala and Ememu (2018), in soils collected from Okpoko and Environs, Southeastern Nigeria and those of Syed *et al*. (2012), in agricultural soil from Dhaka good distribution centre, Bangladesh.

The contamination degree of the soil samples from the different farmlands in Gokana varied from 4.927 – 6.190. the lowest values were observed in K-Dere, while the highest value was observed in Bodo. Based on the values observed within the locations, the degree of contamination of the different soil were within the interpretation category of uncontamination with heavy metals.

The values obtained for contamination degree in the present work is lower than those of other authors elsewhere (Syed *et al*., 2012; Salman *et al*., 2019). Syed *et al*. (2012), observed values in the range of 2444.42 - 5751.26 in soil from Dhaka export area, Bangladesh, which fall within the category of very high contamination degree, depicting an environment enclosed with the threat of heavy metals. Salman *et al*., (2019), observed values of contamination degree within the range of 6.6 – 52, which fall within the category of very high contamination degree.

The values of the modified contamination degree (mCD) observed from the present work were within the range of 0.821 - 1.032. The highest value was observed at the Bodo location, while the lowest value was observed at the K-Dere station. The values of mCD observed from the stations fall within the category of non-contamination with heavy metals.

The values of mCD in this work were lower than those of Nwankwoala and Ememu (2018), in Soils from Okpokocommunity, Anambra State, Nigeria and those of Syed *et al*. (2012), in soil samples from goods deport processed for exportation from Bangladesh.

Table 3: Pollution index, contamination degree and modified contamination degree of Soils from the Sampled Areas

Assessment Index	Stations			
	Yege	Bodo	B-Dere	K-Dere
PI	1.313	1.355	1.312	1.304
CD	5.117	6.190	5.095	4.927
mCD	0.853	1.032	0.849	0.821

IV. CONCLUSION

The present study showed that concentrations of the metals in the farmland soils from the selected locations were lower than the world average value in shale except the values of Cd which were higher. Further analysis of the pollution status of the metals using contamination factor indicated that the soils were polluted with Cd, but uncontaminated with the other metals, pollution index indicated that all the soils were slightly polluted, but contamination degree and modified contamination degree assessment indicated uncontamination of the farmland soils. Although the general trend of the heavy metals concentrations seems to favour an unpolluted environment with heavy metals, yet there is a promising danger of future effect if the present source (s) of the metals especially Cd continues unabated.

REFERENCES

[1] Adeleken, B. & Abegunde, K. (2011).Heavy metal contamination of soil and ground water at automobile mechanic village in Ibadan, Nigeria. International Journal of the Physical Sciences, 6: 1045-1058.

[2] Akporido, S. O. & Asagba, S. O. (2013). Quality Characteristics of Soil close to the Benin River in the vicinity of a lubricating oil producing factory, Koko, Nigeria. International Journal of Soil Science, 8(1): 1-16.

[3] Akubugwo, E. I., Ogbuji; G. C., Chinyere, C. G. &Ugbogu, E. A. (2009). Physicochemical Properties and Enzyme activity studies in a refined oil contaminated soil in Isikwuato, Abia State, Nigeria. Biokemistri, 21(2), 79-84

[4] Al Saad, M. A., Hatem, A. M. A., Hanan, A. E. E., Muhammad, N. J. & Nada, A. (2019). Estimation and bio-availability of toxic metals between soils and plants. Polish Journal of Environmental Studies, 28(1): 15-24.

[5] Anderson, M. (1997). Long term copper availability and adsorption in a sludge amended Davidson clay loam. Dissertation, April 1997, Blacksburg, VA.

[6] Asia, I. O., Jegede, S. I., Jegede, D. A., Ize-Iyamu O. K. &Akpasubi E. B. (2007). The effects of petroleum exploration and

production operations on the heavy metals contents of soil and groundwater in the Niger Delta. International Journal of Physical Sciences, 2(10), 271-275.

[7] ATSDR, Agency for Toxic Substances and Disease Registry, (2005). Public health statement on Nickel. A division of Toxicology, Department of Health and Human Services, Public Health Service National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161 Web site: http://www.ntis.gov/

[8] Bambara, L. T.,Kabore, K., Zougmoré, F., Cisse, O. &Derra, M. (2015).Assessment of Pollution in Agricultural Soil and Interrelationship between the Heavy Metals at Paspanga, Burkina Faso. IOSR Journal of Environmental Science, Toxicology and Food Technology, 9(8), 84-90.

[9] Benson, N. U.,Enyong, P. A. & Fred-Ahmadu, O. H. (2016). Trace Metal Contamination Characteristics and Health Risks Assessment of Commelinaafricana L. and Psammitic Sand flats in the Niger Delta, Nigeria. Applied and Environmental Soil Science, Volume 2016, Article ID 8178901, 14 pages. http://dx.doi.org/10.1155/2016/8178901

[10] Buck, W. (1978). Copper/molybdenum toxicity in animals: Toxicity of heavy metals in the environment, Part I, edited by F.W. Oehme, Marcel Dekker, Inc. New York and Basel.

[11] Challa, S. & Kumar, R. (2009).Nanostructured oxides.Weinheim, Germany: Wiley. Pp 29.

[12] Chernoff, R. (2005). Getriatic nutrition: the health professional's handbook. Ontario, Canada: Jones and Bartlett Publishers. Pp102.

[13] Chishti, K. A., Khan F. A. & Hassan, S. S. M. (2011).Estimation of heavy metals in the seeds of blue and white capitulums of silybummarianum grown in various districts of Pakistan. Journal of Basic and Applied Science, 7(1): 45 - 49.

[14] Ediin, G., Golantu, E. & Brown, M. (2000).Essentials for health and wellness. Toronto, Canada: Bartlett Publishers. Pp 368.

[15] Edori, O. S. and Kpee, F. (2017).Assessment Models for Heavy Metal Pollution in Soils within Selected Abattoirs in Port Harcourt, Rivers State, Nigeria. Singapore Journal of Applied Research, 7(1): 9-15.

[16] Fardiaz S. (1992). Water and air pollution in Kanisius, Yokyakarta, Indonesian. 923pp.

[17] Gaur, A. &Adholeya, A. (2004). Prospects of arbuscularmycorrhizal fungi in phytoremediation of heavy metal contaminated soils. Current Science, 86 (4): 528–534.

[18] Håkanson, L. (1980).Ecological risk index for aquatic pollution control.A sedimentological approach. Water Research, 14: 975-1001

[19] Hilgenkamp, K. (2006). Environmental health: ecological perspective. Toronto, Canada: Jones and Bartlett Publishers. Pp 83.

[20] Howell, J. &Gawthorne, J. (1987). Copper in Animals and Man.Volume II. CRC Press, Inc. Boca Raton, Florida.

[21] Huaug, Q., Chen, W. and Gou.X. (2002).Sequential fractionationof Cu, Zn, Cd in soils in absent and presence of rhizobia.Paper Presented in 17th WCSS, 14 – 21August 2002, Thailand. Symposium, 47 Paper no. 490, 1 – 9

[22] Idodo-Umeh, G. and Ogbeibu, A. E. (2010).Bioaccumulation of the Heavy Metals in Cassava Tubers and Plantain Fruits Grown in Soils Impacted with Petroleum and Non-Petroleum Activities. Research Journal of Environmental Sciences 4 (I): 33-41.

[23] Jaradat, M. &Momani, A. (1999).Contamination of roadside soil, plants and air with heavy metals in Jordan, a comparison study. Turkish Journal of Chemistry, 23: 209-220.

[24] Lacatusu, R. (2000). Appraising levels of soil contamination and pollution with heavy metals.

[25] *European Soil Bureau Research Report*, 4: 393-402.

[26] Marcus, A. C., Nwineewii, J. D. &Edori, O. S. (2017). Heavy metals assessment of leachate contaminated soils from selected dumpsites in Port Harcourt, Rivers State, South-South, Nigeria. International Journal of Chemical Studies, 5(6): 1507-1511.

[27] Mebrahtu, G. &Zebrabruk, S. (2011). Concentration of heavy metals in drinking water from urban areas of the Tigray Region, Northern Ethiopia.Maejo. International Journal of Science and Technology, 3: 105-121.

[28] Njoku, J. D., Ebe, T. E. &Enem, A. O. (2016).Analysis of heavy metal contamination by artisanal refining plants in the Niger Delta Region, Southern Nigeria. British Journal of Environmental Sciences, 4(3), 39-48.

[29] Nwankwoala, H. O. &Ememu, A. J. (2018).Contamination Indices and Heavy Metal Concentrations in Soils in Okpoko and Environs, Southeastern Nigeria.Journal of Environmental Science and Public Health, 2(2), 77- 95.

[30] Nwanyanwu, D. H., Fred-Nwagwu, F. W. &Yousuo, A. A. (2015). Oil and gas multinational companies' activities in Nigeria: The challenges in methods of waste management in Niger Delta. IOSR Journal of Environmental Science, Toxicology and Food Technology, 9(9), 109-117.

[31] Nwaugo, V. O.,Onyeagba, R. A., Azu, N. and Nwachukwu, N. C. (2006) Bacteriological quality of cercariae (Schistosomahaematobium) infested abandoned quarry pits water. Journal of Science & Engineering Technology, 13(2),6697–6706.

[32] Nwineewii, J.D., Edori, O. S. andOnuchukwu, P.U.G (2018). Concentration, Ecological risk and enrichment factor assessment of selected heavy metals and sediments from New Calabar River, Nigeria. *Journal of Applied Sciences and Environmental Management (JASEM)*, 22(10), 1643-1647.

[33] Osam, M. U. (2011). Evaluation of the efficacy of selected wild-type legumes in the remediation of crude oil contaminated Agricultural soils. PhD Dissertation, Biochemistry Department, University of Port Harcourt, Nigeria.

[34] Osuji, L. C. and Onojake, C. M. (2004). Trace Heavy Metals Associated with crude oil: A case study of Ebocha-8 oil-spill-polluted site in Niger Delta, Nigeria. *Chemistry and Biodiversity*, 1: 1708-1715.

[35] Owens, C. (1981).Copper Deficiency and Toxicity.Noyes Publications, Park Ridge, New Jersey, USA.

[36] Pehlivan, E., Ozkan, A. M., Dinc¸ S. &Parlayici, S. (2009). Adsorption of Cu2+ and Pb2+ ion on dolomite powder. Journal of Hazardous Materials, 167 (1–3), 1044–1049.

[37] Proshad, R., Islam, M. S., Kormoker, T., Bhuyan, M. S., Hanif, M. A., Hossain, N., Roy, R. & Sharma, A. C. (2019). Contamination of Heavy Metals in Agricultural Soils: Ecological and Health Risk Assessment. SF Journal of Nanochemistry and Nanotechnology, 2(1), 1 – 13.

[38] Qing, X., Yutong, Z. &Shenggao, L. (2015).Assessment of heavy metal pollution and human health risk in urban soils of steel industrial city (Anshan), Liaoning, Northeast China. Ecotoxicology and Environmental Safety, 120, 377–385.

[39] Rehman, A.,Ullah, H., Khan, R. U. & Ahmad, I. (2013). Population based study of heavy metals in medicinal plant Capparis decidua. International Journal of Pharmacy and Pharmaceutical Sciences, 5(1), 108–113.

[40] Salim, H.M. and Spark, D.L. (2001) Heavy metals release in soils,CRC PressyLewis Publisher, Baco Raton, FL.

[41] Salman A. S., Zeid, S. A. M.,Seleem, E. M. & Abdel-Hafiz, M. A. (2019). Soil characterization and heavy metal pollution assessment in Orabi farms, El Obour, Egypt. Bulletin of the National Research Centre, 43:42, https://doi.org/10.1186/s42269-019-0082-1.

[42] Sedghi, M., Torkashvand, A. M., Asadi, M. E. &Pazira, E. (2019). Evaluation of some heavy metals contaminated soils around the ShahidSalimi Power Plant, Neka,Mazandaran Province, Iran. Polish Journal of Soil Science, 52(1), 129 -141.

[43] Shah, A., Niaz, A., Ullah, N., Rehman, A., Akhlaq, M., Zakir, M. & Khan, M. S. (2013). Comparative Study of Heavy Metals in Soil and Selected Medicinal Plants.Journal of Chemistry, Volume 2013, Article ID 621265, 5 pages, http://dx.doi.org/10.1155/2013/621265.

[44] Sheded, M., Pulford, I. &Hamed, A. (2006).Chromium. Journal of Arid Environments, 66 (2), 210-217.

[45] Simeonov, L., Kolhubovski, M. &Simeonov, B. (2010).Environmental heavy metal pollution and effects on child mental development. Dordrecht, Netherlands: Springer. 114-115.

[46] Sulaiman, M. B., Salawu, K. & Barambu, A. U. (2019).Assessment of concentrations and ecological risk of heavy metals at resident and remediated soils of uncontrolled mining site at Dareta Village, Zamfara, Nigeria. Journal of Applied Science and Environmental Management, 23(1), 187–193.

[47] Syed H. R., Dilara K., Tanveer, M. A., Mohammad, S. I., Mohammad, A. A. & Mohammad, A. A. (2012). Assessment of heavy metal contamination of agricultural soil around Dhaka Export Processing Zone (DEPZ), Bangladesh: Implication of seasonal variation and indices. Applied Sciences, 2, 584-601.

[48] Yap, C. K., Fitri, M. M., Mazyhar, Y. & Tan, S. G. (2010).SainsMalaysiana 39 (3), 347-352.