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Land Use Pattern Effect on Trace Metals Load and Quality of Soils: A Case Study of Lagos Municipal City

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Abstract: The quality of soil is influenced by natural activities: geological formations of an area and volume of water (rain), as well as anthropogenic events such as land use patterns. The patterns correlate with the trace metals load in an area. This study, thus, seeks to evaluate of the potentially toxic metals loads in both top and sub soils based on land use in the municipality of Lagos, using pollution indices. Six (6) composite samples collected from top and subsoils in five different land use areas: Industrial (Ikeja and Ilupeju), Coastal (Iyagbe and Badagry), Residential (Surulere and Yaba), Landfill (Abule Egba and Igando) and Agricultural areas (Fi, Niger and LASU road), were analyzed for trace metals employing standard method. Data obtained were subjected to pollution indices namely; Contamination Factor (CF) Enrichment Factor (EF), Geo Accumulation index (I_{geo}) and Pollution Load Index (PLI). The EF results showed minimal enrichment by iron (1.0) and lead (0.39), significant enrichment with zinc (8.9), and extremely high enrichment in respect of cadmium (95.5) and copper (524.3). The order of metals Cd > Cu > Fe > Zn > Pb is as revealed by I_{geo} while the order of PLI value of each area show the impact of land use; industrial (6.61) > landfill (6.40) > Residential (4.43) > Agricultural (3.30) > Coastal (2.67), indicating varying levels of deterioration of soils through anthropogenic sourced pollution. Measures must be implemented by the relevant agencies, to regularly monitor build-ups of metals and environmentally enlighten, ensuring sustainable environment in line with goal eleven (Sustainable cities and Communities) of Sustainable Development Goals.

Keywords: Land Use, Geo Accumulation Index, Coastal Area, Landfill Area, Pollution Load Index

1. Introduction

Land use is a socio-economic activity in which land space is allocated to various uses and purposes agricultural, industrial residential and government purposes. It could also be described as a man-made concept that shows how parcels of land are made use of [1] and is closely related to community development and its sustainability [2, 3]. Awoniran, [4] also describe land use pattern as converting and managing a natural environmental settings such as wilderness or forests into built environments including human settlement including field, recreations, residence and industries.

Environmental Pollution Agency (EPA) [5] has shown interest on various land use pattern and their possible impact on the environment and human health. The land use concept contributes to both point and non-point pollution aquatic and soil environment [6, 7]. Various classification of Land use patterns has been reported in many environmental studies [8, 9], but the most commonly referred is the classification by Balasubramanian [8], which are categorized into five (5), and they are: Recreational, Transportation, Agriculture, Residential, and Commercial. Some other land use pattern, including those that are peculiar to the local environment of the land use, are often termed Indigenous knowledge (IK) [10, 11]. The Indigenous knowledge is of significance for sustainability and management of activities natural environment which include, water and soil conservation [12]. The location of a place is a major factor that dictate what use a land or land space is allocated to, and other contributing factors are availability of water, soil fertility and proximity to other human activities. There are many environmental consequences of the inappropriate land use of an area include; land degradation and soil quality deterioration. It also affect the pace and nature of development in an area.

Furthermore, land use pattern influences the quality of the soil's environment, including disappearance of soil vegetative cover, topsoil moisture, infiltration and soil water holding capacity, organic matter, soil fertility, natural regeneration capacity, and water table. These factors listed are pointers to soil health status [11].

Soil is a universal sink, which bears the burden of environmental pollution. Trace metals remain major pollutants sourced through various activities in the environment, and are closely tied to Land use patterns. These activities include management of municipal solid wastes (MSW), agricultural practices, disposal of industrial solid wastes and effluents. Trace Toxic metals (TTM) are well-known environmental pollutants for the negative environmental consequences as a results of their toxicity, bio-accumulative nature and persistence in the environment [13, 14]. Land use pattern also affects the concentration and oxidation state of various trace metals in the environment, thereby, influencing the toxicity of the metal. Health implications of trace metals have been extensively documented [15-17].

Lead, chromium, arsenic, cadmium, and mercury, are on the list critical metals that are of public health interest. These potentially toxic metals are considered systemic toxicants to cause multiple organ damage, even at lower levels of exposure. The consumption of excessive trace metal in food items can cause dysfunction in the human digestive, cardiovascular and central nervous system [18]. A chronic exposure to potentially toxic metals like Cd, Pb, and Cr, may cause cancer, liver damage, and eventually, death [19]. In Africa, particularly, soils from various types of land use patterns are used for subsistence farming, and top soils from landfills or dumpsites are often scrapped, then transported to support the fertility of non-performing farms. This practice is not only dangerous to the integrity of the ecosystem but also constitutes a trace metal compromise on food web. Therefore, this study aims at investigating the trace metal assessment and effect of land use pattern on the quality of soil in the municipality of Lagos.

2. Experimental

2.1. Study Area

The study was carried out in five different land use areas in Lagos State: Industrial areas (Ikeja and Ilupeju), Coastal areas (Iyagbe and Badagry), Residential areas (Surulere and Yaba), Landfill areas (Abule Egba and Igando) and Agricultural land (Fi Niger Area and Lasu road- Ojo) with details shown below in Table 1. while control samples for the study was picked from a remote part behind the new Students residential village in Lagos State University campus with GPS coordinates N6°28'56N 3°15'47E and N6°28'55N 3°.

Table 1. *Details of Land use areas and Coordinate.*

Land use	Location	GPS	Description
Agricultural	Fi, Niger Area	N6°32'3, E3°35'41 N6°32'4, E3°35'44 N6°32'6, E3°35'44	These areas have been in use for Agricultural activities (crop) for over three decades. The farmers specialize in vegetables and shrubs, thus involving application of synthetic chemicals and fertilizers thereby increasing metals load in the soil
	Lasu road, Ojo.	N6°30'1, E3°32'36 N6°30'28, E3°32'44 N6°30'28, E3°32'44	
Industrial	Ikeja	N6°37'28, E3°39'45 N6°37'25, E3°39'41 N6°37'25, E3°39'43	These areas are known industrial estates and have been in existence for over six decades. Ikeja industrial estates alone accommodate more than 3000 industries, including primary, secondary and tertiary industries.
	Ilupeju.	N6°34'28, E3°38'44 N6°34'28, E3°38'44 N6°34'28, E3°38'44	
Coastal	Iyagbe	N6°25'8, E3°15'58 N6°25'9, E3°15'58 N6°29'2, E3°18'57	Iyagbe and Badagry sampling locations are coastal communities in Ojo, and Badagry local Government areas respectively, with Fishing, and sediment dredging as main preoccupations in these areas.
	Badagry.	N6°29'2, E3°18'57 N6°29'28, E3°18'44 N6°29'28, E3°18'44	
Residential	Surulere	N6°33'28, E3°34'43 N6°33'25, E3°34'41 N6°33'25, E3°34'43	These areas are part of the municipalities of Lagos. They are fully residential with socio environmental significance, transportation and commercial activities.
	Yaba.	N6°30'28, E3°39'44 N6°30'28, E3°39'44 N6°30'28, E3°39'44	
Landfill	Abule Egba	N6°31'28, E3°39'43 N6°31'25, E3°39'41 N6°31'25, E3°39'43	They are fully government-controlled dumpsites. Abule Egba (10.2 hectares opened in 1978) and Igando (8 hectares, opened in 1993).
	Igando.	N6°30'28, E3°34'44 N6°30'28, E3°34'44 N6°31'28, E3°39'43	

2.2. Samples and Sampling Technique

Soil samples were taken employing a stainless soil auger at five different sampling locations, in different land use areas. The sampling locations were carefully chosen to give true representative samples guided by the pre-sampling site survey. The soil samples were collected at two depths; 0 -15 cm (top soil), and 15-30 cm (sub soil) in the months of February and July, 2021. All soil samples were kept in well-labelled polyethylene bags and transported to the laboratory for analyses.

2.3. Chemical Laboratory Analyses

2.3.1. Preparation and Treatment of Soil Sample

The soil samples collected were air dried, ground using a pre-cleaned mill (mortar and pestle), and sieved through a 2.00 mm sieve size. The mortar and pestle was cleaned after each sieving to prevent cross-contamination.

2.3.2. Determination of pH

20.0 g of the sieved soil samples weighed into a 250 mL beaker, 20 mL deionized water was added and mixed with occasional stirring using a glass rod while standing for 30 minute. The pH value was afterwards taken using a pH meter (pHep HANNA HI 98107) that had been pre calibrated with buffer solutions.

2.3.3. Determination of Potentially Toxic Metals in Soils by Atomic Absorption Spectrophotometric Method

A precise 2.0 g of the sieved soil samples was weighed into a clean 250 mL beaker, and moistened with drops of deionized water to prevent spattering during digestion, thereby leading of loss of soil materials. 10.0 mL of concentrated HNO_3 was used to digest the weighed sample on a hot plate in a fume cupboard until the volume was reduced to 3 mL volume.

A mixture of concentrated acids of 5 mL each of HCl, HNO_3, and $HClO_4$ was further used to digest the residues obtained [20] at room temperature for 10 minutes, until the solution was reduced to a final volume of about 5 mL on a hot plate in the fume cupboard. The digest was cooled, filtered using Whatman No. 1 filter paper into a 100 mL volumetric flask and made up to mark with the deionized water. The digest was analysed for metals using a model 210 VGP flame atomic absorption spectrophotometer. A standard addition technique was introduced to compensate for the usual variation caused by interferences in the sample solution. The blank samples were treated in same way test samples were analyzed. Each analysis was repeated twice, to ascertain the validity of the method. The control samples were also treated as test samples.

3. Data Analysis

Soil laboratory analyses generate results (Data) that were subjected to statically analyse using Graph Pad Prism (version 5.00). Descriptive analysis was carried out. Correlations were performed in a pairwise fashion employing the Pearson correlation procedure. Different pollution indices were also applied to assess potential ecological risks. These pollution indices include; Contamination Factor (CF), Enrichment Factor (EF), Geo accumulation Index (I_{geo}), and Pollution Load Index (PLI).

Geo Statistical Analyses

3.1. Contamination Factor (CF)

The pollution index expresses the load of contaminant of soil, and it is calculated using equation (1).

$$CF = \frac{C_{metal}\text{Sample}}{C_{metal}Control} \quad (1)$$

Where C_{metal} (sample) is the concentration of the potential toxic metals in the study test sample and C_{metal} (control) concentration of the metal in the unpolluted control sample. The result is then categorized as:

1) CF < 1 indicates low contamination.
2) 1<=CF < 3 indicate moderate contamination.
3) 3<=CF < 6 indicate considerable contamination.
4) CF > 6 indicate very high contamination.

3.2. Enrichment Factor (EF)

This is an index that helps in determining how much an element in a sample has increased relative to average natural abundance because of human activity. Of potential toxic metals in the soil it is calculated using equation (2).

$$EF = \frac{\left[\frac{C_{metal}}{C_{normalizer}}\right]Sample}{\left[\frac{C_{metal}}{C_{normalizer}}\right]Control} \quad (2)$$

Where C_{metal} are concentrations of potential toxic metals in soil samples and unpolluted control, $C_{normalizer}$ are concentrations of normalizer in soil samples and unpolluted control samples [21]. Five (5) categories of metal contamination are recognise as follows;

1) Category one: EF < 2 mean deficient to minimal enrichment.
2) Category two: EF 2-5 mean moderate enrichment.
3) Category three: EF 5-20 mean significant enrichment.
4) Category four: EF 20-40 mean very high enrichment.
5) Category five: EF > 40 mean extremely high enrichment.

3.3. Pollution Load Index (PLI)

The index helps to determine the level to which a site is polluted by metals. It is calculated using equation (3):

$$PLI=(CF_1 \times CF_2 \times CF_3 \times \ldots CF_n)^{1/n} \quad (3)$$

Where n is the number of metals studied,

CF is the contamination factor.

The degree of site deterioration is categorized into the following:

1) PLI <1 reveal perfect site,

2) PLI =1 reveal baseline pollution,
3) PLI >1 reveal deterioration.

3.4. Geo Accumulation Index (I_{geo})

The I_{geo} of potential toxic metals in the soil may be calculated using equation (4),

$$I_{geo} = \frac{\log_2[C_{metal}\text{Sample}]}{1.5[C_{metal}Control]} \quad (4)$$

Where,

$C_{metal(samples)}$ is the concentration of the potential toxic metals in the test sample, while C_{metal} (control) is the concentration of the metal in the control sample. Factor 1.5 is introduced to minimize the effect of the possible variations in the background or control which may be attributed to lithogenic variations in the soil [22]. The degree of pollutant is evaluated using seven contaminant categories based on the increasing value of the index as follows:

1) Category one: I_{geo}= 0 indicates unpolluted,
2) Category two: 0< = I_{geo}<1 indicates unpolluted to moderately polluted,
3) Category three: 1< = I_{geo}<2 indicates moderately polluted,
4) Category four: 2< = I_{geo}<3 indicates moderately to strong polluted,
5) Category five: 3< = I_{geo}<4 indicates strong pollute,
6) Category six: d4< = I_{geo}<5 indicates strong to very strong polluted,
7) Category seven: I_{geo}>=5 indicates very strong polluted.

4. Results and Discussion

The result of pH and level of potential toxic metals investigated in this study is presented in Table 2. The pH values obtained ranged from 4.4 to 7.8 which fall within the normal soil pH range of 3.0-10 [23]. High level of acidity or alkalinity will affect the availability of nutrients, particular the micro nutrients and potential toxic metals, hence resulting in unbalanced absorption of elements in plants [24] Iyagbe soil shows an acidic pH value and this could ultimately lead to the death of some soil micro-organisms [25] The pH of soil could be affected by the geological formation of an area, the volume of rainfall in that area, and the nature of human activities in the environment. The applications of chemicals and fertilizers could also be a pointer to the acidic pH observed in both Fi – Niger, and LASU road - Ojo areas. The situation with the range of pH 4.8 -5.1 is similar to that of Olusosun dumpsite study [20]. Onwordi et al., [26] reported a similar result in a study of the level of potential toxic metals in soils around a cultivated agricultural land in Lagos.

The level of potential toxic metals in this study shows a general trend that reveals high concentration in topsoil more than in subsoil except in a few locations. This portends great health risk to man because of possible metal absorption by plants in the root zone (top soil region). The order of potential toxic metals analyzed in both top and subsoil is Fe>> Zn > Cd > Cu > Pb. The concentration of iron in all the study areas is high except for the FI-NIGER area and an indication of the geological formation and sources from various anthropogenic activities such as run off from farm. The Fe level in the area study is lower compared to control samples, however the Fi – Niger samples had the lower value of iron when compared with other land use pattern studied. The iron load obtained in the industrial area is also lower compared with study., [27]. Iron is classified as a nutritive element at low concentration, but becomes toxic to human metabolic systems when the level is high. The iron has been implicated in several disease conditions when in execs [28, 29]. The concentrations of zinc, copper, and cadmium observed in this study are lower than the USEPA [30] allowable limits, but higher compared to values in control samples as shown in Table 2. It is an indication of metal build-up which is both significant and dangerous.

Zinc exists in the soil solution as a divalent cation Zn^{2+}, and its availability for uptake depends on several factors, including; soil pH, organic matter, climatic conditions, and interaction with other metals such as Cu and Fe. The levels of zn are high in industrial, residential, and landfill areas, but low in agricultural areas possibly as a result of phosphorous treatment in the soil to tame high levels of zinc [31]. Zinc is needed for proper functioning of immune healing of wound, clotting of blood, proper functioning of thyroid, and much more. Uwitonze et al., [32] reported that zinc also plays a key role in maintenance of sight and strong effects against viruses at a high level, but it causes nausea, vomiting, stomach cramps, loss of appetite, diarrhea, headaches, low copper levels, lower immunity, at low levels. The concentrations of Copper in this study displayed the same trend as that of zinc. Copper is an essential chemical element and trace mineral that occurs naturally in rock, soil, sediment, water, and at low levels, in the air as well as anthropogenic sources which include manure, mineral fertilizers, application of pesticides, urban runoff, Industrial solids and liquid wastes, and municipal solid waste and landfill leachate [33].

Table 2. *Levels of metals in soils (mg/kg) and pH values in Land use areas.*

Land use area	Location	Depth	Fe	Cu	Zn	Cd	Pb	pH
COASTAL	IYAGBE	0 - 15	1870.7	5.26	98.7	68.1	2.00	4.4
		15- 30	1402.8	3.31	60.2	37.7	2.00	
	BADAGRY	0 - 15	784.6	3.21	52.3	1.05	2.00	7.8
		15- 30	844.7	2.01	68.8	10.4	2.00	
RESIDENTIAL	SURULERE	0 - 15	1280.6	7.46	101.7	60.6	2.00	6.0
		15- 30	1346.1	4.56	110	67.1	2.00	
	YABA	0 - 15	2098.7	32.6	76.6	76.2	2.00	5.6

Land use area	Location	Depth	Fe	Cu	Zn	Cd	Pb	pH
LANDFILL		15- 30	2049.1	9.32	145.8	88.1	2.00	
	IGANDO	0 - 15	1858.4	12.3	92.8	42.8	1.50	7.1
		15- 30	1845.7	11.4	94.1	40.3	1.50	
	ABULE EGBA	0 - 15	1901	14.1	167	92.3	2.00	5.7
		15- 30	1740	121	146	58.11	2.00	
AGRICULTURAL	FI NIGER	0 - 15	64.4	10.6	64.4	25.6	2.0	5.1
		15- 30	35.1	4.46	35.1	38.4	20.9	
	OJO	0 - 15	849.2	27.2	43.2	26.7	79.1	4.8
		15- 30	1452.9	17.4	25.9	19.6	57.7	
INDUSTRIAL	IKEJA	0 - 15	2597	13.6	161	83.2	2.00	6.9
		15- 30	2515	12.7	207	84.7	2.00	
	ILUPEJU	0 - 15	2101.7	12.1	196	97.2	2.00	6.7
		15- 30	2304.6	14.1	186	83.6	12.5	
	Mean± SD		1547.1±73	16.1±25	154±56	55.1±29	10.1±20	6.0±1.1
Control	LASU	0 - 15	3910	0.53	58.9	0.20	49.63	6.8
		15- 30	2270	0.18	9.80	0.21	55.70	
Standards	[29]			4300	7500	85	420	
	[34]			36	300	3.0	100	
	[35]				50	0.8	85	

Top soil = 0 - 15 cm, Sub soil = 1

Cu plays cofactor role in various enzymes and performs essential roles in processes such as photosynthesis, respiration, and the electron transport chain. Copper toxicity to roots occurs when Cu exceeds 50 mg/kg in sandy soils up to 150 mg/kg for silty-clay or clay soils [36]. The human body system needs little amounts of copper from diets as a buildup of copper could be health hazardous. It may result in brain damage, liver failure, or death if it is not treated [37]. Copper has also been implicated in an inherent genetic disorder known as Wilson Disease [38]. Cadmium (Cd) is toxin that is scarcely of any known benefit in human body. The main source of cadmium to man is the ingestion of certain foods grown in contaminated soil, and exposure to cigarette smoke [39]. Cd has been implicated in the impairment of lung functions and consequently increasing the risk of lung cancer [40, 41]. The inter elemental association amongst the metals investigated in this study is evaluated using Pearson correlation coefficient as shown in Table.

Table 3. *Correlation coefficient of trace metals in the soils of different land use in Lagos.*

	Fe	Cu	Zn	Cd	Pb
Fe	0				
Cu	-0.593	0			
Z n	0.899	-0.631	0		
Cd	0.754	-0.435	0.711	0	
Pb	0.453	0.0528	0.291	0.136	0

This concept, furthermore, tells more about the origin of each metal. Correlation coefficients are used to measure the strength of the relationship between two variables. An elemental pair Fe/Zn maintains a very strong positive relationship indicating the same source of origin. Hence, the higher the level of iron observed in the study area, the higher the zinc too. Cadmium was observed to have a strong positive interrelation with both Fe and Zn. Cu/Zn interrelationship is though strong but negative indicating reverse in their origin.

Clusters Analysis

The dendrogram of hierarchical cluster analysis (Figure 1) shows four clusters clearly at a 2.8 index of dissimilarities. The clustering of land use area indicates soil qualities which varied in a way to suggest the influence of both natural (geochemical formation of the environment) sources and anthropogenic sources which include; urban runoff, leachate from landfill, and applications of chemical and fertilizers. Clusters I, II, III, and IV can be differentiated on the strength of iron contamination.

Cluster I comprise land use soil locations 5, 6, 1, 4, and 10 with a very high level of iron concentration. Another common trend in all soil locations is the higher level of iron and cadmium in topsoil than in subsoil. Cluster II is a lone cluster with soil location of 9 with the peculiarity of having the highest level of element iron ranging from 2515 to 2597 mg/kg.

Cluster III comprises soil locations 3, 8, and 2 with the peculiarity of iron concentration lower at the topsoil and higher at the subsoil. Cluster IV is also a lone soil location of 7 with the lowest concentration of iron (64.4/35.1 mg/Kg for top/subsoil) in the entire study area. The scree plot of the dendrogram is shown in figure 2 The scree plot helps in revealing level of several factors to retain in the principal component analysis (PCA) [42]. The observed values for geo statistical variables investigated; Contamination factor, Enrichment factor, and Geo accumulation Index of potential toxic metals of the land use soil as presented in Table 4. They help in further interpreting the basic descriptive data generated from laboratory analyses, thereby enhancing a better understanding of the soil environment. Contamination factor values as shown in table 3 reveal low contamination of iron and lead, considerable contamination of zinc, and very high contamination of cadmium and copper. The EF values for the soil investigated are shown in Table 4.

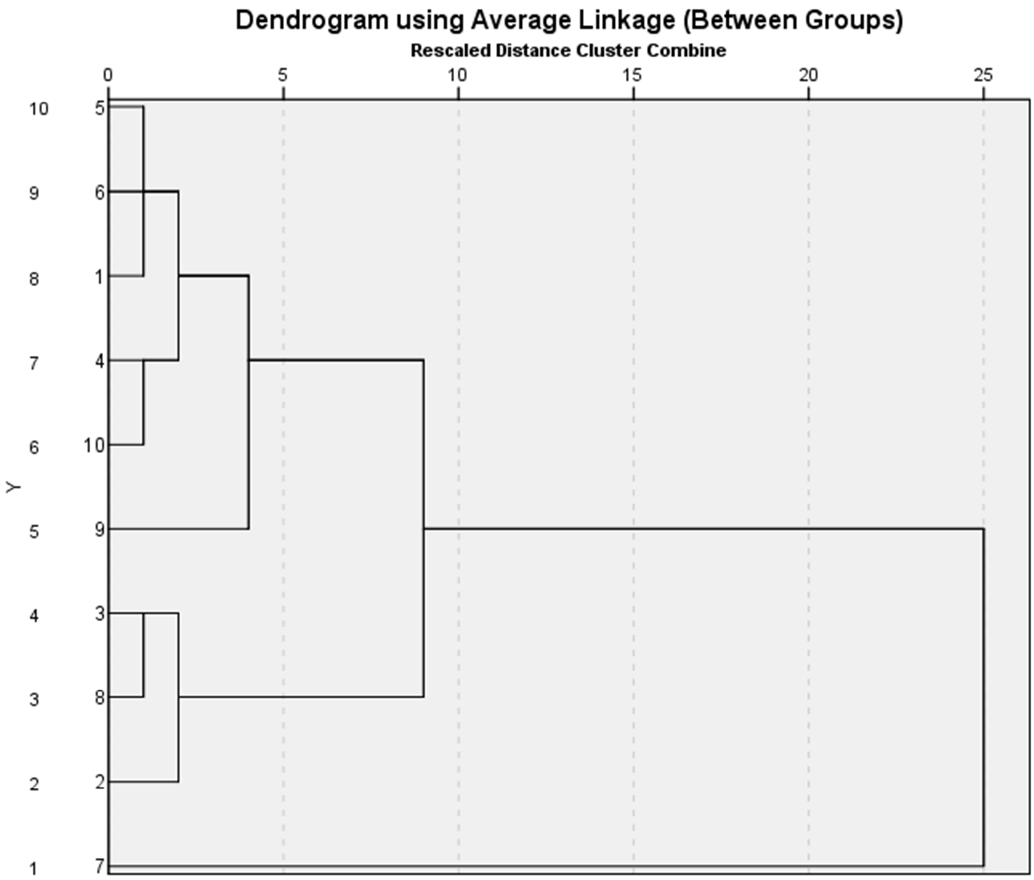

Figure 1. *Dendrogram showing clustering of the land use soil locations.*

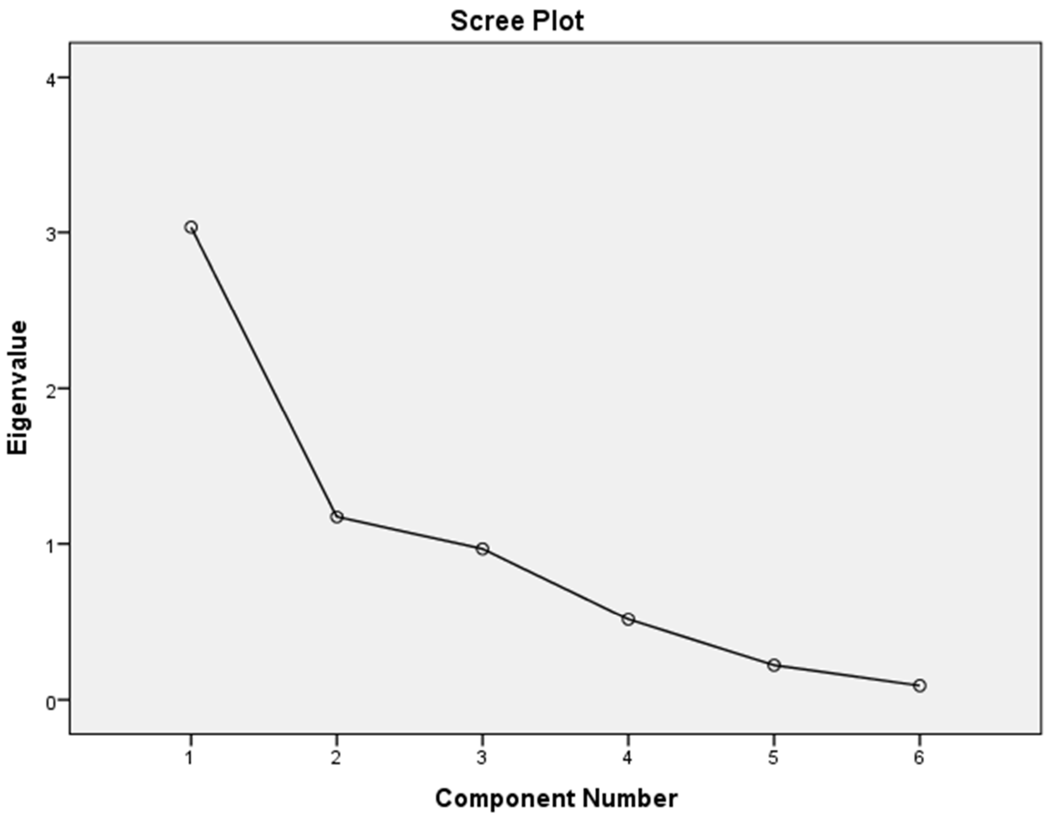

Figure 2. *The scree plot of the dendrogram.*

Lead and iron have minimal enrichment while zinc has significant enrichment and an extremely high enrichment concerning Cadmium and copper. The Ef and I_{geo} are indicators of the presence and degree of man induced contaminant deposition in soil. The two indices help to determine the level of contaminants and the health status of the soil environment. The geo accumulation Index values in this study are presented in table 4 below.

Table 4. *Enrichment factor, Contamination factor, and Geo accumulation Index of potential toxic metals of the land use soil.*

	Fe	Cu	Cd	Zn	Pb
C(Ms) mg/kg	1547.1	16.1	55.1	154	10.1
C(Fes) mg/kg	1547.1	1547.1	1547.1	1547.1	1547.1
C(Mc) mg/kg	3090	0.355	0.21	34.4	52.7
C(Fec) mg/kg	3090	3090	3090	3090	3090
CF	0.50	45.4	262.4	4.48	0.19
EF	1.00	95.5	524.3	8.9	0.39
I_{geo}	1.74	4.92	7.50	1.58	-2.97

The negative value of Pb (-2.97) shows that the soils under investigation were not affected by Pb pollutant. I_{geo}values of iron and zinc (1.74) and (1.58) respectively classified the two metals as moderately polluted. The I_{geo} of copper places the metal in the zone of strong to very strong polluted, while the I_{geo} value of cadmium (7.50) classified the metal as very strong polluted.

Pollution Load Index (PLI) is another pollution index of importance tool. It evaluates the degree to which soil sediments associate, and how potential toxic metals might impact the micro flora and fauna of the soil. Hence, it helps in revealing the extent of deterioration of the study area. PLI calculated from the entire study is 8.18, which indicates a deterioration status.

5. Conclusion

This study investigated the quality of soils in different land use areas in Lagos municipal city. This was achieved through the determination of trace metals load in the soils from the study area. Various Geostatistical pollution indices were employed to reveal the degree of pollution and health status of the soils in the study areas. The enrichment factors (EF) value of potential toxic metals determined revealed no enrichment by iron and lead, a significant enrichment with zinc, and a high enrichment with respect to cadmium and copper. The geo accumulation Index (I_{geo}) presented the order of pollution of metals investigated as Cd > Cu > Fe > Zn > Pb. Conclusively, the PLI showed the order of the worst deteriorated areas as industrial area > landfill area > residential area. This also indicates a general deterioration of the soils under investigation through man induced sourced pollutants. Strict regular environmental monitoring will keep the trace metal load in view thereby ensuring safety of man and sustainability of environment.

References

[1] Somantri L. & Nandi N. (2018). Land Use: One of Essential Geography Concept Based on Remote Sensing Technology. DOI: 10.1088/1755-1315/145/1/012039.

[2] Yamamura T. (2018). "Pop culture contents and historical heritage: The case of heritage revitalization through 'contents tourism' in Shiroishi city". Contemporary Japan, 30 (2): 144–16 doi: 10.1080/18692729.2018.1460049. S2CID 158229168.

[3] Ugwu A. N., & Aruma E. O. (2019). Community Participation as a Tool For The Promotion of Sustainable Community Development. International Journal of Community and Cooperative Studies, 7 (1): 1-10.

[4] Awoniran D. (2012). Geo-Spatial Analysis of Land Use and Land Cover Change in the Lower Ogun River Basin. Unpublished M. Sc. Thesis. Obafemi Awolowo University Ile-Ife.

[5] Environmental Protection Agency EPA. (2002). Guidance for Comparing Background and Chemical Concentrations in Soil for EPA/600/P-95/002Fc. Office of Research and Development, U.S. EPA.

[6] Wu Y., & Chen J. (2013). Investigating the effects of point source and nonpoint source pollution on the water quality of the East River (Dongjiang) in South China. Ecological Indicators 32: 294–304. DOI: 10.1016/j.ecolind.2013.04.002.

[7] Kuai P., Li W, & Liu N. (2015). Evaluating the Effects of Land Use Planning for Non-Point Source Pollution Based on a System Dynamics Approach in China. PLoS ONE, 10 (8): e0135572. doi.org/10.1371/journal.pone.0135572.

[8] Balasubramanian A. 2015. Categories of Land use, DOI: Conference https://doi.org/10.13140/RG.2.2.224 03.09763.

[9] Jie L., Jincai X., Huifang S., & Li F. (2020). Land-Use Classification Via Co nstrained Extreme Learning Classifier Based on Cascaded Deep Convolutional Neural Networks. In European Journal of Remote Sensing, 53 (1): 219-232. https://doi.org/10.1080/22797254. 2020.1809528.

[10] Khormali F., Ajami M., Ayoubi S., Srinivasarao C., & Wani S. (2009). Role of Deforestation and Hill slope Position on Soil Quality Attributes of Loess-Derived Soils in Golestan Province Iran. Agriculture, Ecosystems, and Environment. 134 (3-4): 17189. DOI: 10.1016/j.agee. 2009.06.017.

[11] Awdenegest M., Melku D., & Fantaw Y. (2013). Land Use Effects on Soil Quality Indicators: A Case Study of Abo-Wonsho, Southern Ethiopia. Applied and Environmental Soil Science. vol 2013, Article ID 784989, 9 pages doi.org/10.1155/2013/784989S.

[12] Solomon H. & Yoshinobu K. (2006). Traditional Irrigation management in Betmera-Hiwane, Ethiopia: The Main Peculiarities for Persistence of Irrigation Practices. In Journal of Mountain Science, 2: 139–146. doi.org/10.1007/s11629-006-0139-0.

[13] Bing H., Zhou J., Wu Y., Wang X., Sun H., & Li R. (2016). Current State, Sources, and Potential Risk of Potential toxic metals in Sediments of Three Gorges Reservoir, China. In Environmental Pollution, 214: 485–496. DOI: 10.1016/j.envpol.2016.04.062.

[14] Varol M. (2020). Environmental, Ecological and Health Risks of Trace Metals in Sediments of a Large Reservoir on the Euphrates River (Turkey). Environmental Research. 187. https://doi.org/10.1016/j.envres.2020.109664.

[15] Mendil D., Demirci Z., Tuzen M., & Soylak M. (2010). Seasonal Investigation of Trace Element Contents in Commercially Valuable Fish Species from the Black Sea, Turkey. Food Chem Toxicol., 48: 865–870. https://doi.org/10.1016/j.fct.2009.12.023.

[16] Xie W., Peng C., Wang H., & Chen W. (2017). Health Risk Assessment of Trace Metals in Various Environmental Media, Crops and Human Hair from a Mining Affected Area. In International Journal of Environ Res Public Health., 18; 14 (12): 1595.

[17] Salam M., Paul A., Zain R., Bhowmikm S., Nath M., Siddiqua S., Aka T., Iqbal M., Kadir W., Ahamad R., Khaleque M., Rak A. & Amin A. (2020). Trace Metals Contamination Potential and Health Risk Assessment of Commonly Consumed Fish of Perak River, Malaysia. PLoS One. 26; 15 (10). Malaysia. doi: 10.1371/journal.pone.0241320.

[18] Isibor P., Imoobe T., Enuneku A., Akinduti P., Dedeke G., & Adagunodo T. (2020). Principal Components and Hierarchical Cluster Analyses of Trace Metals and Total Hydrocarbons in Gills, Intestines, and Muscles of Clarias gariepinus (Burchell, 1822). Sci Rep., https://doi.org/10.1038/s41598-020-62024-9.

[19] Hosseini M., Nabavi S. M., Nabavi S. N., & Pour N., (2015). Potential toxic metalss (Cd, Co, Cu, Ni, Pb, Fe, and Hg) Content in Four Fish Commonly Consumed in Iran: Risk Assessment for the Consumers. In Environ Monit Assess., 187: 1–7.

[20] Adeyi A., Majolagbe A. O., & Osibanjo O. (2019). Trace Metal characterization of Soils in the Vicinity of a Major Active Dumpsite in Lagos: An integrative multivariate indices approach. In R. Ponnadurai (Ed), Chemistry for a Clean and Healthy Planet. (pp 153-167). Switzerland: Springer. DOI: 10.1007/978-3-030-20283-5_10.

[21] Edith-Etakah B. T., Shapi M., Penaye J., Mimba M. E., NguemheFils S. C., Nadasan D. S., Davies T. C., & Jordan, M. A. 2017. Background Concentrations of Potentially Harmful Elements in Soils of the Kette-Batouri Region, Eastern Cameroon. Research Journal of Environmental Toxicology, 11: 40-54. DOI: 10.3923/rjet.2017.40.54.

[22] Mediolla L, Domingues M., & Sandova M. 2008. Environmental Assessment of Active Tailings Pile in the State of Mexico (Central Mexico). In Research Journal of Environmental Science, 2 (3): 197-208. DOI: 10.3923/rjes.2008.197.208.

[23] Neina D. (2019). The Role of Soil pH in Plant Nutrition and Soil Remediation. Applied and Environmental Soil Science. Article ID 5794869. DOI: 10.1155/2019/5794869.

[24] Zhao J., Dong Y., Xie X, Li X., Zhang X. & Shen X. (2011) z. Effect of Annual Variation in Soil pH on Available Soil Nutrients in Pear Orchards. In Acta EcologicaSinica., 31 (4): 212–216.

[25] Li S., Liu Y., Wang J,, Yang L, Zhang S, Xu C., & Ding, W. (2017). Soil Acidification Aggravates the Occurrence of Bacterial Wilt in South China. Front Microbiol., 8: 703.

[26] Onwordi C. T., Majolagbe A. O. & Okwandu C. C. (2008). Heavy metals composition in vegetables along highway. Chemical & environmental Research, 17 (1&2) 113-120.

[27] Onwordi C. T., Lawal O., Olaiwola O. & Olowu R. A. (2017). Assessment of the physicochemical characteristics and potentially toxic metals in soils at Agbara Industrial Estate. Ogun State. Nigeria J Sci. Res. Dev., 17 (1) 1-8.

[28] Jaishankar M., Tseten T., Anbalagan N., Mathew B, B., & Beeregowda K. N. (2014). Toxicity, mechanism and health effects of some potential toxic metalss. Interdiscip Toxicol., 7 (2): 60-72. doi: 10.2478/intox-2014-0009.

[29] Ndayisaba A., Kaindlstorfer C., & Wenning G. K. (2019). Iron in Neurodegeneration - Cause or Consequence? Front Neurosci., 13: 180 doi:.10.3389/fnins.2019.00180.

[30] United State Department of Agriculture (USDA) 2000. Urban Technical Notes No 3: Soil Quality Institute, USA.

[31] Nguyen T. D., Cavagnaro T. R, Watts W. & Illiams S. J. (2019). The effects of soil phosphorus and zinc availability on plant responses to mycorrhizal fungi: aphysiological and molecular assessment. Sci Rep., 9 (1): 14880.

[32] Uwitonze, A. M., Ojeh, N., Murererehem, J., Atfi, A. and Razzaque, M. S. 2020. Zinc Adequacy Is Essential for the Maintenance of Optimal Oral Health. Nutrients, 12 (4): 949. doi: 10.3390/nu12040949. PMID: 32235426; PMCID: PMC7230687.

[33] Zhang H., Luo Y., Wu H., Hungry C., & Christie, P. (2015). Residues and potential ecological risks of veterinary antibiotics in manures and composts associated with protected vegetable farming. Environmental Science and Pollution Research, 22 (8): 5908–5918. Doi: 10.1007/s 11356-014-3731-9.

[34] Kemaji B., Hazbije S., Jeton H., Mentor B., & Ilir M. 2021. Effect of Mining Activity in Accumulation of Heavy Metals in Soil and Plant (Urtica dioica L) Journal of Ecological Engineering, 22 (1): 1–7 https://doi.org/10.12911/22998993/128691.

[35] World Health Organization WHO. (2006). Guidelines for Drinking-Water Quality. First Addendum to 3rded.1, Recommendation. J. Hydro Geneva, WHO, 595.

[36] Fonseca J., Lee H., Boschiero C., Griffiths M., Lee S., & Zhao P. 2020. Iron-Sulfur Cluster Protein Nitrogen Fixations-Like1 and Its Interactor Frataxin Function in Plant Immunity. In Plant Physiology, 184; 1532-1548. doi: 10.1104/pp.20.00950.

[37] Boos M., Sabine H., Marion O., Esther K., Jean F., & Huneau I. (2016). Dietary Copper and Human Health: Current Evidence and Unresolved Issues. Journal of Trace Elements in Medicine and Biology, 35: 107-115. https://doi.org/10.1016/j.jtemb.2016.02.006.

[38] Aggarwal A., & Bhatt M. (2013). Update on Wilson disease. In International Rev Neurobiol, 110: 313-48. DOI: https://doi.org/10.1016/B978-0-12-410502-7.00014-4.

[39] Caruso R. V., O'Conno R. J., Stephens W. E., Michael K. C., & Fong G. T. (2014). Toxic Metal Concentrations in Cigarettes Obtained from U.S. Smokers in 2009: Results from the International Tobacco Control (ITC) United States Survey Cohort. International Journal of Environmental Research and Public Health, 11 (1): 202-17 DOI: 10.3390/ijerph 110100202.

[40] Bernard A. (2008). Cadmium & Its Adverse Effects on Human Health. In Indian J Med Res., 128 (4); 557-64. PMID: 19106447. DOI**:** 19106447.

[41] Zhang X., Jiang N., Wang L., Liu H., & He R. (2017). Chronic obstructive pulmonary disease and risk of lung cancer: a meta-analysis of prospective cohort studies. Oncotarget, 18; 8 (44): 78044-78056.

[42] Ledesma R. D., & Valero-Mora P. (2007). "Determining the Number of Factors to Retain in EFA: An easy-to-use computer program for carrying out Parallel Analysis," Practical Assessment, Research, and Evaluation, 12: (2). doi.org/10.7275/wjnc-nm63.