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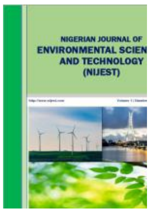

Appraising Heavy - Metals distribution in Street Dust of Ketu-Mile 12 Area of Lagos-State, South-Western, Nigeria

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ABSTRACT

This research reports the results of Heavy metals Zn, Pb,Cu, Ni, Cd contents of Street dust of Ketu-Mile 12 Area of Lagos - State , South - Western, Nigeria. The dust samples were collected randomly from August - December, 2022 at ten different locations of Ketu - Mile 12 Area by sweeping surface dust into plastic waste packer using plastic brush and transferred into pre-labeled polythene. The samples collected at each location were filtered through 75µm stainless steel sieve, weighed and digested with appropriate amount of HNO_3 and H_2O for 2 hours. The concentrations of Heavy metals were analyzed using Atomic Absorption Spectrophotometer (AAS).Results showed that the average concentration of Heavy metals were: Zn 176.43 mg/kg, Cu 162.25mg/kg, Pb 32.22mg/kg, Ni 6.98mg/kg and Cd 0.33mg/kg with the most abundant pollutant Heavy metal was Zn while the least abundant was Cd. The most polluted site was Owode - Onirin 263.54mg/kg while the least polluted site was Alapere 2.269mg/kg. The Principal Component Analysis PCA showed that the major sources of heavy metals are mainly anthropogenic and two factors PC1 and PC2 accounted for 72.95% of the total variance. Each of these factors were identified as sources of heavy metals in dust of Ketu - Mile 12 area with Traffic/ Vehicular emission dominating. Pearson's significant correlation analysis revealed that there is strong positive correlation between the Heavy metals at 0.01 levels. The concentration of Heavy metals exceeded the recommended limits of the Federal Ministry of Environment (FME), European communities (EC) and United Nations Environmental Programme (UNEP) permissible level. Therefore, there is need for environmental monitoring, safety and management of Ketu - Mile 12 dust.

Keywords: Environment, Sample, Significant, Concentration, Dust, Anthropogenic

1.0. Introduction

With rapid increase in industrialization and urbanization, the quality of air in major cities around the world especially in developing city like Lagos State, Nigeria particularly Ketu - Mile 12 area is rapidly deteriorating as a result of the presence of Heavy metals contamination arising from energy generation, vehicular traffic, combustion of fossil fuel and poor waste management policies. Characteristic distribution of Heavy metals in Street road dust may depend upon different functional sites of an urban area because of the types and intensities of anthropogenic activities in the study Area.(Wang *et al.*, 2016; Li *et al.*, 2017). Dusts are fine solid particles in the atmosphere from various sources such as soil, dust lifted by wind and pollutions. Street dust is a fine powder inform of fine sand or earth which can be found in the street (Lu *et al.*, 2014; Rahman *et al.*, 2019). They are made up of solid particles deposited on impermeable materials that originate from the interaction of solids, liquids, and gases in the environment (Keshavarzi *et al.*, 2018). Dust act as sink and source of toxic metals to the environment (especially soil and air) (Men *et al.*, 2020). Heavy metals are the stable metals or metalloids whose density is greater than 4.5 g/cm^3, namely Pb, Cu, Ni, Cd, Zn, Hg and Cr, etc.(Chopra *et. al.*,2009). Some of these metals are essential for life at very low concentration levels but at high levels of concentration they may lead to harmful effects in humans, plants and animals (Cao, 2009)). Those that are of grave concern are the non-essential heavy metals like As, Pb, Cd and Cr which may be considered major air and land pollutants in areas where they are most concentrated (Moses *et al.*, 2009)). Heavy metals are dangerous because they tend to bio-accumulate (Bawuro *et al.*, 2018). Long term exposure to the polluted road dust would cause severe damage through if inhalation, ingestion, and dermal contact (Lu *et al*,.2010). Chemical composition of Street dust can be used as an indicator for environmental pollution (Han *et al*.,2006), a valuable medium for characterizing urban environmental quality (Liu *et al*., 2014), and exposure health risk assessment (Hussain *et al*., 2015). Heavy-metal levels in dust are an important indicator of environmental contamination (Yadav *et al.*, 2019; Dytlow *et al.*, 2021; Jahandari *et al.*, 2020).There are various methods of sampling dust. Those that have been reported include the use of: a plastic dustpan and a brush (Wei *et al.*, 2009, Aguilera *et al.*, 2019, Praveena *et al.*, 2019), a plastic hand broom and dustpan (Zhang *et al.*, 2012; Soltani *et al.*, 2015), brushing 1 m^2 of previously delimited surface of asphalt (Reyes *et al.*, 2013), an ABA- 1-120-02A portable aspirator (Sahakyan *et al.*, 2016; Saghatel *et al.*, 2014), a brush and plastic hand shovel (Trujilo-Gonzalez *et al.*, 2016), a vacuum cleaner (Yu *et al.*, 2007; Tanner *et al.*, 2008) , and a portable high-pressure washer device with a piston fitted into a rigid, sealed rubber dome(Budai *et al.*, 2018).

The five metals addressed in this study (Zn, Pb, Ni, Cu and Cd) are among the most often found heavy metals in the atmosphere including dust and to a large extent are harmful to human beings and the entire ecosystems. For instance, Consumption of excessive amounts of Zinc might result in pancreatic problems, anemia, and muscle soreness (Roney *et al.*, 2006). Studies on atmospheric dust fall reported that Zn likely comes from the combustion of engines, fossil fuels, tire wear, vehicular emissions (Valotto *et al.*, 2015; Valotto, Cattaruzza & Bardelli, 2017, Hwang *et al.*, 2016; Kui Cai *et al.*, 2019). Pb in the Street dust might be accumulated from traffic emission, industrial activity and As pollution from the use of arsenical pesticides, herbicides, crop desiccants and metal smelting (Bhuiyan *et al.*, 2015; Men *et al.*, 2018; Xiao *et al.*, 2020; Rahman *et al.*, 2019). Cu is regarded as a tracer for non-exhaust vehicle emission (Cui *et al.*, 2019; Rai *et al.*, 2021),Cu is used in lubricants to improve friction stability and emits during brake abrasion (Querol *et al.*, 2007; Amato *et al.*, 2014). Sources of Cu also include non-ferrous metallurgical industry, metal processing and refinery industry (Ramírez *et al.*, 2018; Men *et al.*, 2018). High levels of Copper exposure can impair the immune system; induce liver, renal, and gastrointestinal problems, as well as Wilson’s syndrome and anxiousness (Taylor *et al.*, 2020; Briffa *et al.*, 2020). Exposure to excessive amounts of Cd has been linked to renal disease, infertility, mental and digestive issues, and cancer (Faroon *et al.*, 2012). A number of health problems are associated with prolonged exposure to cadmium (particularly in children), including neurologic problems, kidney problems, high blood pressure, heart disease, and reproductive system problems (Abadin *et al.*, 2007). The major source of Cd in Street dust might be lubricating oil, diesel fuel, tire, and brake wear, batteries, plastic and building materials (Foti *et al.*, 2017; Men *et al.*, 2020; Heidari *et al.*, 2021; Wei *et al.*, 2010). Human exposed to Nickel, are more likely to suffer from respiratory problems, cardiovascular disease, and cancer (Buxton *et al.*, 2019).

Although, there are enormous studies on the levels of Heavy metals in Street dust in the world (Liu *et al.*, 2015; Salwan *et al.*, 2020; Kui, Cai and Chang, Li (2019); Xu *et al.*, 2021; Abassi *et al.*, 2020; Kara *et al.*, 2020; Li *et al.*, 2020) but currently there are little or no literature on Heavy metals on Street dust in Lagos State, particularly Ketu - Mile 12. Ketu - Mile 12 is an urban area with a large market characterized with high Population density with high Commercial and vehicular activities. Therefore, the objectives of the present study were to : (1) assess and evaluate the levels of Heavy metals Street dust of Ketu - Mile 12 Area (2). determine the degree of bioaccumulation and Characteristic distribution of the Heavy Metals and (3) determine whether there is a significant difference in the levels of Heavy metals from one location to another within the study area. It is hopeful that this study will provide the percentage contributions of each Heavy Metal and their potential sources.

2.0. Methodology

2.1 The study area

This study was conducted in ketu - mile 12 areas (N 6º .60854, E 3º.40922 - N 6º.51626, E 3º.37369) of Lagos state namely: Ile - ile, Owode - Elede, Kosofe, Iyana - school, Mile 12, Ketu - garage, Aalapere, Agboyi, Ikosi - road and Owode - Onirin. The sampling points were about 300m from the main roads and 100m from minor roads. The sites were carefully chosen based on the following criteria: accessibility to the street dust, availability of open spaces with minimal influence from traffic as well as industrial activities.(Table 1). The geo-referencing was carried out by using GPS MAP 76S (Garmin).

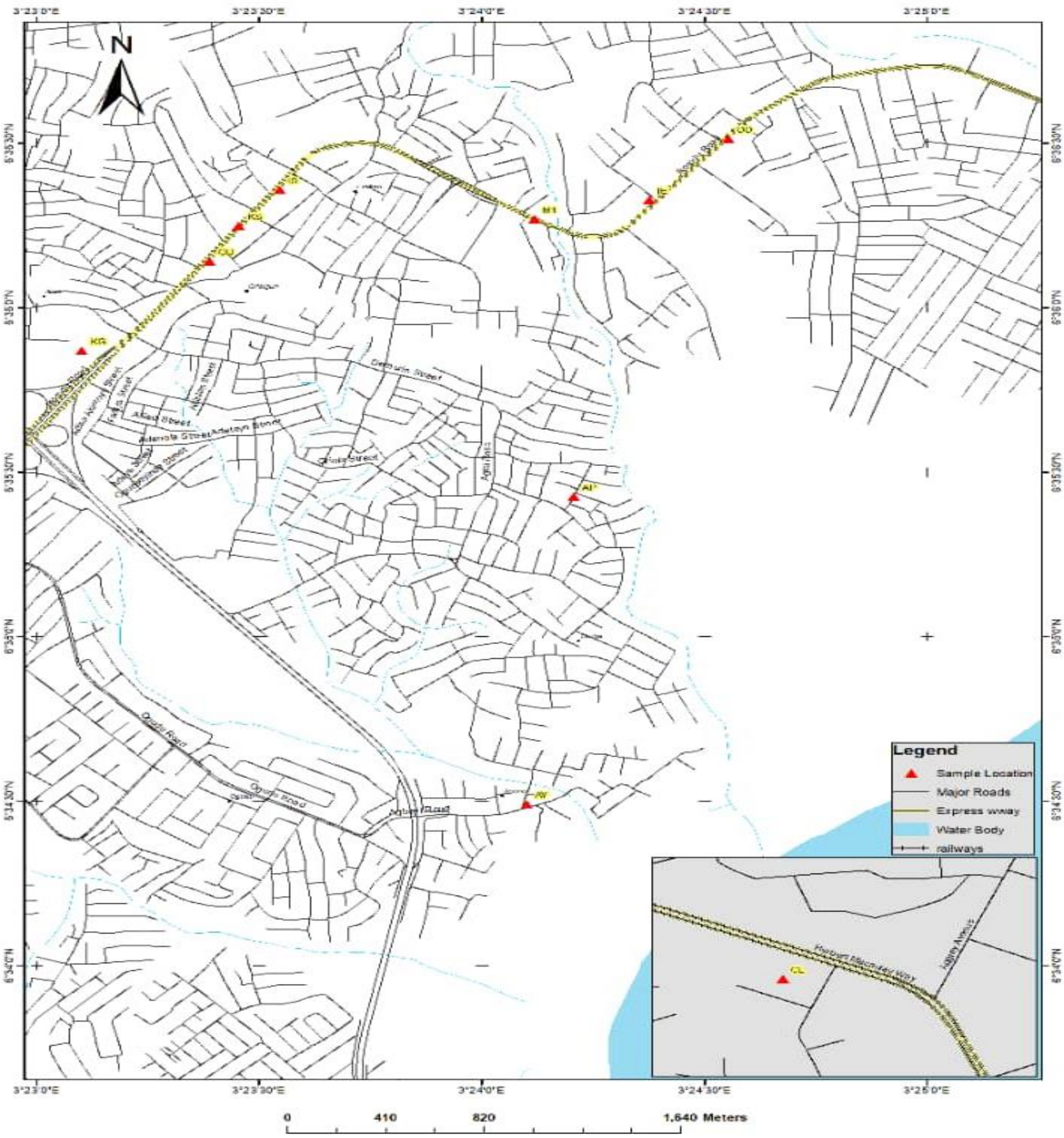

Figure 1: GIS Location Map showing Sample Sites in Ketu - Mile 12 Area

2.2. Street Dust Sampling

The dust samples were collected from eleven (11) sites within the study area, at least 100m apart within the months of August - December, 2022. Samples were collected in the morning while the dust has settled well throughout the night and before heavy morning traffic movement that can disrupt the dust. The samples were randomly collected from both sides of the road by sweeping surface dust into plastic waste packers using plastic brush and transferred into pre- labeled polythene bag. All irrelevant materials such as cigarette ends, papers, plastics etc. were carefully hand- picked. Thereafter, samples collected at each location were filtered through 75µm stainless steel sieve. The samples were then taken to the laboratory for further treatment and analysis (Shabbaj *et al.*, 2018; Aguilera *et al.*, 2019; Praveena *et al.*, 2019).

Table 1: Description of Sampling Sites with their Location Coordinates

S/N	Location / Sites	Codes	Latitude	Longitude	Site description
1	Ile-Ile	IE	N6º.60543	E3º. 40626	This is a dumping site for scrap metals with high traffic and vehicular activities.
2	Owode-Elede	OD	N6º.60234	E3º.38981	It is a major road with high vehicular activities, abandoned vehicles, filling stations and few welding shops.
3	Kosofe	KS	N6º.60413	E3º.39091	It is a residential area with few vehicular activities.
4	Iyana-school	IS	N6º.60594	E3º.39244	It is a dumping site for metals with abandoned vehicules.
5	Mile 12	Ml	N6º.60448	E3º.40197	This is commercial area, filing stations with high vehicular activities.
6	Ketu garage	KG	N6º.59780	E3º.38503	It is an area with mechanic workshops, abandoned vehicles and smoking activities.
7	Alapere	AP	N6º.59042	E3º.40343	It is a residential area with few vehicular activities.
8	Agboyi	AY	N6º.57484	E3º.40168	It is an area with few vehicular activities and galvanized metal works.
9	Ikosi road	IR	N6º.59943	E3º.38024	It is an area with high vehicular activities with filling station.
10	Owode - Onirin	OO	N6º.60854	E3º.40917	It is an industrial area with high welding, mechanical and metal works / activities, dumping of scrap metals, galvanized metals and steel.
11	Botanical garden (control)	BG	N6º.51626	E3º.7369	It is an area with little or no anthropogenic activity.

2.3. Digestion of dust Samples for Heavy metals

2.0g of sieved dust was weighed using an analytical balance and transferred into a conical flask for digestion. 30ml nitric acid and 10ml concentrated hydrochloric acid prepared in the ratio 3:1 was added. The solution was mixed thoroughly and heated on magnetic heated stirrer, then refluxed at 90ºc for 20 minutes. After the disappearance of brown fumes, the digested solution was cooled and then filtered through Whatman type 589/2 filter paper. The filtrate was diluted to 50 cm^3 with de-ionized water. The metal contents in the filtrate were determined using an atomic absorption spectrophotometer (AAS) PG - 990. (Men *et al.,* 2019; Benhaddya *et al.,* 2016).

2.4 Statistical analysis

The analysis of variance (ANOVA) together with mean and standard deviation of each heavy metals were carried out on the data obtained from the street dust(Table 3). Kaiser-Meyer - Olkin and Battlet's test were also carried out to confirm the sampling adequacy.(Table 2).

Table 2 : KMO and Battlet's test

		Heavy metals
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.723
Bartlett's Test of Sphericity	Approx. Chi-Square	2769.207
	Df	55
	Sig.	0.000

3.0 Results and Discussion

3.1. Characteristic Distribution of Heavy metals in Ketu- Mile 12 Area

The results of this research showed that the main contributors to dust pollution in Ketu- Mile 12 area are Zn- 46.7 %, Pb - 8.5 %, Cu-42.9 % and to a lesser extent Ni -1.8% and Cd- 0.1 % (Figure 2). The most abundant Heavy metal in the dust of Ketu - Mile 12 is Zn - 1764.334 mg/kg followed by Cu- 1622.507 while Cd - 3.264 mg/kg is the least abundant (Table 3). The high presence of Zn may be due to emission originating from wearing of brake lining; losses of oil and cooling liquid, corrosion of galvanized steel safety fence, wearing of tyres etc; while nickel could be due to the combustion of fossil fuels, smelting of metals / steel and oil activities. Lead levels could be attributed to emissions from vehicles which use leaded gasoline and to exhaust gas coming from fuel and from worn metal alloys which might have accumulated over time owing to its long residence time in the environment. The highest concentration of Zinc- 165.267mg/kg, lead - 989.427mg/kg, Copper-1453.161mg/kg, Cadmium-1.314mg/kg and Nickel-26.316mg/kg were recorded at Owode - Onirin while the least concentration of Zinc- 3.930mg/kg, lead-0.490mg/kg, Copper-0.591mg/kg, Cadmium-0.010mg/kg and Nickel-0.131mg/kg were also recorded at Alapere. The high presence of lead may be due to the high commercial, automobile and vehicular activities in the area, spillage of petroleum products, smoking of cigarettes, paint chips from the walls of industrial buildings, careless discard of lead acid batteries used in automotives as well as the use of industrial grade and non - domestic paints by the surrounding industries. The level of Zinc and Lead at Owode - Onirin were significantly different ($p < 0.05$) from all other sites (Table 3). The presence of copper may be due to the manufacturing of electrical cables, mining of metal, production of cans and the use of pesticides, combustion of fossil fuels, smelting of metals, vehicular emission, traffic congestion and industrial processes that uses these metals or their compounds. Furthermore, the presence of nickel in this Owode - Onirin may be as a result of fuel combustion from generators as well as frequent bush burning in the surroundings. The high significant levels of Zn, Pb and Cu obtained in the Ketu - Mile 12 dust is an indication of their concentration in the dust while the low concentration of Cadmium Cd and Nickel Ni suggest low contributing factors to their spread and as well as the dust inability to preferentially accumulate these metals. There is significant difference in the level of heavy metals in the study area ($Pv < 0.05$) (Table 3).

Table 3: Mean ± Standard Error of instrument reading of digested sample (PG -990 AASpectrophotometer)

Sites	Lead (Pb) Mean ± SD	Zinc (Zn) Mean ± SD	Copper (Cu) Mean ± SD	Cadmium (Cd) Mean ± SD	Nickel (Ni) Mean ± SD
Ile-Ile	24.54 ± 0.88	128.89 ± 0.84	30.65 ± 0.69	0.24 ± 0.037	6.50 ± 0.71
Owode-Elede	48.71 ± 1.05	225.02 ± 0.85	59.57 ± 0.91	0.38 ± 0.046	11.19 ± 0.84
Kosofe	7.40 ± 0.64	6.62 ± 0.57	BLD	0.44 ± 0.037	9.36 ± 0.36
Iyana-School	36.67 ± 0.64	52.74 ± 0.83	38.45 ± 0.51	0.23 ± 0.033	5.77 ± 0.47
Mile 12	1.28 ± 0.33	26.5 ± 0.84	1.57 ± 0.12	0.038 ± 0.0044	0.36 ± 0.039
Ketu Garage	1.12 ± 0.13	8.79 ± 0.58	0.66 ± 0.055	0.039 ± 0.0061	0.25 ± 0.017
Alapere	0.49 ± 0.084	3.93 ± 0.55	0.59 ± 0.054	0.010 ± 0.0012	0.13 ± 0.028
Agboyi	34.44 ± 0.66	304.78 ± 0.46	36.08 ± 0.57	0.46 ± 0.045	9.56 ± 0.37
Ikosi-Road	2.26 ± 0.26	17.59 ± 0.58	1.78 ± 0.089	0.10 ± 0.0049	0.34 ± 0.039
Owode-Onirin	165.26 ± 0.88	989.43 ± 0.39	1453.16 ± 2.71	1.31 ± 0.054	26.32 ± 0.37
Botanicalgarden (Control)	0.83 ± 0.066	2.75 ± 0.41	0.63 ± 0.068	0.032 ±0.0044	0.031±0.0024

Mean difference is significant at P<0.05

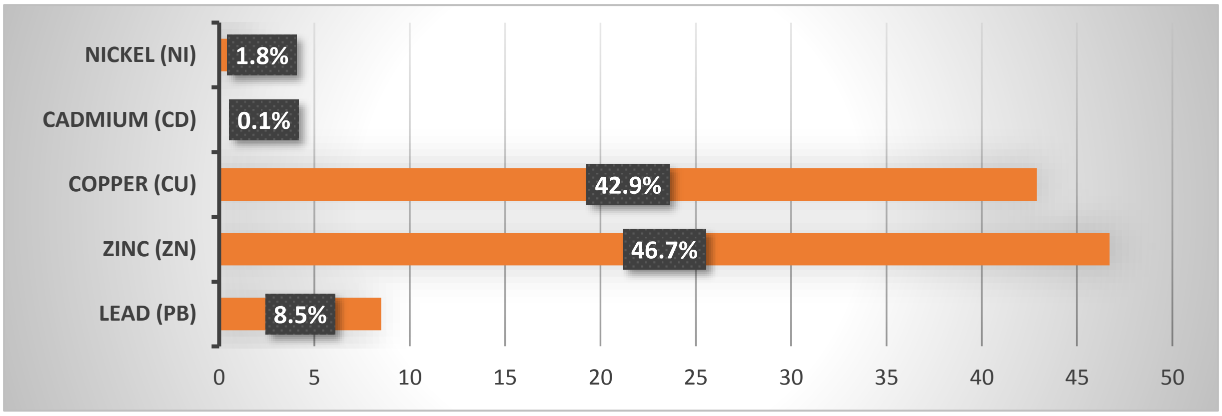

Figure 2: Percentage Contribution of Heavy metals in Ketu- Mile 12 Area

The sequence and Characteristic distribution of Heavy metals content of Ketu - Mile 12 dust is as follows: Zn > Cu > Pb > Ni > Cd with the mean concentration of - 176.433, 162.2507, 32.2166, 6.978 and 0.3264 mg/kg respectively (Table 4). The most polluted site is Owode-Onirin - 2635.485 mg/kg while the least polluted site is Alapere-5.152 mg/kg. This could be as a result of both vehicular, human, commmercial and Industrial activities in the area. The trend and percentage contribution of each site to pollution of Ketu dust is as follows: OO- 69.90 % > AY- 10.20 % > OD - 9.11 % > IE- 5.00 % > IS- 3.52 % > MI-0.80 % > KS- 0.60 % > IR- 0.60 % > KG- 0.3 % > AP- 0.20 % > BG(CTL) - 0.12 % (Figure 3).

Table 4: Average Mean Concentration of Heavy Metals in different sites of Ketu - Mile12 Area from August - December, 2022. (mg/kg)

Samples location	Code	Pb	Zn	Cu	Cd	Ni
Ile-Ile	IE	24.544	128.899	30.653	0.243	6.505
Owode- elede	OD	48.709	225.020	59.566	0.381	11.194
Kosofe	KS	7.395	6.618	BLD	0.441	9.363
Iyana - school	IS	36.666	52.736	38.449	0.232	5.769
Mile12	M1	1.276	26.538	1.572	0.038	0.356
Ketu garage	KG	1.115	8.790	0.656	0.039	0.247
Alapere	AP	0.490	3.930	0.591	0.010	0.131
Agboyi	AY	34.442	304.784	36.083	0.463	9.562
Ikosi-road	IR	2.262	17.592	1.776	0.103	0.338
Owode- onirin	OO	165.267	989.427	1453.161	1.314	26.316
Yaba College of Technology Botanical garden(control)	BG	0.834	2.754	0.626	0.032	0.031
TOTAL		322.166	1764.334	1622.507	3.264	69.781

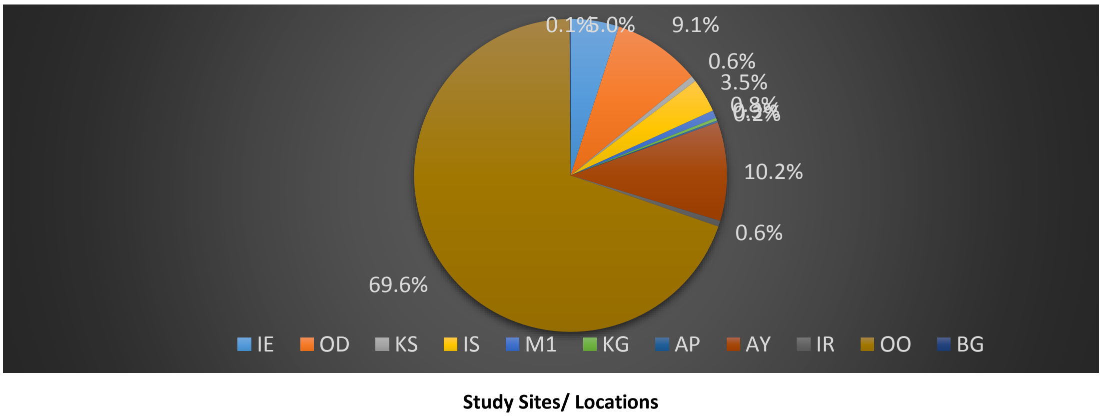

Figure 3: Percentage Distribution of heavy metals Pollution on Street dust in Ketu - Mile 12 Area

The result of this research agrees with the results obtained from other cities in the world and also showed that concentration of heavy metals depends on the nature of activities in the sites (Wang *et al.,* 2021; Li *et al.,* 2020; Kui Cai (2019) ; Xu *et al.*, 2020; Kara *et al.*, 2020; Adie *et. al.,* 2014 ; Ekpo *et. al.,* 2012 ; Mohsen *et al.*, 2012; Christoforidis *et al.*, 2009; Lu *et al.,* 2010; Karbassi *et al.,* 2005 ; Ojiodu *et. al.* 2017; 2018a, 2018b). Though, the concentrations of Heavy metals (Zinc, Lead, Copper, Cadmium and Nickel) in Ketu- Mile 12 dust may be high when compared with the values other cities in world (Table 5). This may be due to differences in vehicular and human activities (burning / dumping of waste), environmental management policies and technologies employed, frequency of city street cleaning and local meteorological conditions such as rains, temperature, windspeed which can affect the Heavy metals in the dust (Mohsen *et al.,* 2012). The level of heavy metals in this study area were far greater than the recommended limits of the Federal Ministry of Environment (FME), European Communities (EC) and United Nations Environmental Programme. The level of heavy metals in the study area were far greater than the recommended limits of the Federal Ministry of Environment (FME), European Communities (EC) and United Nations Environmental Programme (UNEP) permissible level for heavy metals in the atmosphere (EC, 2006). The concentration of heavy metals in all the sites was higher than the control value . This may be due to the fact that the control environment is an area with little or no anthropogenic activity.

Table 5: Mean concentration of Heavy metals in Street dusts of Ketu- Mile 12 and other selected cities of the world (mg/kg)

CITY	Pb	Zn	Cu	Cd	Ni
Ketu- Mile 12 (this study)	**322.999**	**1767.090**	**1623.133**	**4.078**	**69.811**
Central China / Arid Desert(Chiana) (Zhe *et al.,* 2021)	91.55	222.82	20.00	0.39	-
Shijiazhuang (China) Chang Li *et al.,* 2019	154.78	496.17	91.06	1.86	40.99
Xian(Chiana) Pan *et al.,* 2017	97.4	169.2	46.6	0.72	29.3
Shanghai (Korea) Li *et al.,* 2015	295	735	197	1.23	84
Chengdu (Korea) Li *et al.,* 2015	375	1117	244	4.4	88.1
Guizhou (Korea) Duan *et al.,* 2017	67.81	185.98	129.80	0.62	61.07
Shihwa(Japan) Jeong *et al.,* 2019	612	1824	992	2.22	164
Delhi (India) Suryawanshi *et al.,* 2016	120.7	284.5	191.7	2.64	36.4
(South Africa) Olowoyo *et al.,* 2016	754.3	304.6	157.2	2.54	74.3

3.2. Source Apportionment

3.2.1 Using principal component analysis (PCA) to identify the potential sources of Heavy metals in Ketu - Mile 12 Area.

The Principal Component Analysis (PCA) are the primary factor analysis techniques that uses eigen values to apportion data sets to identify emission sources depending on the data sets that have been submitted for PCA. It is widely used to reduce large data sets to a few components, and here it makes it easier to understand the potential sources of Heavy metals in Ketu- Mile 12 dust**.** The data acquired at Ketu - Mile 12 sites were used to conduct PCA analysis. The data for PCA were arranged in a matrix, with the columns representing concentrations of Zn, Pb, Ni, Cu and Cd in dust and the rows representing the sampling locations/ sites. The variance - normalized data matrix were used to identify the predominant components for implicating the potential Heavy metals sources. Varimax rotation with Kaiser Normalization were used in the PCA. All KMO values for the individual items (Pv > 0.70) were well above 0.5 and the Kaiser - Meyer Olkin Measure was 0.723 indicating that the data were sufficient for Exploratory Factor Analysis (EFA). The Bartlett's test of Sphericity $\chi^2_{(10)}$ = 117.375, $P < 0.05$ showed that there was patterned relationships between the items. The Scree plot confirmed the findings of retaining two (2) factors. Table 6. Showed the factor loadings after rotation using a significant factor criterion of 0.60. Using the Eigen value greater than one rule, two factors are identified. All characteristics with factor loadings of 0.50 and above are retained. Since the goal of factor analysis is to model the interrelationships among items, we focus primarily on the variance and covariance rather than the mean. Two factors were identified as those contributing to the measured values in Ketu - Mile 12 area(Table 6). The PCA analysis classified the dataset of Heavy metals into two principal components (PCs) PC1 and PC2 which accounted for the variances of 72.95% of the total variation in the dataset collected from Ketu - Mile 12 area of Lagos state. The two principal components are: PC1: This factor 1 accounted for 51.09 % of the total variance in the data. This factor was highly loaded with Zn, Pb, Cu and Ni. The source of these Heavy metals were from emissions from Traffic / Vehicular and burning of industrial wastes, lubricating oil, diesel fuel, tire, and brake wear (Foti *et al.*, 2017; Men *et al.*, 2020; Heidari *et al.*, 2021). Factor 1 is attributed to emission from Traffic / Vehicular, industrial wastes, lubricating oil, diesel fuel, tire, and brake wear. PC2: This factor 2 accounted for 21.86% of the total variance in the data. This factor is loaded with Pd and Cd. (Table 6). These Heavy metals are released from Waste dumpsite / improper disposal of domestic wastes.

Table 6 : The rotated component matrix for data of Heavy metals in street dusts of Ketu - Mile**.**

Heavy metals	Principal Components	
	PC1	**PC2**
Pb	**0.769**	0.140
Zn	**0.899**	0.269
Cu	**0.778**	-0.238
Cd	0.085	**0.967**
Ni	**0.736**	0.094
Eigen values	2.554	1.093
% of Variance	51.086	21.863
% of Cumm. Variance	51.086	72.949

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

3.2.2 Correlation coefficient analysis

Pearson's significant correlation analysis were employed to statistically link the concentrations of Heavy metals with the sources of road dust. Pearson's significant correlation analysis is used to evaluate the relationship among Heavy metals concentrations in road dust (Lv *et al.,* 2019). The values of the correlation coefficient range from -1 to 1. The sign of the correlation coefficient indicates the direction of the relationship (positive or negative). There is a strong positive correlation amongst the heavy metals. We can see that the sample correlations among Zn, Pb, Cu, Cd, and Ni are all directly related and positive which were suitable for the principal component analysis and exploratory factor analysis. There is a significant strong positive correlation amongst the heavy metals at 0.01 levels of significant (Enuneku *et al.*, 2017; Kara *et al.*, 2020; Hui- Liang *et al.*, 2021)(Table 7). This results showed that Pb, Zn, Cu and Ni are likely from common anthropogenic sources such as Traffic /Vehicular, Industrial activities, combustion of fossil fuels, gasoline and diesel exhaust while Cd are also likely from common anthropogenic source Waste dumpsite/ improper disposal of domestic wastes and sewage.

Table 7 : Correlation Analysis among the heavy metals in the dust of Ketu - Mile 12 (N = 77).

Metals	Pb	Zn	Cu	Cd	Ni
Pb	**1**				
Zn	0.674**	1			
Cu	0.477**	0.557**	1		
Cd	0.161	0.292*	-0.028	1	
Ni	0.339**	0.689**	0.367**	0.099	1
Mean	109.08	9.47	6.37	13.34	3.33
SD	84.67	7.29	8.13	11.62	3.61

****.**Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.2.3 Cluster Analysis

The bi - plot suggested that there are two clusters groups for the heavy metals in Ketu- Mile 12 dust. (Figure 4). We used hierarchical clustering because the datasets were small and continuous in nature and its' represented by dendrogram.(Figure 5). There are two : clusters 1 (Pb, Zn, Cu and Ni) and Cluster 2: Cd. The heavy metals in each cluster are from the same origin or Source, For example Heavy metals in Cluster 1 may originated from traffic / vehicular emission, industrial activities, combustion of fossil fuels, gasoline and diesel exhaust while Cd in Cluster 2 originates from Waste dumpsite/ improper disposal of domestic wastes and sewage . The results of the cluster analysis is in agreement with the results from the Principal component analysis : Factor 1 - PC1/Cluster 1: Pb - 0.899; Zn - 0.769; Cu - 0.778; Ni - 0.736 and Factor 2 - PC2 / Cluster 2 : Cd - 0.967 and Pearson's significant correlation analysis.

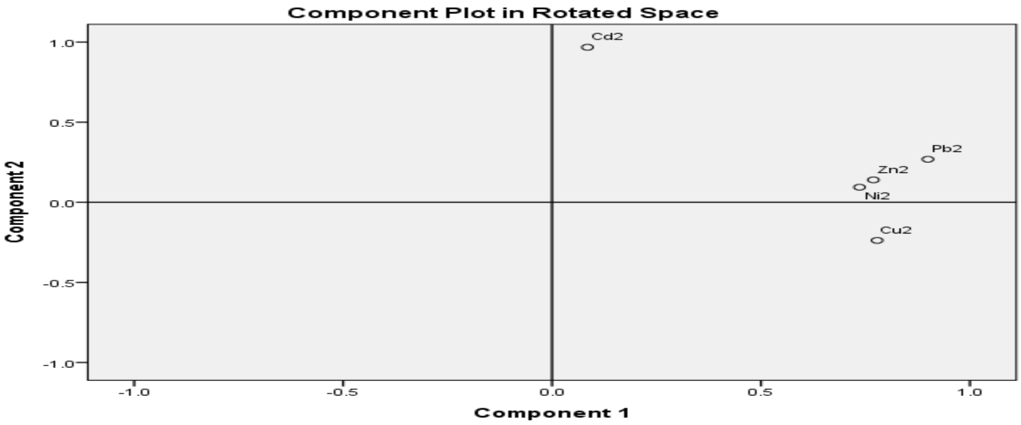

Figure 4: Bi - plot of the Components

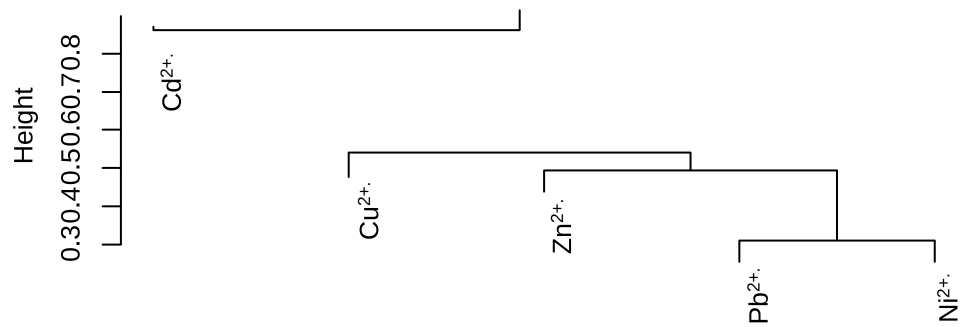

Figure 5: Cluster Dendrogram

4.0. Conclusions

It is evident that the dust of Ketu – Mile 12 is highly polluted with the heavy metals Zinc Zn-(1764.334 mg/kg), Lead Pb- (322.166 mg/kg), Copper Cu -(1622.507 mg/kg), Nickel Ni -(69.781mg/kg) and Cadmium Cd-(3.264 mg/kg). The high concentration of these heavy metals could be attributed to anthropogenic activities such as traffic / vehicular emission, industrial activities, industrial wastes, Waste dumpsite/ improper disposal of domestic wastes and sewage, lubricating oil, diesel fuel, tire, and brake wear. Therefore, there is need for environmental monitoring, safety and management of Ketu - Mile 12 area due to high concentration of these metals pollution which could be very hazardous to human and plants existence.

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