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CHARACTERIZATION OF LEACHATES FROM UNCONTROLLED OPEN DUMPSITE IN AHIAEKE, ISIEKE AND NSUKWE UMUAHIA, ABIA STATE

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ABSTRACT

This study aimed to characterize the chemical in the leachates from uncontrolled open dumpsite in Ahiaeke, Isieke and Nsukwe in Umuahia, Abia State. Air, soil and leachate samples were analysed using an absolute instrument system, AIS (Aerocet model 5315) and standard procedures to measure the concentration of SO_4, NH_3, O_3, CO_2, VOC, PM_{10}, $PM_{2.5}$, H_2S and CO in the air and some selected physicochemical and heavy metal content. From the result, SO_4 ranges from 0.02 - 0.19 mg/m^3, NH_3(1.11 - 14.05), O_3(0.01 - 0.15), CO_2(618.50 - 832.50), VOC (1889.50 - 6343.50), PM_{10}(46.19 -751.50), $PM_{2.5}$(14.03 - 344.72), H_2S (0.02 - 5.91), CO (1.91 - 6.91 mg/m^3),For leachate and soil analysis, pH ranges from 8.75 - 9.01, Potassium (2.04 - 6.93 mg/l),Iodine (1.24 - 7.86), Fluorine (0.32 - 31.96), Acidity (344.70 - 821.65), Magnesium (209.70 - 498.66), Nitrate (0.34 - 2.07), DO (1.95 - 6.82), COD (3181.29 - 19090.56), Phosphate (13.42 - 57.35), Boron (0.79 - 3.15), Ammonia (0.85 - 3.55), Lead (0.00 - 3.76 mg/kg),Mercury (0.12 - 0.88), Cadmium (0.21 - 1.49), Manganese (2.13 - 14.72) , Chromium (0.10 - 0.61), Nickel (2.14 - 8.12), Iron (1.13 - 6.28), Zinc (0.15 - 1.22),Barium (24.15- 172.02), Copper (1.18 - 9.56 mg/kg). In this study, concentration of all air parameters was higher at distance closer to the dumpsites. The level of ammonia, PM_{10}, $PM_{2.5}$ and some heavy metals exceeded WHO guidelines. Hence, the waste dumps were observed to be the major contributors of increase in chemical and heavy metal levels in the leachate.

Keywords: *Air Quality, Heavy Metal, Leachate, Open Dumpsite.*

INTRODUCTION

In developing countries like Nigeria, solid waste is mostly disposed in an uncontrolled manner into the open dumps without any liner, leachate collection and treatment facilities (Obiora-Okeke *et al*., 2022). Leachate is a high strength toxic with a complex matrix of organic and inorganic pollutants (Alao *et al*., 2022). Leachates are produced as a result of rainwater percolation through the waste layers; physical, chemical, biochemical, and microbiological reactions of the organics within the waste mass and due to the inherent or interstitial water content of the waste (Rajoo*et al*., 2020). Increasing urbanization and population growth rate is considerably accountable for the increased number of landfills across the world. With the increase of population and urban growth, the demand for manufactured products and materials increases. As the demand increases, so does the increase of solid wastes (Alao, 2023).With the current increase of open dumpsites all over the world, especially in Africa, the qualities of underground resources such as soil and water are under major threat (Okpoli, 2013). This is because all dumpsites (large or small) are usually associated with leachate plumes and odorous gas polluting the environment and water resources (Vaccari *et al*., 2018).

Reports indicate that the degree of leachate impacts, and emission gases of a landfill depends on the nature of landfills (Arndt,

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2001; Mojiri *et al*., 2021). However, pollution problems are particularly severe for waste dumped in abandoned gravel pits and sediment regions which may extend down to the groundwater table (Eggen *et al*., 2010). The solution to these challenges in our modern urban society demands fast and effective special geophysical techniques due to high ion concentrations associated with landfill leachates, which in turn weaken the subsoil resistivity. Studies revealed that the leachates formed within the dumpsite rarely remained at the point of discharge (Abdullahi *et al*., 2010; Omeiza *et al*., 2023), they are transported through the porous media within the subsurface. This is because water pollution happens mostly through the percolation of fluvial water and the infiltration of contaminants via the soil in waste disposal sites (Alao *et al*., 2022). The major source of pollution from open dumpsites and landfills is leachate (Obiora-Okeke *et al*., 2022). Leachate is produced when moisture enters the refuse in a landfill or open dump, extracts contaminants into the liquid phase, and produces moisture content sufficiently high to initiate liquid (Rajoo *et al*., 2020).

Leachates constitute a variety of pollutants due to the diverse nature of waste dumped and also the age of the dumpsites/landfills, which can cause the severe pollution of groundwater and other bodies of water. This in turn harms vegetation, aquatic organisms and humans by polluting drinking water and irrigation for agriculture (Alao *et al*., 2022).The major environmental challenges experienced around the open dumpsite areas are the contamination of groundwater via discharged leachate, soil and air pollution. The impact of open dumpsite leachate on the surface and groundwater has given rise to a number of studies in recent years (Mor *et al*., 2006; Alao *et al*., 2022). This study therefore aims to assess the environmental quality of uncontrolled open dumpsite leachate Ahiaeke, Isieke and Nsukwe in Umuahia, Abia State.

MATERIALS AND METHOD

The Study Area

Umuahia, the capital of Abia State is located along the railroad that lies between Port Harcourt to Umuahia South and Enugu city to its North. It is found in the tropical rain rainforest zone of Nigeria on latitude 5.5250°N and longitude 7.4922°E with a population of 147,167 (NPC, 2006).

The rainfall distribution pattern of the study area ranges between 1900 mm and 2200 mm, almost evenly distributed throughout the wet season while temperatures range between 30˚C and 31°C. the climate is essentially humid tropical, with mean annual climatic data of 216mm rainfall which is bi-modally distributed between March/April- October or early November with break in August (NRCRI, 2014). Relative humidity ranges from 51 % - 87 %.Vegetation essentially secondary forest that is tending towards derive savannah (Njoku *et al*., 2016). Soils are ferritic and sandy and steadily become shallower with increasing elevation. Other soil types include alluvial soils found along the low terrace of the Cross River and other rivers.

Abia State has a variety of landforms despite the fact that it is dominated by flat and low-lying land, generally less than 120m above sea-level. The low-lying plain is the inland extension of the coastal plain from the Bight of Benin. The central part of the state is characterized by undulating land with many hills. The highland areas are part of the Enugu-Nsukka-okigwe cuesta. This area has an average height of between 120m and 180m above sea level from Okigwe (Imo state), This escarpment extends in a west east direction and on getting to Afikpo (Ebonyi State), veers south-eastwards to Arochukwu where it terminates (Obiora-Okeke *et al*., 2023).The present land use of the study areas includes Arable cash crops such as Maize, Garden egg, rice, maize, plantain, cucumber and okra especially in the Aba Area.

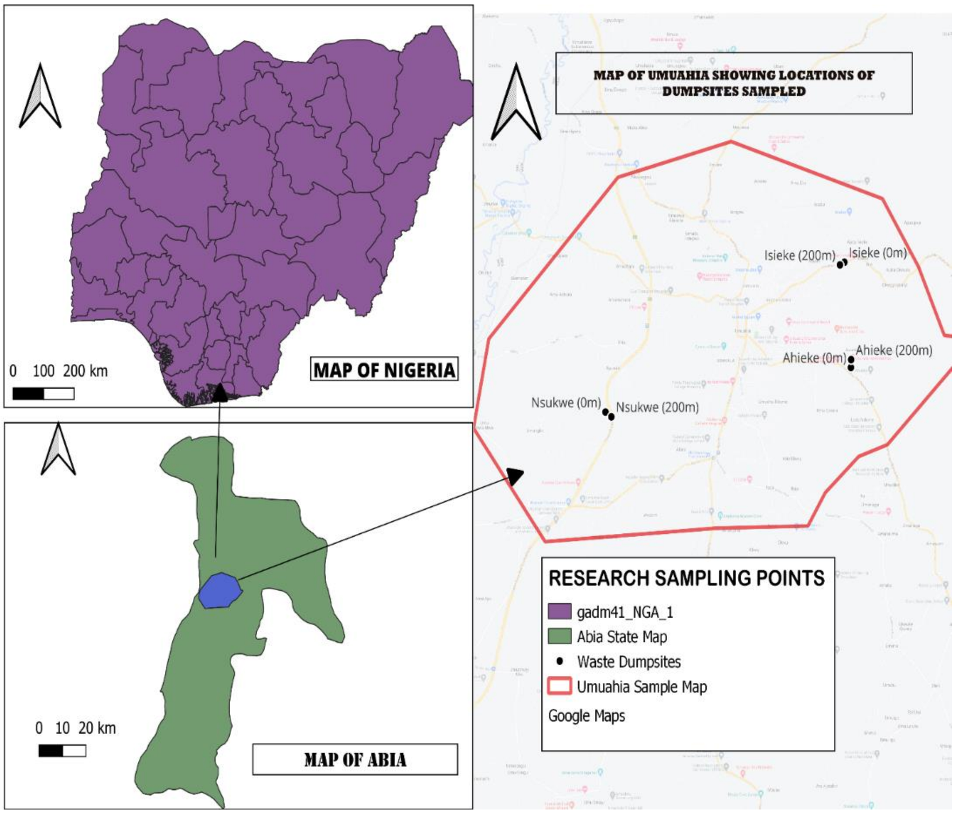

Figure 1: Map showing study area and sampling sites.

Soil and Leachates Sample Collection

Soil samples were collected at depth 0-15 cm each from refuse dumpsite (RDS1, RDS2, RDS3) within the premises (0 meters apart) , 50 metres and 200 metres away from the site which will be used as the control sample (Control).

Air Sample Collection

Air samples were collected using an absolute instrument system, AIS (model Aerocet 5315) to measure the total concentration of some particulate matter (PM) ($PM_{2.5}$, PM_{10}), Nitrogen oxide (NO), and Nitrogen dioxide (NO_2), in the air. The air samples were randomly collected from five (5) different sampling points (north, south, east, west and center) of the waste dumpsite. The control was taken about 3.2 km from the landfill site where there was no visible sign of contamination since some quantities of particulate matter are known to be suspended in air several kilometers from its source of generation before deposition on soil, plants, and water bodies or inhaled by man. The instrument was held 2 m above the ground and at stability, readings for particulate matter (respirable and inhalable particulates $PM_{2.5}$ and PM_{10}), NO, NO_2, and CO_2 will be taken. The air monitor was calibrated according to the manufacturer's directions before being deployed for the air quality sampling. Sampling was carried out for one-hour (1 hour) in the morning, afternoon and evening each day for a period of three (3) days in each of the five (5) air monitoring points in January (dry season) and June (wet season). The 3 days served as replicates and the average of the means for the three days was determined as concentrations for $PM_{2.5}$, and PM_{10}, NO, NO_2. Other parameters that were measured include air temperature with

Digital thermometer (model Omron MC-246) and relative humidity with hygrometer (Cigar Oasis Caliber 4R Gold Digital/Analog).

Sample Preparation and Laboratory Analysis

The samples was taken to the laboratory; air dried for three (3) days at room temperature and sieved using a 2mm sieve and kept in a clean and dry place for analysis and the determination of particle size distribution, texture, some chemical properties and selected heavy metals. Soil samples were analysed in the laboratory using standard laboratory procedures for some selected physical and chemical properties as well as the total heavy metal content of Lead and Zinc. Particle Size Distribution was determined using the hydrometer method by Bouyoucus (1962).Soil pH was determined both in water and 1N KCl in 1:2.5 soil water ratio using the glass electrode meter as described by Thomas (1996).Available phosphorus in soil was determined using Bray-2 method as described by Bray and Kurtz (1945).Total Nitrogen in the soil sample was determined by Kjeldahl digestion method as described by Bremmer and Mulvaney (1988).Total Exchangeable Bases (Ca, Mg, K, Na)were determined using 1N NH_4AOC method. The exchangeable acidity was determined by 1N KCl Extraction by (Mclean 1982).Effective cation exchange capacity was determined or calculated by the summation of total exchangeable bases {TEB} (Ca, Mg, Na, K) and Exchangeable Acidity (EA).Soil organic carbon was determined by Walkey and Black Wet – Oxidation Method as modified by Nelson and Sommers (1996).Soil organic matter was determined by multiplying the value of organic carbon with 1. 724. Lead and zinc were determined using the digestive method of A.O.A.C. (2002).

Statistical Analysis

Data collected was analyzed using descriptive statistics to obtain the means and the standard deviations. Variations in means were analyzed using analysis of variance test (ANOVA) at 5% probability. If, significant ($p<0.05$) means will be separated using Fisher's Least Significant Difference (LSD) at alpha 0.05. Principle component analysis (PCA), cluster analysis and correlation analysis were carried out using IBM SPSS version 26.

RESULTS

Air Quality Assessment of Dumpsites Within The Study Area

Air quality status of air around selected dumpsite in the study area is presented in table 1. From the result, SO_4 ranges from 0.02 mg/m^3 at Ahieke to 0.19 mg/m^3 at Isieke. The SO_4 values across the sampled locations showed that there was a significant difference ($p<0.05$) at 50m and 200m sampling point. NH_3 ranges from 1.11 mg/m^3 at Ahieke to 14.05 mg/m^3 at Nsukwe. The NH_3 values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. O_3 ranges from 0.01 mg/m^3 at Nsukwe to 0.15 mg/m^3 at Ahieke. The O_3 values across the sampled locations showed that there was a significant difference ($p<0.05$) at 50m and 200m sampling point. CO_2 ranges from 618.50 mg/m^3 at Isieke to 832.50 mg/m^3 at Ahieke. The CO_2 values across the sampled locations varied significantly ($p<0.05$) across all sampling point. VOC ranges from 1889.50 mg/m^3 at Nsukwe to 6343.50 mg/m^3 at Ahieke. The VOC values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. PM_{10} ranges from 46.19 mg/m^3 at Isieke to 751.50 mg/m^3 at Nsukwe. The PM_{10} values across the sampled locations showed that there was a significant difference ($p<0.05$) at 0m, 50m and 200m sampling point.

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$PM_{2.5}$ ranges from 14.03 mg/m^3 at Isieke to 344.72 mg/m^3 at Nsukwe. The $PM_{2.5}$ values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. H_2S ranges from 0.02 mg/m^3 at Isieke to 5.91 mg/m^3 at Nsukwe. The H_2S values across the sampled locations showed that there was a significant difference ($p<0.05$) at 0m and 50m sampling point, however there was no significant difference in the mean H_2S values across the three sampling location at 200m sampling point. CO ranges from 1.91 mg/m^3 to 6.91 mg/m^3 at Nsukwe. The CO values across the sampled locations showed that there was a significant difference ($p<0.05$) at 0m and 50m sampling point, however there was no significant difference in the mean CO values across the three sampling location at 200m sampling point.

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Table 1: Air quality status of air around some selected dumpsite within the Study Area.

Parameters	**Sampling**	**SAMPLING LOCATION**			
(mg/m^3)	**Points**	**Ahieke**	**Isieke**	**Nsukwe**	**WHO**
SO_4	0m	0.10 ± 0.01^a	0.11 ± 0.01^a	0.13 ± 0.01^a	
	50m	0.02 ± 0.00^b	0.03 ± 0.00^b	0.11 ± 0.01^a	20
	200m	0.03 ± 0.00^c	0.19 ± 0.01^a	0.09 ± 0.01^b	
NH_3	0m	4.25 ± 0.07^{ab}	5.35 ± 0.07^{ab}	5.75 ± 0.07^a	
	50m	1.35 ± 0.07^b	1.05 ± 0.07^b	14.05 ± 0.01^a	0.1
	200m	1.11 ± 0.01^b	2.05 ± 0.07^{ab}	2.90 ± 0.01^a	
O_3	0m	0.09 ± 0.00^a	0.08 ± 0.00^a	0.12 ± 0.01^a	
	50m	0.02 ± 0.00^b	0.05 ± 0.00^a	0.01 ± 0.00^b	100
	200m	0.15 ± 0.01^a	0.02 ± 0.00^b	0.04 ± 0.00^b	
CO_2	0m	779.05 ± 0.07^a	738.50 ± 0.71^b	638.50 ± 0.71^c	
	50m	832.50 ± 0.71^a	619.50 ± 0.71^c	720.50 ± 0.71^b	-
	200m	785.50 ± 0.71^a	618.50 ± 0.71^c	658.50 ± 0.71^b	
VOC	0m	3908.50 ± 0.71^c	4328.50 ± 0.71^b	5291.50 ± 0.71^a	
	50m	6343.50 ± 0.71^a	1978.50 ± 0.71^c	4901.80 ± 0.01^b	-
	200m	2020.50 ± 0.71^b	2381.50 ± 0.71^a	1889.50 ± 0.71^c	
PM_{10}	0m	178.11 ± 0.01^b	153.53 ± 0.00^b	751.50 ± 0.01^a	
	50m	60.18 ± 0.01^b	57.87 ± 0.01^b	560.05 ± 0.01^a	50
	200m	83.03 ± 0.01^a	46.19 ± 0.01^b	65.45 ± 0.01^{ab}	
$PM_{2.5}$	0m	80.33 ± 0.01^b	16.81 ± 0.01^c	344.72 ± 0.01^a	
	50m	25.88 ± 0.01^b	14.03 ± 0.01^c	68.77 ± 0.01^a	25
	200m	17.26 ± 0.01^b	51.97 ± 0.01^a	18.76 ± 0.01^b	
H_2S	0m	0.98 ± 0.00^b	1.09 ± 0.01^b	1.71 ± 0.01^a	
	50m	0.05 ± 0.00^b	0.02 ± 0.00^b	5.91 ± 0.01^a	0.7-11.2
	200m	0.03 ± 0.00^a	0.02 ± 0.00^a	0.03 ± 0.00^a	
CO	0m	4.11 ± 0.01^b	3.81 ± 0.01^b	6.91 ± 0.01^a	
	50m	2.01 ± 0.01^{ab}	2.81 ± 0.01^a	1.91 ± 0.01^b	10
	200m	2.51 ± 0.01^a	2.80 ± 0.00^a	2.90 ± 0.01^a	

Means ± standard deviation in the same column with different superscripts are significantly different ($p<0.05$). Sulphate (SO_4), Carbon dioxide (CO_2), Ammonia (NH_3), Ozone (O_3), Volatile Organic Compound (VOC), Hydrogen Sulfide (H2S), Particulate matter (PM), Carbon oxide (CO).

Chemical Properties Of Leachate From Open Dumpsites Within The Study Area

Chemical properties of leachate from some selected waste dumpsite in The study area is presented in table 2. From the result, the Hydrogen ion (pH) ranges from 8.75 at Nsukwe to 9.01 at Isieke dumpsite. Potassium (K) ranges from 2.04 mg/l at Isieke dumpsite to 6.93 m/l at Nsukwe dumpsite. Iodine (I) ranges from 1.24 mg/l at Isieke dumpsite to 7.86 mg/l at Nsukwe dumpsite. Fluorine (F) ranges from 0.32 mg/l at Isieke dumpsite to 31.96 mg/l at Nsukwe dumpsite. Acidity ranges from 344.70 mg/l at Isieke dumpsite to 821.65 mg/l at Nsukwe dumpsite. Magnesium (Mg) ranges from 209.70 mg/l at Isieke dumpsite to 498.66 mg/l at Nsukwe dumpsite. Nitrate (NO_3), ranges from 0.34 mg/l at Isieke dumpsite to 2.07 mg/l at Nsukwe dumpsite. Dissolved Oxygen (DO) ranges from 1.95 mg/l at Isieke dumpsite to 6.82 mg/l at Nsukwe dumpsite. Chemical Oxygen Demand (COD) ranges from 3181.29 mg/l at Isieke dumpsite to 19090.5650 mg/l at Nsukwe dumpsite. Phosphate (PO_4) ranges from 13.42 mg/l at Isieke dumpsite to 57.35 mg/l at Nsukwe dumpsite. Peroxinitrate (NO_4) ranges from 0.08 mg/l at Isieke dumpsite to 0.47 mg/l at Nsukwe dumpsite.

Sulphate (SO_4) ranges from 27.42 mg/l at Isieke dumpsite to 78.06 mg/l at Nsukwe dumpsite. Boron (B) ranges from 0.79 mg/l at Isieke dumpsite to 3.15 mg/l at Nsukwe dumpsite. Ammonia (NH_3) ranges from 0.85 mg/l at Isieke dumpsite to 3.55 mg/l at Nsukwe dumpsite. Turbidity ranges from 75.19 mg/l at Isieke dumpsite to 333.25 mg/l at Nsukwe dumpsite. Sodium (Na) ranges from 12.05 mg/l at Isieke dumpsite to 30.73 mg/l at Nsukwe dumpsite. Colour ranges from 826.08 mg/l at Isieke dumpsite to 2976.50 mg/l at Nsukwe dumpsite. Hardness ranges from 860.01 mg/l at Isieke dumpsite to 2050.01 mg/l at Nsukwe dumpsite. Chlorine ranges from 306.62 mg/l at Isieke dumpsite to 782.63 mg/l at Nsukwe dumpsite. Total suspended solid (TSS) ranges from 191.57 mg/l at Isieke dumpsite to 1379.25 mg/l at Nsukwe dumpsite. Bicarbonate ranges from 973.75 mg/l at Isieke dumpsite to 7010.48 mg/l at Nsukwe dumpsite. All chemical properties of leachate showed a significant difference ($p<0.05$) across all sampling location.

Table 2: Chemical Properties of Leachate From Waste Dumpsite Within the Study Area.

Parameters	**SAMPLING LOCATION**			
(mg/l)	**Ahieke**	**Isieke**	**Nsukwe**	**WHO**
pH	8.84±0.01[b]	9.01±0.01[a]	8.75±0.01[c]	6.5-8.5
K	2.44±0.00[b]	2.04±0.01[c]	6.93±0.00[a]	-
I	2.05±0.00[b]	1.24±0.00[c]	7.86±0.00[a]	-
F	2.09±0.00[b]	0.32±0.00[c]	31.96±0.00[a]	-
Acidity	2.61±0.01[b]	2.41±0.01[c]	3.61±0.01[a]	-
Ca	364.74±0.01[b]	344.70±0.01[c]	821.65±0.01[a]	-
Mg	221.32±0.01[b]	209.70±0.01[c]	498.66±0.01[a]	-
NO_3	0.60±0.00[b]	0.34±0.00[c]	2.07±0.00[a]	-
DO	2.60±0.00[b]	1.95±0.00[c]	6.82±0.00[a]	6.4
COD	5847.88±0.01[b]	3181.29±0.01[c]	19090.5650±0.01[a]	30
PO_4	17.35±0.00[b]	13.42±0.00[c]	57.35±0.00[a]	3.5
NO_4	0.13±0.00[b]	0.08±0.00[c]	0.47±0.00[a]	50
SO_4	32.03±0.00[b]	27.42±0.00[c]	78.06±0.00[a]	500
CO	0.35±0.00[b]	0.17±0.00[c]	1.26±0.00[a]	-
B	1.01±0.00[b]	0.79±0.00[c]	3.15±0.00[a]	-
NH_3	1.16±0.00[b]	0.85±0.00[c]	3.55±0.00[a]	-
Turbidity	95.68±0.00[b]	75.19±0.00[c]	333.25±0.01[a]	10
Na	17.74±0.00[b]	12.05±0.00[c]	30.73±0.00[a]	-
Color	1074.87±0.00[b]	826.08±0.01[c]	2976.50±0.01[a]	5.125
Hardness	910.00±0.00[b]	860.01±0.01[c]	2050.01±0.01[a]	-
Cl	451.32±0.01[b]	306.62±0.01[c]	782.63±0.01[a]	350
TSS	268.19±0.01[b]	191.57±0.01[c]	1379.25±0.07[a]	0.75
HCO	1363.16±0.00[b]	973.75±0.07[c]	7010.48±0.01[a]	-

Means ± standard deviation in the same column with different superscripts are significantly different ($p<0.05$). Hydrogen ion (pH), Potassium (K), Iodine (I), Florene (F), Calcium (Ca), Magnesium (Mg), Nitrate (NO_3), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Phosphate (PO_4) Peroxinitrate (NO_4), Carbon oxide (CO), Boron (B), Ammonia (NH_3), Sodium (Na), Chlorine (Cl), Total soluble solids (TSS), Hydrogen Carbonate (HCO).

Heavy Metal Properties Of Leachate From Open Dumpsites Within The Study Area

Heavy metal properties of leachate from some selected dump sites in The study area is presented in table 3. From the result, Lead (Pb) ranges from 0.00 mg/kg of Isieke dumpsite to 3.76 mg/kg of Nsukwe dumpsite. The Pb values showed a significant difference ($p<0.05$) across all sampling locations. Mercury (Hg) ranges from 0.12 mg/kg of Isieke dumpsite to 0.88 mg/kg of Nsukwe dumpsite. The Hg values showed a significant difference ($p<0.05$) across all sampling locations Cadmium (Cd) ranges from 0.21 mg/kg of Isieke dumpsite to 1.49 mg/kg of Nsukwe dumpsite. The Cd values showed a significant difference ($p<0.05$) across all sampling locations. Manganese (Mn) ranges from 2.13 mg/kg of Isieke dumpsite to 14.72 mg/kg of Nsukwe dumpsite. The Mn values showed a significant difference ($p<0.05$) across all sampling locations. Chromium (Cr) ranges from 0.10 mg/kg of Isieke dumpsite to 0.61 mg/kg of Nsukwe dumpsite. The Cr values showed a significant difference ($p<0.05$) across all sampling locations. Nickel (Ni) ranges from 2.14 mg/kg of Isieke dumpsite to 8.12 mg/kg of Nsukwe dumpsite. The Ni values showed a significant difference ($p<0.05$) across all sampling locations. Molybdenum (Mo) ranges from 14.43 mg/kg of Isieke dumpsite to 53.29 mg/kg of Nsukwe dumpsite. The Mo values showed a significant difference ($p<0.05$) across all sampling locations. Iron (Fe) ranges from 1.13 mg/kg of Isieke dumpsite to 6.28 mg/kg of Nsukwe dumpsite. The Fe values showed a significant difference ($p<0.05$) across all sampling locations. Zinc (Zn) ranges from 0.15 mg/kg of Isieke dumpsite to 1.22 mg/kg of Nsukwe dumpsite. The Zn values showed a significant difference ($p<0.05$) across all sampling locations Barium (Ba) ranges from 24.15 mg/kg of Isieke dumpsite to 172.02 mg/kg of Nsukwe dumpsite. The Ba values showed a significant difference ($p<0.05$) across all sampling locations. Copper (Cu) ranges from 1.18 mg/kg of Isieke dumpsite to 9.56 mg/kg of Nsukwe dumpsite. The Cu values showed a significant difference ($p<0.05$) across all sampling locations.

Table 3: Heavy metal properties of leachate from waste dumpsite Within the Study Area.

Parameters (mg/l)	**SAMPLING LOCATION**			**WHO**
	Ahieke	**Isieke**	**Nsukwe**	
Pb	0.47±0.00^{b}	0.00±0.00^{c}	3.76±0.00^{a}	0.3
Hg	0.23±0.00^{b}	0.12±0.00^{c}	0.88±0.00^{a}	-
Cd	0.39±0.00^{b}	0.21±0.00^{c}	1.49±0.00^{a}	0.2
Mn	3.38±0.00^{b}	2.13±0.00^{c}	14.72±0.00^{a}	-
Cr	0.17±0.00^{b}	0.10±0.00^{c}	0.61±0.00^{a}	-
Ni	2.87±0.00^{b}	2.14±0.00^{c}	8.12±0.00^{a}	67.9
Mo	19.12±0.00^{b}	14.43±0.00^{c}	53.29±0.00^{a}	-
Fe	1.86±0.00^{b}	1.13±0.00^{c}	6.28±0.00^{a}	425.5
Zn	0.33±0.00^{b}	0.15±0.00^{b}	1.22±0.00^{a}	99.4
Ba	35.60±0.00^{b}	24.15±0.00^{b}	172.02±0.01^{a}	-
Cu	2.20±0.00^{b}	1.18±0.00^{b}	9.56±0.00^{a}	73.3

Means ± standard deviation with different superscripts are significantly different. Lead (Pb), Mercury (Hg), Cadmium (Cd), Manganese (Mn), Chromium (Cr), Nickel (Ni), Molybdenum (Mo), Iron (Fe), Zink (Zn), Barium (Ba), Copper (Cu).

Principal Component Analysis of Leachate from Open Dumpsites within the Study Area

Principal component analysis was carried out using IBM SPSS 26.0 version to understand the hypothetical variations in the parameters and to explain the experiential interrelationship of cluster parameters in simple patterns, as expressed in the nature of correlations between the parameters. In this study, an exploratory factor analysis was performed, to investigate the proportion of variation explained by each relative parameter, and a correlation matrix was produced. The primary data used for the factor analysis, which was inspected for adequate determinant factor, sampling adequacy (Kaiser-Meyer-Olkin (KMO) test and sphericity (Bartlett's test) was performed. The principle components (PC) with eigenvalues greater or equal to one (≥ 1.0) were being considered and extracted for further analyses using a PCA and rotated using a varimax rotation. Adopting Pearson's correlation option and factor loadings after varimax rotation, the eigenvectors greater than 0.50 (> 0.5) and less than 0.50 (< 0.5) were considered significant and insignificant, respectively.

Two principal component (PC) was extracted in the sampled locations which accounted for 100% of the variance in the data set. The contributors were as followed – principal components 1, 2 accounted for 99.9% and 0.1% respectively. PC1 loaded high eigenvector pH. This result indicates that Component 1 had 99.9 % explanation of the total variation of heavy metals. This implies that all the variation in chemical properties is explained in Component 1.

The loading showed that only pH had positive values. This suggests that living organism are more likely to be affected by pH than, K, I, F, Acidity, Ca, Mg, NO_3, DO, COD, PO_4, NO_3, SO_4, CO, B, NH_3, Turbidity, Alkalinity, Na, Color, Hardness, Cl, TSS, and HCO. Component loading showing the variation in leachate chemical properties from some selected waste in the study area is presented in Table 4.

Table 4: Component Loading Showing the Variation in Leachate Chemical Properties From Some Selected Waste in The study area.

Parameter	Component 1	Component 2
pH	0.1692	0.8003
K	-0.1670	0.0907
I	-0.1690	0.0340
F	-0.1655	0.1283
Acidity	-0.1710	-0.0307
Ca	-0.1647	0.1474
Mg	-0.1646	0.1499
NO_3	-0.1703	-0.0049
DO	-0.1695	0.0186
COD	-0.1711	-0.0321
PO_4	-0.1673	0.0818
NO_3	-0.1693	0.0268
SO_4	-0.1674	0.0797
CO	-0.1710	-0.0280
B	-0.1676	0.0728
NH_3	-0.1683	0.0484
Turbidity	-0.1668	0.0961
Alkalinity	-0.1757	-0.2474
Na	-0.1754	-0.2473
Color	-0.1689	0.0445
Hardness	-0.1647	0.1474
Cl	-0.1757	-0.2468
TSS	-0.1659	0.1168
HCO	-0.1659	0.1168
% Variability	**99.9**	**0.1**

Hydrogen ion (pH), Potassium (K), Iodine (I), Florene (F), Calcium (Ca), Magnesium (Mg), Nitrate (NO_3), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Phosphate (PO_4) Peroxinitrate (NO_4), Carbon oxide (CO), Boron (B), Ammonia (NH_3), Sodium (Na), Chlorine (Cl), Total soluble solids (TSS), Hydrogen Carbonate (HCO).

Component loading showing the variation in leachate heavy metal properties from some selected waste in the study area is presented in Table 5. From the result, component 1 had a 99.9 % explanation of the total variation of heavy metals. This implies that all the variation in heavy metals is explained in Component 1. The loading showed no positive values. This suggests that living organism are more likely to be affected by the heavy metal parameters under this study. Biplot diagram showing the variation in leachate heavy metal properties from some selected waste in the study area is presented in figure 3. From the result, the Cl, Alkalinity, and Na, were grouped indicating a negative correlation exists within them. Cu, Ni, Mo, Pb, NH_3, NO_3, Hg Fe, Acidity, COD, NO_4, Cd and Cr were grouped on the Negative axis, indicating they are negatively correlated. Hydrogen ion pH was not found in a cluster with any trace metal which indicates that its contributions are not about the existence of other trace metals.

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Table 5: Component loading showing the variation in leachate heavy metal properties from some selected waste in the Study Area.

Parameter	Component 1	Component 2
Pb	-0.1692	0.0298
Hg	-0.1700	0.0034
Cd	-0.1699	0.0066
Mn	-0.1678	0.0674
Cr	-0.1697	0.0130
Ni	-0.1690	0.0356
Mo	-0.1689	0.0373
Fe	-0.1699	0.0065
Zn	-0.1714	-0.0415
Ba	-0.1667	0.0988
Cu	-0.1690	0.0363
% Variability	**99.1**	**0.1**

Lead (Pb), Mercury (Hg), Cadmium (Cd), Manganese (Mn), Chromium (Cr), Nickel (Ni), Molybdenum (Mo), Iron (Fe), Zink (Zn), Barium (Ba), Copper (Cu).

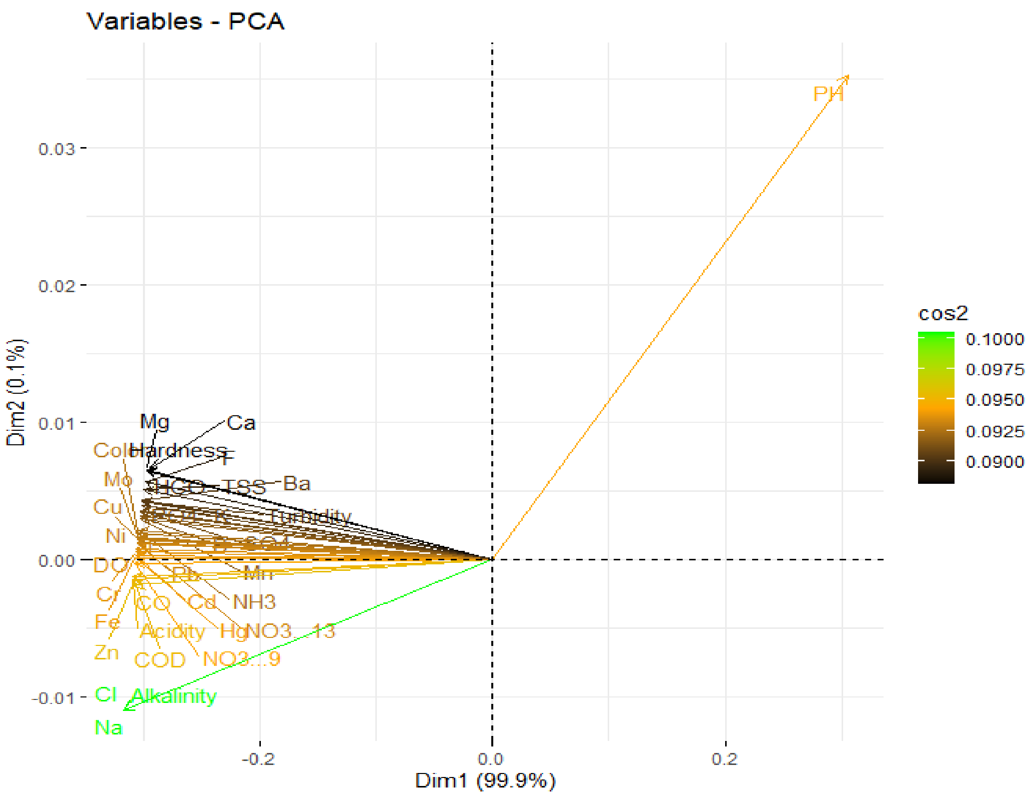

Figure 3: Biplot diagram showing the variation in leachate and heavy metal properties from some selected waste in the study area.

Physicochemical Properties of Soil from Open Dumpsites within the Study Area

The physical parameter of soil from selected waste dumpsite in the study area is presented in table 6. The result shows that Sand ranges from 38.67% at Isieke dumpsite to 88.41% at Ahieke dumpsite. The Sand values across the sampled locations showed that there was a significant difference ($p<0.05$) at 50m sampling point, however, there was no significant difference at 0m sampling point. Silt ranges from 5.41% at Ahieke dumpsite to 35.27% at Isieke dumpsite. The Silt values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Clay ranges from 6.20% at Ahieke dumpsite to 26.07% at Isieke dumpsite. The Clay values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point.

The chemical parameter of soil from some selected waste dumpsite in the study area is presented in table 7. From the result, pH ranges from 7.90 at Isieke dumpsite to 8.60 at Nsukwe dumpsite. The pH values across the sampled locations showed that there was no significant difference ($p>0.05$) across all sampling point. pH $CaCl_2$ ranges from 5.91 at Isieke dumpsite to 7.90 at Nsukwe dumpsite. The pH $CaCl_2$ values across the sampled locations showed that there was a significant difference ($p<0.05$) at 0m sampling point. Phosphorus (P)ranges from 33.79 mg/kg at Ahieke dumpsite to 64.60 mg/kg at Isieke dumpsite. The PH $CaCl_2$ values across the sampled locations showed that there was a significant difference ($p<0.05$) at 0m sampling point. Nitrogen (N)ranges from 0.03% at Ahieke dumpsite to 0.23% at Nsukwe dumpsite. The N values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Organic Carbon (OC)ranges from 0.79% at Ahieke dumpsite to 2.25% at Isieke dumpsite. Effect of difference in location varied significantly ($p<0.05$).

Organic Matter (OM)ranges from 1.35% at Ahieke dumpsite to 3.88% at Isieke dumpsite. The OM values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Calcium (Ca)ranges from 7.41 Cmol/kg at Ahieke dumpsite to 20.21 Cmol/kg at Isieke dumpsite. Effect of difference in location varied significantly ($p<0.05$). Magnesium (Mg)ranges from 5.81 Cmol/kg at Ahieke dumpsite to 18.80 Cmol/kg at Isieke dumpsite. The Mg values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Potassium (K)ranges from 0.10 Cmol/kg to 0.18 Cmol/kg at Nsukwe dumpsite. The K values across the sampled locations showed that there was no significant difference ($p>0.05$) across all sampling point. Sodium (Na)ranges from 0.09 Cmol/kg at Isieke dumpsite to 0.12 Cmol/kg at Ahieke dumpsite. The Na values across the sampled locations showed that there was no significant difference ($p>0.05$) across all sampling point. Exchangeable Acidity (EA)ranges from 1.44 at Ahieke dumpsite to 2.00 at Isieke dumpsite. The EA values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Effective Cation Exchange Capacity (ECEC)ranges from 15.36 at Ahieke dumpsite to 41.02 at Isieke dumpsite. The ECEC values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Base Saturation (BS)ranges from 87.51 at Ahieke dumpsite to 95.28 at Isieke dumpsite. The BS values across the sampled locations showed that there was no significant difference ($p>0.05$) across all sampling point.

Table 6: Variation in Physical Parameter Content of Soil from Selected Waste Dumpsite in the Study Area.

Physical Properties	**Sampling Point**	**SAMPLING LOCATION**		
		Ahieke	**Isieke**	**Nsukwe**
Sand (%)	0m	86.40±0.00[a]	46.41±0.01[b]	86.41±0.01[a]
	50m	88.41±0.01[a]	38.67±0.00[c]	74.40±0.00[b]
Silt (%)	0m	7.40±0.00[b]	31.41±0.01[a]	7.41±0.01[b]
	50m	5.41±0.01[c]	35.27±0.00[a]	15.40±0.00[b]
Clay (%)	0m	6.20±0.00[b]	22.21±0.01[a]	6.21±0.01[b]
	50m	6.21±0.01[c]	26.07±0.00[a]	10.20±0.00[b]

Means ± standard deviation with different superscripts are significantly different.

Table 7: Variation in chemical parameter content of soil from selected waste dumpsite in The study area

Chemical properties	Sampling Point	SAMPLING LOCATION		
		Ahieke	Isieke	Nsukwe
pH H_2O	0m	7.80±0.00[a]	7.81±0.01[a]	8.31±0.01[a]
	50m	8.11±0.01[a]	8.00±0.00[a]	8.90±0.00[a]
pH $CaCl_2$	0m	6.20±0.00[b]	5.91±0.01[b]	7.51±0.01[a]
	50m	7.71±0.01[a]	7.60±0.00[a]	7.90±0.00[a]
P (mg/kg)	0m	61.21±0.00[a]	64.60±0.01[a]	43.62±0.01[b]
	50m	33.79±0.01[a]	35.68±0.00[a]	34.23±0.00[a]
N (%)	0m	0.07±0.00[b]	0.11±0.01[b]	0.23±0.01[a]
	50m	0.03±0.01[b]	0.11±0.00[a]	0.10±0.00[a]
OC (%)	0m	1.32±0.00[c]	1.95±0.01[ab]	2.14±0.01[a]
	50m	0.79±0.01[a]	2.25±0.00[b]	2.03±0.00[b]
OM (%)	0m	2.28±0.00[b]	3.46±0.01[a]	3.68±0.01[a]
	50m	1.35±0.01[c]	3.88±0.00[a]	2.81±0.00[b]
Ca(cmol/kg)	0m	12.40±0.00[c]	20.21±0.01[a]	15.21±0.01[b]
	50m	7.41±0.01[c]	20.00±0.00[a]	13.89±0.00[b]
Mg(cmol/kg)	0m	8.80±0.00[b]	16.61±0.01[a]	13.61±0.01[a]
	50m	5.81±0.01[b]	18.80±0.00[a]	9.22±0.00[b]
K(cmol/kg)	0m	0.17±0.00[a]	0.16±0.01[a]	0.18±0.01[a]
	50m	0.15±0.01[a]	0.13±0.00[a]	0.10±0.00[a]
Na (cmol/kg)	0m	0.12±0.00[a]	0.11±0.01[a]	0.12±0.01[a]
	50m	0.10±0.01[a]	0.09±0.00[a]	0.09±0.00[a]
EA	0m	1.44±0.00[a]	1.85±0.01[a]	1.53±0.01[a]
	50m	1.93±0.01[a]	2.00±0.00[a]	1.93±0.00[a]
ECEC	0m	22.93±0.00[b]	38.91±0.01[a]	30.62±0.01[a]
	50m	15.36±0.01[c]	41.02±0.00[a]	24.43±0.00[b]
BS (%)	0m	93.72±0.00[a]	95.28±0.01[a]	95.04±0.01[a]
	50m	87.51±0.01[a]	95.11±0.00[a]	89.31±0.00[a]

Means ± standard deviation with different superscripts are significantly different. Hydrogen ion (pH), Phosphorus (P), Nitrogen (N), Organic carbon (OC), Organic matter (OM), Potassium (K), Calcium (Ca), Magnesium (Mg), Sodium (Na), Exchangeable acidity (EA), Base Saturation (BS), Effective Cation Exchange Capacity (ECEC).

Heavy Metal Properties of Soil From Open Dumpsites Within The Study Area

The heavy metal properties of soil from selected waste dumpsite in the study area is presented in table 8. From the result, Zinc (Zn) were only detected in Nsukwe dumpsite at 0.01 mg/kg. Iron (Fe) was at an average of 0.04 mg/kg in Ahieke and Isieke where they were detected. Manganese (Mn) ranges from 0.01 mg/kg at Ahieke to 0.25 mg/kg at Nsukwe where they were detected. Copper (Cu) was only detected in Nsukwe waste dumpsite at an average of 0.12 mg/kg. Molybdenum (Mo), ranges from 1.22 mg/kg at Isieke dumpsite to 2.45 mg/kg at Ahiaeke. The Mo values across the sampled locations showed that there was no significant

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difference ($p<0.05$) across all sampling point. Cobalt (Co) ranges from 0.01 mg/kg at Ahieke dumpsite to 0.05 mg/kg at Nsukwe where they were detected. Barium (Ba) ranges from 0.01 mg/kg at Ahieke to 3.03 mg/kg at Nsukwe. The B values across the sampled locations showed that there was a significant difference ($p<0.05$) across all sampling point. Cadmium (Cd), Lead (Pb) and Mercury (Hg) was not detected in the soil from all the waste dumping locations in this study. Boron (B) ranges from 0.01 mg/kg at Isieke to 0.13 mg/kg at Nsukwe dumpsite. Effect of difference in location were significant ($p<0.05$). Nickel (Ni), ranges from 0.01 mg/kg at Isieke dumpsite to 0.15 mg/kg at Nsukwe. The Ni values across the sampled locations showed that there was no significant difference ($p>0.05$) across all sampling point. Chromium (Cr)) was at an average of 0.01 mg/kg in Ahieke and Isieke where they were detected

Table 8: Variation in heavy metal properties (mg/kg) of soil from some selected waste dumpsite in the study area

Parameter (mg/kg)	Sampling Points	SAMPLING LOCATION Ahieke	Isieke	Nsukwe
Zn	0m	ND	ND	0.01±0.00
	50m	ND	ND	0.00±0.00
Fe	0m	0.07±0.00	0.02±0.00	ND
	50m	0.00±0.00	0.05±0.00	ND
Mn	0m	0.25±0.00	ND	0.15±0.00
	50m	0.00±0.00	ND	0.09±0.00
Cu	0m	ND	ND	0.13±0.00
	50m	ND	ND	0.11±0.00
Mo	0m	2.45±0.00^{a}	1.88±0.00^{a}	2.45±0.00^{a}
	50m	1.45±0.00^{a}	1.22±0.00^{a}	2.04±0.00^{a}
CO	0m	0.02±0.00	ND	0.05±0.00
	50m	0.00±0.00	ND	0.04±0.00
Ba	0m	1.51±0.00^{b}	1.81±0.00^{b}	3.03±0.00^{a}
	50m	0.01±0.00^{b}	0.28±0.00^{b}	2.01±0.00^{a}
Cd	0m	ND	ND	ND
	50m	ND	ND	ND
B	0m	0.04±0.00^{b}	0.02±0.00^{b}	0.13±0.00^{a}
	50m	0.01±0.00^{b}	0.01±0.00^{b}	0.09±0.00^{a}
Pb	0m	ND	ND	ND
	50m	ND	ND	ND
Ni	0m	0.11±0.00^{a}	0.11±0.00^{a}	0.15±0.00^{a}
	50m	0.02±0.00^{a}	0.01±0.00^{a}	0.01±0.00^{a}
Cr	0m	0.01±0.00	0.01±0.00	ND
	50m	0.01±0.00	0.01±0.00	ND
Hg	0m	ND	ND	ND
	50m	ND	ND	ND

Means ± standard deviation with different superscripts are significantly different. Molybdenum (Mo), Iron (Fe), Zink (Zn), Barium (Ba), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb), Mercury (Hg), Cadmium (Cd), Chromium (Cr), Not Detected (ND).

DISCUSSION

This study was carried out to assess the air quality around some selected waste dumpsite, chemical properties of leachate , physical and chemical properties of the soil and heavy metal properties of the soil in The study area. The result from this study has shown varying chemical properties both in the air, and soil. Hence, confirming the previous studies on air quality (Rim-Rukeh, 2014; Njoku *et al*., 2016), Soil (Amusan *et al*., 2005), Microbial load and heavy metals properties of leachates (Zige and Izah, 2015, Angaye *et al*., 2015).

Air quality around waste dumpsite

Open waste dumping is an old and unhygienic method of waste management. Dumpsites are often established in disused quarries, mines or excavated pits and unoccupied lands in cities (Angaye and Abowei, 2018). In this present study concentrations of all the air quality parameters were higher at distances closer to the dumpsite. This further, confirms that the air quality changes are a determinant caused by the refuse dump. This agrees with the study by Oguntoke *et al*. (2019) in the study on assessment of air pollution and health hazard associated with sawmill and municipal waste burning in Abeokuta Metropolis, Nigeria. The levels of particulate matter (PM_{10} and $PM_{2.5}$) exceeded the world health air quality guidelines for 24 hours exposure. This indicates that the activity of waste disposal may have resulted to the increase in offensive gasses and toxic particles. Particulate matter, especially the smaller particles (PM_{10} and $PM_{2.5}$), have the most harmful effects on human health than any other pollutant (Vitorino *et al*., 2017).The PMs were larger in Nsukwe waste dumpsite than any other dumps, this may be connected to the fact that this site is the largest sites in The study area for waste dumping. This may lead to increase in diseases associated to poor air quality like Asthma. Several studies have found an association between air pollution and human health. A study in 2016 on the Global Burden of Disease estimates that 7.5% of deaths globally were attributable to ambient air pollution. In the same year, 27.5% of deaths due to Lower Respiratory Tract Infections and 26.8% of deaths due to Chronic Obstructive Pulmonary Diseases were also linked to air pollution (Odeyemi *et al*., 2011).

Chemical properties of leachate

The chemical properties of the leachate from the varying locations of dumpsites in The study area varied significantly ($p<0.05$). The pH levels at of leachate from all the waste dump site exceeded the WHO standard of 6.5 – 8.5 pH levels. The pH of this current study agrees with those of Ogundiran and Afolabi (2008) who studied the assessment of the physicochemical parameters and heavy metals toxicity of leachates from municipal solid waste open dumpsite and reported thatthe mean pH of the whole landfill was 7.88 while its pH ranged from 7.01 to 8.22 which falls within the WHO regulated value. The result shows higher chemical properties (Potassium (K), Iodine (I), Fluorine (F), Magnesium, Nitrate (NO_3), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Phosphate (PO_4) Peroxinitrate (NO_4), Sulfate (SO_4), Chlorine (Cl), Boron (B), Ammonia (NH_3), Turbidity, Sodium, color, hardness, TSS and HCO) were observed in Nsukwe followed by Ahieke. This there confirms that Nsukwe dumpsite posse's chemical pollution threats around the environment. Also, the values of the chemical properties in Nsukwe exceeded the WHO standards. The pH was observed to have similarity in relation with other chemical properties. Hence, it was located in the positive axis of the biplot while other chemical properties share same clusters in the negative axis.

Heavy metal properties of leachate

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The result of the heavy metal in the leachate from waste dumpsite in The study area shows that there was presence of toxic metals like Pb, Hg, Cr, and Cd. This therefore possess threats to nearby agricultural farms and water body, which can easily receive the leachate product from the dumpsite. Similar report was earlier made by Angaye *et al*., (2015). The levels of heavy were observed to be in greater concentration in the leachate from Nsukwe waste dumpsite. This may be connected to the large waste disposal done on the site when compared to the other waste dumpsite. Hence, the low levels of heavy metals observed in Isieke and Ahieke waste dumping site. In the same vein, household and industrial garbage that contain batteries, insect sprays, nail polish, cleaners, plastics polyethylene or polyvinyl chloride made bottles and other assorted products will release toxic materials such as lead, cadmium, mercury, manganese into the receiving environment (Odunaike *et al*., 2008). Also, the disposal of remnants of staple foods that contain traces of radioactive materials or contaminants constitute environmental hazard to exposes populace.

All the heavy metal was observed to have negative contributions in the variability and relation of the chemicals in the soil. Hence, positive eigen vector of pH in this study suggest that change in the pH may have contributed to increase in heavy metals. Effect of difference in location were significant ($P<0.05$). Similar, Angaye *et al*. (2015) stated that there was significance difference ($P<0.05$)in the Cr level among the sampling points. The concentration of Cr from this study is slightly higher than the findings of this study. All the heavy metal test was seen to be present in all the sites of this study. This indicates that waste dumps are of severe threats to the environments. As these metals may find its way into nearby plants, water and human, through bioaccumulation processes and the food chain. Leachate which emanates from dumpsites is of particular environmental concern since it contains potentially toxic heavy metals (Angaye *et al*. 2015). These metals are known to bioaccumulate in soil and have long persistence time through interaction with soil component and consequently enter food chain through plants or animals (Baran and Antonkiewicz, 2017)

Soil physical and Chemical properties

The findings from this study shows that the soil in Ahieke and Isieke were largely sandy at the surface, while Nsukwe had more clay and silt in the soil. This indicates that the refuse dump had more decaying matter as waste than the other dumpsite. This was corroborated by Ideriah *et al*. (2006) who determined the soil quality around a solid waste dumpsite in Port-Harcourt, Nigeria, which is in the same humid tropical area. The soil pH property was more alkali, no acidic soil pH was observed. This varied from the initial report by Dosumu *et al*. (2003) who reported pH below 6 for municipal waste dump soil. However, Ideriah *et al*., (2006) stated in agreement to the findings of this study, that the soils from the main dump and sediment were slightly alkaline while the control soil was moderately acidic.

Phosphorus levels less in Nsukwe than Ahieke and Isieke. This shows that high refuse dump in Nsukwe may have negative effect on phosphorus. The Nitrogen, organic matter and organic carbon were higher soil from Isieke and Ahieke. Ideriah *et al*. (2006) who reported that in main waste dumpsite nitrogen and phosphorus level were higher at N (0.09 ± 0.06 %), and P (15.11 ± 7.57 μg/g). The soil Ca, Mg, were higher in soil from Isieke dumpsite. Soil sodium concentration did not vary with locations. Generally, all the soil chemical properties were higher in soil from the epicenter (0m) of the dumpsite than those of the 50 m away. This establishes that increase in chemical is as a result of the waste dump. Ideriah *et al*. (2006) reported that the total N content of dump soils ranged between 0.06±0.07 and 0.24±0.09 % which is slightly higher than those of the control site which varied between 0.14±0.43 and 0.15±0.86 %

Soil heavy metal properties

Heavy metal properties of soil around the mining site were generally and, in most cases, not detected. Mo, Ba, B, and Ni was observed in the sample location. Except for Cr all other major toxic metal like Hg, Cd and Pb wasn't observed in all the waste dumps. This was in contrast to Ideriah *et al*., (2006) who reported Cd (1.72±1.22 μg/g) and Pb (53.50±40.09 μg/g). Higher levels of heavy metals were observed in soil in Nsukwe site than any other site. Indicating that the higher the waste, the higher the accumulated heavy metal.

CONCLUSION

The findings from the study had shown that there is variation in air quality parameters found in the area. Particulate matter (PM_{10} and $PM_{2.5}$), Ammonia and H_2S were the most pronounce air parameters in excess of regulatory standard. The parameters were observed to be at larger quantity in Nsukwe dumpsite than Ahiaeke and Isieke dump sites. The leachate showed high level of physicochemical parameters above World Health Organization permissible limit. The result showed that greater levels of these chemicals were observed Nsukwe dumpsite than Ahiaeke and Isieke open dumpsite. More worrisome was the presence of all toxic heavy metals (Pb, Hg, Cr, and Cd) at levels above the permissible limits of the WHO standards. The chemical and heavy metal concentrations were observed to be at higher concentration in distances closer to the dumpsite than 50 m away. Hence, the waste dumps were observed to be the major contributors of increase in chemical and heavy metal levels in the leachate.

The soil samples were physically sandy in Ahiaeke and Isieke dump sites and loamy in the Nsukwe in samples from Nsukwe waste dumpsite. The chemical properties of the soil were largely present in Nsukwe dump site than Ahiaeke and Isieke dump sites. The heavy metal properties of the soil were low across all sampling sites. Toxic metals like Cd, Hg and Pb were not observed in all the sampling site in this study. However, presence of other metals (B, Mn, Ni, Cu, Ba, Co, and Zn) may suggest the possibility of the other metals getting introduced to the soil through bioaccumulation.

RECOMMENDATION

Given the outcome of this study, need to improve waste disposal methods in the study area is thereby recommended. Hence, direct discharge of waste on roadside and areas close to water bodies and human habitat should be discourage as some of these toxins have capacity of getting to humans and animals through food chain or other means. Waste sorting and treatment is hence encouraged in Umuahia to reduce high mixture biodegradable waste with non-biodegradable that can be recycled and reuse (some which are metal waste). Priority should be given to the establishment of air monitoring stations in all urban centers of the country in order to provide accurate and continuous information on air quality. Further studies should explore the possibility of ground water contamination by the leachate chemicals, the uptake of toxic metals by plants around the waste dump sites and lower soil depth contamination.

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