Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 7 ~ Issue 11 (2021) pp: 10-18
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Edaphic factors and heavy metal concentration of soils in Bonny and Nekede Dumpsite, Niger Delta region, Nigeria: A comparative analysis

Asoegwu C. R, Njoku J. D, Iwuji M. C, Uyo C. N and Babanlungu Z. A
Department of Environmental Management, Federal University of Technology, Owerri, Nigeria

ABSTRACT
Pollution of soil by leachate from surrounding municipal waste dumps has been recognized for a long time. In Nigeria, urban solid waste crises have grown in the last thirty years which is attributed mainly to three factors, namely, rapid increase in urban population, heavy consumption pattern of urban dwellers and inefficiency of the authorities whose statutory responsibilities include efficient refuse management in cities. Physicochemical and heavy metals analyses were carried out on soil samples from two different waste dumpsites to compare the effects of the refuse dumpsites on soil quality. The dumpsite locations are Bonny area of Rivers State and Nekede area of Imo State. Soil samples collected at 1.0 – 2.5 meters depth were analysed for Physicochemical parameters such as pH, Organic Matter, Organic Carbon, Electrical Conductivity, Nitrogen, Exchangeable acidity, Calcium, Magnesium, Potassium and Sodium, and also for the following heavy metals Cu, Zn, Mn, Cd, Pb and Cr. The result was subjected to relevant statistical analysis like ANOVA and t–Test. The analyses indicated that there are some levels of contaminations on both soils from Bonny and Nekede dumpsites. The mean concentration of electrical conductivity count was found to be higher in Bonny area dumpsite with a value of 1.3mS/cm soil compared to the soil samples in Nekede with a value of 0.6mS/cm, while the other physicochemical parameters were higher at Nekede dumpsite soil samples. For the concentration of heavy metals analyzed, it was observed that the mean concentrations of Cu, Mn and Cr with values 6.03×10^{-2}, 7.00×10^{-2}, *and* 6.73×10^{-2} *respectively were higher in Bonny area dumpsite soil while Zn, Cd and Pb with values* 6.60×10^{-1}, 2.18×10^{-1} *and* 4.52×10^{-1} *were higher at Nekede dumpsite. This is an indicator that leachate from the Bonny waste dumpsites which are rich in heavy metal are interacting with the soil and thereby enriching it. Waste management education and awareness creation should be carried out more often and appropriate guidelines and standards on environmental pollution and conservation should be established in every community and constantly monitored by an appointed group and where they already exist, they should be resolutely meted out.*

Received 03 November, 2021; Revised: 15 November, 2021; Accepted 17 November, 2021

I. INTRODUCTION

Pollution of soil by leachate from surrounding municipal waste dumpsites has been recognized for a long time (Banar *et al*., 2016; Alloway, 2010; Tahri *et al*., 2015; Lin *et al*., 2012; Amadi *et al*., 2010). In Nigeria, like in other developing countries, open dumpsites are the widely used option for solid waste disposal in the cities. (Chopra *et al*., 2009) described waste dumpsite practices as the disposal of solid waste by infilling depressions on land. The depressions into which solid wastes are often dumped include valleys and burrow pits. The negligence of the effects of unlined waste dumpsites on the soil and underlying shallow aquifers in Southern Nigeria characterized by largely unconfined, porous and high permeable aquiferous system is worrisome. Soil and groundwater system can be polluted due to poorly designed waste disposal facilities, leakage from underground storage tanks and agricultural runoffs. Soil and groundwater acidification and nitrification have been linked to waste dumpsites (Bacud *et al*., 2014) as well as microbial contamination of soil and groundwater system (Awomeso *et al*., 2010).

Challenges associated with improper waste management has assumed a frightening dimension with its attendant effects on the environment, health and well-being of people hence, approaching it holistically is a non-negotiable alternative for a healthy and sustainable living (Ahmad *et al.*, 2013). Population growth and economic development led to enormous amounts of solid waste generation by the dwellers of the urban areas (Verge and Rowe, 2013) while urban Municipal Solid Waste (MSW) is usually generated from human settlements, small industries and commercial activities (Singh *et al*., 2011). Soil contamination through waste discharges, particularly hazardous wastes, is a worldwide phenomenon and carries different metals which can be transferred to plants by different ways (Akinbile and Yusoff, 2012). The contamination of soil by heavy metal can cause adverse effects on human health, animals and soil productivity and depending on the tendency of the contaminants, they end up either in water held in the soil or leached to the underground water. Contaminants like Cd, Cu, Ni, Pb and Zn can alter the soil chemistry and have an impact on the organisms which depend on the soil for nutrition (Voutsa *et al*., 2012).

In developing countries such as Nigeria, open dumpsites are common practice due to the poor implementation of environmental laws and lack of political will. A good amount of the city garbage is dumped in low lying areas which pose serious threat to soil and groundwater resources (Akinbile, 2012; Agamuthu and Fauziah, 2011). Studies show evidence of seriousness of hazards caused by open waste dumpsites, ultimately affecting the plant life, and leading to irreversible erosion trend (Phil-Eze, 2010). Solid waste pollutants serve as an external force affecting the physicochemical characteristics of soil ultimately contributing towards the vegetal growth (Christensen *et al*., 2014). Nigeria is generally faced with rapid deterioration of environmental conditions due to the conventional system of collection and dumping of solid wastes.

Therefore, waste management has become a major concern in Urban and peri-urban areas. Little efforts have been made in order to improve the waste collection technologies and disposal facilities. The movement of contaminants from sites where wastes are disposed off to adjoining ecosystems is complex and involves biological and physicochemical processes (Mpofu *et al*., 2017).Open dumpsites could be a source of microbial and toxic chemical pollution of the soils of the dumpsites. This can also pollute hand dug wells, posing serious health risks and leading to the destruction of biodiversity (Ogunmodede *et al*., 2014). The composition of the wastes influences the concentration of the leachates' constituents which may be adsorbed on to the soil during this diffusion (Shaikh *et al*., 2012). This process creates health hazards, soil and water pollution and offensive odors, which increase with an increase in ambient temperature levels (Abdus-Salam *et al*., 2011).

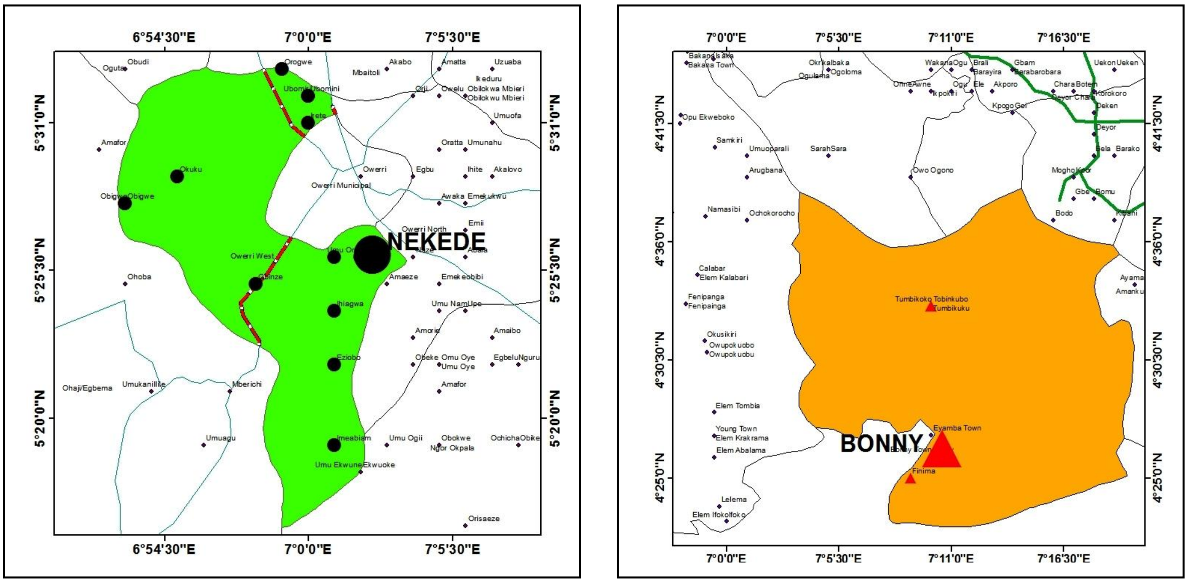

Figure 1. Map of the study locations, Nekede and Bonny Island

II. METHODOLOGY

Method of sample collection

Total of 3 soil samples were collected each from Bonny and Nekede study areas between 1.0 – 2.5 meters depth while additional 2 samples at the same depth range were collected at 500m each away from the study locations to serve as the control samples. The sampling tools were washed with water and dried before the next sample was collected. The samples were collected once every day for 8 days during the rainy season of 2019. The sample bags for Bonny were labelled with sample codes Point 1 – 3 respectively and codes A - C for samples from Nekede. The control bags were labelled Control BN for Bonny and Control NK for Nekede.

Sample Preparation

The samples were labelled appropriately, stored in sealed polythene bags and transported to School of Agriculture and Agricultural Technology Laboratory, FUTO for digestion and analysis. The soil samples were air-dried in the laboratory at room temperature, ground to fine mixture using pestle and mortar and sieved under 2mm mesh. The soil samples were digested in a mixture of concentrated nitric acid (NHO_3), concentrated hydrochloric acid (HCl) and 27.5% hydrogen peroxide (H_2O_2) according to the USEPA method 3050B for the Physicochemical and heavy metals analysis of soil (USEPA, 1996). The pH measurement of the aqueous suspension 1:5 (w/v) of the <2 mm fraction of the soil was performed. The pH was measured with Electrometric method BS 1377 part 1 (1990). Soil pH was determined potentiometrically using pH meter in a soil: solution ratio of 1:2.5. Conductivity meter and filter membrane method were used for the determination of conductivity and bacteria count respectively. The distilled water used for the preparation of the suspension had been previously boiled and cooled and the sample for determination of bacteria count was incubated for at least 24 hours. The determination of heavy metals (Cu, Zn, Mn, Cd, Pb and Cr) was done using the inductively coupled plasma atomic emission spectrometer, ICP-AES, with simultaneous detection Optima 5300 DV (Perkin Elmer), with axial and radial dual vision.

Physicochemical Characterization

The physicochemical properties of the soil analysed in this study are: pH, Organic Matter, Organic Carbon, Electrical Conductivity, Nitrogen, Exchangeable acidity, Calcium, Magnesium, Potassium and Sodium. This was followed by soil texture tests which include the following textures: Sand, Soil and Clay. The samples were also tested for heavy metals concentrations such as Zinc, Copper, Lead, Cadmium, Chromium and Manganese.

The pH value of samples was determined using the Electrometric method following APHA 4500B (2005). The pH electrode was immersed in the sample beaker. The pH reading was recorded once the reading stabilized. Calcium and magnesium in soil samples were determined by pipette method as described by Piper (1966). Potassium was determined photometrically after extracting the soil with neutral normal ammonium acetate (Jackson, 1973). Sodium in soil samples was determined turbidometrically. The intensity of turbidity was measured using spectrophotometer at 420 nm of wavelength as outlined by Piper (1966). Nitrogen was determined by macro distillation of the sample following alkaline permanganate method as suggested by Subbiah and Asija (1956). The electrical conductivity (EC) used to measure the ability of a sample to carry an electric current was determined using a conductivity cell containing a platinized electrode and following APHA 2510B (2005).

The heavy metals content was determined by Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) using method APHA 3125B (2005). The heavy metals were determined as per Mg/l in the ICP-MS after the samples were refluxed and heated at 95°C.

III. RESULT PRESENTATION

Table 1: Physicochemical Properties of the Soil Samples

Samples	Parameters									
BONNY	**Ph**	**EC (mS/cm)**	**% OM**	**% OC**	**% N**	**Temperature (°C)**	**Ca (Cmol/kg)**	**Mg (Cmol/kg)**	**K (Cmol/kg)**	**Na (Cmol/kg)**
Point 1	7.81	3.0	0.86	0.50	0.09	26.3	3.00	2.31	0.05	0.021
Point 2	7.60	3.5	1.89	1.10	0.13	27.6	26.30	5.34	0.09	0.016
Point 3	7.17	4.2	0.52	0.30	0.05	26.1	17.30	3.67	0.09	0.017
Control BN	7.60	1.3	0.80	0.50	0.08	25.8	1.60	0.59	0.02	0.019
Mean	**7.55**	**3.00**	**1.01**	**0.59**	**0.09**	**26.5**	**12.05**	**2.98**	**0.06**	**0.018**
NEKEDE										
A	7.60	0.6	2.41	1.40	0.15	27.4	39.36	8.68	0.01	0.012
B	7.43	1.0	0.76	0.44	0.08	26.8	12.33	3.68	0.05	0.036
C	8.67	0.8	1.34	0.78	0.12	27.7	9.42	3.59	0.04	0.075
Control NK	7.60	1.5	1.07	0.62	0.11	27.2	4.11	2.08	0.12	0.025
Mean	**7.83**	**0.98**	**1.39**	**0.81**	**0.11**	**27.3**	**16.31**	**4.51**	**0.05**	**0.037**

Source: Fieldwork, 2020.

Soil pH and Electrical Conductivity

Table 1 above shows the results and the mean of the physicochemical concentration of elements of the soil samples from Bonny area of Rivers State and Nekede in Owerri. The pH of samples from Bonny ranged between 7.17 – 7.81, and has a mean of 7.50, while samples from Nekede has a pH that ranged between 7.43 – 8.67, with a mean of 7.83. The pH values above 7.5 recorded in most of the samples indicates the presence of alkaline in the samples, as the optimal pH range for most plants is between 5.5 and 7.5. Soil pH level is an important factor in soil as it controls many chemical processes that take place in the soil, specifically, plant nutrient availability.

It was observed that the EC of the samples from Bonny has a range of 1.3mS/cm to 4.2mS/cm with a mean of 3.0mS/cm, while samples from Nekede ranged between 0.6mS/cm to 1.5mS/cm. According to (Abegunrin *et al*., 2013), the Electrical Conductivity (EC) of a normal soil should be less than 4mS/cm (<4mS/cm). Comparing the EC of the samples with the claim by (Abegunrin *et al.*, 2013), the samples were classified as not posing any threat with respect to salinity hazards, except sample point 3 from Bonny which has an EC of 4.2mS/cm; this is an indication that the soil is saline.

Organic Matter and Organic Carbon

Soils with high levels of silt and clay usually have higher levels of organic matter than those of a sandier texture (Sustainable Agriculture Research and Education). From Table 1, it is evident that the percentage of Organic Matter for samples from Nekede has the range of 0.76 to 2.41 with a mean of 1.39, while samples from Bonny ranged between 0.52 to 1.89 with a mean of 1.01. The results of organic matter as indicated shows that samples from Nekede contain higher percentage of organic matter than samples from Bonny. This could be linked to the higher percentage of silt and clay in the soil samples from Nekede, except for sample B which shows a relatively weak percentage of organic matter.

For organic carbon, samples from Nekede have a predominantly higher percentage which ranged between 0.44 to 1.40 with a mean of 0.81 compared to samples from Bonny which ranged between 0.30 to 1.10, with a mean of 0.59. The higher percentage of soil organic carbon present in samples from Nekede can be attributed to the higher percentage of soil organic matter in that area compared to samples from Bonny. This is an indication that the soil from Nekede is healthier and more fertile for agricultural practices, as increasing soil organic carbon is the basis of soil fertility which releases nutrients for plant growth, promotes the structure, biological and physical health of soil, and also a buffer against harmful substances.

Soil Nitrogen and Temperature

Nitrogen is an essential element of all proteins; it affects the growth of a plant and quantity and quality of produce. If nitrogen is low, growth is stunted, and all plant functions are disturbed. Plants require more nitrogen than any other nutrient. According to Soil Nitrogen Supply (SNS), the mineral nitrogen in soil should account for at least 2% of nutrients, but from the sampled soils, it was observed that percentage level of all the samples are below the standard recommended by SNS. The level of nitrogen recorded in the samples from Nekede has a range between 0.08% to 0.15% with a mean of 0.11%, while samples from Bonny ranged between 0.05% to 0.09% with a mean of 0.09%.

The temperature values of the soil samples from the locations were similar, ranging from 25.8^oC to 27.6^oC with a mean of 26.5^oC for samples from Bonny, and 26.8^oC to 27.7^oC with a mean of 27.3^oC for samples from Nekede; this is similar to the permissible limit of soil recommended by Osakwe and Otuya (2008) as cited by Henry *et.al* (2017).

Calcium and Magnesium

Results obtained from the analysis of the samples as shown in table 1 shows that samples from Bonny have a range of Calcium 1.60Cmol/kg to 26.30Cmol/kg with a mean of 12.05Cmol/kg, while samples from Nekede shows a level of Calcium which ranged between 4.11Cmol/kg to 39.36Cmol/kg with a mean of 16.31Cmol/kg. The control samples from the two locations were found to have the lowest level of Calcium.

The concentration of Magnesium in samples from Bonny ranged between 0.59Cmol/kg to 5.34Cmol/kg and has a mean of 2.98Cmol/kg, while samples from Nekede show higher concentration of Magnesium with a range of 2.08Cmol/kg to 8.69Cmol/kg with a mean of 4.51Cmol/kg.

Potassium and Sodium

The concentration of Potassium for the samples from both Bonny and Nekede were similar with a range between 0.2Cmol/kg to 0.9Cmol/kg and 0.1Cmol/kg to 0.12Cmol/kg respectively.

Sodium values for Bonny ranged from 0.016Cmol/kg – 0.021Cmol/kg with a mean of 0.018Cmol/kg, while values from Nekede ranged from 0.012Cmol/kg – 0.075Cmol/kg with a mean of 0.037Cmol/kg. Although the control samples were found to be higher than some sampling points in the two locations.

Table 2. Result of Soil Texture Analysis

Samples	Soil Textures		
BONNY	**% Sandy**	**% Clay**	**% Silt**
Point 1	96.24	2.76	1.00
Point 2	94.24	2.48	3.28
Point 3	96.24	1.76	2.00
Control BN	97.24	1.76	1.00
NEKEDE			
A	95.68	1.04	3.28
B	97.00	2.04	0.96
C	93.68	3.04	3.28
Control NK	95.68	1.04	3.28

Source: Fieldwork, 2020.

Textural Characteristics of Soil

The textural characteristic of a soil refers to the proportion of the soil separates that make up the mineral component of the soil. These separates are called sand, silt and clay. Table 2 shows that samples from Nekede contain higher percentage of Silt compared to those from Bonny, while samples from Bonny shows a relatively higher percentage of Clay than those from Nekede. It can be seen also that the dominant formation was sand, which indicates that the samples have a higher percentage of Sandy soil.

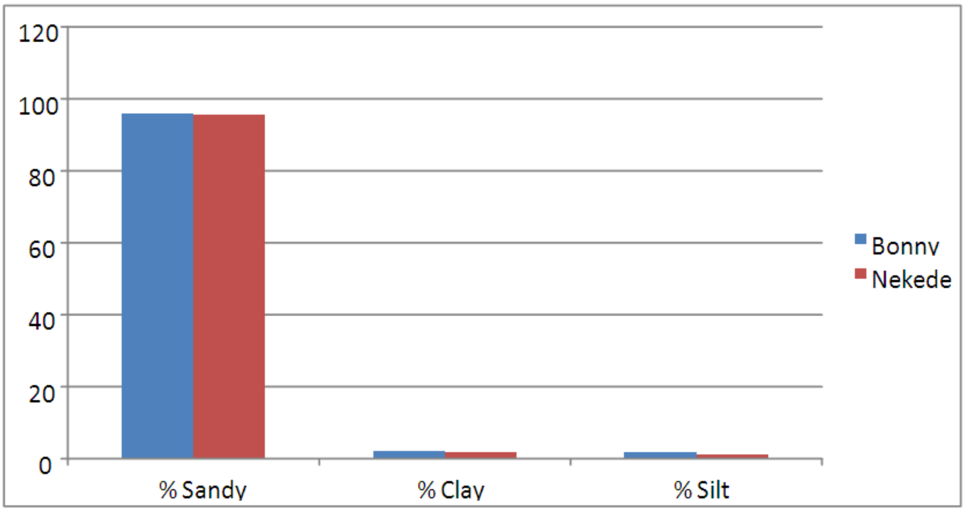

Figure 2: A Bar chart of mean concentration of soil textures at Bonny and Nekede Dumpsites.

Table 3: Heavy metals concentration of Samples

Samples	Parameters (mg/kg)					
	Cu	**Zn**	**Mn**	**Cd**	**Pb**	**Cr**
BONNY						
Point 1	5.3×10^{-2}	5.78×10^{-1}	6.4×10^{-2}	1.23×10^{-1}	3.25×10^{-1}	6.1×10^{-2}
Point 2	7.8×10^{-2}	7.89×10^{-1}	8.4×10^{-2}	3.06×10^{-1}	5.57×10^{-1}	8.3×10^{-2}
Point 3	4.4×10^{-2}	5.24×10^{-1}	5.7×10^{-2}	1.17×10^{-1}	3.06×10^{-1}	5.2×10^{-2}
Control BN	6.6×10^{-2}	5.95×10^{-1}	7.5×10^{-2}	1.36×10^{-1}	3.79×10^{-1}	7.3×10^{-2}
MEAN	$\mathbf{6.03 \times 10^{-2}}$	$\mathbf{6.22 \times 10^{-1}}$	$\mathbf{7.00 \times 10^{-2}}$	$\mathbf{1.71 \times 10^{-1}}$	$\mathbf{3.92 \times 10^{-1}}$	$\mathbf{6.73 \times 10^{-2}}$
NEKEDE						
A	7.5×10^{-2}	8.87×10^{-1}	8.6×10^{-2}	3.15×10^{-1}	5.79×10^{-1}	8.1×10^{-2}
B	8.7×10^{-2}	9.15×10^{-1}	9.6×10^{-2}	3.29×10^{-1}	5.88×10^{-1}	9.2×10^{-2}
C	3.9×10^{-2}	5.12×10^{-1}	5.1×10^{-2}	1.24×10^{-1}	4.28×10^{-1}	4.4×10^{-2}
Control NK	2.3×10^{-2}	3.24×10^{-1}	3.5×10^{-2}	1.03×10^{-1}	2.14×10^{-1}	3.6×10^{-2}
MEAN	$\mathbf{5.6 \times 10^{-2}}$	$\mathbf{6.60 \times 10^{-1}}$	$\mathbf{6.7 \times 10^{-2}}$	$\mathbf{2.18 \times 10^{-1}}$	$\mathbf{4.52 \times 10^{-1}}$	$\mathbf{6.33 \times 10^{-2}}$

WHO STANDARD	**36**	**50**	**12**	**0.8**	**85**	**100**

Source: Fieldwork, 2020.

Heavy Metals Concentration of the Soil Samples

Heavy metals refer to biological toxicity of the soil. A total of 6 heavy metals were analysed in this study. Table 3 shows that the mean values of Copper, Manganese and Chromium were higher in Bonny than Nekede, with values 6.03×10^{-2}, 7.00×10^{-2} and 6.73×10^{-2} respectively. While the mean values of Zinc, Cadmium and Lead were found to be higher in Nekede than Bonny, with values 6.60×10^{-1}, 2.18×10^{-1} and 4.52×10^{-1}. The concentrations of the heavy metals tested were lower than the control in Nekede, but higher in point 2 samples in Bonny. However, all the heavy metals analysed in both sample locations were below the World Health Organization (WHO, 1996) standard.

Table 4. Descriptive Statistics of the Physicochemical Parameters for Bonny

Parameters	**Minimum**	**Maximum**	**Mean**	**Standard Error**
pH	7.17	7.81	7.5	±0.134
EC	1.3	4.2	3	±0.618
OM	0.8	1.89	1.01	±0.300
OC	0.3	1.1	0.59	±0.173
N	0.05	0.13	0.09	±0.017
Temperature	25.8	27.6	26.5	±0.397
Ca	1.6	26.3	12.05	±5.928
Mg	0.59	5.34	2.98	±1.009
K	0.02	0.09	0.1	±0.017
Na	0.016	0.021	0.018	±0.001

Source: Fieldwork, 2020.

Table 5: Descriptive Statistics of the Physicochemical Parameters for Nekede

Parameters	**Minimum**	**Maximum**	**Mean**	**Standard Error**
pH	7.43	8.65	7.83	±0.285
EC	0.6	1.5	0.98	±0.193
OM	0.76	2.41	1.40	±0.358
OC	0.44	1.4	0.81	±0.209
N	0.08	0.15	0.12	±0.014
Temperature	26.8	27.7	27.28	±0.189
Ca	4.11	39.36	16.31	±7.871
Mg	2.08	8.68	4.51	±1.438
K	0.01	0.12	0.06	±0.023
Na	0.012	0.075	0.04	±0.014

Source: Fieldwork, 2020.

Descriptive Comparative Graphs of Analysed Soil Parameters and Soil Textures

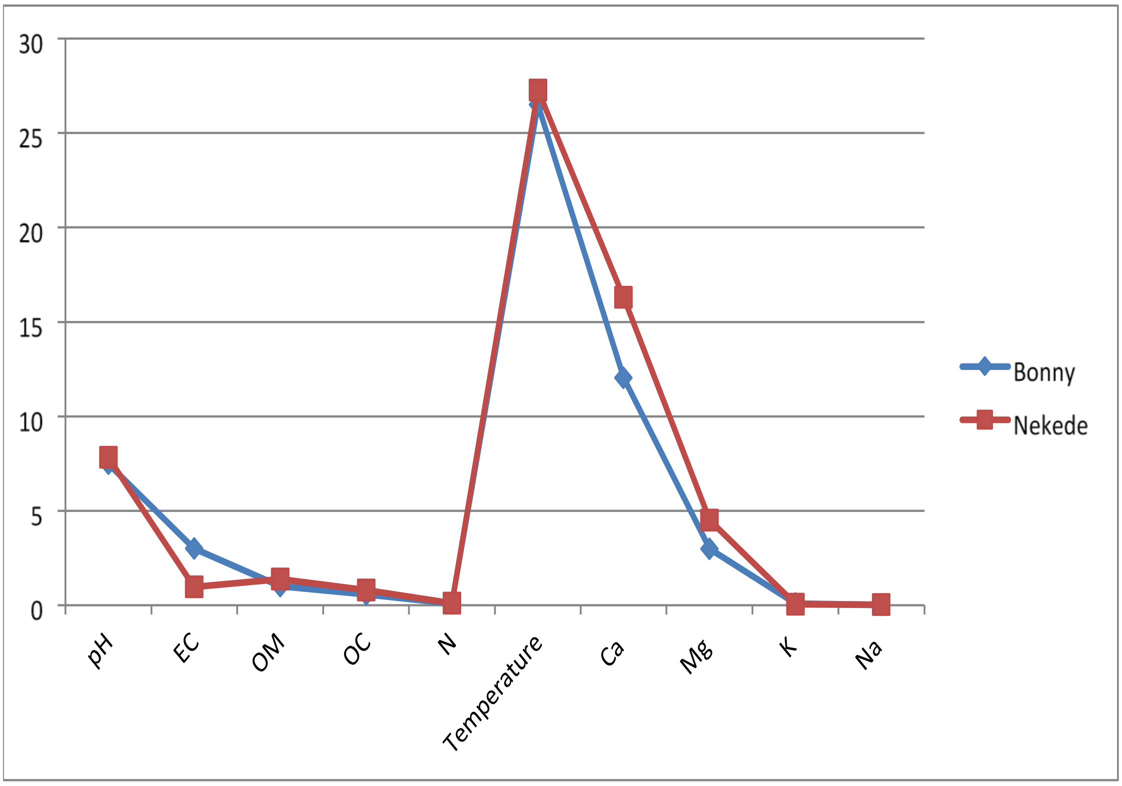

Figure 3: A Graph of mean concentration of physicochemical parameters analysed at Bonny and Nekede Dumpsites

Table 7. ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.5136	1	1.5136	0.019793	0.889678	4.413873
Within Groups	1376.453	18	76.46959			
Total	1377.966	19				

From the result of ANOVA statistics, it was concluded at 95% confidence level that there is a significant difference between the means of the analysed parameters from the two studied locations. This is a confirmation that the means of the analysed parameters from the two locations significantly differs. However, the ANOVA does not tell us where the difference lies; hence a t-Test was used to test each pair of means.

Table 8. t-Test: Two-Sample Assuming Unequal Variances

	Bonny	***Nekede***
Mean	5.3838	5.934
Variance	70.34628	82.59289333
Observations	10	10
Hypothesized Mean Difference	0	
df	18	
t Stat	-0.14069	
P(T<=t) one-tail	0.444839	
t Critical one-tail	1.734064	

P(T<=t) two-tail	0.889678
t Critical two-tail	2.100922

From the t-TEST table above, the t Critical two-tail > t Stat, that is 2.100922>-0.14069, therefore, we are accepting the null hypothesis. The observed difference between the sample means (5.934 – 5.3838) is not convincing enough to say that the average quantity of soil pollutants between the two study locations differ significantly.

IV. DISCUSSION

The test results analyses generally indicated that there are some levels of contaminations on the soil. The pH values above 7.5 recorded in most of the samples indicates elevated alkaline level in the samples, as the optimal pH range for most plants is between 5.5 and 7.5. Soil pH level is an important factor in soil as it controls many chemical processes that take place in the soil, specifically, plant nutrient availability.

The mean concentration of electricity conductivity count was found to be higher in Bonny area dumpsite soil compared to the soil samples in Nekede, while the other physicochemical parameters were higher at Nekede dumpsite soil samples. For the concentration of heavy metals analysed, it was observed that the mean concentrations of Cu, Mn and Cr were higher in Bonny area dumpsite soil while Zn, Cd and Pb were higher at Nekede dumpsite. The high concentration of Cadmium (Cd) may be due to the decay of abandoned electric batteries and other electronic components on the dumpsites. The soil samples collected far away from the dumpsites used as controls show significantly lower concentrations in Nekede than Bonny compared to those from the vicinity of the dumpsites. This indicates that leachate from the Bonny waste dumpsite which are rich in heavy metal are interacting with the soil and thereby enriching it. Although the soil samples from the control in Bonny shows relatively lower concentration in physicochemical parameters compared to the soil samples from the control in Nekede.

Also, from the awareness creation with the use of check list within the study locations, it was realised that most residents and business owners within these locations have little or no knowledge of proper waste management.

V. SUMMARY OF RESEARCH FINDINGS

Wastes discarded openly or in landfills are usually subjected to series of intricate biochemical and physical processes, which may lead to the production of leachate capable of contaminating the soil. To this effect, it was necessary for this research to study soil samples collected from two waste dumpsites from two different study locations, one at Bonny area of Rivers State and the other at Nekede area of Imo State, and analyze their impacts on the soil parameters, and also compare the results obtained from the soil samples analyzed from the two study locations. Results and the mean of the physicochemical concentration of elements of the soil samples from Bonny area of Rivers State and Nekede in Owerri shows that:

- PH of the samples from Bonny ranged between 7.17 – 7.81, and has a mean of 7.50, while samples from Nekede have a pH that ranged between 7.43 – 8.67, with a mean of 7.83. The pH values above 7.5 recorded in most of the samples indicates the presence of alkaline in the samples, as the optimal pH range for most plants is between 5.5 and 7.5. Soil pH level is an important factor in soil as it controls many chemical processes that take place in the soil, specifically, plant nutrient availability.

It was also observed that the,

- EC of the samples from Bonny has a range of 1.3mS/cm to 4.2mS/cm with a mean of 3.0mS/cm, while samples from Nekede ranged between 0.6mS/cm to 1.5mS/cm. According to Abegunrin *et. al* (2013), the Electrical Conductivity (EC) of a normal soil should be less than 4mS/cm (<4mS/cm). Comparing the EC of the samples with the claim by Abegunrin *et. al* (2013), the samples were classified as not posing any threat with respect to salinity hazards, except sample point 3 from Bonny which has an EC of 4.2mS/cm; which is an indication that the soil is saline.

.

- A total of 6 heavy metals were analysed for this study. The result shows that the mean values of Copper, Manganese and Chromium were higher in Bonny than Nekede, with values 6.03×10^{-2}, 7.00×10^{-2} and 6.73×10^{-2} respectively. While the mean values of Zinc, Cadmium and Lead were found to be higher in Nekede than Bonny, with values 6.60×10^{-1}, 2.18×10^{-1} and 4.52×10^{-1}. The concentrations of the heavy metals tested were lower than the control in Nekede, but higher in point 2 samples in Bonny.
- From the awareness creation carried out with the use of checklist, it was discovered that most residents of the both locations have little or no knowledge on proper waste management.

VI. CONCLUSION

The analysis of waste disposal on the selected dumpsites in the studied locations indicated that the dumpsites pre-existed some of the residential houses and buildings in the study areas. From the study, it was established that the two dumpsites were still in their active stage. With the development rate and increasing population in the area, there is an increase in the level of waste generated leading to massive accumulation of wastes at the dumpsites.

From the analysis carried out at the two locations, it can be concluded that there is no significant difference between the heavy metals concentration in the terrestrial sample location of Nekede dumpsite and the wetlands sample location of Bonny Dumpsite.

REFERENCES

[1]. Abdus-Salam N., Ibrahim M. S., and Fatoyinbo F. T. (2011): Dumpsites in Lokoja, Nigeria: a silent pollution zone for underground water. *Waste Manag Bioresour Technol*. 2011, 21–30
[2]. Abegunrin T., Awe, G., Idowu, D., Onigbogi, O. and Onofua, O. (2013): Effect of kitchen wastewater irrigation on soil properties and growth of cucumber (Cucumis sativus). J. Soil Sci. Environ. Manag. 2013, 4, 39–145.
[3]. Agamuthu P. and Fauziah S. H. (2011): Challenges and issues in moving towards sustainable landfilling in a transitory country – Malaysia, waste management and research, 29, (1): 13–19
[4]. Ahmad S. Z., Sanusi M., Ahamad S. and Yusoff M. S. (2013): Spatial effect of new municipal solid wastelandfill siting using different guidelines, Waste management and Research, 32 (1): 24–33
[5]. Akinbile C. O. (2012): Environmental Impact oflandfill on groundwater quality and agricultural soils in Nigeria, Soil and Water Research, 7 (1): 18-26.
[6]. Akinbile C. O. and Yusoff M. S. (2012): Solid Waste Generation and Decomposition using Compost bin Technique in Pulau Pinang, Malaysia, Waste Management and Research. 30 (5): 498-505
[7]. Alloway B. J. (2010): Heavy metals in soil. John Wiley and sons Inc., New York, 2010 339p
[8]. Amadi A. N., Ameh M. I. and Jisa J. (2010): The impact of dump-sites on groundwater quality in Markurdi Metropolis, Benue State. Natural and Applied Sciences Journal, 2010, 11(1): 90 – 102
[9]. APHA Standard (2005): 2510B: Electrical conductivity test for Water and Wastewater - Laboratory Method. Washington, DC: American Public Health Association.
[10]. APHA Standard (2005): 3125B: Metals by Inductively Coupled Plasma/Mass Spectrometry; Inductively-Coupled Plasma/Mass Spectrometry (ICP/MS) Method
[11]. Awomeso J. A., Taiwo A. M., Gbadebo A. M. and Arimoro A. O. (2010): Waste disposal and pollution management in urban areas: A workable remedy for the environment in developing countries. American Journal of Environmental Sciences, 2010, 6(1): 26 – 32
[12]. Bacud L., Sioco F. and Majam J. (2014): A descriptive study of the water quality of drinking wells around Payatas dumpsite, Unpublished BSc Thesis, University of the Philippines College of Public Health, 12 – 24
[13]. Banar M., Aysun O., and Mine K. (2016): Characterization of the leachate in an urban landfill by physicochemical analysis and solid phase microextraction. GC/MS. Environ. Monitor. Assess., 2016, 121: 439 – 459
[14]. Chopra A. K., Pathak C. and Prasad G. (2009): Scenario of heavy metal contamination in agricultural soil and its management. Journal of Applied and Natural Sciences, 2009, 1: 99 – 108
[15]. Christensen D., Drysdale D., Hansen K., Vanhille J. and Wolf A. (2014): Partnerships for development: Municipal solid waste management inKasese, Uganda. Waste Management and Research. 32(11) 1063–1072
[16]. Jackson M. L. (1973): Soil chemical analysis. Prentice Hall of India Private Ltd., New Delhi, 56-70
[17]. Lin Y. P., Teng T. P.and Chang T. K. (2012): Multivariate analysis of soil heavy metal pollution and landscape in Changhua Country in Taiwan. Landscape Urban Plan., 2012, 62: 19 – 35
[18]. Mpofu K., Nyamugafata P., Maposa I. and Nyoni K. (2013): Impacts of waste dumping on Pomona medium sand clay loams soils and surface water quality in Harare, Zimbabwe. *ARPN J Sci Technol* [Internet]. 2013. December [cited 2017 May 7]; 3 12: 1215–21.
[19]. Ogunmodede O. T., Adewole E., Ajayi O. O. and Onifade A. K. (2014): Environmental assessment of solid waste management in Nigeria: a case study of Ikere Ekiti, Ekiti state. *J Phys Chem Sci* [Internet]. 2014. January 21
[20]. Osakwe S. A. and Otuya O. B. (2008): Elemental Composition of Soils in Some Mechanic Dumpsites in Agbor, Delta State, Nigeria. Proceedings of Chemical Society of Nigeria. 557-559
[21]. Phil-Eze P. O (2010): Variability of soil properties related to vegetation cover in a tropical rainforest landscape. Journal of Geography and Regional Planning Vol. 3(7):177-184
[22]. Piper C. S. (1966): Soil and Plant Analysis. Hans Publisher, Bombay
[23]. Shaikh P. R., Bhosle A. B., and Yannawar V. B. (2012): The impact of landfill on soil and groundwater quality of the Nanded City, Maharashtra. *Res* 47: 56–63.
[24]. Singh R. P., Singh P., Arouja A. S. F., Ibrahim M. H. and Sulaiman O. (2011): Management of urban solid waste: vermicomposting a sustainable option. Resource Conservation and Recycling. 55: 719–729.
[25]. Subbiah B.V. and Asija G.L. (1956): A Rapid Procedure for the Estimation of Available Nitrogen in Soils. Current Science, 25, 259-260.
[26]. Tahri F., BenyaM., Bounakla E. I. and Bilal J. J. (2015): Multivariate analysis of heavy metal in soils, sediments and water in the region of Meknes, Central Morocco. Environ. Monitor. Asses., 2015, 102: 405 – 417
[27]. United State Environmental Protection Agency (USEPA) (1996): "Method 3050B: Acid Digestion of Sediments, Sludges, and Soils," Revision 2. Washington, DC.
[28]. Verge A. and Rowe R. K. (2013): A framework for a decision support system for municipal solid waste landfill design. Waste management and Research. 31(12): 1217–1227
[29]. Voutsa D., Grimanis A. and Samara C. (2016): Trace elements in vegetables grown in an industrial area in relation to soil and air particulate matter. Environmental Pollution, 94, 325–335
[30]. WHO (1996): Permissible limits of heavy metals in soil and plants (Geneva:World Health Organization), Switzerland.