Turkish Journal of Agricultural Engineering Research

https://dergipark.org.tr/en/pub/turkager
https://doi.org/10.46592/turkager.2020.v01i02.004

Turk J Agr Eng Res (TURKAGER)
e-ISSN: 2717-8420
2020, 1(2): 261-270

Research Article

Assessment of Physicochemical Properties of Soil at Old Nekede Dumpsite Owerri, Imo State, Nigeria

Christopher Ikechi OBINECHE[ID][a*] **Donatus Okwudiri IGBOJIONU**[ID][a] **Isiguzo Edwin AHANEKU**[ID][b]

[a*] Department of Agricultural Engineering *Technology, Federal College of Land Resources Technology Owerri, NIGERIA*

[b] *Department of Agricultural and Bio-Resources Engineering. College of Engineering and Engineering Technology, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State. NIGERIA*

(*): Corresponding author. ikechiobineche@gmail.com; Tel: (+234) 0803 622 1412

ABSTRACT

Developing countries with inadequate waste disposal system unit or regulatory process is at risk of metal land. The aim of the study is to access the suitability of soils around old Nekede road in Owerri West L.G.A of Imo State in Nigeria. After the removal of the overlying waste soil samples were collected from five (5) different control points of open waste landfills (deposit point, North point, south point, east point and west point), 100m away from each other and at a depth of three different depths (0-15 cm, 15-30 cm and 30-45 m) on an open waste landfill using a Dutch soil auger. The physicochemical parameters of the soil were determined using standard laboratory methods, while, the diethylene triamine penta- acetic acid (DTPA) extraction method was used for Fe and Zn. The results were evaluated by ANOVA. Iron and zinc concentrations in deposit point with the depth of 0-15 cm,15-30 cm, 30-45 cm, ranged from 202.85 mg kg^{-1}, 164.47 mg kg^{-1}, and 131.33 mg kg^{-1}. Hence, it falls within the permissible range from 2760.1 to 2833.07 mg 100g^{-1}; while, Zinc ranged from 147.5 mg kg^{-1}, 67.22 mg kg^{-1}, 26.13 mg kg^{-1}, and falls within the permissible limits of 300 mg kg^{-1}. The concentration of heavy metals on under review was moderate and falls under the permissible standard during the time of this study. It will be suggested that the land can adequately produce with or without additional treatment. Crops such as cassava, plantain and banana can be encouraged in such areas.

RESEARCH ARTICLE

Received: 15.05.2020
Accepted: 15.08.2020

Keywords :

- Landfill,
- Dumpsite,
- Soils,
- Heavy-metals,
- Physicochemical Status,
- Nekede

To cite: Obineche CI, Igbojionu DO, Ahaneku IE (2020). Assessment of Physicochemical Properties of Soil at Old Nekede Dumpsite Owerri, Imo State, Nigeria. Turkish Journal of Agricultural Engineering Research (TURKAGER), 1(2): 261-270. *https://doi.org/10.46592/turkager.2020.v01i02.004*

INTRODUCTION

Natural constituent of the earth's crust such as heavy metals are non-degradable and sometimes, they find their way in our bodies through drink, food, water and air. Some heavy metals for instance, iron (Fe) and zinc (Zn) are essential for metabolic maintenance in humans. However, if not regulated at higher concentrations heavy metals have been shown to have negative effects and impact on the environment and humans (Sia Su, 2008). Heavy metal is any metallic substance that has a relatively high density and a low concentration, it is toxic. Some of such heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), titanium (Ti) and lead (Pb), etc. An open waste dump site is defined as a land disposal site whereby solid wastes are disposed of in a manner that does not protect the people and environment; it is vulnerable to open burning. Open waste dumping includes the solid waste of this different sort which when disposed poses reasonable possibility of adverse effects on the health of the environment (Adelekan and Alawode, 2011).

Gases such as methane are released in the surrounding as decomposition takes place, air and micro-organisms acting as a catalyst on the waste during the process. Fires pollutes the air with acidic smoke and other several volatiles liquids which were discharged, seeps through the solid waste heap, in due course reaches the soil, gravity water (surface) and ground water. Dangerous materials such as hydrocarbons, heavy metals, herbicides and pesticides that dissolves as liquid often contaminate and pollute water and soil (Adelekan and Alawode, 2011). Anikwe and Nwobodo (2001) noted that regular depositing of municipal waste on soils and its surface water would be unfriendly to deep feeding crops. Heavy metals such as nickel, cobalt, arsenic, cadmium, lead, chromium, and mercury are of great concern largely because of their capability to cause harm to humans, soil organisms, plants and animals (Adelekan and Abegunde, 2011).

Bacud *et al.* (1994) pointed out that the pollution soil and ground water system could be as result of a poorly designed waste water tanks. Soil and ground water acidification and nitrification have been linked to waste dumps as well as microbial contamination of soil and ground water system (Awomeso *et al.*, 2010). According to Sia Su (2008), solid waste dumps through leachate seeps to the groundwater, thereby causing abnormalities, such as cancer of the body and heart diseases. Rapid urbanization due to population increase laid to higher waste generation and improper waste management gives rise to both health and environmental concerns.

Adelekan and Alawode (2011) noted that waste from municipal dumpsites bear soils that are satisfactorily rich in organic matter that would be acceptable for surface feeder plants. Subsequently, Brady (1996) and Helmore and Ratta (1995) reported concurrently, that an open dump sites perform a twofold purposes of a safe disposal of waste and simultaneously approved chemical properties of soils that constitute productive agricultural fields. Nigeria a Western African country has a comparatively very poor waste management approach. Thus, the inadequate waste management approach has the potential of increasing soil metal concentration in and around the Nekede open dumpsite. Soil metal contamination increases health risks and deteriorates agricultural lands. In Imo state, the Ministry of Environment is saddled with the responsibility of checkmating solid waste and other waste disposal. The ministry has verse land allocated along old Nekede road for disposal of wastes both solid and others collected from different parts in Owerri town and its environments.

Owerri a non-industrial area that, refuses generated within the city comprise largely of degradable and non-degradable materials from the shopping malls, local markets, offices, hospitals and households such as garbage, plastics, textiles, sludge from sewage, dead animals, ashes, wood, disposed of food, stationaries and farm waste produce. However, damaged metallic materials from vehicle parts, electronics, computers, can drinks, etc. are also disposed of in the same way as the other non-metal contaminants. Methane and other gases are released into the surrounding air and micro-organisms decays loosening the solid waste and numerous volatile liquid that discharge; which seeps through the solid waste pile ultimately reaches the soil, shallow water and ground water. The harmful materials which include heavy metallic concentration, pesticides, herbicides and hydrocarbons consequently dissolves to form liquids that contaminate both soil and water (Adelekan and Alwaode, 2011).

Anikwe and Nwobodo (2001) postulated that disposal of municipal waste on soils may cause an increment in heavy metals composition in the soil and shallow water that would be amicable to deep feeding crops. Therefore, this study seeks to access the physicochemical properties of some selected soil samples of municipal open waste dumpsite in old Nekede Road Owerri West Local Government Area, Imo State of Nigeria. Specifically, the objectives are to, determine the organic matter composition with respect to its amount that will be favorable to plants growth around the dumpsite, determine the composition of Fe and Zn contents and fertility position of the soils around the dumpsite. The crux of the study is to know that continuous disposal of degradable municipal waste material from different locations of the state such as markets, offices, hospitals and house - holds which includes garbage, plastics, textiles, stationeries, and sludge from waste production soils leads to an increase in heavy metallic concentration in the soil. Surface waters are also affected which would be harmful to deep feeding plant. The study was conducted in an open dumpsite along old Nekede Road, Owerri West Local Government Area, Imo State. It is limited to the determination of the physical and chemical parameters of some waste soil such as pH, moisture content, carbon, available phosphorous, bulk density, cation exchange capacity, nitrogen, calcium, sodium, phosphorus, potassium and heavy metals such as iron and zinc.

MATERIALS and METHODS

The study was conducted near a dumpsite located along the old Nekede road in Owerri West L.G.A of Imo State (Figure 1). It lies between longitude 5° 25’ 03” N and latitude 6° 55’ 06” E.

The study area was about 3 km from Owerri main town. It was characterized by a main annual rainfall ranging from 2000-2500 mm, a mean temperature ranging from 26-28 ^{0}C and humidity ranging from 70-80% (Obineche *et al.,* 2016).

Surface soil samples were collected from old Nekede road dumpsite in Owerri West Local Government Area, Imo State After the removal of the overlying waste, samples were collected from (5) different control points of open waste dumpsites (deposit point, north point, south point, east point and west point), 100 m away from each other and at a depth of three different depths (0-15, 15-30 and 30-45 cm) on an open waste dumpsite using a Dutch soil anger. The soil samples from the waste collected were air dried, grinded and sieved using a 2mm sieve. These soils were stored in a labeled black polythene bags and taken to the laboratory for analysis. The soil physical and chemical analysis was carried out at the soil Research Laboratory. Standard laboratory procedures were followed in the analysis of the selected soil properties considered in the research, soil pH was measured in a water suspension using the glass electrode coupled pH meter. The (CEC) cations was determined by extracting a 1m ammonium acetate buffered (colloids) at pH 7. Calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) were determined by EDTA method as described by Udo *et al.* (2009). Titration method was used to determine exchangeable acid (EA) according to Juo (1979). One gram of each of the sieved soil samples was 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 analysis of heavy metals and major ions (USEPA 1996). The concentration of heavy metals Fe and Zn was extracted by the diethylene triamine penta-acetic acid (DTPA) method as described by Udo *et al.* (2009) and was determined using atomic absorption spectrophotometer (Unican solar 32) following standard procedures given in ALPHA (1995). Statistical was done using, excel and analysis of variance (ANOVA) at 5% level of probability and was also subjected to FAO (1976) standard for water and waste data evolution.

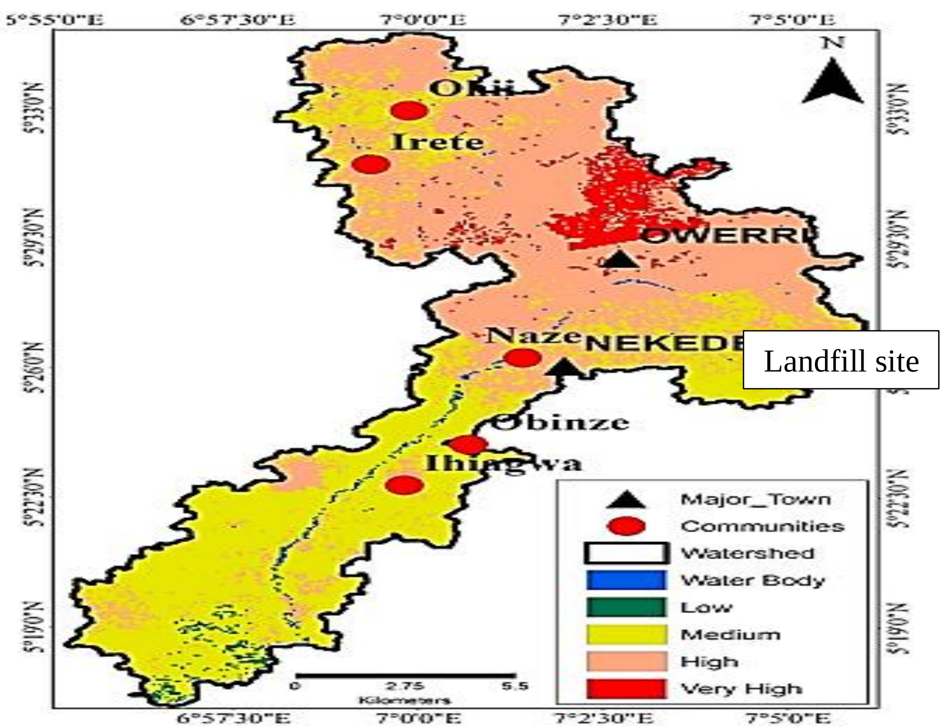


Figure 1. Map location of the study area (Ngozi *et al.*, 2016)

RESULTS and DISCUSSION

Table 1A and 1B indicate the values of physical and chemical parameters in different sampling points and depths. GMC (%) ranged from 23.09 to 30.12 % at depth of 0-15, 15-30 and 30-45 cm respectively at deposit point, However GMC (%) in other locations at the landfill varies in their content value (i.e. the amc %) of deposit point. This suggests lower layers are fine textured compared to the top layer, of which water holding capacity is higher. at minimum range of 23.09% and maximum range of 30.12%. Other locations are below the range of value of deposit point. This suggests that waste soil at deposit point have required value of moisture content suitable for plant growth.

Table 1A and 1B. The values of physical and chemical parameters in different sampling points and depths of open waste dumpsite on old Nekede road, Owerri West

Table 1A.

CP	Rep.	Depth	Sand (%)	Silt (%)	Clay (%)	GMC	BD	TP (%)	K-sat	MWD	pH-H_2O	pH-KCl
Dp	1	0-15	76.8	10.4	12.8	23.09	1.38	47.92	12.14	3.098	5.6	4.5
Dp	1	15-30	70.4	14.0	15.6	25.48	1.47	44.52	7.01	4.241	4.7	3.6
Dp	1	30-45	67.4	10.8	21.8	30.12	1.58	40.37	2.33	5.649	4.8	3.6
N	1	0-15	72.0	14.6	13.4	17.02	1.44	45.66	8.53	3.811	5.9	4.8
N	1	15-30	65.2	18.6	16.2	19.12	1.49	43.77	5.03	4.703	5.4	4.3
N	1	30-45	62.4	17.0	20.6	26.71	1.63	38.49	1.88	5.941	5.1	4.0
S	1	0-15	74.2	13.0	12.8	18.34	1.40	47.16	9.44	3.575	5.8	4.9
S	1	15-30	66.8	17.1	16.1	21.04	1.50	43.39	6.12	4.864	5.5	4.5
S	1	30-45	64.3	14.1	21.6	27.98	1.67	63.01	1.25	5.883	5.3	4.1
E	1	0-15	77.2	9.8	13.0	16.84	1.43	46.03	8.94	3.515	5.9	4.8
E	1	15-30	70.2	13.6	16.2	18.64	1.49	43.77	5.13	4.605	5.3	4.4
E	1	30-45	67.6	9.5	22.9	24.72	1.59	40.00	1.08	5.991	5.0	4.0
W	1	0-15	75.0	11.6	13.4	18.63	1.46	44.90	9.03	3.595	6.0	4.9
W	1	15-30	69.4	15.1	15.1	20.12	1.51	43.01	7.01	4.900	5.4	4.3
W	1	30-45	65.2	13.2	21.6	27.18	1.66	37.35	1.52	5.973	5.1	4.1

Table 1B.

CP	Depth	Av.P	N (%)	OC	OM	Ca	Mg	K	Na	EA	CEC	BS	Al	Fe ($mg\ kg^{-1}$)	Zn ($mg\ kg^{-1}$)
Dp	0-15	29.4	0.211	2.38	4.10	18.8	6.4	0.680	0.548	1.29	27.66	95.33	0.24	202.85	147.50
Dp	15-30	22.0	0.178	1.42	2.44	12.4	3.8	0.356	0.306	1.40	18.26	92.33	0.32	164.47	67.22
Dp	30-45	18.5	0.083	1.08	1.86	4.8	1.8	0.164	0.144	1.38	8.28	83.33	0.28	131.33	26.13
N	0-15	25.6	0.188	1.94	3.34	6.8	2.8	0.334	0.294	1.12	11.34	90.12	0.08	68.44	37.14
N	15-30	20.1	0.092	1.02	1.76	4.4	1.2	0.203	0.188	1.28	7.27	82.39	0.18	26.08	14.06
N	30-45	14.9	0.068	0.73	1.26	2.0	0.8	0.108	0.084	1.36	4.35	68.73	0.26	11.11	3.25
S	0-15	24.8	0.184	1.88	3.24	6.4	2.4	0.294	0.203	1.18	10.47	88.72	0.12	58.64	29.60
S	15-30	21.3	0.098	1.12	1.93	4.6	1.0	0.186	0.162	1.36	7.30	81.36	0.26	38.56	18.43
S	30-45	13.6	0.069	0.69	1.19	2.2	0.6	0.093	0.078	1.42	4.39	67.65	0.28	19.12	5.16
E	0-15	26.0	0.193	1.90	3.27	7.2	2.2	0.321	0.288	1.12	11.12	89.92	0.08	65.77	34.45
E	15-30	21.4	0.085	0.96	1.66	4.9	1.4	0.211	0.174	1.38	8.06	82.87	0.24	30.13	21.31
E	30-45	14.3	0.058	0.58	0.99	2.1	1.0	0.113	0.081	1.38	4.67	70.44	0.28	16.18	6.03
W	0-15	25.8	0.180	1.83	3.15	7.0	2.6	0.304	0.290	1.08	11.27	90.41	0.06	61.98	37.17
W	15-30	19.4	0.096	1.09	1.88	4.8	1.8	0.193	0.155	1.24	8.18	84.84	0.18	32.16	20.44
W	30-45	15.2	0.062	0.66	1.14	2.2	0.8	0.082	0.059	1.39	4.52	69.24	0.26	15.99	8.03

CP: Control point, Dp: Deposit point, Depth (cm), GMC: Gravimetric content (%), BD: bulk density ($g\ cm^{-3}$), TP: total porosity, K-sat: Potassium saturated ($cm^3\ h^{-1}$), MWD: mean weight diameters (mm), pH-H_2O (water), pH-KCl (potassium chloride), AV.P: Available phosphorus ($mg\ kg^{-1}$), Ca: Calcium ($C\ mol\ kg^{-1}$), Na: Sodium ($C\ mol^{-1}$), TN: Total nitrogen (%), OC: Organic carbon (%), OM: organic matter (%), BS: Base saturation (%), NP: North point, SP: South point, EP: East point, WP: West point.

K-sat (cm^3) of the waste soil at the deposit point ranged from 12.14 cm^3 and 2.33 cm^3 at a specific depth of 0-15 cm and 30-45 cm respectively, but varies on other locations at a range < 8.53 and >1.52 at the depth of 0-15 cm and 30-45 cm respectively. This indicates that the surface soil of the deposit point has high value than other locations; this raise in concentration maybe due to the nearest of the deposit point to the dump pit. Some crops may yield well due to the content of potassium saturation in the waste soil which is vital for plant growth.

Mean weight diameter (mm) on table 1 indicates that waste soil at the deposit point ranged from 3.098 and 5.649 mm at a specific depth of 0-15 cm and 30-45 cm respectively (mm) of other location at the landfill area. pH-H_2O of the waste soils at the deposit point ranged from 5.6 and 4.8 at a specific depth of 0.65 cm and 30.45 cm respectively but has similar pH content in other location at the landfill area. The result implies that four different location points at the landfill area have high acidic content in them.

pH-KCl of the waste soils at the deposit point ranged from 4.8 and 3.6 at the specific depth of 0-15 cm and 30-45 cm respectively. The result of the deposit point is equivalent to other location where the pH content of KCl is the same.

Available phosphorus (mg kg^{-1}) of the waste soils at the deposit point ranged from 29.4 mg kg^{-1} and 18.5 mg kg^{-1} at a specific depth of 0-15 cm and 30-45 cm respectively. When compared to other values of different location point, it is confirmed that the deposit point of landfill has high content of available phosphorus than other location point. This indicates that deposit waste soils are suitable for plant growth.

Total nitrogen % in the refuse waste soils of deposit ranged from 0.211 and 0.083% at a specific depth of 0-15 cm and 30-45 cm respectively. This shows that the less Nitrogen concentration of these locations may be attributed to have contributed to the poor growth of plants observed in the sites. Organic carbons (%) in soils influence soil chemical and physical processes and it is an important indicator of the soil as a rooting environment. However, organic carbon (%) of the refuse waste soil shows that it is not a requirement for plant growth. Calcium (Ca), magnesium (Mg); and potassium (K) of the refuse waste soil predominates in deposit point of landfill area which indicate that the different five location points have poor macro nutrient to grow and complete life cycle of the plant. In other words, the dumpsite area contributed to the deficiency of fertilizer in the waste soils.

Sodium (Na) and Aluminum (Al) of the refuse waste soils at five different location points in the landfill area shows very little or no content of sodium and Aluminum on the waste soil. The two macronutrients are capable of making the soil become more acidic. This process achieved by aluminum taking hydroxide out of the water and leaving hydrogen ion behind.

The cation exchanges capacity (CEC) of the waste soils at the deposit ranged from 27.66 and 8.28 cmol kg^{-1} at a specific depth of 0-15 cm and 30-45 cm respectively. But varies in other location points at the range of < 4.52 and >11.12 cmol kg^{-1} of depths 0-15 and 30-45 cm respectively. This indicates that the deposit point of the landfill has a higher rate of cation exchange capacity (CEC) than other location points.

The exchangeable acidity (EA) of the waste soils at different five location points of a varied depth beneath the earth crest indicates that there is little or no content of exchangeable acidity. In other words, it is immeasurable to affect the productivity of plants.

The base saturation (%) of the refuse waste soils at the deposit point ranged from 95.33 and 83.33% at a specific depth of 0-15 cm. But have similar base saturation (%) content in other locations points ranged from < 67.65 and $> 92.23\%$ of depths 0-15 cm and 30-45 cm. The respect shows that the diffusing five location point has high content of base saturation in the waste soils. This will enhance the growth and productivity of plant in the dumpsite area.

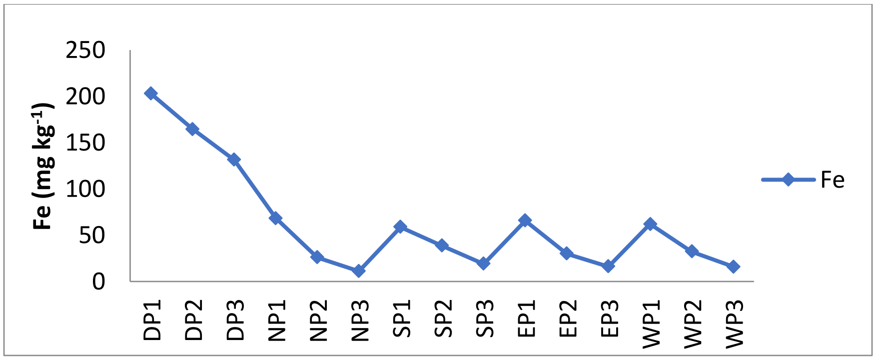
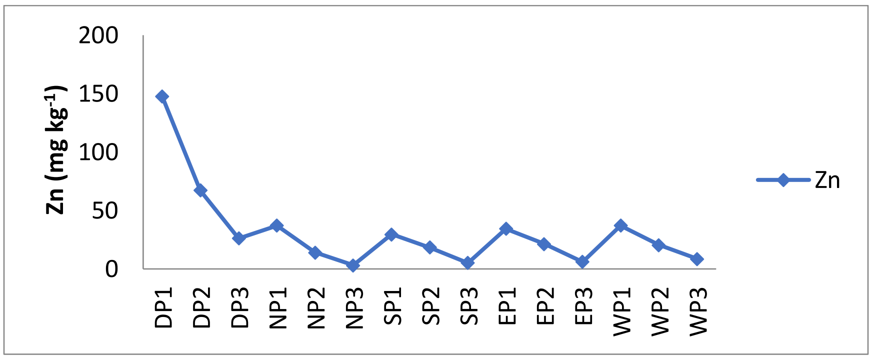


Figure 2. The graphs of locations against iron (Fe) concentrations



DP-deposit point depths1, 2 and 3, NP –north point depths 1, 2, and 3, SP-south point depths1, 2 and 3, EP-east point depths 1, 2, 3, WP- west point 1, 2 and 3.

Figure 3. The graphs of locations against zinc (Zn) concentrations

Tables 3 show the result of some heavy metal concentration in open waste landfill.

Tables 3. The result of some heavy metal concentration in open waste landfill

CP	Depth (cm)	Fe (mg kg^{-1})	Zn (mg kg^{-1})
DP	0-15	202.85	147.50
DP	15-30	164.47	67.22
DP	30-45	131.33	26.13
NP	0-15	68.44	37.14
NP	15-30	26.08	14.06
NP	30-45	11.11	3.25
SP	0-15	58.64	29.60
SP	15-30	38.56	18.43
SP	30-45	19.12	5.16
EP	0-15	65.77	34.45
EP	15-30	30.13	21.31
EP	30-45	16.18	6.03
WP	0-15	61.98	37.17
WP	15-30	32.16	20.44
WP	30-45	15.99	8.03

CP-control point, DP-deposit point, NP-north point, SP-south point, EP-east point, WP-west point, Fe-iron, Zn-zinc

Figure 4A shows iron (Fe) concentration in each location points of the landfill area. Figure 4B shows zinc (Zn) concentration in each location points of the landfill area.

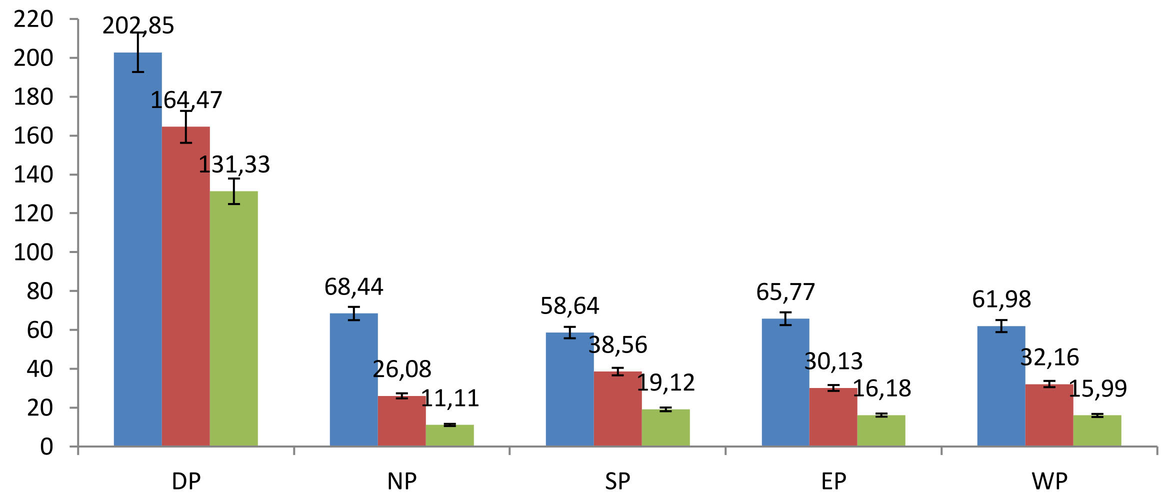
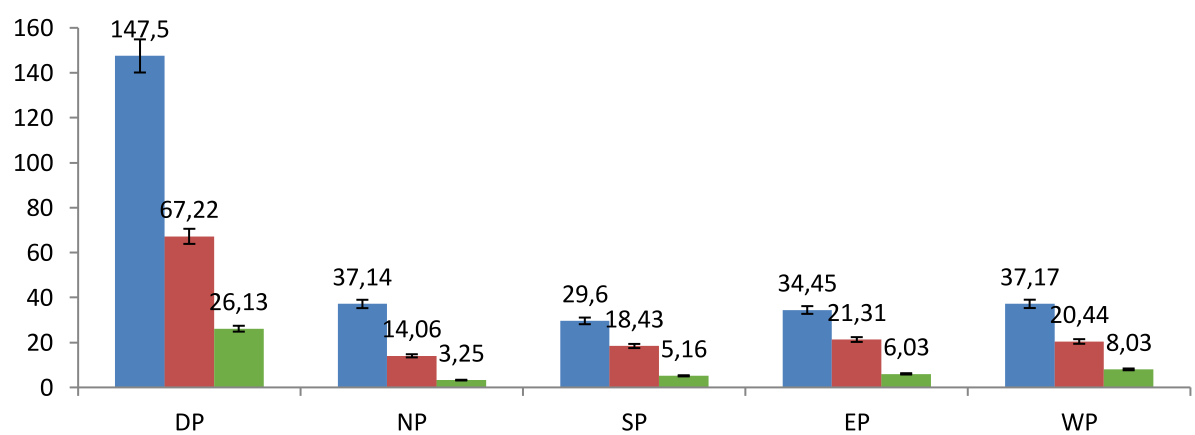


Figure 4A. Iron (Fe) concentration in each location points of the dumpsite area.

The iron (Fe) concentrations in deposit point of depth 0-15, 15-30 and 30-45 cm, ranged from 202.85, 164.47 and 131.33 mg kg^{-1} respectively. This indicates that successive extractions of metal in the deposit point have high level of iron in waste soil which is potentially toxic to plants if not regulated.

The iron (Fe) concentrations in North point of depth 0-15, 15-30 and 30-45 cm ranged from 68.44, 26.08 and 11.11 mg kg^{-1} respectively; South point of depth 0-15, 15-30 and 30-45 cm ranged from 58.64, 38.64 and19.12 mg kg^{-1} respectively; East point of depth 0-15, 15-30 and 30-45 cm ranged from 65.77, 30.13 and 16.18 mg kg^{-1} respectively; West point of depth 0-15, 15-30, 30-45 cm ranged from 61.98, 32.16, and 15.99 mg kg^{-1}. This shows that other control point of waste soils in landfill area have minimum concentration of iron (Fe) content which is suitable or permissible for plant growth.



DP- Deposit point, NP- North point, SP-South point, EP- East point and WP- West point

Figure 4B. Zinc (Zn) concentration in each location points of the landfill area.

Zinc (Zn) concentrations in deposit point of depth 0-15, 15-30 and 30-45 cm ranged from 147.5, 67.22 and 26.13 mg kg^{-1}; North point of depths 0-15, 15-30, 30-45 cm ranged from 37.14, 14.06, 3.25 mg kg^{-1}; South point of depths 0-15, 15-30 and 30-45 cm ranged from 29.6, 18.43 and 5.16 mg kg^{-1}; East point of depths 0-15, 15-30, 30-45 cm ranged from 34.45, 21.31 and 6.03 mg kg^{-1} and West point of depths 0-15, 15-30 and 30-45 cm ranged from 37.17, 20.44, 8.03 mg kg^{-1} respectively. This indicates that results of the successive extractions of zinc in the samples have it contents within the permissible limits of 300 mg kg^{-1} for practice of agriculture. Therefore, waste soils in the landfill locations points have low content of zinc (Zn).

CONCLUSION

This research work focuses on physical and chemical properties of an open waste dumpsite and heavy metal contamination levels in old Nekede road, Imo State. From the result obtained, iron (Fe) had the highest content all through the analysis. The results showed also that activities within the various control points might have been responsible for the increased level of iron (Fe) in the landfill. Results of physical and chemical properties indicated that refuse dumpsite soils to be slightly acidic with moderate moisture content. Total organic carbon/matter and total nitrogen content of the refuse waste soil were moderate with moderate's values of C:N ratio implying that waste soil can be used in some agricultural soil, as it will not pose problem to the crop, USDA (1996). Thus, the overall physical and chemical parameters revealed that the soils were fertile to support plant species diversity, changes and growth such plant includes plantain, banana and cassava. It is therefore appropriate to recommend as follows; that solid waste deposited at the landfill contained materials with high heavy metal content; hence, adequate refuse disposal mechanism should be put in place to reduce the high acidic content. Sorting into biodegradable and non – biodegradable ones before deposition should be keenly encouraged. It is also recommended that proper remediation work should be done on such site found to contain high level of heavy metals before it can be used for the cultivation of edible food crop in order to avoid heavy metal poisoning through bio magnification. Lastly, it will be very important to adhere strictly and comply with regulatory limits in sludge to be released from the villages into the environment.

DECLARATION OF COMPETING INTEREST

The authors hereby declare that they have no conflict of interest whatsoever.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

The authors hereby declare that the contributions given are correct.
Christopher Ikechi Obineche: Literature review and methodology
Donatus. Okwudiri Igbojionu: Review of original draft and data analysis
Isiguzo.Edwin Ahenaku: Reviewing the writing precision in the original draft.

REFERENCES

Adelekan BA and Abegunde KD (2011). Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. *International Journal Physical Science, 6 (5): 1045-1058.*

Adelekan BA and Alawode AO (2011). Contributions of refuse dumps to heavy metal concentrations in soil profile and groundwater in Ibadan, Nigeria. *Journal of Applied Bioscience, 40: 7227-2737.*

Anikwe MAN and Nwobodo KCA (2001). Long term effect of municipal waste disposal on soil properties and productivity of sites used for urban agriculture in Abakaliki, Nigeria. *Bioresources Technology, 83 (3): 241-250.*

APHA (1995). American public health association. Standard methods for the examination of water and wastewater,19th edn APHA-AWWA-WPCF, pp. 525-987

Awomeso JA, Taimo AM, Gbadebo AM and Arimoro AO (2010). Waste disposal and pollution management in urban areas. A workable remedy for the environment in developing countries. *American Journal of Environmental Sciences, 6 (1): 26-32*.

Bacud L,Sioco F, and Majam J (1994). *A descriptive study of the water quality of drinking wells around payatas dumpsite*, Unpublished BSc Thesis, University of Philippines College of Public Health 12-24.

Brady NC (1996). The nature and properties of soils, 11th ed.; *McMillan,* New York. P 621.

FAO (1976). A framework for land Evaluation. FAO Bulletin 32, *FAO/UNESCO*, France.

Helmore K and Ratta A (1995). The surprising yields of urban agriculture, choices. The human development magazines of UNDP 4(1).

Juo ASR (1979). Selected methods for soil and plant analysis. *IITA Manual* No.1.

Ngozi AC Chukwuocha, Ogbenna U, Ogugua C and Emenike N (2016). Erosion sensitivity assessment of communities in Owerri, Nigeria using geographic ınformation system and revised universal soil loss equation-based model. *American Journal of Geographic Information System, 5 (2): 55-67.*

Obineche CI, Emekachris CC, Igbojuonu DO and Obani O (2016). Quality assessment of direct harvested rainwater near Nekede Dumpsite in Owerri West L.G.A. Imo State, Nigeria. *Umudike Journal of Engineering and Technology (UJET) (Under Review)*

Sia S (2008). Assessing the effect of a dumpsite to groundwater quality in Payatas Philippines. *American Journal of Environmental sciences 4 (4): 262-266*.

Udo EJ, Ibia TO, Ogunwale JA, Ano AO and Esu IE (2009). Manuel of plant and water analysis. *Sibon Books Ltd. Lagos*, pp:183.

USEPA (1996). Test methods for evaluating soild waste. Physical/Chemical Methods 3rd Edn, method 3050B, Acid Disgestion of Sediment, Sludges and Soils, USEPA*, Washington DC*, SW-846.

World Health Organization (WHO) (1993). Standard maxima for metals in agricultural soils.