Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

ASSESSMENT OF SOME HEAVY METALS AND PHYSICO-CHEMICAL PROPERTIES OF SOILS WITHIN THE VICINITY OF UNIVERSITY OF PORT HARCOURT TEACHING HOSPITAL MEDICAL DUMPSITE, PORT HARCOURT, RIVERS STATE, NIGERIA.

Osayande A.D*[1]. and Nwokedi A. V.[1]

Department of Geology and Mining Technology, University of Port Harcourt, Choba Rivers state.
**Email: desmond.osayande@uniport.edu.ng; desosayande1@gmail.com*

Received: 18-01-19
Accepted: 15-04-19

ABSTRACT

It is imperative to assess the toxicity of the medical waste on areas prone to contamination in order to ascertain their present level and offer some remediation or preventive measures. Soil samples TS (0-15cm) and SS (15-30cm) were collected from a sample point using hand auger, four samples were collected around the dumpsite in a grid format with a control point, that is about 100m away from the dumpsite and were characterized using standard methods. The results shows that the area was alkaline with pH ranging from 10.48-11.78 for the dumpsite and 10.04-10.83 for the control point., Electrical conductivity (EC) ranges from 58-200 μS/cm, Cation Exchange Capacity (CEC) ranges from 0.30-1.08meq/100g, Total Nitrogen 0.22-1.31mg/kg, Total Phosphorus was low ranging from 0.01-0.1mg/kg, Total organic matter 0.24-0.62%,Total carbon 0.26-0.36% with sand particles ranging from 67-79.4%, silt particles represented 7.8-12.2% and Clay particles with 8.2-22.8%.The mean value results of some of the heavy metals are: Ni 1.46mg/kg, Fe 20.26mg/kg, Pb 1.11mg/kg, Cr 0.14 mg/kg, Cd 0.040mg/kg, Mn 11.24mg/kg, Zn 1.24mg/kg, Cu 1.26mg/kg. These values can be attributed to the nature of medical waste with high percentage of non-biodegradable materials, periodic burning of the waste that have a way of adding potash to the soil, age of the dumpsite and vertical movement of leachates and plume. These values are all far below the maximum tolerable levels set by Food and Agriculture Organization (FAO) and World Health Organization (WHO, 1992) for agricultural soil. The study revealed that the dumpsite and the control area lack adequate soil nutrients, hence low levels of metals should eventually be converted to agricultural farmland.

Keywords: Heavy Metals, Physicochemical Properties, UPTH, Medical Dumpsite.

INTRODUCTION

Recent studies in Nigeria has estimated waste generation to be between 0.562 to 0.670 kg/bed/day and as high as 1.68 kg/bed/day ((*Longe and Williams, 2006).* This shows that developing nations like Nigeria produce large quantity of medical waste which increases the health risks. The problem with developing nation is that they lack proper waste management policies and effective regulatory agencies to curb indiscriminate disposal of medical waste either through open field dumping/bury or open container burning, this makes it easier for leachate from the waste to infiltrate the soil and contaminate the aquifer. Any substance that can infiltrate into the subsurface has the potential to contaminate the soil and aquifer, this means that whenever a given area of land has been exposed to pollutant over a long period of time, chances are that the soil and the subsurface in close proximity to the area is in danger of being polluted which can lead to contamination.

One estimate shows that about 5.2 million people (including 4 million children) die each year from waste related diseases, over the last decades there has been increasing global concern over the public health impacts attributed to pollution, in particular, the global burden of diseases. World Health Organization (WHO, 1992*)* estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to Pollution (Water, Air or Soil). Most of these Pollution related diseases are however not easily detected and may be acquired during childhood and manifest later in adulthood (Bio-accumulation).

"Meeting the needs of the present without compromising the ability of the future generations to meet their own needs is Sustainable development." (*Brundtland Commission 1987),* makes it imperative to carryout Environment impact assessment (EIA) on the effects of the activities of man on the environment.

Waste is a terminology for any material that is discarded after primary use, or is worthless, unusable and defective and of no use at the moment (Awuchi and Igwe, 2017). There are many waste types defined by modern systems of waste management and sources including: Municipal waste, Agricultural waste, Hazardous waste, biomedical waste, special hazardous waste. This research was centred around the effects of medical waste on the environment and public health because most medical facilities such as hospitals, dental clinics, veterinary facilities produces hazardous, radioactive and infectious waste with the potential to transmit diseases, contamination of groundwater and surface water, burning of waste in open container results in release of toxic pollutants(e.g. Dioxin, methane, CO) in the air, bio-accumulation of toxic and carcinogenic waste within soil affects the nutrients of the soil and in turn affects the productivity of that soil . This justifies the need to carryout this work in University of Port Harcourt Teaching Hospital (UPTH) dumpsite. Medical waste is defined as "any solid or liquid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals"(*BAN & HCWH, 1999).*

MATERIAL AND METHODS

Data source

The study area is in University of Port Harcourt Teaching Hospital (UPTH) Choba, a town in Obio/Akpor L.G.A. in Rivers state and is located between latitude 04°54.114'N, and longitude 006°55.681' E are the latitudes and longitudes as shown in the map.

This Teaching hospital has a dump site where all their wastes are dumped untreated and this dumpsite is less than 150m from Medical Student's Hostel and Classroom, and also fifty metres away from the hospital. This makes it a point source of concern. The dumpsite is accessible by road

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

and footpath that is close to the UPTH mortuary, but there is no restrictions to that place which increases the risks of illegal scavengers. A composite soil samples were collected at a depth of 0-15cm and 15-30 cm from the hospital dumpsite using soil (hand) auger. Four different locations, was chosen from the dump site in a grid format. Soil samples of control site were also collected which was one hundred and fifty metres away from the dumpsite. The collected samples were transferred into a black polythene bag, properly labelled and transported to BGI laboratory in Rumuokwurusi, PortHarcourt. The geographical position coordinates of the sampled locations were identified and mapped using global position system (Garmin, GPS).

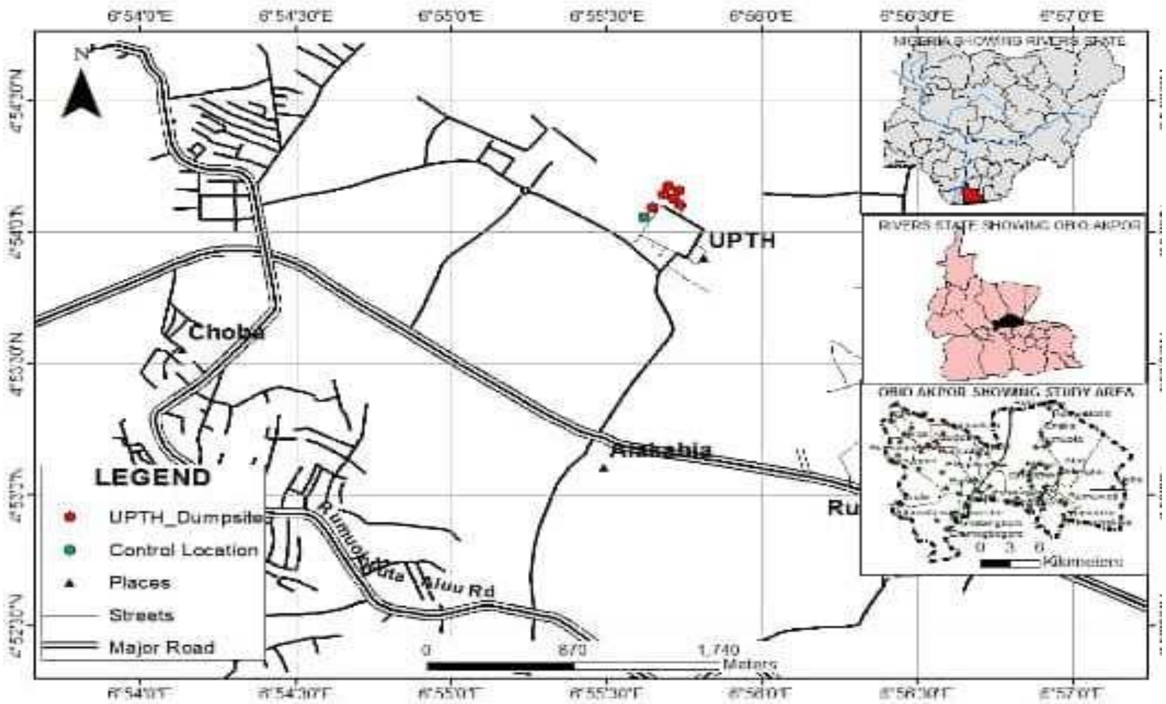

Fig. 1: Map showing the sampling points.

3.0 Results

Table1: Summary of Analytical Techniques Used and the results of the physio-chemical Parameter.

S/N	Parameter	Method	Sample A		Sample C		Sample D		Sample F		Sample G	
			0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	*0-15*	15-30
1	pH	ASTM D 1293	11.78	10.96	11.50	12.20	10.48	11.23	10.60	11.55	10.04	10.83
2	Electrical Conductivity (µS/cm)	APHA-2510-A	200.00	156.00	62.00	58.00	152.00	66.00	93.00	115.00	42.00	23.00
3	Total Nitrogen (mg/kg)	APHA 4500 NO3-	0.25	0.28	1.31	1.06	0.41	0.26	0.22	0.92	0.24	0.25
4	CEC(meq/100g)		1.08	0.98	0.33	0.34	0.32	0.30	0.86	1.09	0.96	0.23
5	Total Phosphorus (mg/kg)	APHA 4500-P	0.04	0.01	0.03	0.05	0.08	0.02	0.04	0.10	0.02	0.01

6	Total Organic Matter (%)	Walkley Blacky	0.48	0.62	0.55	0.45	0.48	0.24	0.52	0.50	0.36	0.41
7	Total Organic Carbon (%)	Walkley Blacky	0.28	0.36	0.32	0.26	0.28	0.14	0.30	0.28	0.18	0.24
8	Ca (mg/kg)	APHA 3111B	127.33	135.02	17.21	0.74	12.12	2.09	105.12	141.75	135.02	0.93
9	Mg (mg/kg)	APHA 3111B	50.72	33.75	26.45	15.12	40.65	28.214	43.65	51.54	27.40	12.58
10	Na (mg/kg)	APHA 3111B	2.04	1.864	1.77	0.886	2.054	2.029	1.754	0.998	2.77	0.541
11	K (mg/kg)	APHA 3111B	8.18	7.48	9.02	4.05	3.34	6.23	8.85	6.04	4.56	5.57
12	Particle Size Distribution (PSD)	Sand (%)	78.80	75.80	73.20	70.20	67.00	79.40	78.40	69.80	70.40	79.60
		Clay (%)	8.20	8.60	16.40	18.60	19.20	22.80	8.80	9.40	20.40	20.00
		Silt (%)	12.20	12.60	7.80	8.20	10.60	10.20	11.80	12.20	9.80	9.60

Table 2: Showing Results of Mean, Standard Deviation SD of the Heavy Metal and the Permissible Limits

S/N	**Ni (mg/kg)**		Fe **(mg/kg)**		Pb **(mg/kg)**		Cr **(mg/kg)**		Cd **(mg/kg)**		Mn **(mg/kg)**		Zn **(mg/kg)**		Cu **(mg/kg)**	
	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
Sample A	1.54	1.04	22.32	22.79	1.14	1.44	0.125	0.224	<0.001	0.064	12.28	8.327	2.208	2.82	1.79	3.15
Sample C	1.35	1.6	19.03	10.91	0.09	0.46	0.14	0.052	<0.001	<0.001	10.781	12.708	0.26	0.13	0.55	0.48
Sample D	1.63	1.75	21.46	25.19	0.032	0.404	0.219	0.177	<0.001	0.019	13.014	10.808	0.75	0.62	0.81	0.54
Sample F	1.41	1.33	18.85	20.98	3.98	1.28	0.03	0.155	0.045	0.023	11.295	10.658	2.024	1.08	1.87	0.89
Mean	1.48	1.43	20.42	19.97	1.31	0.90	0.13	0.15	0.045	0.035	11.84	10.63	1.31	1.16	1.255	1.266
Control	1.41	1.69	10.91	26.77	0.203	0.558	<0.001	0.236	<0.001	<0.001	11.295	13.492	0.042	0.147	0.32	0.52
SD	0.126	0.313	1.741	6.280	1.851	0.540	0.077	0.073	0.00	0.025	0.998	1.794	0.954	1.171	0.673	1.270
NIS mg/L	0.21	0.21	0.30	0.30	0.01	0.01	0.05	0.05	0.003	0.003	0.02	0.02	3.00	3.00	1.00	1.00
BIS mg/l	-	-	0.30	0.30	0.05	0.05	0.05	0.05	0.01	0.01	0.1	0.1	5.00	5.00	0.05	0.05

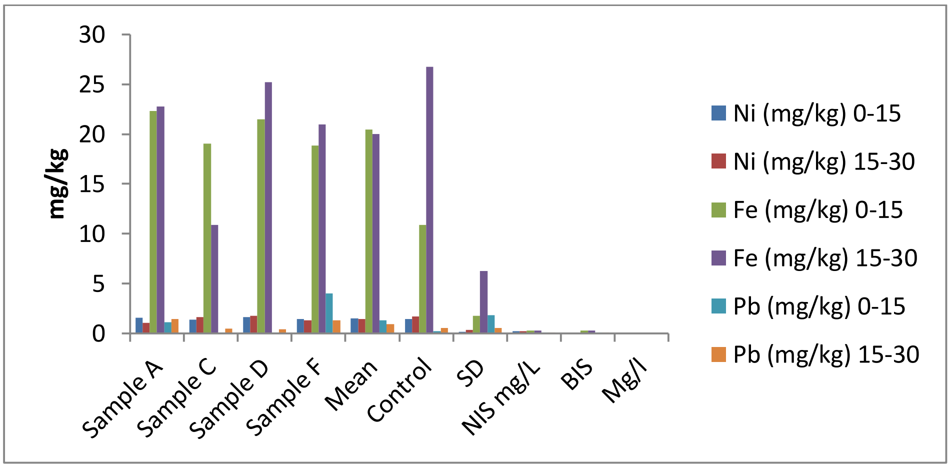

Fig. 2a: Showing Results of Ni, Fe, Pb and the Permissible Limits

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931

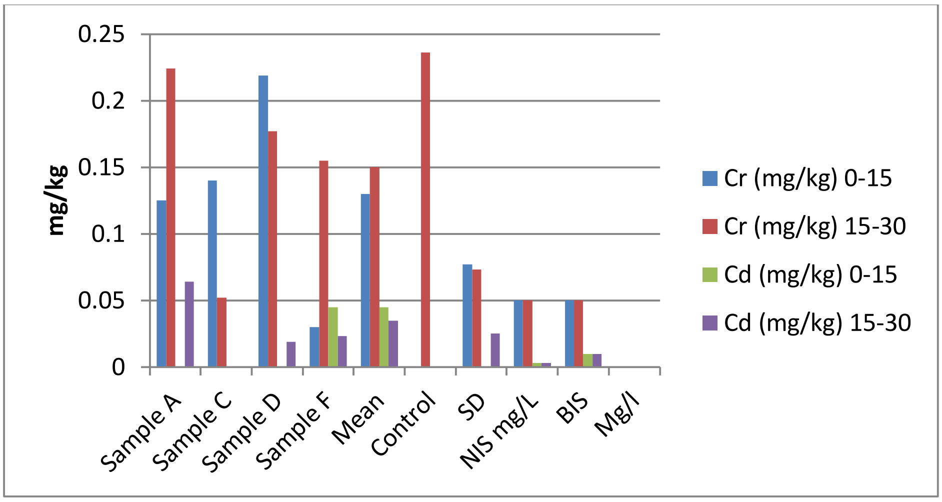

Fig. 2b: Showing Results of Cr, Cd and the Permissible Limits

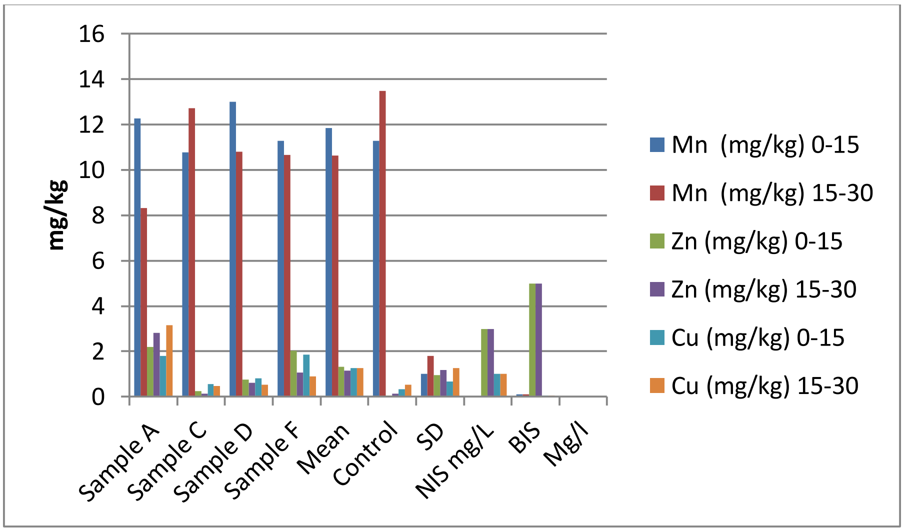

Fig. 2c: Showing Results of Mn, Zn, Cu and the Permissible Limits

DISCUSSION

pH

The pH of the waste soils ranged from 10.48 to 12.2 with dumpsite D and C having the lowest and highest pH values, respectively. The soils were observed to be moderately alkaline with a mean pH value of 11.09 for the topsoil (0-15cm) and 11.25 for the subsoil depth at the various locations of the waste dumpsites including the control site (10.04-10.83), this suggests that the dumpsites and the base ground were mostly alkaline in nature. This was contrary to the reports of most authors that the pH of dumpsites and Niger delta soils are usually acidic in nature. But similar alkaline results were reported for dumpsites by other researchers (Uba *et al*., 2008; Elaigwu *et al*., 2007; Gupta and Sinha, 2006, Obasi *et al*, 2012). The degree of acidity or alkalinity is considered a master variable that affects nearly all soil properties; chemical, physical and biological while some organisms are unaffected by a rather broad range of pH values, others may exhibit considerable intolerance to even minor variations in pH. pH affects the mobility of heavy metals in soil, It has been found that soil pH is correlated with the availability of nutrients to the plant (Gray *et al.,* 1998). Consequently, as pH decreases, the solubility of metallic elements in the soil increases and they become more readily available to plants and vice versa (Oliver *et al.,* 1998; Salam and Helmke, 1998), therefore higher pH value would not favour availability, mobility and redistribution of the heavy metals (Oviasogie and Ndiokwere, 2008).The pH of the Hospital dumpsite was found to be more alkaline than that obtained from the control soils which has 10.04 and 10.83 for top soil (0-15 cm) and sub soil (15-30) which may be as a result of the nature of medical waste such as non-biodegradable waste (usually plastics, bottles, string) and the burning of the waste periodically, this might be a way of introducing potash to the soil which in turn increases the alkalinity of the soil at the dumpsite. The alkalinity of the soil in the studied site increased with depth expect for sample A which is at the mouth of the dumpsite, however, these values are not within WHO (1992) permissible limit (6.5 - 8.5).

Electrical Conductivity EC

Soil electrical conductivity (EC) is a measure of the amount of salts in soil (salinity of soil).

Electrical conductivity values ranged from 62-200 μScm-1 for hospital dump sites and 23-42 μScm-1 for the control site. The EC values for the hospital dump sites were found to decrease from top soil to sub soil expect for sample F. However the EC value in the control site was very low when compared to the hospital dump sites. This could be as a result of the waste (needles, scalpels, broken thermometers and blood pressure gauges) present on the top soils which contributed to high EC values. Electrical conductivity is an important indicator of soil health. It affects crop yields, crop suitability, plant nutrient availability, and activity of soil microorganisms which influence key soil processes including the emission of greenhouse gases such as nitrogen oxides, methane, and carbon dioxide, Excess salts hinder plant growth by affecting the soil water balance, but the values all fell within WHO (1992) permissible limit.

Cation Exchange Capacity CEC

The Cation Exchanges Capacity (CEC) is a measure of the negative sign of the soil colloid in which the positive charge cation act on. The cation exchange capacity (CEC) is a direct contribution from the clay and organic matter contents of soil. Soil CEC is also known as a good indicator for evaluating soil fertility. The CEC is the number of moles of positive charge adsorbed per unit mass. In this study, the CEC values were low with a range of 0.3-1.09 meq/100g, with dumpsite D and F having the lowest and highest exchangeable cations respectively. The low values were attributed to high sandy nature of the soil, a soil low in CEC content but high in sand is susceptible to high leaching because the retention power of heavy metals and other pollutant in its soil is low, CEC gives the soil a buffering capacity which may slow down the leaching of nutrient cations and positively charged pollutants because they affect both soluble and exchangeable metal levels (Yoo and James, 2002).

Organic Carbon and Soil Organic Matter

The presence of organic carbon increases the cation exchange capacity of the soil which retains nutrients assimilated by

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

plants. Total organic carbon in the soils under investigation in this study was low and ranging from 0.14% to 0.36% as indicated in Table 1. The low amount of organic carbon of the refuse dump soils is suggestive of presence of non-degradable waste (Munoz et al., 1994) or the level of exposure (Age of the dumpsite).

Soil organic matter enhances the usefulness of soils for agricultural purposes. It supplies essential nutrients and has unexcelled capacity to hold water and absorb cations. It also functions as a source of food for soil microbes and thereby helps enhance and control their activities (Brady, 1996). The organic matter in the soil samples varied from 0.24% to 0.62%. The dump soils contain low amount of organic matter, which may be responsible for increase in the soil pH as compared to other dumpsite (Oyedele & Oyedele (2017), Nwakal, et al (2017)). While soil organic carbon is not a requirement for plant growth, the levels of organic matter in soils influence a number of soil chemical and physical processes, and it is an important indicator of the soil as a rooting environment and indicates some microbial activities in the dumpsite soil. (Okalebo et al., 1993).

Total Nitrogen Content

The total Nitrogen content of dump soils ranged between 0.22 and 1.31mg/kg which is slightly higher than those of the control site which varied between 0.24 and 0.25mg/kg. The implication of these is that the soils are poor in macro-nutrients and therefore an indication of good yield potential with any input of fertilizers especially NPK Fertilizer.

Available Phosphorous

The dumpsite had low levels of Phosphorus ranging from 0.01 to 0.1mg/kg as compared to the control which varied between 0.01 and 0.02 mg/kg; this could be attributed to the presence of low amount of organic matter and plants decomposition (Ideriah et al., 2006). The low concentration of phosphorous contributes to poor growth of plants as was observed. All the soil samples had available P values less than 10 mg/kg considered suitable for crop production (FAO, 1976), therefore the soil is not fertile for agriculture.

Particle Size Distribution PSD

Texture is related to certain physical properties of soil such as plasticity, permeability, ease of tillage, fertility, water holding capacity and overall soil productivity. For instance, for irrigation purposes, loamy and clay textures are classed as soils of high moisture holding capacity while loamy sands and sands have low moisture holding capacity (Brady, 1996).

From the textural analysis, the Hospital site and control soils have low clay and silt content and a high sand fraction (67-79.6 %). The silt and clay fractions ranged from 7.8-12.6% and 8.2- 22.8% respectively. In general, all soil examined contained less than 23% clay. The soil texture plays an important role in mobility of metals in soil. Texture reflects the particle size distribution of the soil and thus the content of fine particles like oxides and clay. These compounds are important adsorption media for heavy metals in soils. The clay soil retains high amount of metals when compared to sandy soil. Thus it is predictable that the dump site soil and the control site under investigation are susceptible to leaching. These results indicate that hospital waste will have a significant effect on all the soil properties. According to Nyles and Ray (1999), soils with separate high sand and low clay content have high pollutant leaching potentials. Though the soils of the dumpsites predominantly contain high sand fractions (>70.0%) that allows high permeability of water and leachates, clayey texture of soils favours low permeability of water and leachates (Ahn, 1993).

Heavy metal Concentrations

The evaluation of dumpsite soils for the concentration levels of toxic elements is essential for healthy crop production, thus this study has endeavoured to determine the levels of Pb, Cr, Fe, Cu, Mn, Zn, Ni and Cd in the various soil samples. Heavy metals are elements having some atomic weight between 63.54 and 200.59, and a specific gravity greater than 4.0 (Kennish, 2002). Although trace amount of some heavy metals are required by living organisms, any excess amount of these metals can be detrimental to organisms (Berti and Jacobs, 1996). The solubility of the metals in soils is predominantly controlled by pH (Baker and Walker, 1990; McNeil and Waring, 1992; Henry, 2000),

Lead (Pb)

The Lead concentration from the hospital dumpsite were significantly higher than the levels observed in the control sites especially those sample point at the mouth of the dumpsite when compared to those in soils at 100m away (control site) from the dumpsite. This could be attributed to the availability of metals containing wastes at dumpsite (especially hospital dumpsite) which eventually leached into the underlying soils. This is in agreement with the present study because when a substance that contains lead is burn, the ashes will still be rich in lead.

Pb is toxic to plant when present in the soil at concentrations above tolerance level. From the results obtained, the concentration of lead at dumpsite ranged from 0.03mg/kg for hospital dump site and the control site has 0.203 mg/kg for Topsoil and 0.553mg/kg for Subsoil. Lead is an uncommon element but highly toxic even at low concentrations, the values of lead in the dumpsite exceed the permissible limit of NIS 2007. Since lead is a cumulative pollutant, the pollution of soil by lead remains a very serious problem that should be given much attention by environmental chemists in collaboration with government agencies.

Iron (Fe)

From this study, iron concentration in the hospital dumpsite varied between 18.85-25.19mg/kg. The control soil has a concentration of 10.91 mg/kg for Topsoil and 26.77mg/kg for Subsoil. Studies carried out by previous authors, suggested that any pollution of the environment by iron cannot be conclusively linked to waste materials alone but other natural sources of iron must be taken into consideration. Despite the fact that iron is a micro nutrient, it should be properly monitored to maintain its concentration in the accepted range to avoid health defects caused by the deficiency or excess amount of it. Iron is vital for all life on earth and abundant in the earth’s crust but due to its low solubility the concentration in aquatic environment is naturally low. Notwithstanding the essential nature of iron at high concentrations it may

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

result in negative effects to life in aquatic and terrestrial environments including human. However, the mean obtained is lower than 0.30 mg/l recommended for soil in Nigeria by NIS and BIS. Thus, consumption of vegetable from around the dumpsite may not cause iron toxicity and its attendant's effects on the consumers.

Chromium (Cr)

The mean concentrations of Cr in the dump soil varied between 0.030 -0.224 mg/kg, which was slightly higher, as compared to the control site (0.001-0.236 mg/kg), the values of the chromium are within the permissible limits set by NIS 2007(0.05mg/L) Sources of Cr in the soils could be due to waste consisting of lead-chromium batteries, coloured polythene bags, discarded plastic materials and empty paint containers (Jung et al., 2006).

Cadmium (Cd)

Cadmium is a known toxic element even at a low concentration and can interfere with the necessary functions of the essential elements in living cells. Cadmium levels in all the soil samples varies from trace amounts 0.001 to0.064 and these values are far lower than the natural limits of 0.01-3.0 mg/kg in soil as given by MAFF (1992) and EC (1986). It was also observed that the value of cadmium was more in the subsoil and in trace amount in the control site, this showed that the increase in the amount of cadmium in the dumpsite is subjective to the nature of waste in the dumpsite. The values of the metal concentrations obtained for both sites are all far below the maximum tolerable levels proposed for agricultural soil. This is in agreement with the findings of Asawalam and Eke (2006) and Njoku and Ayoka (2007) who investigated the trace metal concentrations and heavy metal pollutants from dump soils in Owerri, Nigeria.

Zinc (Zn)

Zinc is required for normal growth of plants and animals; in human it is vital for enzymatic and reproductive activities. Nevertheless, high concentration of zinc in human can cause negative health implications. The concentration of zinc in hospital dumpsite was obtained to range from 0.13-2.82mg/kg with a mean concentration of 0.13mg/kg for Topsoil and 1.16mg/kg for subsoil, The mean zinc concentration is also lesser than 5.00 mg/l stipulated for soil in Nigeria by NIS. The high zinc concentration reported in Sample A may be attributed to the impact of medical waste. Consumption of zinc might result in nausea, vomiting, dizziness, fatigue, fever and diarrhoea. It may also have negative impact on the micro-organisms and along the food chain as reported by Fort *et al*.(1989) and Robinette(1990).

Copper (Cu)

Copper is required for proper growth by flora and fauna, it is also involved in normal human metabolic activities. However, at high concentrations copper can affect life negatively in both aquatic and terrestrial ecosystems including human. A mean concentration of 1.255mg/kg for topsoil and 1.266 for subsoil was recorded for copper in the dumpsite.The high copper concentrations in cannot be solely attributed to the medical waste alone because of the high baseline value of copper from the control point. The obtained mean is lower than the Nigerian standard for copper in soil (0.05mg/l) by NIS. The concentrations of this metal in the studied samples were also below the toxic limit of 250 mg kg-1 set by USEPA (1986) for agricultural lands. Both the dumpsite and control site concentration of copper within the study area falls below the DPR intervention value. World Health Organization stated that, the injection of copper can lead to severe muscular irritation, nausea, vomiting, diarrhea, intestinal cramps, severe gastrointestinal irritation, and other dangerous health defects.

Nickel (Ni)

The essentiality and toxicity of nickel for human, plants and animals has been reported by many Environmentalists. However, at concentration a little higher than what is required for proper functioning of living cells it can be highly poisonous. This study area recorded values ranging from 1.04 to 1.75mg/kg with a mean nickel concentration of 1.48mg/kg. This mean obtained is also below the permissible limit of 0.2 mg/l for soil in Nigeria by NIS (2007). But unchecked accumulation of Nickel in the soil can cause behavioural changes such as surfacing, rapid mouth and opercula movements, convulsions and eventually death of organism.

Manganese (Mn)

Manganese in this study has a range of 8.327-13.014 mg/kg for hospital dump site. The control site has a value of 11.29 and 13.49 mg/kg for top soil and sub soil respectively. In general the topsoil has higher concentration of these metals than the subsoil with the exception of the control point. From the study area there was high concentration of manganese, this metal can be gotten from the waste products of dry cell batteries, glass and ceramic, paints, fertilizers and fireworks etc. it is required by plant in trace amount, this calls for remediation of the soil around the dumpsite.

CONCLUSION

The anthropogenic influence of medical waste has been assessed and results obtained confirmed that dumping of medical waste within the area may have contributed significant amount of these metals to the host environment. The mean concentration of the metals, Pb, Ni, Cu, Cr, Cd, and Zn are all far below the maximum tolerable levels set by NIS and FEPA except for Fe, Mn. The results of this study have clearly demonstrated that the low levels of heavy metals is present in the studied area. The low concentration of physico-chemical and heavy metals in the dumpsite could be attributed to the following:

The nature of the waste; Research has proved that most medical waste consist of about 70% non-biodegradable materials ranging from plastic to paper to polythene material, all these materials requires decades before they will decompose unlike Municipal wastes. The periodic Burning; Burning of materials produces ashes which are usually rich in Potash, this has a way of increasing the pH of the soil thereby reducing the solubility, mobility, occurrence, distribution of heavy metals and other parameters in the dumpsite.

The level of Exposure; This is a very important factor that influences the occurrence of contaminants in an environment. The longer the exposure, the more the impacts of the contamination. This dumpsite is less than 10 years old, this period is small for contamination to occur considering the nature of the wastes and other factors aforementioned.

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

The results also show that the soil is not polluted by various pollutants and not harmful for recreational but lack adequate nutrient for agricultural purposes.

However, constant monitoring of activities in these sites will go a long way in preventing bioaccumulation of these heavy metals in environment, therefore, the only remediation technologies are by destruction or transformation of the contaminant or by immobilization to reduce the bioavailability and separation of the contaminant from the bulk soil using the in-situ technique (Ghosh and Singh, 2005). This method is cost effective and can reduce impact on the ecosystem. This technique involves importing clean soil and mixing with the contaminated soil, thereby immobilizing the inorganic contaminants in the soil. This can be achieved by complexing the contaminants, or through decreasing the soil pH (pH adjustment). Increased pH decreases the solubility of heavy metals in soils. Other physicochemical techniques for soil remediation can render the land useless for plant growth as they remove all biological activities, including useful microbes such as nitrogen fixing bacteria, mycorrhiza, fungi as well as fauna in the process of decontamination (Burns *et al.*, 1996).

REFERENCES

Abah, S.O., and Ohimain, E.I. (2011). Healthcare waste management in Nigeria: A case study. *J. Public Health Epidemiol.;3(3):99–110.*

Ahn P.M,(1993).Tropical Soils and Fertilizer Use. *Longman Scientific Technical, UK*

Akter N, Acott R.E, Chowdhury SA. (1998). Medical hospital waste disposal at BRAC health centres: An environmental study. *BRAC Research, Research and Evaluation Division,* 75 Mohakhali C/A, Dhaka 1212.

Amos-Tautua, Bamidele Martin et al (2013). Assessment of some heavy metals and physicochemical properties in surface soils of municipal open waste dumpsite in Yenagoa, Nigeria. *African Journal of Environmental Science and Technology*. *Vol. 8(1), pp. 41-47.*

Anegbe B, Okuo JM. Okieimen FE. (2017**).** Characterization and remediation of soil co-contaminated by heavy metals and petroleum hydrocarbons. *Mostvirtue Benin City,* Edo State, Nigeria. Pp 177**.**

Asawalam, D.O and Eke C.I (2006). Trace metal concentration in soils used for waste disposal around Owerri, Nigeria. *In: Proceedings of the 40th Conference of the Agriculture Society of Nigeria, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.* pp427-430.

Awuchi, C.G and Igwe V.S (2017) *International Journal of Advanced Academic Research, Science, Technology and Engineering* **Vol 3(1) 26:42**

Baker, A. J. M and Walker, P L (1990). Heavy metal tolerance in Plants: Evolutionary Aspects. (ed Shaw AJ). *Boca Raton:* CRC Press 155-177.

BAN and HCWH. (1999). Medical hospital waste in developing countries. An analysis with a case study of India, and a critique of the Basel –TWG guidelines. *Basel Action Network*

(BAN) secretariat, Asia Pacific Environmental Exchange, 1827 39th Ave. E., Seattle, WA., 98112 USA..

Berti, W.R and Jacobs, L.W.P (1996). Chemistry and phytotoxicity of soil trace elements from repeated sewage sludge application. *J. Environ. Qual*.25:1025-1032

Brady N.C (1996). The Nature and Properties of Soils, 11th ed.; *Mcmillan:New York*. P 621

Brundtland G.H (1987). Our Common Future: World Commission on Environment and Development. *Oxford, UK: Oxford University Press*.

Burns, R.G, Rogers,S. And McGhee, I., (1996). Contaminants and the Soil Environment in the Australia Pacific Region (ed Naidu, R, Kookana RS, Oliver, D.P, Rogers, S, McLaughin MJ), - *Kluwern Academic Publishers, London*.361-410

Chioma C.O., Ogechukwu N.M., Bright C.O., Simon C.O., Agaptus U.O., Linda U.N., Faraday N., (2014). Impact of Disposal of Hospital Waste into Nworie River in Imo State Nigeria. *International Journal of Environmental Monitoring and Protection.* Vol. 1, No. 1, 2014, pp. 7-11.

Chukwu U.J and Anuchi S.O. (2016). Impact of Abattoir Wastes on the Physicochemical Properties of Soils wi muthin Port Harcourt Metropolis.*The International Journal Of Engineering And Science* (IJES) || Volume 5 || Issue || 6 || Pages || PP -17-21 || 2016 || ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805 www.theijes.com The IJES Page 17

David N.O., Benjamin L.K, Patrick O.Y., (2009). Some physico-chemical and Heavy metal levels in soils of waste dumpsites in Port Harcourt Municipality and Environs. *J. Appl. Sci. Environ. Manage.* Vol. 13(4) 65 – 70

EC (council of the European Communities) (1986). *Directive 86278 EEC on the protection of the Environment and in Particular of the Soil when Sewage Sludges is used EEC.Brussels.*

Elaigwu, S.E, Ajibola, V.O and Folaranmi, F.M (2007).*Studies on the impacts of municipal wastes dumps on the surrounding soil and quality of two cities in Northern Nigeria. J. Applied Sci.,7(3), 421-425.*

Etu-Efeofor, J. O. and Akpokodje, E. G. (1990). *Aquifer systems of the Niger Delta.*

Etu-Efeotor, J. O. (1981). Preliminary hydrogeochemical investigation of subsurface water in parts of the Niger Delta. *Jour. Min. Geol. 18(1):103 – 105*

FAO (1976). A frame work for Land Evaluation. *FAO Bulletin 32, FAO/UNESCO, France.*

Fort, D.J., James, B.L and Bantle, J.A. (1989). Evaluation of the developmental toxicity of five compounds with the frog embryo tetratogenesis assay, Xenopus (FETAX) and a metabolic activation systems. *Journal of Applied Toxicology,9:377-388.*

Godwin A.E., Helen S.E., (2017) Impact of Anthropogenic Activities on Metal Load of Sagbama River, Niger Delta Region of Nigeria**.** *Chemistry Research Journal*, 2(2):96-103. http: www.chemrj.org

Gray, C.W. McLaren, R.G, Roberts A.H and Condron L.M (1998). Sorption and

Scientia Africana, Vol. 18 (No. 3), December, 2019. Pp 61-74
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

desorption of Cadmium from some New Zealand soils: Effect of pH and contact time. *Aust. J. Soil Res*.36:199-216.

International Research Journal of Engineering Science, Technology and Innovation (IRJESTI) Vol. 1(5) pp. 130-141, August 2012. http://www.interesjournals.org/IRJESTI

Ghosh, M., Singh, S.P., (2005). A review of phytoremediation of heavy metals and utilisation of its by products. Applied Ecology and Environmental Research 3(1):1-18

Henry, J.R (2000). An Overview of phytoremediation of Lead and Mercury-NNEMS Report, Washington, D.C.3-9.

Jibrin Gambo et al., (2018). Assessing the impacts of improper medical waste disposal and resident's perception of their disposal practices in Hadejia Metropolis, Jigawa state, Nigeria. *Nigerian Research Journal of Chemical Sciences*, *Vol. 4, 2018*

Kennish,M.J. (2002). Environmental threats and environmental future of estuaries. Environmental Conservation, *Journal of Mining Geology*, *26(2):279 – 284.*

Kogbe, C.A. 1989. Geology of Nigeria, *2nd Edition*, *Rock View (Nigeria) Ltd*, *pp 59.*

Longe, E.O. and Williams A. (2006). *A preliminary study of medical waste management in Lagos metropolis, Nigeria. A project submitted to the Department of Civil and Environmental Engineering, University of Lagos, Lagos State, Nigeria.*

McNeil, K.R and Warring S., (1992). Contaminated Land Treatment Technologies(ed ReesJ.F.). *Society of Chemical Industry. Elsvier Applied Sciences, London.*143-159.

Nnaji, Mercy (2017). Environmental impact of groundwater contamination by heavy metals from the burrow pit. *An undergraduate thesis submitted to Geology and mining technology department, Uniport (Unpublished*).

NIS. (2007). Nigerian Industrial Standard NIS 554:2007,Nigerian Standard for drinking water Approved by Standard Organisation of Nigeria(SON),ICS13.060.20,1-30

Obasi, N.A., Akubugwo, E.I., Ugbogu O.C., and Glory O., (2012). Assessment of Physico-chemical Properties and Heavy Metals Bioavailability in Dumpsites along Enugu-port Harcourt Expressways, South-east, Nigeria. *Asian Journal of Applied Sciences*, 5: 342-356. https://scialert.net/abstract/?doi=ajaps.2012.342.356

Oliver, D.P, Tiller K.G ,Alston A.M, Cozens GD and Merry R.H(1998). Effect of soil pH and applied cadmium on cadmium concentration in wheat grain. *Aust. J. Soil Res.*36:571-583

Oyedele, O.A. & Oyedele, A.O. (2017). Impacts of Waste Dumps on the Health of Neighbours: A Case Study of Olusosun Waste Dump , Ojota , Lagos State, Nigeria, *Journal of Civil, Construction and Environmental Engineering*, 2 (1), 27–33.

Nwaka1, P. O., Anegbe B., Adeniyi, O., Okunzuwa I.G. and Jideonwu A., (2017). Impact of Leachate on Physio-chemical Properties of Soil, Within the

Vicinity of Oghara Medical Dumpsite, Delta State Nigeria. *Physical Science International Journal. pp 17(1): 1-14, 2018*; Article no.PSIJ.37470

Reyment, R.A.C., 1965. Aspects of the Geology of Nigeria. *University of Ibadan Press Nigeria. pp* 145.

Robinette,C.L.(1990). Zinc, Veterinary Clinics of North America Small Animal Practice,*20:539-544*

Salam A.K and Helmke P.A (1998). The pH dependence of free ionic activities and total dissolved concentrations of copper and cadmium in soil solution. *Geoderma* 83;281-291

Short, K.C. and Stauble, A.J., (1967). Outline of Geology of Niger Delta Association Petroleum Geologists Bulletins 51, pp.761-779 Southern Nigeria.

Sunday I.E., (2013).Waste Disposal Problems and Management in Ughelli, Nigeria. *Journal of Environmental Protection*. pp 4-11.

Uba S., Uzairu A., Harrison G.F.S, Balarabe M.L. and Okunola O.J., (2008). Assessment of heavy metals bioavailability in dumpsites of Zaria metropolis, Nigeria. *African Journal of Biotechnology*. Vol 7 pp122-130

Ukpaka, C. P. and Pele A.(2012) Elemental analysis of soil characteristics due to municipal solid waste in Port Harcourt City.

U.S Environmental Protection Agency (USEPA).(1986).Health assessment document for nickel and nickel compounds.EPA Report 600/8-83/012FF.460

WHO (2002). Wastes from healthcare activities. *Fact sheet no 231, April 2002*.

World Bank. Environmental assessment sourcebook. Sectorial guidelines. *World Bank Technical Paper. Environmental Department, The World Bank*. Washington, DC. Appia 20, CH-1211 Geneva 27, Switzerland. 1991;2:140

World Health Organization (WHO) (1992). Managing Medical Waste in Developing countries. Report of a consultant on medical waste management in developing Countries, Geneva. Available at http://whqlibdoc.who.int/hq/1994/