Assessment of the Impact of Waste Dumpsite on Soil Quality in Nekede, Imo State, Nigeria

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DOI: 10.56201/ijgem.v10.no8.2024.pg53.64

Abstract

This research was carried out to assess the physicochemical properties of the soil and concentration of heavy metals (lead, copper, zinc and nitrate) in waste dumpsite Ihiagwa Imo State, Nigeria. In other to assess the physicochemical properties of the soil in the study area , soil samples were collected from three (3) points labeled Point 1, Point 2 and Point 3(Control point) with depth ranging from 0-15 (top soil), 15-30 (Sub-soil), and 30-45 (Bottom). The physicochemical parameters and heavy metal results shows that the pH ranges from 5.756(sub soil) to 6.009 (top soil) at Point 1, from 5.722(sub soil) to 5.976(top soil) at Point 2, from 5.137(sub soil) to 6.147(bottom) at Point 3. The electrical Conductivity ranged from 80.50µs/cm (top soil) to 162.9µs/cm (bottom) at point 1, from 52µs/cm (top soil) to 90.1µs/cm(sub soil) at point 2, from 58.4µs/cm(sub soil) to 95.9µs/cm (bottom) at point 3. The bulk density ranged from 1.396g/cm3(top soil) to 1.462g/cm3 (bottom) at point 1, from 1.375g/cm3 (top soil) to 1.459g/cm3 (bottom) at point 2, from 1.399g/cm3 (top soil) to 1.511 (bottom) at point 3. Copper (Cu) ranged from 0.148Mg/100g (top soil) to 0.928Mg/100g (bottom) at point 1, from 0.232Mg/100g (top soil) at point 2, from 0.092Mg/100g (bottom) to 0.489Mg/100g (top soil) at point 3. Zinc (Zn) ranged from 0.12Mg/100g (bottom) to 0.21Mg/100g (sub soil) at point 1, from 0.098Mg/100g (top/sub soil) to 0.217Mg/100g (bottom) at point 2, from 0.026Mg/100g (bottom) to 0.188Mg/100g (top soil) at point 3. Lead (Pb) ranged from 0.138Mg/100g (top soil) to 1.026Mg/100g (bottom) at point 1, from 0.282Mg/100g (top soil) to 0.547Mg/100g (sub soil) at point 2, from 0.084Mg/100g (bottom) to 0.442Mg/100g (top soil) at point 3. Nitrate (NO_3) ranged from 3.336Mg/Kg (bottom) to 4.87Mg/Kg (top soil) at point 1, from 3.82Mg/Kg (bottom) to 4.687Mg/Kg (top soil) at point 2, from 3.838Mg/Kg (bottom) to 5.202Mg/Kg (top soil) at point 3.The range and the mean value of the results from the three soil samples (point 1,2 and 3) were compared with the World Health Organization (WHO) Standard the pH level of the sample shows a deviation of WHO Standard, tilting towards the acidic region of the scale, the Electrical Conductivity of all samples fell above the WHO permissible limit. Nitrate level all fell below the permissible WHO limit except for P3 (top soil) which slightly falls above the permissible limit. Copper (Cu) level all fell within the WHO standard. Zinc (Zn) value all fell below the permissible WHO standard. Lead (Pb) level fells above the permissible WHO standard. The bulk density of the dump site falls within the permissible WHO standards. The statistics of soil quality in the study area shows that conductivity has the highest value of standard error of 26.36481241, 11.0021715 and 11.54647613 for each point 1, 2 and 3 respectively. Also, zinc has the least value of Standard deviation of 0.044094595, 0.068704682, and 0.081663946 respectively.

Keywords: *Physicochemical, Heavy metal, Electric Conductivity, Soil samples, Standard Error, Standard deviation*

1.0. INTRODUCTION

Challenges associated with improper waste management and disposal 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).Soil contamination through waste discharge, particularly hazardous waste, is a worldwide phenomenon and carries different metals which are then transferred to plants by different ways (Akinbile and Yusoff, 2012).The contamination of soil by heavy metal can cause adverse effects of human health, animals and productivity (Smith *et al*; 1996) 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 Cu, N, Pb, and Zn can alter the soil chemistry and have an impact on the organism and plants depending on the soil for nutrition (Voutsa *et al*; 1996).

Here in Nigeria, open dumpsites are common practice due to the low budget for waste disposal and lack of political will. A good number of wastes are dumped in this region and this poses an adverse effect to soil.

Solid waste pollutants serve as an external force affecting the physicochemical characteristics of ultimately contributing towards the poor production of vegetation (Christensen *et al*; 2014).

Ihiagwa 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 this area. Little efforts have been made in order to improve the waste collection and disposal facilities. The present study therefore is conducted to determine the effect of the refuse dumpsite on a predominantly productive agricultural soil quality In Ihiagwa road dumpsite Imo State, Nigeria.

2.0. STUDY AREA

Ihiagwa is situated in Owerri, Imo, Nigeria, its geographical coordinates are 5^{o} 26’19’’North, 7^{o} 1’23’’ East. Ihiagwa is a town in southeastern Nigeria. It falls within the rainforest zone of average rainfall of 2290mm per annum. The Ihiagwa people are members of the Igbo ethnic group in the southeastern Nigeria. They number about ten thousand (10,000) and easily identified among the Oratta people of Owerri.

The Federal University of Technology Owerri (FUTO) is located in Ihiagwa. The surrounding Towns/Villages to Ihiagwa are Nekede, Eziobodo, Obinze, Naze and Obibiezena. The Otamiri River passes through the Town. However, the increase of the local population mainly from the project of the University project has resulted in the increase in solid waste generation. It is estimated that a total quantity of 12.9 tonnes of solid waste are generated daily in this area. Waste on this site comprises of food remains (fruits, vegetables), rags, papers, metals and plastics, e.t.c

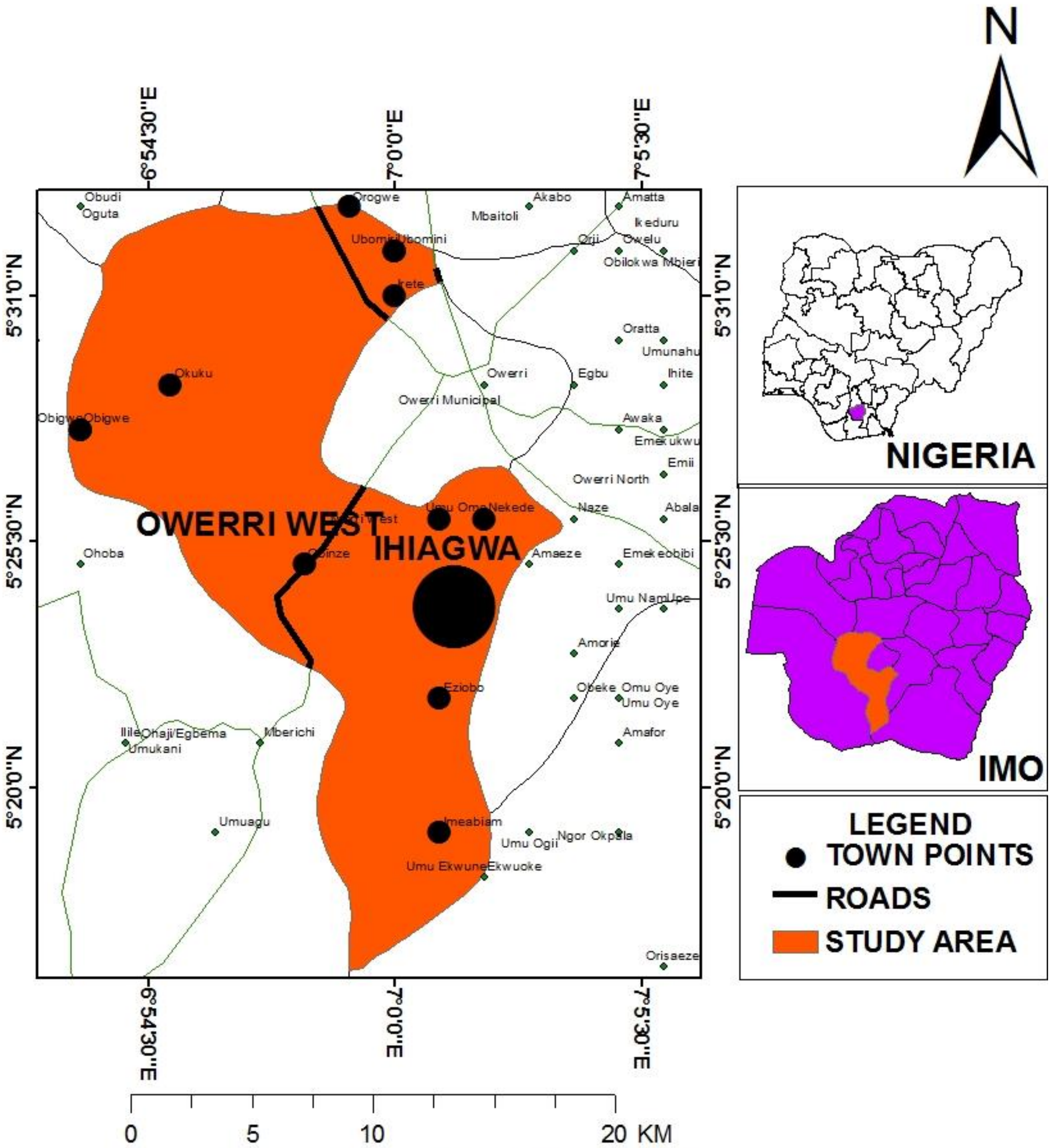


FIG. 1. IHIAGWA STUDY AREA MAP

3.0. METHODOLOGY

Method of sample collection

The samples were taken from the dumpsite at Uhumgboke Ihiagwa at three different points A, B, C with a soil depth of 0 – 15cm, 15 – 30cm, 30 – 45cm for each point. Points A and B were collected at the refuse dump with distance of 570cm apart and Point C is the control point with distance of 11400cm from points A and B. The samples were collected and labeled appropriately in a black waterproof. The coordinate of the location was taken which reads 5^o 26’19’’N and 7^o1’23’’E. The general weather at sampling time was bright with ambient temperature and the samples were promptly sent to laboratory for drying.

3.1. Physical Properties Determination

Bulk Density Determination

Bulk density is the ratio of the mass of soil to the bulk or macroscopic volume of soil particles and pore spaces in the samples. Was determined using the CORE method. The sampler used consists of two cylinders fitted one inside the other. The outer one extends above and below the inner to accept hammer or press at the upper end and to form a cutting edge at the lower. The inside cylinder is the sample holder.

Apparatus

Core sampler, soil sample, plastic bags, aluminum foil, insulated box and weighing balance.

Procedure

a) The sampler was driven not so far into the soil (few millimeters) to avoid compressing the soil in the confined space of the sampler. And the sampler and its contents were carefully removed in order to preserve the natural structure and packaging of the soil as nearly as possible.
b) The two cylinders were separated with the undisturbed soil in the inner cylinder. The ends of the core level and cutter were trimmed by means of a spatula. When found satisfactory, were packed them in plastic bags. The cores were each wrapped in aluminum foil and transferred to the laboratory in an insulated box. Weigh the cutter containing the wet core to the nearest gram.
c) The soil is transferred to a container in the laboratory, weighed placed in an oven at 105°C for 18hours to obtain dry constant weight and then it’s reweighed again. Weigh the dry soil with the cutter and then the cutter separately.
d) The bulk density is the ratio of oven-dry mass of the sample to the sample volume.

The bulk density is calculated as follows;

Bulk Density (g/cm^3) = $md \div v$

Md = Mass of dry soil sample (g), V = Volume of sample (cm$^{3)}$

e) The bulk density for each sample and depth was determined in same way.

3.2. Chemical Properties Determination

Soil pH Determination

This was determined with the glass electrode pH meter. A glass pH meter is an electronic instrument in which the pH is measured by the electromotive force established across the glass electrode.

Apparatus

Water, 50ml beakers, shaker machine, weighing balance, glass electrode pH meter and soil samples, distilled water.

Procedures

a) 20g of the soil sample is measured using the weighing balance and poured into the 50ml beaker.
b) 25ml of distilled water was added to the beaker
c) The solution is been shook for 1 hour using the Orbit shaker machine. This allows time for aggregates to breakdown so that the solution equilibrates with all the soil.
d) The pH of the soil was read using the pH meter. Immediately before immersing the electrode into the sample, the sample is stirred well with the glass rod. The electrode is placed into the soil slurry solution and gently the beaker is turned to make good contact between the solution and the electrode. The electrode is immersed 30seconds in the sample before reading to allow the meter to stabilize. The pH value is read and recorded for the sample. The electrode is rinsed well with distilled water, and then dabbed lightly with tissues to remove any film formed on the electrode.
e) Through this way, the other 8 samples were tested.

Electrical Conductivity Determination

Apparatus

Water, 50ml beakers, shaker machine, weighing balance, and soil samples, distilled water.

Procedures

a) 20g of the soil sample is measured using the weighing balance and poured into the 50ml beaker.
b) 25ml of distilled water was added to the beaker.
c) The solution is been shook for 1 hour using the Orbit shaker machine. This allows time for aggregates to breakdown so that the solution equilibrates with all the soil.
d) The solution was allowed to stand for 30mins and the filtered. The filtrate was used in the conductivity determination.
e) The Hach conductivity was used in µs/cm. the conductivity meter was calibrated using conductivity calibration solution.
f) The electrode of the meter was dipped into the filtrate and conductivity readings taken.

3.3. Soil Heavy Metals Determination (Pb, Cu, Zn)

This was done using the Double acid extraction method. In this technique the soil samples are not completely digested rather extracted.

Apparatus

Shaker machine, extraction bottles-polythene bottles, 250ml, extracting solution (0.05M HCL and 0.0125M HNO_3)

Procedures

a) Place samples in glass petris dishes and dry them in the oven at 35°C
b) After 24 hours of drying, any lumps present should be broken up with a clean rod in order to expose the inside for drying.
c) When the soil appears to be dry, it should be left in the oven for further 24 hours before grinding.
d) After drying the soil should be ground. In heavy soils, it should be necessary to break up the hard pieces using a mortar and pestle.
e) After grinding the sample, it is passed through a 2mm sieve.

Extraction process

a) 5g of the dried soil was transferred to an acid-washed 250ml polyethene extraction bottle in addition to 50ml of extraction reagents(0.05M HCL and 0.0125M HNO_3).
b) The solution was shook for 1hour using the orbit shaker machine and suspension was filtered through a Whatman No. 42 filter paper.
c) Blanks samples were prepared using the sample procedure with soil sample.
d) The filtrates where then analyzed for Pb, Zn, Cu using flame AAS (Atomic absorption spectrophotometer) to obtain absorbance values. Testing for each of the heavy metal using its cathode lamp.

3.4. Determination of Nitrate using spectrophotometric method

Apparatus: Nitrate was extracted using extracting solution (Morgan reagent).

Procedures

a) 10g of the soil sample was weighed and put into a beaker.
b) 0.5g of activated carbon was added and 40ml of the extracting solution (Morgan reagent) and shake on a mechanical shaker for 45-60minutes.
c) The sample is filtered through a filter paper (whatman filter paper).
d) 10ml of the sample was pipette into a 25ml volumetric flask.
e) 2ml of brucine reagent and 10ml concentrated H_2SO_4 rapidly added and sample was mixed for about 30seconds and allowed to stand for 5minutes. The sample was made up to mark with distilled water. The content in the flask was taken and read with the UV/Visible spectrometer. The brucine treated extract was run at a wavelength of 470nm.

4.0. RESULT PRESENTATION

Table 1 - 3: Descriptive Statistics of Soil Quality in the Study Area
Table 1:

Parameters	Point 1 Range	Point 1 Mean	Standard Deviation	Standard Error
Copper (Cu) Mg/100g	0.148 - 0.928	0.495666667	0.396832878	0.229111569
Zinc (Zn) Mg/100g	0.12 - 0.21	0.162333333	0.044094595	0.025458026
Lead (Pb) Mg/100g	0.138 - 1.026	0.492	0.470569867	0.27168364
Nitrate (NO_3) Mg/Kg	3.336 - 4.87	4.278	0.824720559	0.476152637
pH	5.756 - 6.009	5.888	0.126858189	0.073241609
Bulk Density g/cm^3	1.396 - 1.462	1.420666667	0.036018514	0.020795299
Electrical Conductivity µs/cm	80.5 - 162.9	110.0	45.66519462	26.36481241

Source: Researchers'' Fieldwork, 2018

Table 2:

Source: Researchers'' Fieldwork, 2018

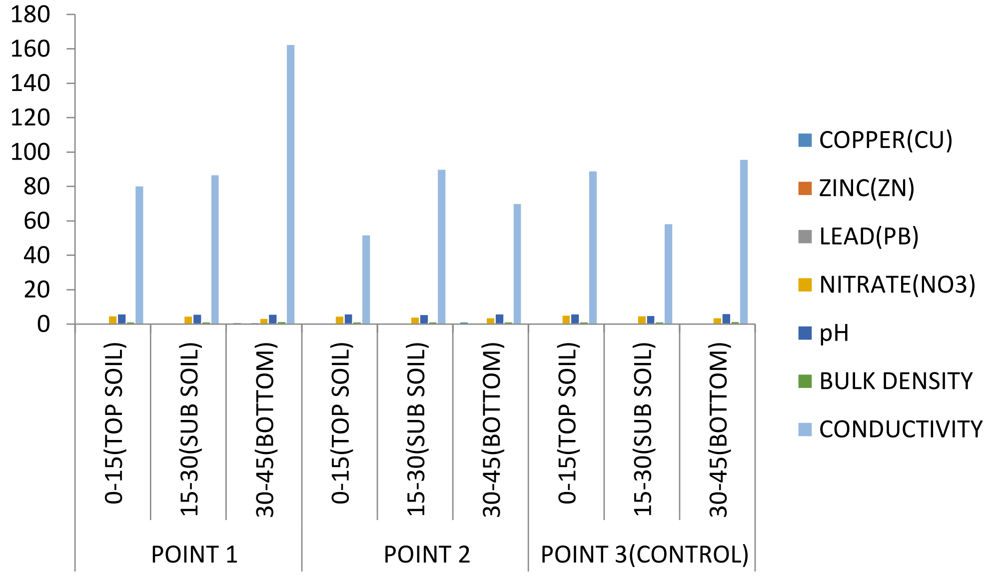
Parameters	Point 2 Range	Point 2 Mean	Standard Deviation	Standard Error
Copper (Cu) Mg/100g	0.232 - 1.376	0.75	0.579596411	0.334630144
Zinc (Zn) Mg/100g	0.098 - 0.217	0.137666667	0.068704682	0.039666667
Lead (Pb) Mg/100g	0.282 - 0.547	0.548333333	0.267002497	0.154153963
Nitrate (NO_3) Mg/Kg	3.82 - 4.687	4.229	0.435572038	0.251477633
pH	5.722 - 5.976	5.879	0.137218803	0.079223313
Bulk Density g/cm^3	1.375 - 1.459	1.415	0.042142615	0.02433105
Electical Conductivity µs/cm	52 - 90.1	70.76666667	19.05632004	11.0021715

Table 3:

Parameters	**Point 3 Range**	**Point 3 Mean**	**Standard Deviation**	**Standard Error**
Copper (Cu) Mg/100g	0.092 - 0.489	0.287666667	0.198560654	0.114639047
Zinc (Zn) Mg/100g	0.026 - 0.188	0.101	0.081663946	0.047148701
Lead (PB) Mg/100g	0.084 - 0.442	0.205666667	0.204700594	0.118183943
Nitrate (NO_3) Mg/Kg	3.838 - 5.202	4.636666667	0.711306779	0.41067316
pH	5.137 - 6.147	5.78	0.558710122	0.322571439
Bulk Density g/cm3	1.399 - 1.511	1.443666667	0.059340823	0.03426044
Electric Conductivity µs/cm	58.4 - 95.9	81.16666667	19.99908331	11.54647613

Source: Researchers' Fieldwork, 2018

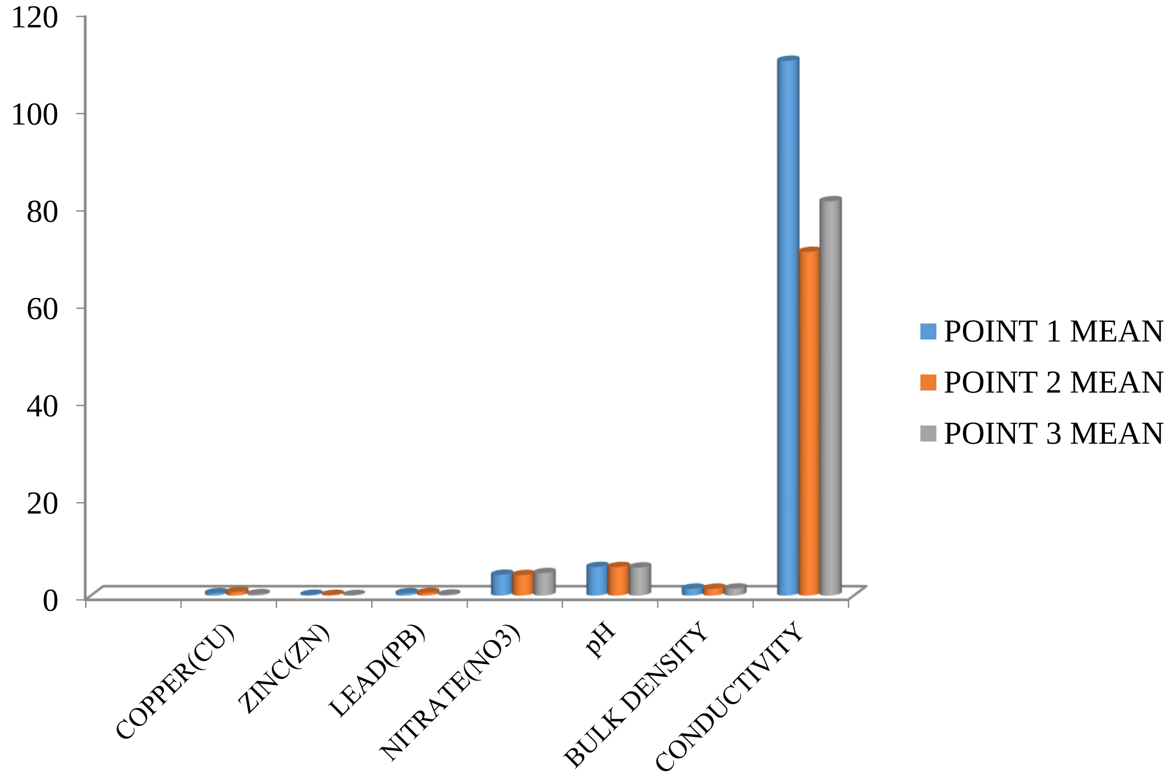
Table 1 - 3 above shows the range, mean standard error and standard deviation of the values of the parameters analyzed. It is observed that conductivity have the highest value of standard error of 26.36481241, 11.0021715 and 11.54647613 for each point 1, 2 and 3 respectively. Also, zinc has the least value of Standard deviation of 0.044094595, 0.068704682, and 0.081663946 respectively.



Source: Researchers'' Fieldwork, 2018

Figure 2: Spatial Variation Physicochemical Parameters and Heavy Metal Concentration of the Soil Samples

In Figure 2 above, the values of the soil parameter in sample 1, 2 and 3 are represented in a multiple bar chart. It is observed that the value of conductivity is very high. The values of copper, zinc, lead, Nitrate, pH and Bulk density is very low.



Source: Researchers'' Fieldwork, 2018

Figure 3: A Graph of Mean Concentration of Physicochemical Parameters and Heavy Metal Concentration of the Soil Samples

5.0. DISCUSSION

The result from the conducted laboratory analysis can be illustrated thus using mean, range, standard deviation and standard error.

From the analysis result, the samples showed a deviation from WHO permissible title towards the acidic region of the pH scale. This can be explained by the formation of the weak acid "carboxylic acid"(HCO_3) from the reaction between carbon (iv) oxide (CO_2) produced from decaying matter in water (H_2O).

From the analysis, the conductivity of the sample all fell above the WHO permissible limit.

From the analysis result, the Nitrate content of the samples all fall below the permissible WHO limit except for P3 (top soil) which slightly falls above the permissible limit. Nitrate in the soil is derived from the decomposition of soil organic matter and nitrogen, amendment in fertilizer and manure. In recent times, nitrate has been found to cause a great deal of effect including miscarriages in pregnant women, blue baby syndrome (methemoglobinemia) in babies when exposed.

From the analysis result, the copper of the sample all fell within the WHO standard.

From the analysis, the zinc value all fall below the permissible WHO standard. That is to say that the dumpsite is not polluted by zinc. High level of zinc in the soil may result from the improper disposal of zinc containing waste from metal manufacturing industries and electric utilities. A short term illness called metal fume fever can result if the people around a waste dump containing a high level of zinc breathe very high level of zinc dust or fumes from a waste dump.

From the analysis, the lead falls above the permissible WHO standard. Excessive lead in the soil is derived from flaking, weathering and chalking paint. Effects on the environment; these effects include impaired mental and physical development, decreased serum level of vitamin D in children that lived around the waste dump site.

From the analysis, the bulk density of the dump site falls within the permissible WHO standards. Bulk density of a soil, gives a good indication of the suitability for root growth and soil permeability and are vitally important for the soil-plant-atmosphere system. It is as well necessary for optimum movement of air and water through the soil.

6.0. SUMMARY OF RESEARCH FINDINGS

The research was carried out to determine the waste dump influence on soil also to assess the level of awareness of the people of Ihiagwa of the effects of indiscriminate waste dump on the environment quality.

There are many disposal methods available for the people to adopt but it was the open dumping method that is mainly used by them. Open dumping which is not on hygienic method of waste disposal should be discouraged as it breeds flies and rodents which are disease vectors. It is unsightly and proves to leaching which may be highly toxic and contain infections agents that contaminate and pollute the surrounding soil, underground and surface water.

Result of this study shows that there was evidence of pollution of a waste dumpsite in the area by some heavy metals such as copper, lead, zinc etc. These metals have great effect on the soil and underground water source. They can enter into food chain by settling on soil and growing plants and vegetables and has carcinogenic effect.

Agencies responsible for solid waste management in the country has not been fully involved and given legal backing as to the solving of environmental pollution problems which has caused many environmental problems such as contamination of ground and surface waters resulting in the fish kills, acid rain, global warming and the depletion of the ozone layer.

7.0. CONCLUSIONS

Waste otherwise must be produced or generated in every activity man engages on in the environment, comprising of only soil, air and water. Therefore, its disposal indiscriminately contaminates and pollutes the sources as well as causing environmental degradation and depletion of natural resources.

Domestic waste management is a problem that affects all works of life and as such every hand should be on deck to see to its efficient disposal.
This is achieved through government acceptance as a duty to protect the environment by promulgating legislations and enforcing it to the latter so that all industries and every household are strictly subjected to the adherence of guidelines and standards stipulated.

The education of the public by the government should be priorities to enable the people know the effects of waste dump on their health and take precautionary measures in handling of domestic wastes.

8.0. RECOMMENDATIONS

Communities throughout Ihiagwa are experiencing increasing demands for basic services at levels that exceed their dwindling budgets. Concurrently, the mounting costs and impacts of air, water and solid wastes pollution are adversely affecting local economies, natural environment and public health. Resource efficiency is a new approach to these widespread problems. Utilizing innovative management practices and technologies, resource efficiency aims to reduce the demand and the costs of energy, water and material within communities. The results are monetary savings, which benefits the local economy; reduce environmental impact and conservation of resources.

Also, the Federal, State and Local Government should have a body or create a department that is to go around nooks and crannies to educate the people on the effect of waste being generated by them and how it should be taken care of properly.

Government should provide waste disposal sites and trained manpower be employed to handle wastes and equipment as to the proper disposal of wastes so that it does not contaminate and pollute the environment.

Government should enforce enlightening campaign to be put in place to get the aware of the danger of not keeping their environment neat and the best way to handle wastes generated.

The Federal Government should set up environmental monitoring unit to carry out soil sampling from time to time in order to monitor the level of pollution concentration in soil.

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