Environmental Implications of Leachates of Sewage Dumpsites in some parts of Owerri, Southeastern Nigeria

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ABSTRACT

The environmental implications of leachates in sewage dumpsites in some parts of Owerri was studied by collecting soil and water samples from Agbala, Uzomiri Nekede, etc., specific in Owerri, Nigeria to determine the presence of ion concentrations. Laboratory analyses such as permeability test, pH, and physio-chemical analyses were carried out. Results showed that Agbala, Uzomiri Nekede, and Mechanic Village have permeability values of 0.0059cm, 2.49cm and 0.38cm with porosity values of 0.421cm, 0.42cm, and 0.43cm, respectively. Physio–chemical water analysis results also revealed that water samples from Agbala, Uzomiri Nekede, and Mechanic Village have pH values of 6.0, 5.0, and 5.0 which is below the WHO (2006) drinking water standard limits. The color of the water samples was clear enough at the various locations. Results also indicated the presence of heavy metals such as Pb, Ni, Cu, Hg and anions in the water samples. The presence of these heavy metals and anions poses health issues that can be serious threats to human health. Federal government and its Agencies should set up a standard for disposal and management of wastes on daily basis in our society.

(Keywords: leachates, wastes, analysis, physio-chemical, ion concentration, heavy metals, pH).

INTRODUCTION

Waste management and disposal has been a very challenging issue in every society in the world. We clamor for development and technology, but the associated adverse effects have not received the necessary attention. The rural-urban migration of human beings, acquisition of certain properties that bring accumulated solid wastes over the place and even some technical activities such as Mechanic Villages that attracts vehicles for maintenance and other heavy equipment call for indiscriminate deposition of feces and other harmful solid wastes in our open places (Ojeshima, 1999; Omishakin and Sridhar, 1985).

Increased number of waste dumpsites as a result of indiscriminate disposal of domestic waste in unauthorized places has posed serious concern of increasing problem for most cities in Nigeria as households have fewer or no opportunities for formal recycling or disposal of such wastes.

A study conducted by Sridhar et al. (1985) showed that refuse is dumped in gutters, streams, and at the back of houses in most cities in Nigeria despite attempts to reduce, re-use and recover and generally to have a strong control of the management of wastes, landfill, and waste disposal sites are still the principal focus for ultimate disposal of residual wastes and incineration residues worldwide (Charlotte, 1998; Waite, 1995). The placement and compaction of municipal wastes in landfills facilitates the development of facultative and anaerobic conditions that promote biological decomposition of landfill wastes.

The threat posed by leachates from city dump sites depends on the waste composition, volume, lifetime, temperature, moisture, availability of oxygen, soil morphology, and the relative distance of the sites to the living community and water body (Ogundirain and Afolabi, 2008). Waste amended soils have been reported to have high organic matter content (Anikwe and Nwobodo, 2002). The contamination of soil with heavy metals even at low concentrations are known to have potential impact on environmental quality and human health as well as posing a long-term risk to groundwater and ecosystems (Slake et al, 2005). Landfill leachates have been reported to contain a wide range of metals. Sources of these heavy metals range from industrial to municipal generation, automobiles, agricultural and land practices (Uba et al, 2008). Hazardous wastes can cause and has caused pollution, damage to health or lead to series of health disorders and even death (Vrijheid, 2000; Alimba et al, 2006).

The extent of contamination arising from percolation of leachates is determined by a number of factors that include the physio-chemical properties of the leachates and soil and also the hydrological condition of the surrounding site. The environmental and health hazards include soil and water pollution, repulsive site, offensive odor and increase in ambient temperature levels. All these have degraded the quality of our environment. This by implication is a call to all stakeholders; individuals, government, and environmental agencies such as federal environmental protection Agency (FEPA), Ministries of Environment to plan and define line of action for the disposal and management of wastes for positive nation hood.

LOCATION PHYSIOGRAGPHY AND GEOLOGY OF THE STUDY AREA

Agbala, Uzomiri Nekede, Mechanic Village, and Ogbosisi are located in Owerri North Local Government Area (L.G.A.) of Imo state. They lie within latitude 50 25' N to 50 33' N and longitude 60 57' E to 70 08'E and occupy land area of about 198 km^2 and an approximate population of 175,395 at the 2006 census. They are located in the eastern part of Owerri municipal council and there are major roads that lead in and out of them with Owerri city. Accessibility of the study area is relatively easy. The elevation of the study area is between 92m and 120m above sea level.

The study area lies within the Pleistocene-pliocene known as Benin formation (Reyment, 1965). It consists of highly massive porous and permeable fresh water bearing sandstones with minor intercalations of clay. Benin Formation varies in thickness with average of 700m. The unconsolidated sands and inter-fingering clays have given rise to systems of aquifers (Uma and Egboka, 1985).

It has a tropical climate with main regimes of dry and wet seasons. The wet season brings rainfall which lasts between March and October while the dry season lasts for about three months. The mean annual temperature is 27^0C while the mean daily temperature attains its highest values (28-30^0C) around March and its lowest values (23-24^0C) in August – September. The average humidity remains between 65% and 85%.

The soil of the area consists of the plain sands and the soil profile is remarkably uniform. The whole area is composed of deep uniform sands and loamy sands which are deeply weathered and intensively leached, very poor in nutrient content, low in pH volume, slightly humus and have a restricted moisture retention capacity.

The heavy rainfall coupled with the free drawing nature of the subsoil give rise to high infiltration of rainwater. The vegetation cover is fairly thick implying significant evaporation, transpiration effect.

MATERIALS AND METHODS

Soil samples obtained from three dumpsite locations at Agbala, Uzomiri Nekede, and Mechanic Village. Water samples collected from five borehole locations at Agbala, Mechanic Village, FMC, Naze, and Ogbosisi, Figure 1.

Water Sampling

The samples collected for this study were labeled properly before subsequent laboratory analysis. The water samples were capped immediately and kept in a cool box packed with ice and analysis was done within two hours after collection.

Soil Sampling

Soil samples were collected using hand auger within the landfill at a depth of 0.5m. Sample for control was also collected at the same time but at a distance of 100m. The samples were put and covered in air-tight manner in Polythene bags and was sent to the laboratory within twenty-four hours of sampling for analysis of the geochemical characteristics of the soil.

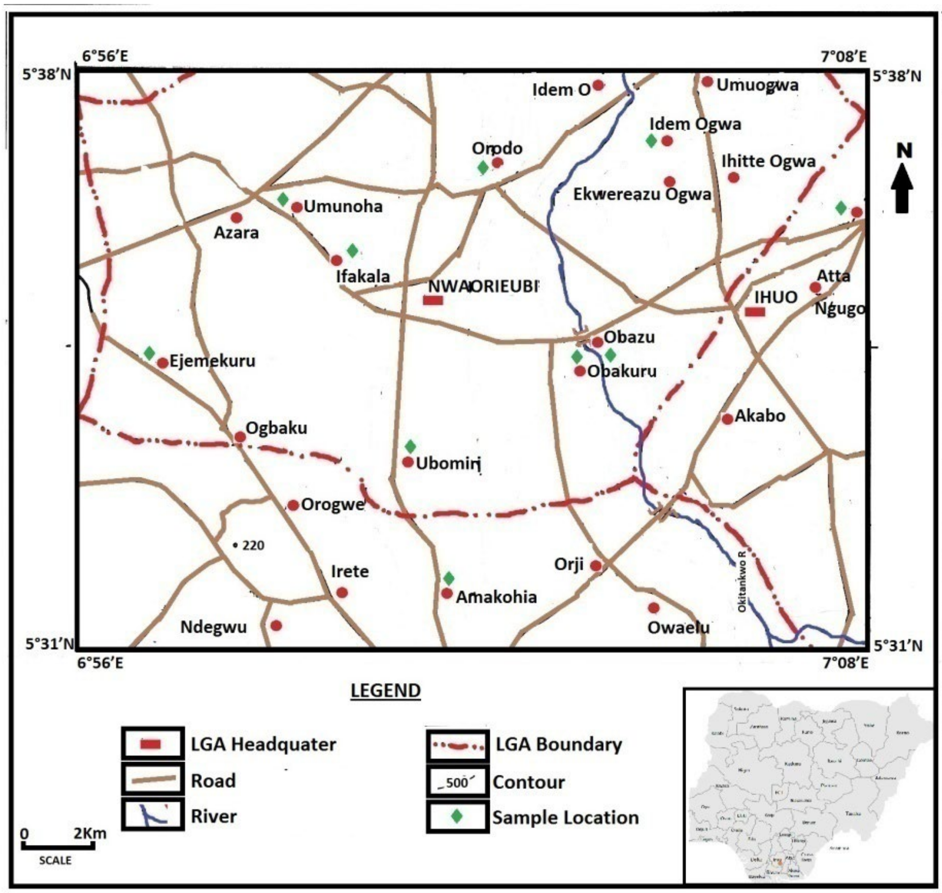

Figure 1: Topographical Map of the Study Area.

Laboratory Analysis to Determine Permeability

Permeability is a process of determining the ease at which fluid can flow through a formation. The samples collected were wetted and disaggregated. According to Allan Hazaen (1972), the coefficient of permeability k, can be estimated using the equation below:

K = 100 x D102 (cm/s)

K = Coefficient of permeability

$$K = \frac{2.3 \times a \times l}{A \times t} \log \frac{h_1}{h_2}$$

D10 = effective size of soil

Where k = Coefficient of permeability (cm/s)

a = Cross sectional area of stand pipe (burette) cm^2

L = length of specimen (cm)

A = Cross sectional area of soil specimen (cm^2)

h_1 = Hydraulic head at beginning of test (cm)

h_2 = Hydraulic head at end of test (cm)

t = Total time for water in burette to drop from h_1 to h_2 (s)

i.e.,

$$K = \frac{2.3 \times a \times l}{A \times t} \log \frac{h_1}{h_2}$$

$$= \frac{2.3 \times 1.0 \times 12.0}{78.5 \times 16} \log \frac{82.0}{44.0}$$

= 5.9 x 10^{-3}

Method of Determining Permeability

Soil samples were saturated and the stand pipe was filled with saturated water to a given level. The test then starts by allowing water to flow through until water in the standpipe reaches a given level of unit. The time is also recorded at often times the test was carried out.

Laboratory Analysis to Determine Soil Porosity

Porosity is measure of the void, empty spaces in a material. The test was carried out to determine the rate in which soil absorbs a known volume of water. The porosity for the studied soil is given by equation:

Bulk density = total mass (g)

VT = Total volume (cm^3) (g)

V = Volume of sample (cm^3)

Volume of solid in dry sample, Vs (cm^3) = dry density

Specific gravity (Gs)

But volume of voids, W (cm^3) = 1 – Vs

Void ratio, e = $vv/_{vs}$ and

Porosity, n = $\frac{e}{1+e}$

Water Analysis (Physical Parameters)

The physical water analysis carried out was to determine the odor, pH (degree of acidity and alkalinity), color, turbidity, specific conductivity, F and temperature. The temperature of the water tested using an alcohol thermometer in a hard plastic cover. pH was determined using a pH meter and pH paper with a universal indicator solution. The clarity of the water was carried out by using Scenic disc or 500ml of water in an increasing cylinder standing on paper marked with black cross. The total dissolved solid was estimated by evaporation method at 180^0C.

Water Analysis (Chemical Parameters)

The chemical parameters of the samples was determined using the principle of Atomic Absorption Spectrophotometer (AAS) and flame emission spectroscopy which involves the absorption of light by free gaseous atoms in a furnace which is used to measure the concentrations of ions in a given sample.

The device has a light source, a wavelength range and accuracy and a spectral band width. The calorimeter uses this phenomenon in which a light source, a tungsten filament light bulb, an optics for focusing the light a colored filter which pauses light of the color which is absorbed by the heated sample in a sample compartment to hold a transparent tube or cell containing the sample and a light sensitive detector, like the light meter on a camera which converted the light intensity into an electric current and finally an electronics used for measuring and displaying the output of the detector. The calorimeter show results in units of light absorbance which need to be compared to a calibration and a filter which transmits light of the color which the solution absorbed. The light passes through a narrow opening known as slit before reaching the sample.

The atomic absorption spectrophotometer determines the total dissolved solids, suspended solids and also heavy metals such as Zu, Pb, Ni, base elements such as Cl, Mn and other ions such as Fe^{2+}, Ca^{2+}, etc. it's sensitivity is particularly high in determining Mg, Zn, Cu, Pb owing to the very high proportion of atoms remaining in the ground state in the flame.

RESULTS AND DISCUSSION

Results

The physio-chemical water quality of Agbala, Uzomiri Nekede, Naze, Mechanic Village, and Ogbosisi have been carried out. Also, the granulometric analysis was done to determine the porosity and permeability of the soil in those locations. The presence of ion concentration as a result of contamination of groundwater by sewage and solid waste disposal was determined. The results are shown in Table 1 and the WHO parameter standards are presented in Table 2.

Table 1: Granulometric Analysis of Soil Samples of the Study Area.

S/N	Parameter	Agbala	Uzomiri Nekede	Mechanic Village
1.	Moisture or Water Content W(%)	15.4	8.6	6.7
2.	Bulk density (glcm^3)	1.82	1.54	1.55
3.	Specific Gravity	2.73	2.49	2.50
4.	Porosity (n)	0.421	0.43	0.42
5.	Permeability k (cm/s)	0.0059 0.0053	0.0045 2.49	0.0053 0.38

The moisture or water content at Agbala is 15.4%, Uzomiri Nekede is 8.6% and 6.7% at Mechanic Village. This shows that moisture in the top soil is highest at Agbala, Figure 1.

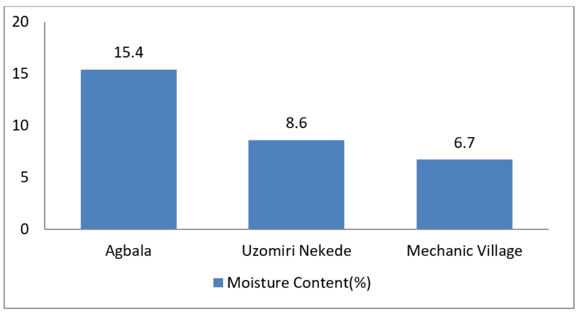

Figure 1: Moisture Content of Samples at Agbala, Nekede, and Naze Mechanic Village.

The bulk and dry density tests of samples at Agbala, Nekede and Mechanic Village are 1.82, 1.54 and 1.55 while the Dry density is 1.58, 1.42 and 1.42 respectively, Figure 2.

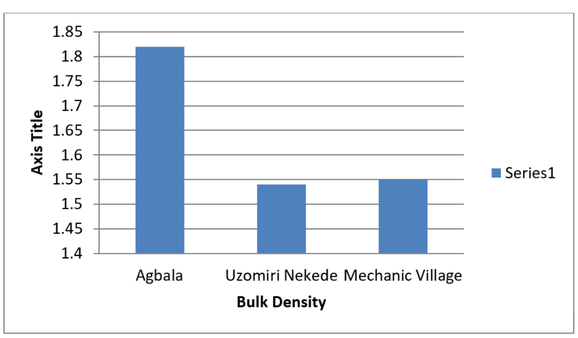

Figure 2: Bulk Density of samples at Agbala, Nekede and Naze Mechanic Village.

Specific Gravity test has the values for the locations as 2.73, 2.49, and 2.50, Figure 3.

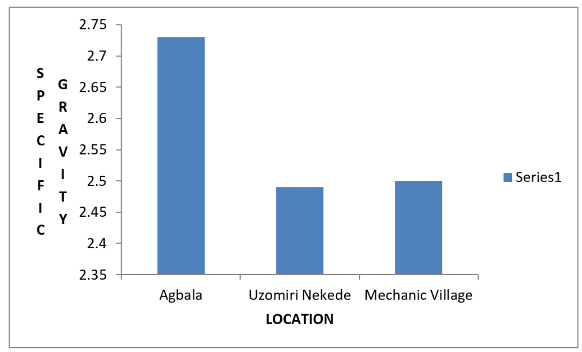

Figure 3: Specific Gravity of samples at Agbala, Nekede and Naze Mechanic Village.

Figure 4 reveals that porosity of soil at Agbala is 0.421, Nekede is 0.43 and Mechanic village is 0.42 considering the factors such as Dry density (mg/cm3), Surface gravity (Gs), Volume of solids (Vs), Volume of Voids (Vv) and Void Ratio (e).

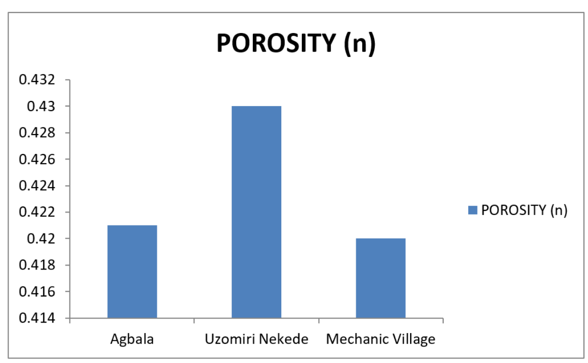

Figure 4: Porosity of Samples at Agbala, Nekede and Naze Mechanic Village.

Table 2: Physio-Chemical Prosperities of Water Samples from Agbala, Nekede Mechanic Village, FMC Owerri, Naza, Ogbosis, and WHO Standard.

S/N	Parameter/Unit	Agbala	Mechanic Village	FMC Owerri	Naza	Ogbosisi	WHO standard
1	Colour (TCU)	2.0	2.0	2.5	3.3	2.0	3.0-15
2	Solids (Ts)	200.0	40.0	40.0	40.0	100.0	1500mg/L
3	pH	6.0-6.3	5.0	6.0	5.0	6.0	8.9
4	Dissolved solids (Ds)	80.0	20.0	20.0	40.0	60.0	
5	Suspended solids (Ss)	120.0-125.0	20.0	20.0	40.0	60.0	
6	Alkalinity	250.0	50.0	100.0	25.0	35.0	100mg/L
7	Acidity	50.0	25.0	50.0	25.0	50.0	
8	Dissolved oxygen	1.67-1.7	5.89	2.26	0.46	0.56	
9	COD	1.77-1.87	7.77	5.77	4.22	3.00	
10	BOD	3.44-3.48	13.66	8.03	4.68	3.56	
11	Nitrate	0.02-0.05	1.0	0.09	0.02	3.02	50
12	Copper	0.0	0.01	0.0	0.0	0.01	2.0
13	Magnesium	0.05	1.0	0.09	0.05	0.02	20
14	Chloride	25.00	25.00	50.00	80.00	15.00	250
15	Iron	0.20	0.02	0.03	0.10	0.02	0.01
16	Lead	0.0	0.01	0.0	0.0	0.0	0.01

Source: Adapted from Table 5 of J.Chem. Society of Nigeria, Vol 32, No 2 pp127

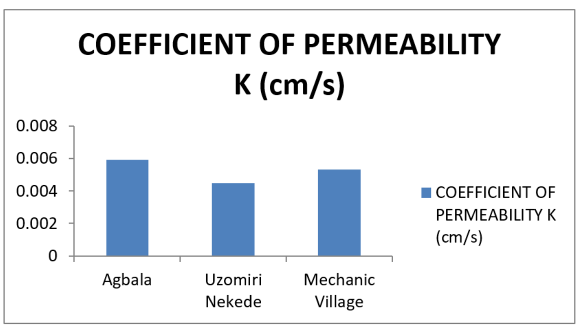

Figure 5: Coefficient of Permeability of Samples at Agbala, Nekede, and Naze Mechanic Village.

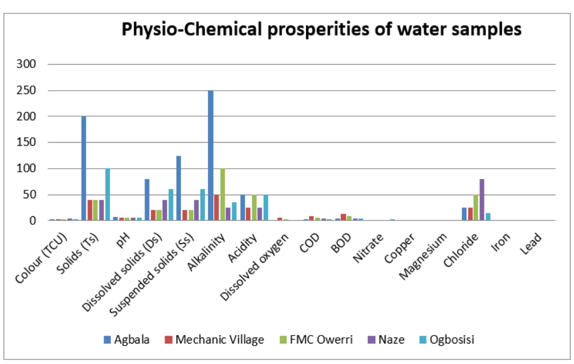

Figure 6: Histogram of the Composite of Parameter at Agbala, Nekede and Mechanic Village.

The ion concentrations in samples show that copper, Lead, Iron, Nitrate are either not present or are negligible while the Chloride and Magnesium contents are highest and within the acceptable range by WHO, Figures 6 and 7.

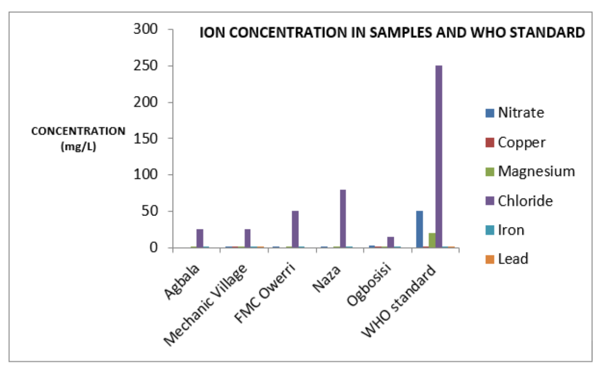

Figure 7: Ion Concentration in Samples and WHO Standard.

CONCLUSION

There is reasonable concentration of solid material such as Nitrates and phosphates derived from wastes that infiltrate into the ground from dump sites to contaminate both the surface and groundwater. The concentration of heavy metals is low but this could be hazardous to health and may also pose some risks to the ecosystems. Other physical and chemical parameters are within the acceptable range for human consumption.

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