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ASSESSMENT OF GROUNDWATER QUALITY IN A VICINITY OF MUNICIPAL DUMPSITE AT ENYIMBA JUNCTION ARIARIA, ABA, ABIA STATE.

Awuchi, Chibueze Gospel[1]; ***Eze**, Chinwe Catherine[2]; **Okomah**, Yvette Esama[3]; **Daniel**, Ogbite, Ekotogbo[4]; **Aniefiok**, Ukpeh Emem[5]

[1,4,5]Department of Environmental Management, Federal University of Technology Owerri, Imo State, Nigeria;
[2]Department of Microbiology, Federal University of Technology Owerri, Imo State, Nigeria;
[3]Nigeria Atomic Energy Commission, Abuja, Nigeria.

***Corresponding Author**

ABSTRACT

Solid waste mostly garbage, agriculture and industrial waste are disposed in landfills where it decomposes and produces a leachate that can contaminate underlying groundwater. Waste management has remained an undisputable environmental problem in Nigeria. This has manifested in the form of indiscriminate disposal of wastes and illegal landfills and dumps along main roads and streets, and the problem is compounded by the generation of enormous quantities of waste. In the developing world such as Nigeria, borehole water users hardly treat water before usage and this poses a serious threat to their health since they utilized this untreated water for consumption, domestic uses, agriculture and industrial purposes. Some groundwater studies have ascertained that leachates from landfill migrate in the direction of groundwater flow to contaminate the underlying aquifer. The study assessed the vulnerability of boreholes located close to a Municipal dumpsite in Ariaria, Aba. Borehole water samples were collected from eight (8) designated boreholes and their physicochemical parameters were analysed. The length, breadth and depth of the dumpsite were measured with a tape and meter rule. The length of the landfill was 560m, the width 330m and the depth 110m. Geographical positioning system (GPS) was used to obtain the static water level from where the groundwater flow map was deduced. Parameters such as BOD, DO, Fe^{2+}, Ni^{2+}, Zn^{2+}, *faecal and total coliform count values when compared with World Health Organization standard (WHO) were seen to exceed the recommended values. The research revealed that groundwater flow from the North to South, carrying along with it dissolved waste materials and leachates which infiltrates into the borehole water and contaminates it, thereby rendering it unsuitable for drinking and domestic use. The researchers therefore suggested that the base of landfills should be properly coated with concrete or cellophane materials to avoid leachates infiltrating into the groundwater. Recycling of municipal waste, proper education and awareness on solid waste management should be encouraged in the study area.*

Key Words: Groundwater, Landfill, solid waste, leachate, contaminants, Garbage, infiltration.

1. INTRODUCTION

Wastes are materials that are not prime product (product produced for the market) for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption and of which he/she wants to dispose. Wastes occur during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. It may also be as any unavoidable material resulting from an activity, which has no immediate economic demand and which must be disposed off (UN, 2007). Waste is commonly classified into three. These are solid, liquid and gaseous wastes.

Solid waste is any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations. Solid waste can be classified into different types, depending on their source; household waste is generally classified as municipal waste; industrial waste as hazardous waste, and biomedical waste or hospital waste as infectious waste (US Law-Solid Waste Act 2 (ULWA), 2013).

Dumpsite also known as landfill is a disposal site where solid waste, such as paper, glass and metal is buried between layers of dirt and other materials in such a way as to reduce contamination of the surrounding land. Classical unlined sanitary landfills and open dumps are well known to release large amounts of hazardous and otherwise deleterious chemicals to nearby groundwater, surface water and soil also to the air, via leachate and landfill gas.

The risk of groundwater pollution is increasing both from disposal of waste materials and from widespread use by industry and agriculture of potentially polluting chemicals in the environment. Pollution can occur whether discrete, point sources, such as from the land-filling of wastes. One of the dreaded consequences of rapid urbanization has been the problem of solid waste management, particularly in terms of environmental nuisance combined with the health hazard and its implications. Waste management has therefore become an endemic problem that characterizes Nigerian cities. Coupled with the lack of capital and appropriate technology for environmentally friendly waste management practices has left most state governments like Abia State relying on the use of dumpsites for solid waste disposal. And in most cases the dumpsites are not properly engineered and operated to accepted world standards.

Dumpsite practices because of its cost effectiveness have become the most favourable choice particularly in Aba, Abia State, after previous attempt at incineration failed. The untreated rubbish being placed in the dumpsite voids comprises biodegradable solids such as vegetable, paper and metal, inert solids such as glass and plastics and other unclassified materials constitute a great threat to underground water quality. Such contamination occur through leakage; which is formed when rain water infiltrates the dumpsite and dissolves the solute fraction of the waste and the soluble product formed as a result of the chemical and biochemical processes occurring within the decaying wastes. The resultant effluent will however impose their Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) on the ground water. Recent studies have shown that the COD and BOD of such wastes may be in the region at 12,000mg/L and 700mg/L respectively with the concentration of inorganic chemical substances like ammonia, iron and manganese varying according to the hydrology of the site and chemical and physical conditions within the site. The international agencies like World Health Organization (WHO), Environmental Protection Agency (EPA) and United Nations Environment Program (UNEP, 2006) are engaged in developing new technologies for waste management and its disposal including its characterization. Management of Municipal Solid Waste for various cities and towns has been widely studied throughout the world. As the huge quantities of solid waste generated in the urban areas is the major problem, majority of researchers concentrated on this issue. Numbers of researchers have tried to find out new techniques for solid waste management. Zhu Minghua *et al.* (2009) studied the management practices carried out for the solid waste from Pudong New Area, China. He illustrated important aspects of waste management, such as the current status of waste collection, transport and disposal in Pudong area.

Sharholy *et al.* (2008) reviewed the status of municipal solid waste management in Indian cities and reported that Municipal Solid Waste Management (MSWM) is one of the major environmental problems of Indian cities where improper management of Municipal Solid Waste (MSW) causes hazards to inhabitants.

Ogwueleka (2009) studied the municipal solid waste characteristics and management in Nigeria. He reported that the municipal solid waste management has emerged as one of the greatest challenges facing environmental protection agencies in developing countries including Nigeria. He concluded that solid waste management is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal.

Oyelola and Babatunde (2008) studied characterization of domestic and market solid waste at source in Lagos metropolis and concluded that waste management is an important element of environmental protection with proper characterization of municipal solid waste as fundamental for the planning of municipal waste management services.

Humans and other living organisms depend on a healthy environment for good health. The Ariaria burrow pit dumpsite examined is situated very close to residential areas and Ariaria International Market, Aba, Abia State. The residents of this area uses water from boreholes located close to the dumpsites for drinking and other purposes. Rapid Population growth and industrialization, coupled with indiscriminate dumping of solid wastes at the site, with little or no sound solid waste management plants at the study area have contributed to increase in the volume of solid wastes at the dumpsite in an alarming rate as shown in the attached images. The different wastes types at the dumpsite possess different physical, chemical and biochemical properties. The waste water produced from the decomposed wastes materials may leach into the groundwater aquifers when rain falls. During this process, the boreholes around the dumpsite may become contaminated. This may be very possible in the study area because the soil texture show that soil around the dumpsite and even outside the dumpsite show very high percentage coarse sand which is highly conducive for leachate transport. When humans and other animals come into direct contact with the contaminated samples they may face serious health challenges.

With the desire to know the present quality of the borehole water, around the dumpsite, the researcher deemed it necessary to determine the physicochemical characteristics of the borehole water around the solid wastes dumpsite which are known to impact on human health. The results of these findings may reveal the present qualities of water from boreholes around the dumpsite.

This research aimed to assess the groundwater quality in a vicinity of a municipal dumpsite at Enyimba junction, Ariaria Aba, Abia State, and specifically adopted the following objectives:

assessed and compared the physicochemical properties of groundwater around Ariaria burrow pit dumpsite with the international standard for drinking water; examined the effect of distance from dumpsite on the physical, chemical and biological properties of sampled water; examined if there is concentration variation in water quality among sampled groundwater sources and sampled leachate from the dumpsite.

2. STUDY AREA

The dumpsite is located along Aba – Port Harcourt Express way, it is 500meters before Faulks Road junction, Aba of Abia State in Nigeria. The waste dumpsite is located on the part of the road that is in Osisioma Ngwa Local Government Area in Aba Metropolis. It shares boundary with Umuode Village and Ariaria Community.

Ariaria in Osisioma Local Government Area is located within Latitude 7°10'E and longitude 5°27'N. It forms one of the major districts in Aba, the central commercial city of Abia State, South Eastern Nigeria. It is highly populated, with an average population density of 3000 inhabitants per square kilometer. The people are predominately traders. It occupies a total land area of approximately 3 sq. kilometers.

The lowest natural elevation in the area is located in the southern part. It is characterized with heavy rainfall of about 2400 mm/year especially intense between the months of April through October.

Ariaria is a humid zone as well as other towns of the Aba, Abia State; it has a tropical rainforest climate. It exhibits two major seasons, (rainy and dry season), harmattan is a minor season. The rainy season begins in March and ends in October with a break in August usually referred to as the August break. The rainy season is caused by the South West Trade Wind. The dry season which lasts for four months begins in November. Harmattan begins in December and ends in February, it is triggered by the North-East Trade Wind. The total rainfall decreases from 2200mm in the south to 1900mm in the north.

The relative humidity is usually high throughout the year, reaching a maximum during the rainy season when values above 90% are recorded. Temperature is averagely 26^{o}C throughout the year.

The vegetation in Ariaria is ordinarily considered part of tropical rain forest which is the dominant natural vegetation in Abia State and most parts of Southern Nigeria. The soils are not much fertile and are prone to much leaching due to heavy rainfall.

Trade and Agriculture are the major occupation of the people of the Area. The area covers a part of the popular Ariaria International Market and also possesses a rich alluvial soil which stretches through the study area. Commercial trading is prevalent and about 70% of the population engage in it while about 30% engages in subsistence farming. With its adequate seasonal rainfall, Ariaria has much arable land that produces yams, maize, plantains, and cassava. Rearing of livestock is also one of the prominent sectors of agriculture in the state.

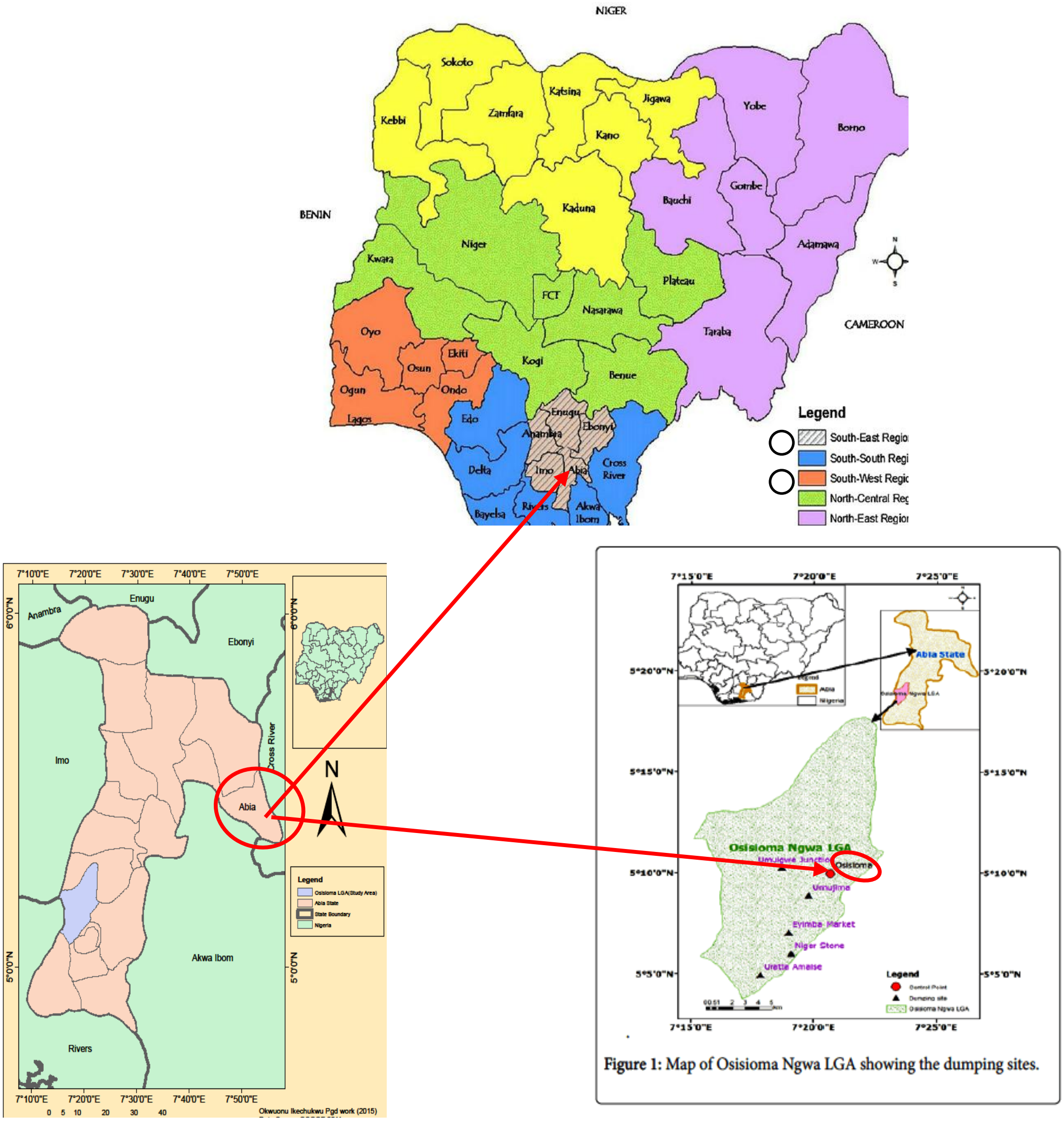

Figure 1. Map of Nigeria showing Abia State and Osisioma Ngwa LGA, the study area

3. MATERIALS AND METHODS

The research utilized both primary and secondary data. The primary data were obtained directly from the field through observation and measurement of landfill depth, width and length using the metre-rule and a tape. Water samples for the analysis were collected from designated boreholes located very close to the dumpsite. A 75cl plastic container was used in collecting the water sample and taken to the laboratory for analysis within 24 hours of collection. A total of eight (8) water samples were collected for the determination of its physicochemical properties. Simple random sampling technique was utilized in the selection of boreholes. The flow direction of groundwater around the dumpsite vicinity was also determined from the elevation values obtained from a handheld Global Positioning System's reading (Garmin GPSMAP 76CSx Model).

The groundwater flow was predicted by utilizing the knowledge of the variation in static water levels across the study area. Data on static water levels were imported into the GIS software anchoring on their coordinates. An interpolation technique called Gaussian Process was applied on the data and contours were automatically generated at two meter interval. Data products from surfer were exported as shape files and imported into ArcGIS where they were organized along with other geo-referenced layers of data such as administrative boundaries, rivers, roads, boreholes and dumpsite locations, to make a map showing flow direction of groundwater across the study area.

Samples Collection

Eight (8) control samples were taken from water boreholes from random distances around the dumpsite, which serves as baseline for all the samples collected in the study areas. These samples were collected to measure and compare the effect of contaminants on the groundwater in relation to the control samples collected. The varying distance of the samples collected were determined through the coordinates of the dumpsite and wells with the aid of Global Positioning System (GPS) device with distance calculated from equation 1 in reference to the bench mark dumpsite.

$D=\sqrt{[(\Delta N)2+(\Delta E)2]}$ ________________________ 1

$\Delta E = E2 - E1$

$\Delta E = E3 - E1$

$\Delta N = N2 - N1$

$\Delta N = N3 - N1$

Where,

D= Distance (m)

ΔE= Difference between East of the two points

ΔN= Difference between North of the two points

The samples were collected using a 5-litre white plastic containers screw capped that have been sterilized in other to avoid contamination by any physical, chemical or microbial means. Samples were properly labelled with details of the sources, date of sampling, time of sampling and address and were taken to the laboratory before 24hours from the time of collection. The samples collected from each borehole were analyzed for physical, chemical and bacteriological parameters of water. The qualitative analyses were carried out at the laboratory of Yematech Consulting and Analytical Services, Aba – Abia State.

Chemical Analysis

The dependent variables analysed were pH, colour, turbidity, hardness, temperature, calcium, chloride, nitrate, total iron, manganese, sulphate, dissolved oxygen (DO), biochemical oxygen demand (BOD), total dissolved solid (TDS). The bacteriological test analyses were carried out for organisms, coliform, and total coliform. Sample measurements were done in replicates.

pH and temperature were determine using WTW pH Electrode. The pH meter was calibrated using HACH (1997) buffers of pH 4.0, 7.0, and 10.0; according to the manufacturer specifications.

Chemical oxygen demand was determined by titration method Procedure:

(i.) Take reflux flask to it 1ml of concentrated H_2SO_4 and 20ml of sample and mix.

(ii) Add 10ml of potassium dichromate ($K_2Cr_2O_7$)

(iii) Mix the content thoroughly and reflux for 2 hours.

(iv) Cool and wash down the condenser. Dilute the mixture to 100ml by adding distilled water.
(v) Add 3 drops of ferroine indicator and titrate with ferrous ammonium sulphate solution, till the color change from green to red. Which is the end point.
(vi) Perform the same procedure with “blank” using distilled water instead of the sample.

$$COD = \frac{(V1\text{-}V2) \times \text{Normality of ammonium sulphate} \times 8000\ (mg/L)}{\text{Volume of sample}}$$

Where: V1 is the volume at end point for sample titration, and V2 is the volume at end point for blank titration.

Dissolved oxygen was measured with Jenway Model 1970 waterpro of DO meter. Dissolved oxygen meter was calibrated prior to measurement with appropriate traceable calibration solution of (5% HCl) in accordance with the manufacturer’s specification. This was measured on site by direct reading. The probe was immersed into the water sample, the switch was turned on. The display was allowed to show a stable value and result was recorded in mg/L.

Biochemical Oxygen Demand (BOD) was determined as the difference in Dissolved Oxygen (DO) before and after incubation of the water samples at 20^oC for 1day (24hours).

Calculation
BOD = X – Y mg/L
Where: X = Initial dissolved oxygen in the water sample
Y = Final dissolved oxygen in the water sample

Nitrate was determined calorimetrically by the spectrophotometric method according to the manufacturer specification.

Procedures:
To the 50ml prepared solution, 2ml of phenoldisulphonic acid reagent was added and mixed thoroughly and allowed for 5 minutes. 1ml of 1-naphthyl ethylene diamine- (NED) reagent was then added and the absorbance was measured after 15-20 minutes at 540nm against a blank and the concentrations taken in mg/L.

Chloride was determined by titration with $AgNO_3$ solution using potassium chromate as indicator (APHA, 2008).

Procedures:
100ml of sample was measured into a conical flask, 1ml of hydrogen peroxide was added to hinder SO_3^2- or thiosulphate interferences. The solution was adjusted to pH of 8 with NaOH solution. 1ml of dichromate indicator was added to the solution and titrated with silver nitrate solution to the pinkish yellow end point. A blank titration was also carried out. Hence, the chloride determination was calculated as follows:

$$mg/L = \frac{(B\text{-}A) \times N}{\text{Volume of sample (ml)}}$$

Where: A = ml titration for the blank sample
B = ml titration for the sample
N = normality of silver nitrate

Heavy metals (Fe, Zn, Cu) were determined using Atomic Absorption pectrophotometer (AAS, Unicom 969) according to the standard methods of Ekpo *et al*. (1999). The spectrophotometer was checked for malfunctioning by passing standard solutions of all the parameters to be measured; Blank samples (de-ionized water) were passed between every three successful measurements to check for any eventual contamination or abnormal response of the equipment.

Figure 2. Sections of the Dumpsite from different angles
Source: Authors Fieldwork

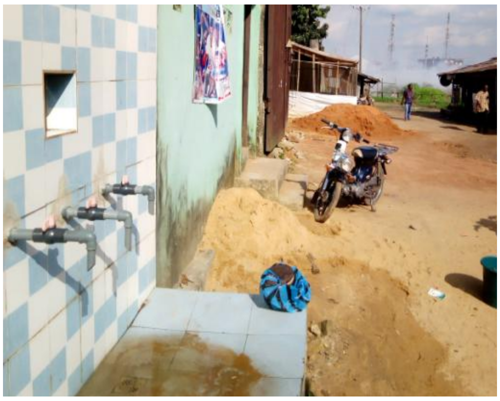

Figure 3. Picture of an active commercial tap near the waste dumpsite
Source: Authors Fieldwork

4. RESULT PRESENTATION

Table 1 below shows the dimensions of the dumpsite

Length	Width	Depth
560m	330m	110m

The table revealed that the total length of the dumpsite was 560m; the width is 330m and the depth 110m. This indicates that the waste covered a large proportion of the study area and could be detrimental to the health and environmental conditions of the inhabitants living close to the dumpsite. The rate of production of municipal solid waste has been on the increase in Aba Metropolis due to increase in population and commercial activities. This shows a clear lack in waste management practices, especially in proper land filling, coupled with the rapid increase in solid waste which poses a negative effect on the immediate environment.

Organic waste in landfills decomposed to form gaseous products and as the change from aerobic to anaerobic condition, carbon-dioxide level continues to increase as methane concentration builds up. Methane is very inflammable and if not properly harnessed, it can result in potential fire and explosion hazard in the study area.

Results obtained from the coordinates and distances of points of samples collection to dumpsite, physicochemical parameters, chemical analysis and bacteriological test were compared with World Health Organization (WHO) standard and Nigeria's Standard (SON) as presented in Tables 2 below.

Table 2: Results of Physicochemical Parameters obtained from Boreholes located close to the Waste Dumpsite

Parameters	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	SON	WHO
pH	5.7	6.2	6.0	8.3	8.7	6.6	5.8	7.8	6.5-8.5	6.5-8.5
Turbidity (NTU)	14.5	3.9	14.6	13.4	15.8	12.8	14.9	6.3	5.0	≤5.0
Hardness	1.4	21.0	80.0	150.0	170.0	220.0	92.0	32.0	500	≤500
Colour	12	11.5	10	15	13.8	11	14	11	10 – 15	10 – 15
Temperature ^{0}C	25.0	27.5	28.0	29.5	26.5	27.5	24.9	26.2	Ambient	Ambient
TDS (mg/L)	3.40	5.50	8.50	5.40	10.50	7.50	2.97	6.34	500	500
BOD (mg/L)	6.50	15.40	19.50	4.80	7.90	10.80	17.32	8.47	-	-
OD (mg/L)	4.50	3.50	18.60	5.10	5.90	10.40	12.92	7.38	-	-
Na^{+1} (mg/L)	1.00	2.50	6.50	4.70	2.70	4.50	5.72	4.83	200	-
Cl^{-} (mg/L)	2.40	0.50	3.50	1.80	0.50	2.00	2.38	3.82	200	≤200
NO_3^{-}(mg/L)	0.70	1.50	0.70	1.80	0.30	1.70	0.86	1.65	50	≤0.3
Fe^{2+} (mg/L)	0.50	0.16	0.23	0.20	0.37	0.60	0.19	0.72	0.3	≤0.3
Cu^{2+} (mg/L)	1.00	2.40	2.00	2.10	1.80	2.70	1.27	1.81	1.0	≤0.55
Ni^{2+} (mg/L)	0.70	1.00	1.60	0.70	2.10	2.50	1.67	0.86	0.02	≤3.0
Zn^{2+}(mg/L)	0.20	1.40	0.40	1.70	1.50	0.90	0.47	1.08	3.0	≤3.0
Coliform	2.40	5.40	9.30	10.50	4.51	4.94	5.40	4.43	0	0

BH – Bore Hole

The result in Table 2 above indicated that parameters such as BOD, Hardness, NO_3-, Fe^{2+}, Zn^{2+}, NO_3^{-} total and coliform values were higher in some sampled boreholes. Composition of leachate depends on the nature of solid waste buried, chemical and biochemical processes responsible for the decomposition of waste materials and water content in the total waste (Long & Salem, 2006).

The research revealed that all the parameters analysed varied from one location to another depending on their proximity to the dumpsite. It was discovered that boreholes located very close to the dumpsite were more contaminated than those located far away from it. This situation occurs because the gravitational movement of fluid and leachate is hindered by the mass of solid soil matter. Table 2 above revealed that borehole 5 and 6 have high values of physicochemical parameters which indicated high contamination by leachate in the study area.

Topography, type of waste and the hydrology of the study area were other possible contributing factors that aided leachate migration into groundwater. About seventy percent (70%) of the waste generated in the area were organic in nature. This is buttressed by the research carried out by Vasanthi (2001) where he proved that high concentration of TDS, Hardness, Nitrates, Chlorides and Sulphates in groundwater near dumpsites/landfill deteriorates the quality of water. It was observed that the major threat to borehole water comes from inadequate controlled landfills where leachate generated from the fill is allowed to escape to the surrounding and underlying water body. The chemical composition of the landfill leachate depends on the nature of the refuse, the leachate rate, and the age of the fill. The date obtained from the study areas indicated that the dumpsite leachate is grossly polluted and a poses a threat to groundwater quality. The hardness of leachate and contaminated ground water is due to the present of carbondioxide (CO_2) generated during the decomposition of the refuse. This CO_2 forms carbonic acid which dissolves calcium compounds in the soil materials and causes increase in the hardness of ground water.

Permeability of rocks within the reservoir plays an important role in the transmission of contaminants from landfills without concrete lining into borehole, especially if the aquifer is characterized by high permeable membrane. Evidence at the field proved that leachate from dumpsite/landfills affects borehole water quality through percolation in the subsoil.

Table 3. Comparing Mean Concentrations of Physicochemical Parameters with WHO and Nigeria Standard for drinking water

Parameters	**Average Mean Values**	**WHO's Standard**	**SON's Standard**
pH	6.9	6.5 – 8.5	6.5 – 8.5
Colour (H.U)	12.3	10 - 15	10 - 15
Turbidity (NTU)	12.0	≤5.0	5.0
Hardness	96.0	≤500	500
Temperature ^{0}C	26.9	Ambient	Ambient
TDS (mg/L)	6.3	500	500
BOD (mg/L)	11.3	-	-
OD (mg/L)	8.50	-	-
Na^{+1} (mg/L)	4.1	-	200
Cl^- (mg/L)	1.6	≤200	200
NO_3^-(mg/L)	1.2	≤0.3	50
Fe^{2+} (mg/L)	0.38	≤0.3	0.3
Cu^{2+} (mg/L)	1.9	≤0.55	1.0
Ni^{2+} (mg/L)	1.4	≤3.0	0.02
Zn^{2+}(mg/L)	1.0	≤3.0	3.0
Coliform	5.9	0	0

Table 3 above indicates that some parameters values exceeded that of the World Health Organization standard for drinking water when compared. BOD, DO, Na^{+1}, Cl^-, NO^{3-}, Fe^{2+},

Cu^{2+}, Ni^{2+}, Zn^{2+}, and coliform had mean values of 11. 80mg/L, 8.50mg/L, 4.10mg/L, 1.60mg/L, 1.20mg/L, 5.2mg/L, 1.90mg/L, 1.40mg/L, 1.0mg/L and 5.9mg/L respectively. All these means values exceeded the W.H.O. recommended standard for drinking water. The dumpsite in the study area was characterized by municipal, industrial and clinical waste and there are hazardous with leachable toxic components like Nickel, Copper and Zinc. The residents suffered from stinking smell and foul odour caused by the biodegradable wastes from the dumpsite. The presence of contaminants in borehole water possesses serious health challenge to the environment.

Scientist believed that the soil layers above the water table act as natural filters that prevent many pollutants from infiltrating down to the groundwater. But findings revealed that those soil layers often do not adequately protect aquifers from contamination as leachates move down the soil strata, because they allow some microbes to penetrate even at great depth (Eni *et al.,* 2013).

High coliform populations in borehole water are indications of poor sanitary conditions in the area. Human waste contaminant in water causes water-borne diseases such as diarrhea, typhoid and hepatitis. Inadequate and unhygienic handling of faeces and solid wastes due to urban growth could have generated high concentration of microbial organisms in borehole water.

The dumpsite through the process of percolation and infiltration contaminates the groundwater in that area. This agrees with Cunningham (2005), who opined that water dissolves biodegradable materials in solid wastes and even some industrial wastes; it mixes with these wastes and contaminates the groundwater through infiltration and recharge process. They also affirmed that dumping of wastes close to recharge zones or on recharge zones leaks through and contaminates the aquifer.

The landfill poses a great threat as it is a major cause of environmental degradation, groundwater contamination and public health concerns in the vicinity. This agrees with Ohiman (2002) who reported that landfill contains a mixture of toxic, infectious and radioactive waste which degrade the environment, contaminates groundwater and can cause serious harm to scavengers.

The implication of the dumpsite on groundwater hydrology is that leachates from dumpsite infiltrates into the ground and also move in the direction of groundwater flow thereby contaminating the groundwater along its path. This movement is from the north (higher pressure gradient) down south (lower pressure gradient). This is affirmed by Henry Darcy who postulated that groundwater moves from higher elevations or higher pressure gradient to lower pressure gradient. Thus, movement of sediments and water also follow this pattern. In addition, Taylor and Allen (2005) affirmed that landfill is a major source of groundwater pollution as the migration of this leachate follows the flow of groundwater movement, for this reason, landfill must be kept off from the direction of flow of groundwater.

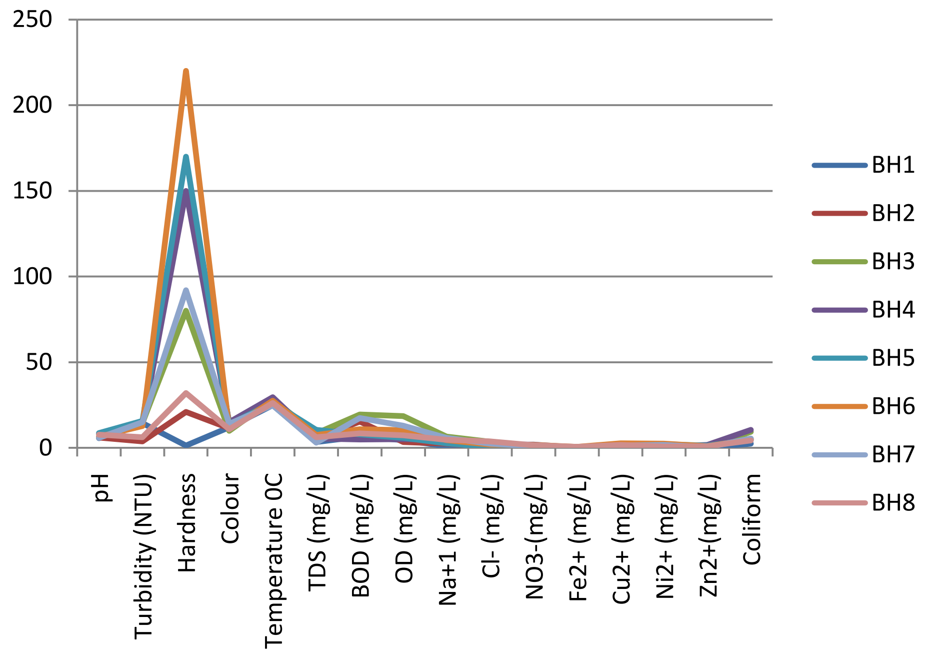

Figure 4. Descriptive Graph of the Results presented in Table 2 above

5. DISCUSSIONS

Physicochemical Parameters

The pH of all the water samples ranges from 5.7-8.7 from Table 2, and allowable WHO (2006) standard and UNICEF (2009) range of 6.5 – 8.5. Samples B4, B5, B6 and B8 falls within allowable standard, all other samples B1, B2, B3, and B7 falls below the range and it can be concluded they were acidic in nature which can adversely affect its use for domestic uses. Also, it was discovered that all samples closer to the dumpsite are more acidic in comparison with the samples farther away from dumpsites.

The desirable colour according to the World Health Organisation (WHO) (2006) and standard United Nations International Children's Emergency Fund (UNICEF) (2009) is 15 (H.U) maximum, and all the samples ranges from 10-15 falls within the allowable range of WHO as shown in Table 2.

The temperature range of groundwater sample in Aba metropolis is virtually constant throughout and ranged between 24.9°C - 29.5°C from Table 2. This depends on the environmental condition at the time of collection of samples.

Turbidity (in NTU) ranges from 3.9-15.8 for samples collected at different points. The WHO 2006 (UNICEF, 2009) allowable is 5 NTU but from the result samples B2 falls within the desirable standard of the WHO (2006) and UNICEF (2009) while sample B1, B3, B4, B5, B6, B7 and B8 falls above the allowable standard, this is an indication that there could be microbial contamination which can cause significant damage to human and turbid water is more expensive to treat.

Total Dissolved Solids (TDS)

The total dissolve solid ranged from 2.97-10.50 mg/L from Table 2. All the water samples fall within the allowable range since the maximum permissible limit is 500 mg/L. This is because water that contains less than 500 mg/L of dissolved solid is generally satisfactory for domestic use and many industrial purposes.

Chloride

The Chloride content for all samples ranges from 0.50 – 3.82 mg/L. Water that contains less than 150mg/L chloride is satisfactory for most purposes. All the sample lies within the maximum permissible limit of 200 mg/L of WHO (2006) and UNICEF (2009) standard.

Total Hardness

Water hardness is the traditional measure of the capacity to react with soap; hard water requires considerable more soap to produce lather Hardness is one of the very important properties of groundwater from utility point of view particularly for domestic purposes. From Table 4.1, water hardness ranges from 1.40–220 mg/L, all the analysed samples are within the maximum allowable limit of 500 mg/L recommended by WHO (2006) and UNICEF (2009) standard. It can also be concluded that all the water samples were soft water.

Heavy Metals Concentration

Parameters like Iron, Manganese, Copper and Zinc are trace elements and were found in minute amounts concentration of less than 100mg/L in all the water samples. WHO (2006) and UNICEF (2009) recommends that the iron content of drinking water should not be greater than 0.3mg/L because iron in water stains plumbing fixtures, stains cloths during laundering, incrusts well screens and clogs pipes. Indications of the presence of Iron include taste, discoloration, deposits and growth of Iron bacteria. Water samples B2, B3, B4, B5 and B7 in the study sites fall within the range of the allowable limit of WHO which ranges from 0.01-0.3mg/L, but samples B1, B5 and B8 indicates the presence of higher iron content, hence defiles WHO's standard. WHO (2006) and UNICEF (2009) recommends a maximum limit of 0.05mg/L. Indications of the presence of copper includes a stringent taste, discoloration and corrosion of pipes, fitting and utensils. Copper recorded for samples from the study dumpsite varies, with, all the samples higher than WHO's standard. Zinc qualities includes (Astringent taste), opalescence and sand like deposit. Zinc recorded for all samples ranges from 0.2-1.70mg/L which falls within the desirable limit of 3.0mg/L of WHO (2006) and UNICEF (2009) standard.

Bacteriological Test

Bacteriological test analysis of the water samples were carried out, as shown in Table 2 indicates that none of the water sample analysed met the WHO (2006) guideline limit. Coliform bacteria must not be detectable in any 100 ml sample of all water intended for drinking as shown on Table 2. Since water is essential to life there is need to have unpolluted pure water. By implication, due to the distance the samples B4, B3, B2 and B7 closed to the dumpsites were more contaminated to the other samples B1, B5, B6, and B8 farther away from the reference dumpsites and however, all samples are not safe for drinking in line with microbial standard of WHO (2006).

5. SUMMARY

Solid waste disposed in landfills is usually subjected to series of complex biochemical and physical processes, which lead to the production of both leachate and gaseous emissions. When leachate leaves the landfill and reaches the water table, it results in groundwater contamination. The quantity of leachate generated in a landfill depends on the climate in which the landfill is situated, type of waste, and the water content. The influence of climate on landfill performance is complex and increase in leachate production after precipitation is rapid.

Borehole water contamination from dumpsite/landfill, poses serious threat to the environment, but other sources of pollution such as fertilizer application, underground storage tanks, oil spillage are also dangerous contaminants. The research has revealed that dumpsite in the study area has affected borehole water quality negatively due to its careless handling which has rendered it unsuitable for public consumption directly without treatment. Groundwater in vicinity is enriched with iron oxide and this is supported by Long and Saleem (2006), where they opined that the principal product from urbanization alters the groundwater chemistry. The high concentration of these ions and the contamination by total coliform indicates that groundwater is contaminated by infiltration from the surface water polluted by the municipal solid waste, agricultural activities and industrial waste through leachate from the landfill.

The research has revealed that apart from physical parameters and heavy metals constituting the contaminants in borehole water, micro organisms like faecal and total coliform also find their way into ground water through infiltration and leaching from soak-away and landfill located close to residential areas. Also the research reveals that ground water in the area flows from the northern part of the state to the southern part and carries along with it debris and leachates as it passes through different soil strata before getting to the water table.

6. CONCLUSION

Investigation into the assessment of solid waste of the selected dumpsite in Aba metropolis indicated that the dumpsite pre-existed some of the residential houses and buildings in the study area. With the development rate and increasing population in the area, the dumpsite as well increases. This has adverse effect on the populace and causes damage to public health.

Generally, the analyses indicated that there are some levels of contaminations on the ground water within the solid waste dumpsite for physical, chemical and bacteriological tests. Sample B4, B3, B2 and B7 was found to be more contaminated by bacteria than Sample B1, B5, B6 and B8; this is because they are more close to the dumpsite. Hence this has rendered the samples unsafe for drinking and other domestic consumptions. Parameters like Iron, Copper, Zinc, Nitrite, Chloride are trace element and were found in minute amounts concentration of less than 100mg/L in all the water samples in the vicinities of the dumpsite which possessed no hazard effect to the quality of groundwater.

The presence of large quantities of mixtures of potentially hazardous chemicals in solid waste dumping sites close to residential area has increasingly caused some significant groundwater and public health concerns. Therefore, there is an increase in risk to public health with groundwater located near solid waste dumping site, which requires adequate monitoring processes.

The principal aims of monitoring drinking water are to prevent the spread of water borne diseases and to protect the health of the people living around the vicinity. The importance of access to good quality water cannot be overemphasized. Increase in population in the area coupled with the rise in human activity pose a great pressure on provision of safe drinking water. This necessitates large number of people to consume water from wash boreholes which constitute a major health problem due to close proximity of the wash boreholes to the dumpsite. This study recorded high number of coliform counts in water samples analyzed, thus making it unsafe for drinking and require further treatment. Therefore, there is an urgent need for awareness to be created about the present situation of these wash boreholes, to enlighten the people on the necessity for further treatment of this water before they can be used for drinking and domestic purposes.

7. RECOMMENDATION

Based on the conclusion drawn, the following recommendations are made: The researchers therefore recommend that the base of landfills should be properly coated with concrete or cellophane materials to avoid leachates infiltrating into the groundwater. There is need for environmental awareness through enlightenment campaigns on solid waste handling, controlling and monitoring techniques in the study area that is geared towards achieving quality environmental condition, solid wastes should be considered for resource recovery methods like, reducing, reusing recycling for other environmental friendly benefits before taking to dumpsites. Exploration of groundwater should be deep and proper analysis should be encouraged at both government and individual levels to know the side effects associated with groundwater before it is consumed. People should be encouraged to use waste bins and other facilities provided by waste managers for disposing of their waste, the involvement of individual and private sector through NGOs would improve the efficiency of municipal solid waste management (MSWM), littering of municipal solid waste should be prohibited through enforcement of law, house-to-house collection of municipal solid waste should be organized through methods like collection on regular pre-informed timing and scheduling, the use of soda ash should be injected to the well to correct the acidity of the water samples as seen in Sample B1, B2, B3 and B7.

Periodic monitoring of ground water around the dumpsite should be encouraged at both government and individual levels to know the current levels of the assessed parameters. The Local and State Government's Ministry of Environment should adopt a good waste management approach to the indiscriminate disposal of waste to the environment possibly by monitoring the chemical composition of waste to be disposed at the dumpsite before they are finally disposed or utilized for beneficial purposes.

Drainage system should be constructed around the dumpsite to reduce water fluxes at the dumpsite and leachate production. This will help to reduce the rate and volume of leachate migration into the stream and low land soils. Based on the outcome of this research, steps needed to be taken to review the efficiency of the refuse dumpsite, including advancement in technology and location of dumpsite at appreciably distance to our water bodies, as well as replacing municipal dumpsites with proper engineered landfills in Nigeria.

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