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Assessment of the Effect of Solid Waste Dump on Groundwater Quality at Nekede, Owerri West Local Government Area, Imo State, Nigeria

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***Abstract*-**This study focused on the assessment of solid waste dump on groundwater quality of Nekede in Owerri West Local Government Area, Imo State. The aim of the study was to determine the effect of the waste dump on borehole water quality in the area. Samples of borehole water were collected from six sampling locations (SLs), selected through simple random sampling. The seventh sampling location was used as the control sample for the study. The collected samples were analysed using standard methods to determine the physical and chemical parameters of the borehole water. The results of all the physical parameters analysed were within the (NESREA 2011; WHO 2010) recommended standards except turbidity (5.81 NTU) and colour (20.00 TCU). Also all the results of chemical parameters were within recommended standard except PO^{3-}_4 (11.90mg/l), Cl (339.89mg/l), Mg (39.15mg/l), Mn (1.45mg/l), and Fe (9.02mg/l). There were spatial variations in the level of all the borehole water quality parameters during the sampling period. Results also showed that TSS, TS, Cl, TH contributed to the highest variability in the borehole water quality. Residents in the area should be sensitized on the dangers of consuming borehole water without proper treatment. Nekede waste dumpsite should be closed and relocated to an appropriate site; due to its present high nuisance value in the area. It can therefore be concluded that borehole water around Nekede Waste Dumpsite is not potable but may be used for different domestic purposes. It has to be properly treated before human consumption.

***Keywords*-** *Solid Waste,Water Quality, Dumpsite, Potable*

I. INTRODUCTION

One of the greatest problems facing urban centres both in developed and developing countries is the disposal of wastes which has become an area of universal concern (Bolaane and Isaac, 2015). Safe and reliable disposal of municipal solid waste, an important component of integrated solid waste management, is lacking in most developing countries where dumpsites are used as common waste disposal methods. However, the introduction of more complex products, increasing urbanization and population growth, have all resulted in huge increase in the impacts of waste dump sites (Saarela, 2003, Kumar *et al*, 2017).

In Nigeria, like other developing countries, open dumping is the major option for solid waste disposal especially in cities. Refuse dumps sites are found both within and at the outskirts of the towns and cities. Due to poor and ineffective management, these dumpsites become sources of health hazards to people living within the vicinity of such dumps. (Mwanza and Phiri, 2013). Aside being susceptible to open burning, these dumps provide breeding grounds to disease causing vectors, cause odor, nuisance and deface urban beauty (Akinbile and Yusuf, 2011). More so, these dumpsites are usually haphazardly located without careful consideration of environmental and public health (Balogun *et al* 2017).

One of the major problems of open dumping as a method of waste disposal is the contamination of ground water. Although sources of contamination may be diverse including splashing of run-offs into wells (Mohon, 2010), flooding at borehole sites (Hoekstra *et al* 2018), latrin seepage (Obibesan, 2016), cracks in aquifers (Switchboard, 2011), seepage emanating from deep well injection of hazardous wastes (Johnson *et al*, 2011), those resulting from waste dumps have been most widespread (Longe and Balogun, 2010). The dumped solid waste gradually releases its initial interstitial water and some of its decomposition by-products get into surface and ground water through the waste deposits. Such liquid containing innumerable organic and inorganic compounds, called leachate, accumulate and percolate through the soil and ultimately into the ground water. Most of the elements contained in the waste including trace and heavy metals, nitrates and salts, as well as bacteria and viruses in few cases (Reda, 2016), infiltrate into the soil and ultimately into ground water contaminating it. Groundwater resources are therefore threatened not only through diminishing quality caused by the elements from waste leaching into them, but the volumetric increase in the quantity of waste generated by the growing population and their regular disposal by open dumping (Amadi *et al*, 2010).

II. MATERIALS AND METHOD

The study area is Nekede Community, in Owerri West Local Government Area at the South East of Owerri Municipal. It is bounded in the North by Ihiagwa Community, North East by Owerri Municipal, South West by Obibiezena and South West by Naze (Fig.1). With a population estimated at over 65,000 (2017 estimate) Nekede Community is today densely populated. The location of the community close to Owerri makes it a dormitory town where many people who work in Owerri live. The site shows a table land, with slight undulation towards the Otamiri River in the North East near Owerri Municipal. However, the dumpsite is located on a table land along the major road passing through the community towards Obinze via Ihiagwa. Topographical disposition has been an asset in the area as it has helped in the development of agriculture, construction of buildings, provision of infrastructure (schools, tertiary institution, churches, etc.) good drainage and road networks. The area is made up of loam soils which is a composition of sandy and clayey soils, firm and stable with high load bearing capacity which can serve as a cover material for a landfill.

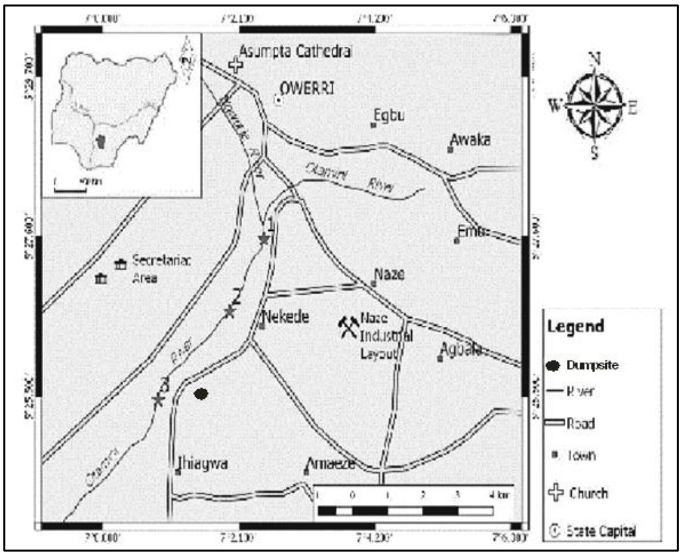

Figure 1. Map showing the study area (Source: ministry of lands, survey and urban planning, Owerri)

A. Sample collections

The study is based on an experimental design which involves field sampling and laboratory analysis. Borehole water samples were systematically collected from sampling points and analysed in the laboratory. This research was carried out in July 2018 when the rate of infiltration from waste dump is considered high. The number of boreholes around the dumpsite were localized and counted. The distance of boreholes from the dumpsite were taken at 50m, 80m, and 200m. These points were therefore designated as A50m, A80m, A200m, B50m, B80 and B200m. Simple random sampling method was used to select the number of boreholes at different distances to eliminate biases. A total of six samples was therefore used for this study. However, the borehole at the Federal University of Technology Owerri F.U.T.O, served as the control, making the seventh sampling point (5km away).

B. Determination of water quality parameters

Borehole water temperature, conductivity, pH, dissolved oxygen (DO), and Total Dissolved Solids (TDS) were determined electrometrically. pH meter with glass electrode, Glass ware (250 ml beakers), for color Colorimetric Platinum Cobalt was used. The zinc content in the water samples were analyzed using Atomic Absorption Spectrophometer (VGP210 Buck Scientific). All parameters were analysed in accordance to the American Public Health Association standard (APHA 1998).

III. STATISTICAL ANALYSIS

Descriptive statistics (means, ranges, minimum and maximum, standard error) and multivariate analyses were carried out with the aid of statistical packages of SPSS v.22.0 and MS Excel 2010.

IV. RESULTS AND DISCUSSION

The results of the physical and chemical parameters of the borehole water are presented in Table 1. Of all the parameters analysed, Total solids (range = 242.00mg/l) and Total Suspended Solids (range = 242.00mg/l), Chloride ions (range = 221.0mg/l) had wide ranges.

Temperature, pH and colour varied from 25.4 to 28.70 (26.83±0.26)^{0}C, 3.71 – 4.81 (4.35±0.09) and 6 - 20 (11.13±1.26) PCU respectively. Nitrate varied between 12.00 and 21.40 (17.6±0.90) mg/l, Total Hardness varied between 141.50 and 195.12(158.36±5.12) µS/cm, Magnesium varied between 29.00 and 39.15(33.66±0.95) mg/l, while Total Dissolved Solute varied between 6.50 and 227.50 (85.44±16.41)mg/l. The minimum and maximum values of TSS and Dissolved Oxygen (DO) as presented in Table 1 were 41.50 and 283.50 (97.08±25.42)mg/l, and 4.10 and 4.60 (4.26± 0.05)mg/l respectively. Biological Oxygen Demand (BOD) ranged from 1.10 to 1.86(1.45±0.07)mg/l, Chemical Oxygen Demand (COD) ranged from 1.76 to 2.88(2.27±0.12)mg/l, while Turbidity ranged from 0.00 to 5.81(2.33±0.74)NTU. Chloride (Cl^-), and Ammonia (NH_3) varied between 117.96 and 339.89(174.53±22.54)mg/l, 0.06 and 0.16(0.11±0.01)mg/l respectively while PO^{4-}_3 varied between 9.50 and 11.90(11.17±0.23)mg/l.

For the heavy metals, Iron and Zinc ranged from 0.00 and 9.02(0.83±0.75)mg/l, 0.10 and 1.13(0.65±0.08)mg/l respectively, while Copper, Manganese and Calcium varied between 0.04 and 0.17 (0.09±0.01)mg/l, 0.10 and 1.45 (0.78±0.17)mg/l, 5.05 and 11.88 (7.23±0.68)mg/l. Faecal Coliforms Count varied between 8.0 and 110.0 (42.17±20.67).

TABLE I. DESCRIPTIVE STATISTICS OF THE QUALITY PARAMETERS OF BOREHOLE WATER AT NEKEDE DUMPSITE

Parameters	Minimum	Maximum	Mean	SE	FUTO (control)	NESREA (2011)	WHO (2010)
pH	3.71	4.81	4.35	0.0963	5.05	6.5-8.5	
Temp (oC)	25.4	28.7	26.83	0.2684	2.4		5
TDS (mg/l)	6.5	7.5	7	0.1508	6.5	500	
EC (µScm)	10	15	12.5	0.7538	10		300
TS (mg/l)	48	290	104	25.5746	9		500
TSS (mg/l)	41.5	283.5	97.08	25.4173	2.5		
Turbidity (NTU)	0	5.81	2.33	0.7381	4.66	≤5	≤5
Colour (PCU)	6	20	11.33	1.2573	4	15	3
DO (mg/l)	4.1	4.6	4.26	0.0457	3.5	≤6.00	6
BOD5 (mg/l)	1.1	1.86	1.45	0.0744	0.4	3	
COD(mg/l)	1.76	2.88	2.27	0.1176	0.64	30	
Cl (mg/l)	117.96	339.89	174.53	22.5385	181.88	250	100
TH(mg/l)	141.5	195.12	158.36	5.1214	39.02		300
NO3 (mg/l)	12	21.4	17.6	0.9007	19.7	50	
PO34 (mg/l)	9.5	11.9	11.17	0.23431	2.7	3.5	
NH3 (mg/l)	0.06	0.16	0.117	0.0111	0.02	0.05	<1.50 <
Ca (mg/l)	5.05	11.88	7.2317	0.67988	8.41		75
Mg (mg/l)	29	39.15	33.66	0.94651	3.56	0.02	0.02
Cu (mg/l)	0.04	0.17	0.09	0.01068	0.03	1	
Mn (mg/l)	0.1	1.45	0.78	0.16894	0.7	0.05	0.05
Fe (mg/l)	0	9.02	0.82	0.74507	0.17	0.3	0.3
Zn (mg/l)	0.1	1.13	0.65	0.08426	0.51		5
Coliform (cfu/ml)	8	110	42.17	20.674	NG		

SE = Standard Error, TH = Total Hardness, EC = Electrical Conductivity, TS = Total Solids, TDS = Total Dissolved Solids, TSS = Total Suspended Solids, DO = Dissolved Oxygen, BOD = Biological Oxygen Demand, COD = Chemical Oxygen Demand, NESREA = National Environmental Standards and Regulations Enforcement Agency, WHO = World Health Organization. (SOURCE: Field Work, 2018).

A. Spatial Variation

There were spatial variations in the levels of the borehole water quality parameters measured during the sampling period. Mean minimum temperature (24.15^{0}C), pH (3.81), and colour (3.50PCU) were recorded at Sampling Locations FUTO, B80M and FUTO while their maximum values of 28.20, 5.15 and 19.50PCU were recorded at B200M, FUTO and B80M respectively (Fig.2). Fig.3 shows that the mean minimum conductivity (12.50µS/cm) and Total Dissolved Solids (TDS) (7.00mg/l) is the same for all the sampling locations, Total Solids (TS) (9.00mg/l) was recorded in FUTO, while the maximum level (290.00mg/l) was recorded in B80M.

Mean minimum values of Total Suspended Solids (TSS) (3.00mg/l) and Total Hardness (TH) (38.52mg/l) were recorded in FUTO, while Chloride (Cl$^-$) (118.96mg/l) were recorded at A50M, also their maximum levels (282.00mg/l,194.12mg/l,337.89mg/l respectively) were all recorded in Sampling Locations B80M (Fig.4). Fig.5 shows that the mean minimum Dissolved Oxygen (DO) (3.35mg/l), Biological Oxygen Demand (BOD) (0.43mg/l), and Chemical Oxygen Demand (COD) (0.59mg/l) were all recorded in FUTO Sampling Location while their maximum levels of 4.45mg/l, 1.83mg/l and 2.78mg/l were all recorded at A80M sampling location. Mean minimum levels or turbidity (0.00NTU), NH$_3$(0.02mg/l) and NO$^-_3$ ions (12.00mg/l) were recorded at A80M/B50M/B80M, FUTO and B200M respectively, while their maximum levels of 5.38NTU,0.16mg/l, and 21.40mg/l were recorded at B200M, A200M, and A200M respectively (Fig.6). Fig.7 shows that the minimum mean levels of Fe (0.05mg/l) and PO$^{4-}_3$ions (4.70mg/l) and coliforms (0.00cfu/ml) were recorded in B50M/B80M, FUTO and A50M/ A200M/B50M/FUTO while their respective maximum values of 9.02mg/l, 11.750mg/l, and107.50cfu/ml were recorded at A50M, A50M, and B80M respectively.

Mean minimum values of Magnesium (Mg) (3.56mg/l), Zn(0.55mg/l), and Ca (5.15mg/l) were all recorded at FUTO, FUTO, and B200M respectively, while their maximum levels (39.15mg/l,1.075mg/l, and 11.83mg/l) were recorded at B80M, B50M, and B80M as shown in Fig.8. Fig.9 shows that the minimum values of Cu (0.05mg/l) and Mn (0.50mg/l) were all recorded at FUTO, and B50M respectively, whereas their maximum values of 0.16mg/l and 1.40mg/l were all recorded at B80M.

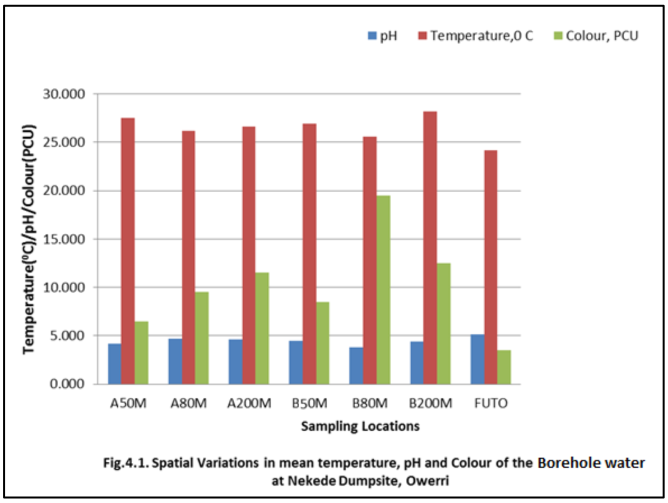

Figure 2. Spatial Variations in mean Temperature, pH and Colour of the Borehole water at Nekede Dumpsite in Owerri

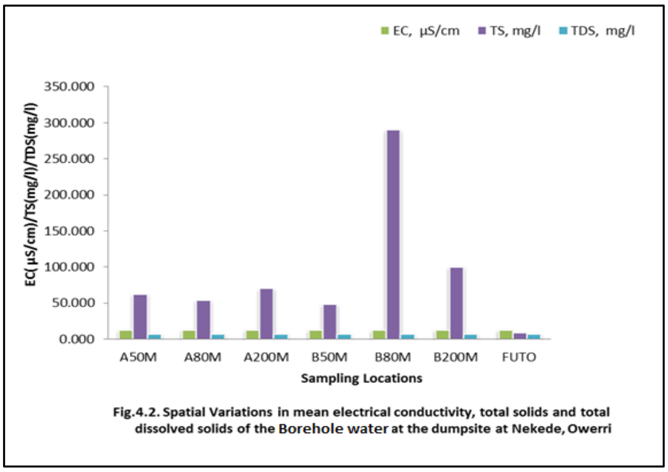

Figure 3. Spatial Variations in mean electrical conductivity, Total Solids and Total Dissolved Solids of the Borehole water at Nekede Dumpsite in Owerri

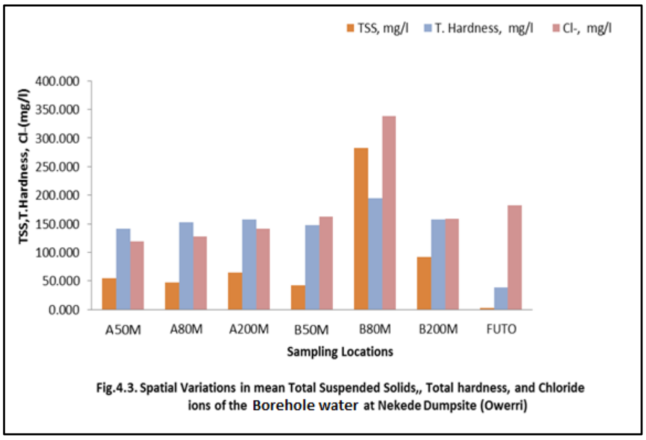

Figure 4. Spatial Variations in mean Total Suspended Solids, Total hardness and Chloride ions of the Borehole water at Nekede Dumpsite in Owerri

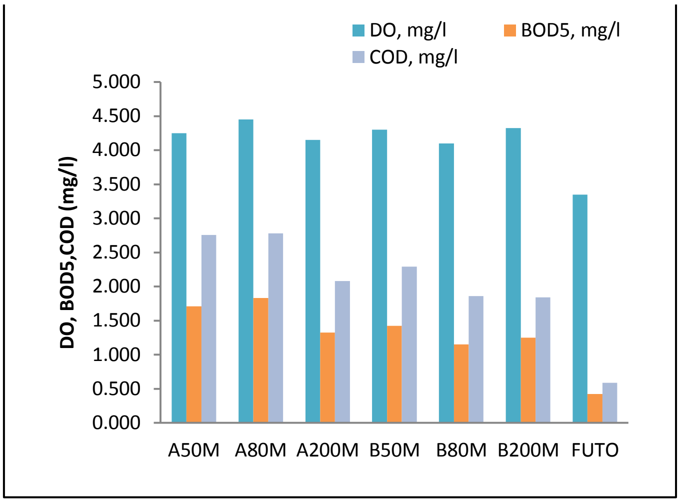

Figure 5. Spatial Variations in mean dissolved oxygen, biological oxygen demands and chemical oxygen demand of the Borehole water at Nekede Dumpsite in Owerri

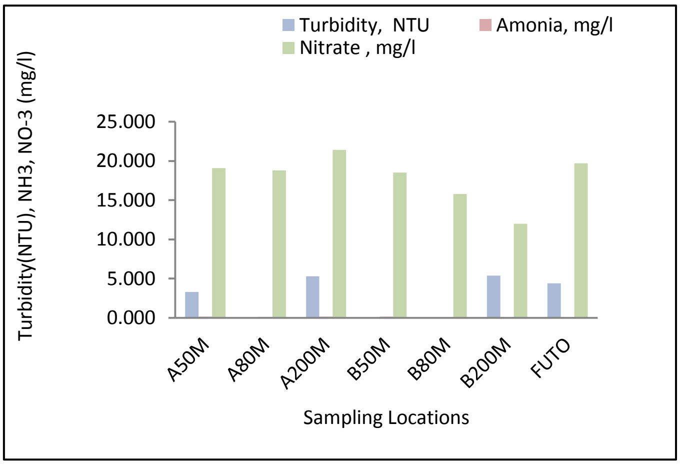

Figure 6. Spatial Variations in mean turbidity, ammonia and nitrate of the borehole water at Nekede Dumpsite in Owerri

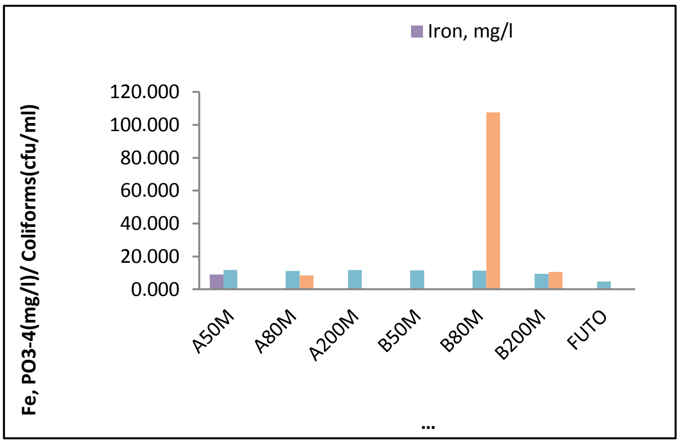

Figure 7. Spatial Variations in mean Fe, phosphate ion concentration and coliform counts of the Borehole water at the Nekede Dump site in Owerri

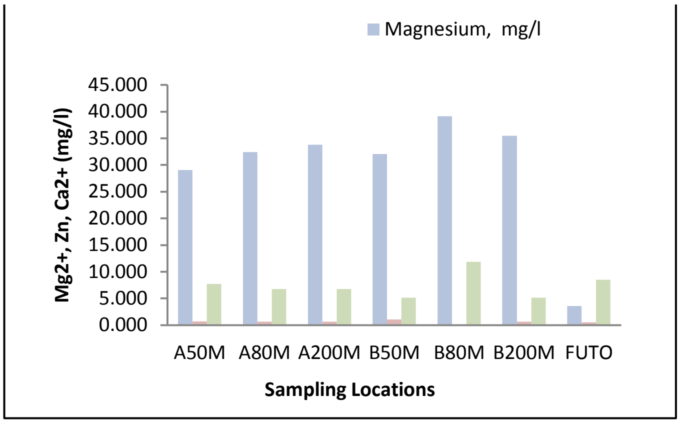

Figure 8. Spatial Variation in mean Magnesium (Mg^{2+}), Zinc (Zn) and Calcium (Ca) ion concentration of the Borehole water at Nekede Dump site Owerri

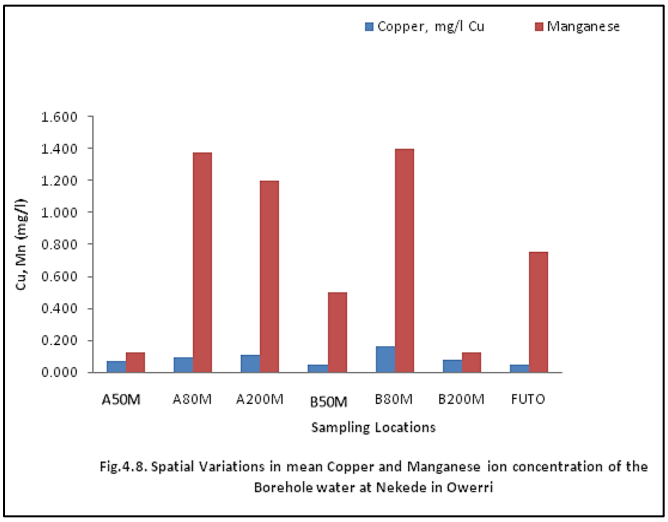

Figure 9. Spatial Variations in mean copper and Manganese ion concentration of the Borehole water at Nekede in Owerri

B. Means plot

The control location (FUTO) was used by a post-hoc ANOVA structure of group means as forecaster variable revealed that at A50M, T. Hardness(141.50mg/l), Cl$^-$ (118.96mg/l), TS (62.00mg/l), TSS (54.50mg/l) and Magnesium (29.05mg/l) contributed the observed heterogeneity most as shown in Fig.10. At A80M, T. Hardness (152.20mg/l), Chloride ions (127.46mg/l), Total Solids (54.0mg/l), TSS (47.00mg/l), and Magnesium (32.44mg/l) contributed the observed heterogeneity as shown in Fig.11. Be that as it may be, at A200M, T. Hardness (157.00mg/l), Chloride ions (140.95mg/l Total Solids (70.0mg/l), TSS (64.50mg/l), and Magnesium (33.80mg/l), at B50M, T. Hardness (147.30mg/l), Chloride ions (162.94mg/l Total Solids (48.0mg/l), TSS (42.00mg/l), and Magnesium (32.06mg/l), whereas at B80M,T. Hardness (194.12mg/l), Chloride ions (337.89mg/l)Total Solids (290.0mg/l),TSS (282.00mg/l), and Magnesium (39.15mg/l), Nevertheless, at B200M, T. Hardness (158.00mg/l), Chloride ions (158.95mg/l) Total Solids (100.0mg/l), TSS (92.50mg/l), and Magnesium (35.49mg/l), were the variables that contributed the observed differences as shown in Fig.12 – Fig.15.

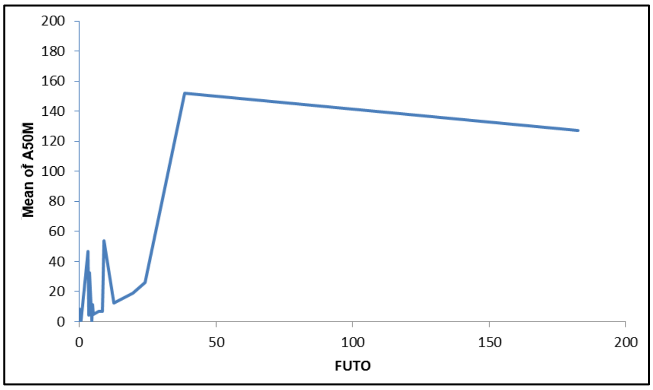

Figure 10. Means plot in levels of water quality between FUTO and A50M

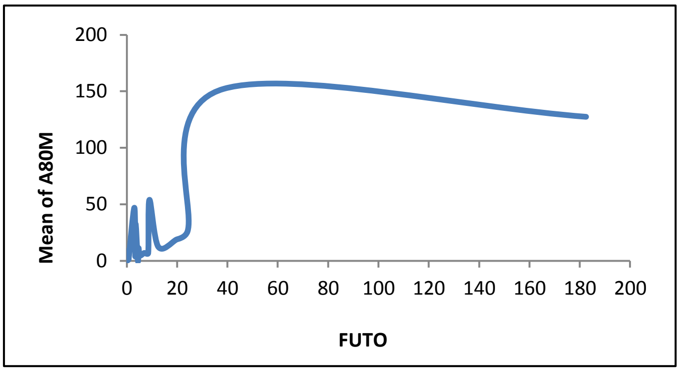

Figure 11. Means plot in levels of water quality between FUTO and A80M

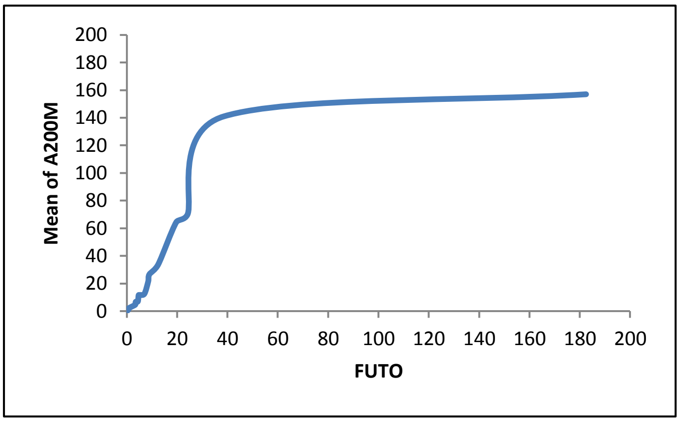

Figure 12. Means plot in levels of water quality between FUTO and A200M

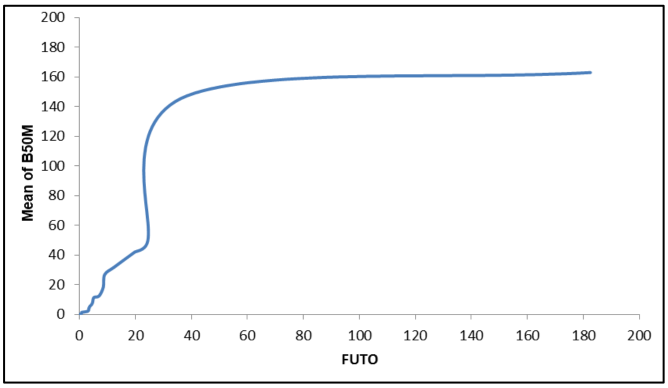

Figure 13. Means plot in levels of water quality between FUTO and B50M

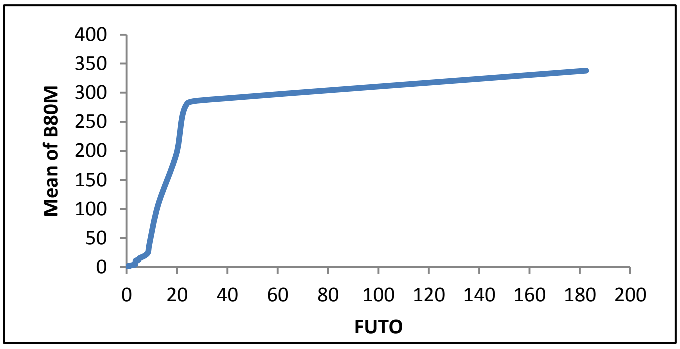

Figure 14. Means plot in levels of water quality between FUTO and B80M

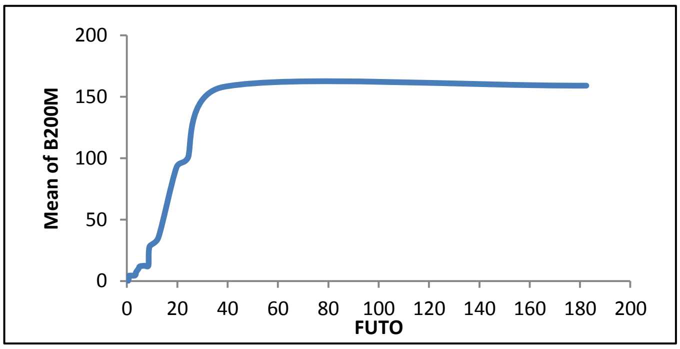

Figure 15. Means plot in levels of water quality between FUTO and B200M

C. Discussions

The results and comparison of the sample parameters with the World Health Organization (WHO) and the National Environmental Standard and Regulation Enforcement Agency (NESREA) were presented in Tables 1.

The presence of colour was an indication of pollution and confirmed leachate infiltration into the groundwater (Mohamed *et al.*, 2009). The WHO (2010) guideline values of 5 hazen unit is the desirable limit but for its presence violates the definition of potability of water. A potable water must be colourless, odourless, tasteless, and free from objectionable and pathogenic organisms and also fit for consumption. The temperature across the sample locations were found outside the range of the WHO standard of 5 degree celcius for domestic water hence indicating the presence of foreign bodies.

Magnesium and calcium, which occur naturally in water bodies, are among the most highly available alkali metals in the environment (Grochow-ska and Tandyrak 2009). Magnesium salts are found naturally and in high concentrations in surface and ground water, and the only other elements that occur in greater abundance are sodium and calcium cations. Magnesium and calcium concentrations in ground and surface waters increase as those elements are washed out from bedrock (Gałczyńska *et al.*, 2013). Calcium compounds occur naturally in surface water, and their concentrations are determined mainly by the carbonate balance (Gałczyńska *et al.*, 2013). Calcium and Magnesium are essential elements needed in good quantity by the human body and they also attribute to water hardness. Calcium functions in teeth and bone formation, neuromascular extractability, good functioning of the contractibility and blood coagulability (Awomeso *et al.*, 2010).The concentration of Ca ion is below permissible range of (WHO, 2010) standards for potable groundwater. The mean values of most of the trace metal contaminants in Nekede Dumpsite apart from Magnesium ion Mg^{2+}, manganese Mn and Iron Fe were found to be within the permissible limits of NESREA. This may be attributed to the low discharge of toxic wastes such as used batteries, rusted and decomposed vehicle machine scraps and used cans on the dumpsite.

Domestic and municipal sewage, excreta and urine residues from domestic animals, and fertilizers have been identified as the major sources of groundwater pollutants (Pacheco et al. 2001).

The mean Chloride ions in borehole water around the Nekede Dump site were within NESREA and WHO specification. This suggests that the groundwater is suitable for drinking and other purposes. Its presence connotes pollution hence require treatment before use. The high value of chlorides connotes the presence of weathered silicate rich rocks beneath the overburden and leaching from soil due to infiltration from the dumpsite and other anthropogenic activities. This agrees with the findings of Igbinosa and Okoh, (2009), Srinivasamoorthy *et al.*, (2009). Chloride is a widely distributed element in all types of rocks in one or the other form. Its affinity towards sodium is high. Therefore, its concentration is high in groundwater, where the temperature is high and rainfall is less. Soil porosity and permeability also has a key role in building up the chlorides concentration.

Hardness is an important factor in determining the suitability of water samples for domestic, and irrigation purposes as it is involved in making the water. Based on the Satyaji *et al*, (2010) water is classified as, soft, hard, moderately hard and very hard. The classification of groundwater based on total hardness indicates all samples are very hard in nature. For the maximum permitted limit of total hardness for drinking is specifies as 500 mg/l. For our research work, the Total Hardness of all the sampling locations were within range.

The Total Dissolved Solids of our various sampling locations all gave the same result that were within specification of the NESREA. Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolving soil minerals. These salts are carried with the water wherever it is used. In case of irrigation, the salts are mixed with the water and remain behind in the soil as water evaporates or is used by the crop. Salinity problem exists if salt accumulates in the crop root zone to a concentration that causes a loss in yield. Water with TDS up to 500 mg/l is considered desirable for drinking, 500–1000 mg/l is permissible for drinking, up to 3000 mg/l is useful for irrigation and the greater than 3000 mg/l is unsuitable for drinking and irrigation purposes Singh (2002). TDS or dissolved ions in water estimates the amount of Electrical Conductivity. TDS in this present study shows similar trend with EC. This trend could be as a result of their relationship. They both also have a high positive correlation. Generally, the higher TDS causes gastro-intestinal irritation to the human beings and the prolonged intake of water with the higher TDS can also cause kidney stones and heart diseases (Garg *et al.,* 2009**)**.

Total hardness (TH) is caused primarily by the presence of cations such as calcium and magnesium and anions such as carbonate, bicarbonate, chloride and sulphate in water. It causes unpleasant taste and reduce ability of soap to produce lather. The acceptable limits for domestic use are 75 mg/l. Hard water is unsuitable for domestic use. The mean TH falls below the maximum acceptable limit of WHO. According to Srinivasamoorthy *et al.,* (2009), hardness refers to reaction with soap and scale formation which increases boiling point of water but does not have any adverse effects on human health. The hardness of water samples may be due to leaching of Ca and Mg ions into the groundwater. Boiling of water at boiling temperature will naturally remove temporary hardness while addition of carbonates and sulphates will eliminate permanent hardness.

The mean pH is bellow 6.5-8.5 which is acidic and indicated presence of metals in the samples particularly toxic metals. This falls outside the WHO permissible range of 6.5-8.5 and confirmed the acidic nature of the water from the wells. Metals such as zinc, damaged battery cells (lead, mercury and alkaline) and improperly disposed used cans of aerosol and other disinfectants deposited in the dumpsite as waste, after exposure to air and water may have found their ways to the groundwater levels through seepage to give the toxic, acidic nature it currently possesses. It was remarked that though 7.0 is the neutral, up to 9.2 may be tolerated, provided microbiological monitoring indicated no deterioration in bacteriological quality WHO (2010). In this case, all indicators showed deterioration in bacteriological quality and deserve urgent attention to avert the imminent catastrophe its continued existence in both the soil and water bodies will pose to the end users of these resources.

Zinc levels in surface water and groundwater normally should not exceed 0.01 and 0.05 mg/l, respectively, concentrations in tap water can be much higher as a result of the dissolution of zinc from pipes. Zinc is found naturally at low concentrations in many rocks and soils principally as sulphide ores and to a lesser degree as carbonates. Zinc is considered an essential trace metal which functions as a catalyst for enzymatic activity in human bodies. Drinking water contains this trace metal in very small quantities which may reduce the possibility of its deficiency in the diet. However, its accumulation in the human body causes harmful effects such as stomach cramps, nausea, vomiting, decrease good cholesterol and acceleration of anaemic conditions (Reda, 2016). The maximum permissible limit for Zn in drinking water is 0.01 g/ml as recommended by WHO. In this study, the mean value of zinc is 0.65 mg/lthough, not up to the maximum permissible level, it still indicated pollution. The zinc contamination may be as a result of wastes containing zinc metals which were dumped on the dumpsite, decomposed and found its way into the water table. A similar result was reported by Igbinosa and Okoh (2009), Dissanayake *et al.,* (2010). This agreed with the findings of Longe and Balogun, (2010), Ikem *et al*, 2002, and Shyamala (2008).

TSS according to Oram (2017), can be defined as the portion of total solids in a water sample retained by a filter. The mean TSS in the present study when compared with the control location FUTO showed very high pollution around Nekede waste dump. PC 1 had high loading of TSS which could be attributed to the presence of the waste dump.

There was a strong positive correlationship between TSS and Turbidity in the study suggests that water with high TSS value; tend to have higher turbidity measurements. TSS has no standard in drinking water.

The highest Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand value was recorded at sampling Locations A50M & B50M respectively. PC 2 correlated highly and positively with COD and BOD respectively. This tends to indicate the maturity of the dumpsite. The trend observed in the COD values is similar to that of BOD but with higher values. The high values of BOD_5 observed for A50M & B50M is explained by microbial activity in the decomposing leachate yet to attained stability. The calculated ratio of 0.64mg/l for BOD/COD suggests high organic strength and this ratio is similar to those obtained by (Yoshida *et al.,* 2002; Amina *et al* 2004). In addition Irene, (1996) asserted that as the BOD_5/COD ratio decreases, the age of the landfill increases. The above assertion is applicable to landfills that have been closed and no longer receive wastes. It is suggested in this study that BOD_5/COD ratio is probably dependent on the depth at which leachate samples are collected for an open dumpsite that continues to receive wastes. In this case decomposition of waste is a continuous process as more wastes are dumped into the open dumpsite, which gives rise to different leachates that infiltrate into the subsurface.

The mean value of Turbidity NTU falls below the desired unit for NESREA and WHO. The observed value in Turbidity in sample A50M and the resultant value in sample A200M and B200M could be due to the proximity to the dumpsite and leachate movement which resulted in a higher value in location A200M and B200M where it is deposited. The WHO, 2010 recommended a value of 5 NTU (nephelometric turbidity unit) as the maximum above which disinfection is inevitable.

The presence of Phosphate ion in a leachate is dangerous as its presence in water increases eutrophication and correspondingly promotes the growth of algae. The mean value of phosphate exceeded the maximum permissible value for NESREA. PC 2 also correlated highly with the Phosphate ions. Phosphate values followed almost the same trend in all the locations throughout the study, and could be attributed to cumulative impact. The high value of phosphate indicated could be as a result of weathering of soluble inorganic materials found on the dumpsite, decaying biomass, animal waste, and detergent.

The mean value of Ammonia NH_3 is found to be above the maximum permissible limit of NESREA. The High content of Ammonia across all the sampling points is adduced to anaerobic condition that existed in the dumpsite and this may have enhanced the decrease of nitrate towards ammonia gas phase. The mean value of Nitrate ion NO^-_3 is below the maximum permissible limit of NESREA. According to Fatta *et al.,* (2001) nitrates are conservative contaminants as they are not affected by biochemical processes and natural decontamination processes taking place inside the landfill as well as their infiltration into the vadose zone. This explains why nitrates are potential threat to groundwater pollution. There was no off specification nitrate value recorded in all the sampling locations.

V. CONCLUSION

The physicochemical parameters such as temperature, colour, magnesium, manganese, iron and phosphate exceeded the maximum permissible limit of NESREA for drinking water while magnesium exceeded that of the W.H.O. The result of the water quality index across the sampling location indicates bad water quality in some of the locations while for others, it is moderate. It can therefore be concluded that borehole water around Nekede Waste Dumpsite is not potable but may be used for different domestic purposes. It has to be properly treated before human consumption.

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