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Assessment of Groundwater Contamination by Leachate from Nearby Open Dumpsite in Ido-Osun, Osun State Nigeria.

FADIPE, olusolaolayemi, 2.ORIAJE, Aremu and 3. AKINLABI, Peters.

1,2,3, Department of Civil Engineering, Osun State University,Osogbo, Nigeria.

***ABSTRACT*:** *In order to complement the hydro- geochemical analysis conducted on the study area,physic-chemical and bacteriological analysis ofwater –resources around the dumpsite was conducted. The municipal solid waste dumpsite has created a lot of problem for the area, the problem becomes worrisome to the residents as flames are being released into the atmosphere from time to time and water from wells are becominguseless as it becomes smelly and have taste.*

Water samples were obtained from 9 wells and the only stream around the study area using the factors such as nearness to dumpsite, elevation, and reports of field work. The pH and temperature were analysd in-situ using hand –held pH meter and a thermometer. Physico-chemical parameters such as alkalinity, hardness, chloride, TDS, EC and sulfate were analysed in accordance with standard methods. Results showed that the water from the area is mostly alkaline. All the parameters fall within the permissible limits of both WHO and Nigeria industrial standard (NIS) except for chloride with a higher value of 761mg/l in sample 6. Microbiological analysis of the samples showed heavily polluted water in wells close to the dumpsites and E.coli was found in almost all the samples.

I. Introduction

Studies have shown that Nigeria urban groundwater quality is influenced by the geology and geochemistry of the environment, rate of urbanization, industrialization, landfill and dumpsite leachate,heavy metals ,bacteriological pollution and effect of seasons. (Ocheri et al 2014). Industrialization and urbanization is growing at an un-precented rate and most times the development is often unbalanced with much of the budget voted to health sector, education,high profile visible infrastructurewith waste disposal and management coming well down the list of priorities in terms of allocation of funding. In the developing world the prevailing method for the disposal of municipal and domestic refuse is usually open dumping, often coupled with waste burning and minimal effort directed towards sanitary landfilling practice. (Klink and Stauart, 1999).Waste deposited in landfills or in refuse dumps immediately becomes a part of the prevailing hydrological system. Fluids derived from rainfall, and groundwater, along with liquids generated by the waste itself through processes of hydrolysis and solubilisation, caused by an entire series of complex biochemical reactions during degradation of organic wastes, percolate through the deposit and mobilize different components within the waste. This leachate, the liquid drains from the dump, chiefly organic carbon largely in the form of fulvic acids migrate downward and contaminate the groundwater (Ugwu, 2009).Leachate refers to the liquids that migrate from the wastes carrying dissolved or suspended contaminants. Municipal landfill leachate are highly concentrated complex effluents which contain dissolved organic matter, inorganic compounds such as ammonium,calcium, magnesium, sodium, potassium,iron,sulphates,chlorides and heavy metals such as cadmium,copper,lead,zinc,nickel,and xenobiotic organic substances(Lee and Jones,1993).

Leachate migration from wastes sites or landfills and the release of pollutants from sediments (under certain conditions) pose a high risk to groundwater resource if not adequately managed (Ikem and Osibanjo, 2002. Review of past result on effect of leachate of Osun State dumping site showed that major ions revealed concentrations within the acceptable limits of WHO standards, except chloride and sodium in some of the wells, probably due to addition of a disinfectant (“water guard”) and weathering of feldspars that characterize the basement rocks. For most of the trace metals, the concentrations were below detectable limits, except for zinc, iron, and manganese. However, iron and zinc concentrations fall well within the acceptable limit of both WHO and NIS permissible limits, while manganese concentrations were above the limit in most of the surface and shallow groundwaters downslope of the dumpsite. In Lagos ,Aderemi*et al*.(2011).reported that high levels of Pb and Cd were observed in the leachate and that result of microbial analysis showed the presence of *Enterobactriaceae* in leachate and groundwater samples.

Assessing groundwater quality and developing strategies to protect aquifers from contamination are necessary for proper planning and designing water resources. In order to complement the result of the hydro-geochemical analysis conducted on the study area, bacteriological and some physico-chemical analysis was conducted on the dumpsite in Ido-osun ,

II. Study Area

The study area location is Ido-Osun, in Egbedore south local government,Osun state, Nigeria. The dumpsite is the only and most active dumpsite for the whole Osogbo metropolis and it also serve other local Governments of the state. The area is characterized by the presence of tropical rain forest and temperatures ranging from 19°C to 34°C (annual mean temperature of about 24°C).The area lies in-between latitudes of 007° 46' 35" N - 007 °47' 45" N and latitude 004° 29' 14" E-004° 30' 28" E.. The area is characterized by the tropical rain forest. It has witnessed rapid growth in population (~155000 inhabitants in 2006). The wind speed is 9.2Km/H north/northwest and Temperature ranges from 19^0C to 34^0C, with 28^0C as averageduring month of January 2016 and 24^0C on annual mean temperature. Average rainfall is about 350mm.The minimal elevation of the town is 220m above sea level and maximum elevation is 624m above sea level(Oyelami*et al*,2013). Figure 1 shows the map of the local government in the state.

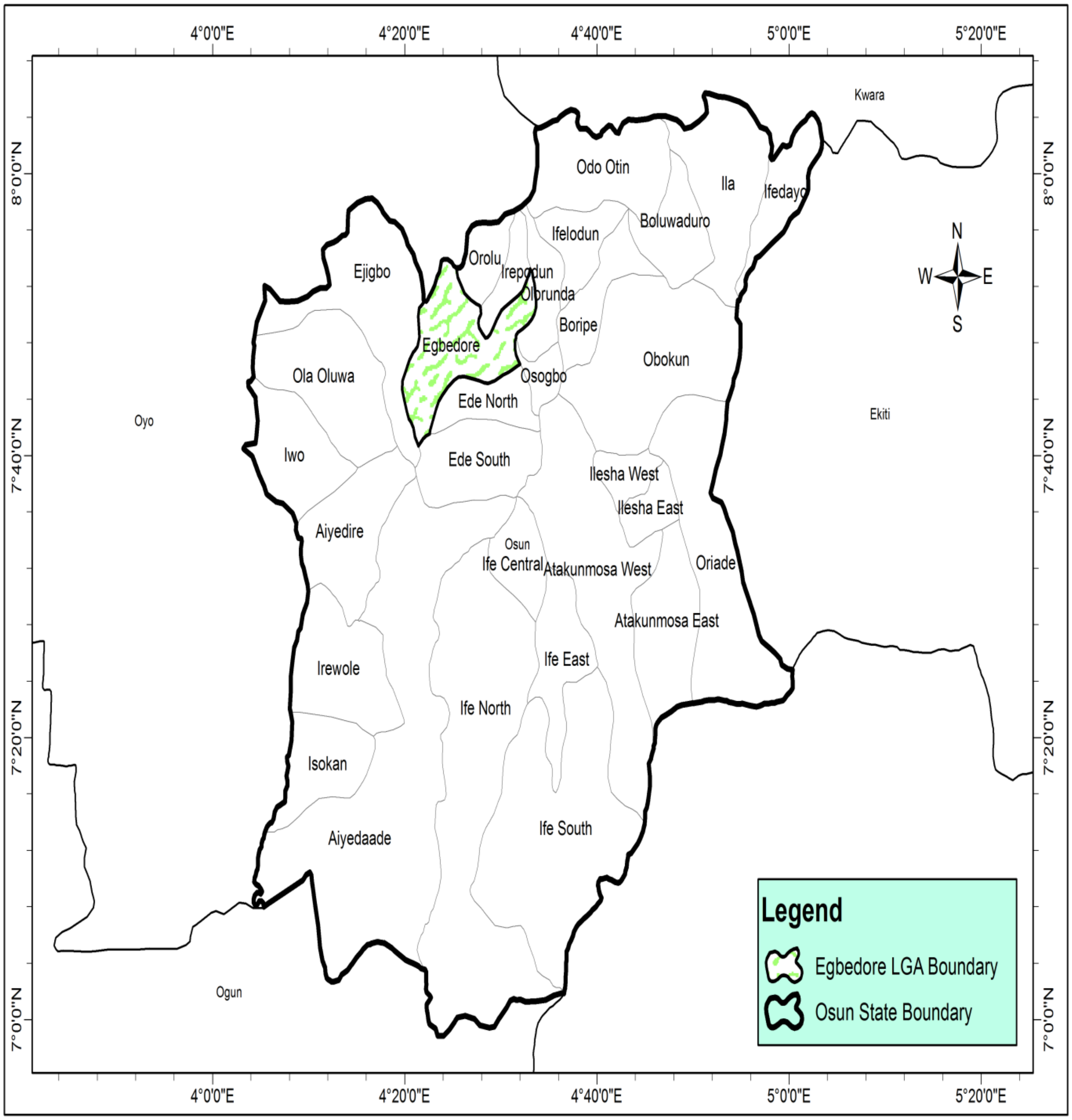

Figure 1: Map of Osun state showing the LGA

3.2 Methods

A total of 70 households were identified in the area with 28 wells as their major source of drinking water. Eight sampling sites were randomly selected from these using factors such as elevation, nearness to the dumping site, reports from oral interview from residents and questionnaires. The lateral distance of the sampling points to the dumpsite is presented in Table 1. Water samples were collected from these wells and from one stream that is equally close to the dumpsite for a period of 3months. Leachates were collected from the well that is the closest to the dumpsite. Details of the sampling sites are presented in Table 2. The locations of the points were obtained with a hand held GPS and points were overlaid on the contour maps as shown in Figure 3. The samples were collected in

1L plastic bottles which have been prewashed and sterilized. At the sampling sites, bottles were rinsed thrice with water samples prior to sampling. Unstable parameters such as pH and temperature were measured in-situ. Samples were conveyed to the laboratory and were analysed within 24 hrs. Samples analyzed are TDS, EC, alkalinity, calcium, magnesium, sulphate and chloride. Bacteriological analysis was carried out using Most Probable Number(MPN) of counting microorganisms. Results of the chemical analysis are presented in Tables 3,4 and 5. The mean of the results is presented in Table 6 while the comparison with WHO and NIS is shown in Table 7. The result of the MPN no of counting microorganism and organisms identified during bacteriological analysis is presented in Tables 8,9 and 10.

Table 1. Lateral distance of sampling points to dumpsites.

Sample no	Distance to dumpsite (m)	Depth of well (m)	Elevation(m)
1	48.9	4.1	313
2	60.4	3.8	310
3	36.4	1.9	299
4	108.34	5.2	307
5	248.34	7.5	315
6	18.02	6.1	316
7	35.8	6.2	307
8	74.0	4.9	314
9	261.0	6.3	298
Stream	16.64	NA	301

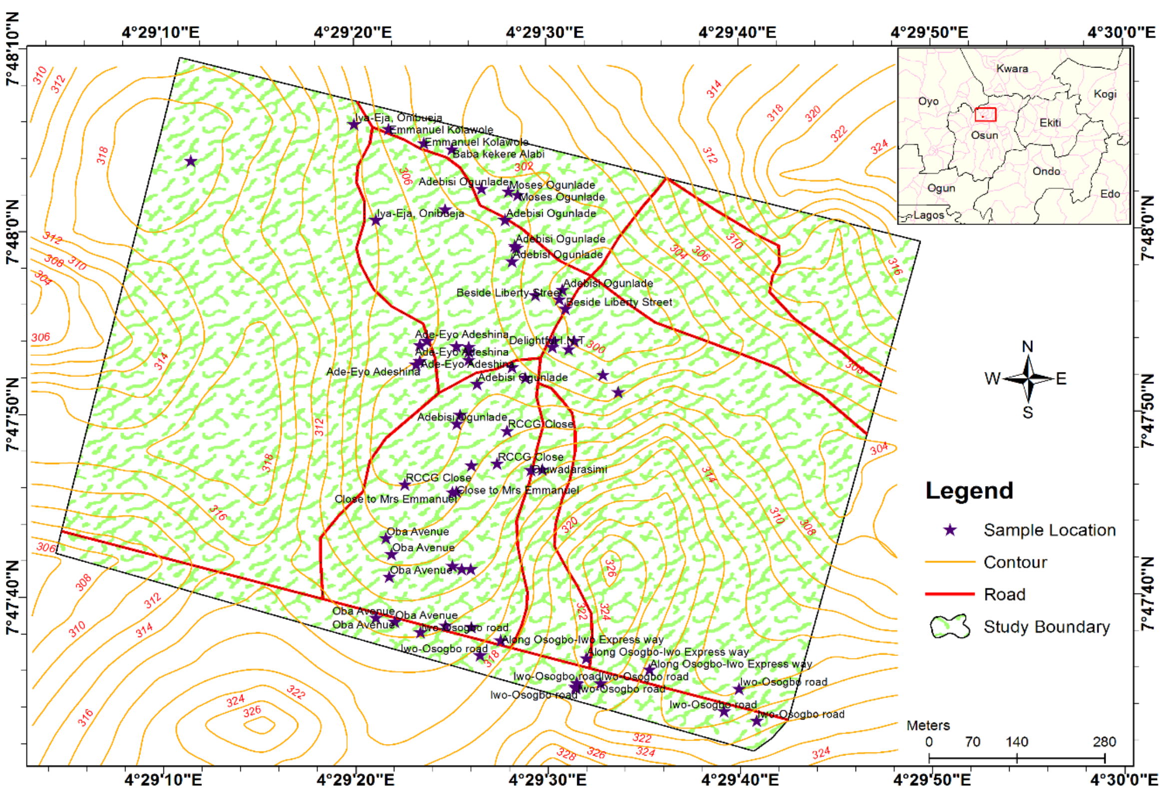

Figure 3.Points of households around the dumpsite superimposed on the contour map.

Table 2. Sample location, elevation, and description of well points

Sample no	Elevation(m)	X coordinates	Y coordinates	Sources	Status of wells (Lined/unlined)	Withdrawal Technology	Odour	Form of treatment (Treated)	Protection of wells (Covered)	Depth (m)
Sample 1	313	664341	861830	Well	Dug/ lined	Manual	Yes	None	Yes	4.1
Sample 2	310	664326	861959	Well	Dug/ unlined	Manual	Yes	None	Yes	3.8
Sample 3	299	664485	862203	Well	Dug/ring	Manual	None	None	None	1.9
Sample 4	307	664421	862169	Well	Dug/ lined	Pump	None	Yes	Yes	5.2
Sample 5	315	664274	862179	Well	Dug/ lined	Manual	None	None	Yes	7.5
Sample 6	316	664397	862007	Well	Dug/ lined	Manual	Yes	None	Yes	6.1
Sample 7	307	664250	861972	Well	Dug/ lined	Manual	Yes	None	Yes	6.2
Sample 8	314	664496	862283	Well	Dug/ring	Manual	None	None	Yes	4.9
Sample 9	298	664430	862458	Well	Dug/ring	Manual	None	None	Yes	6.3
STREAM(sample 10)	301	664442	862151	Stream	NA	Manual	Yes	None	None	ND

Table 3 Results of water samples analysis for the first month

Parameters/union		**Samples**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Stream**
Depth to water(m)		2.4	2.5	1.0	4.5	6.3	5.4	5.1	4.0	5.4	ND
Depth to bottom(m)		4.1	3.8	1.9	5.2	7.5	6.1	6.2	4.9	6.3	ND
pH		8.8	8.6	8.1	8.3	8.2	7.5	7.6	8.0	8.1	8.3
Temperature (^{0}C)		26	27	28	29	30	29	29	27	29	28
EC(µS/cm)		128	178	209	103	210	98	104	230	216	273
TDS(mg/L)		198.3	121.6	148	98.4	190	90.6	188.2	158.2	152.1	290
Alkalinity ($CaCO_3$) (mg/L)		240	228	86	44	198	152	130	182	152	216
Calcium (Ca^{2+})(mg/L)		51.6	45.9	22.3	11.3	38.6	28.2	40.8	4.6	23.1	32.6
Magnesium (Mg^{2+})(mg/L)		3.2	1.8	3.4	1.8	3.6	5.7	5.3	3.9	0.4	4.5
Sulphate (SO_4^-)(mg/L)		29.30	7.15	4.99	22.68	5.08	1.88	10.10	4.52	12.33	27.38
Chloride (Cl^-)(mg/L)		90.28	56.72	42.54	42.54	28.36	751.5	170.2	42.54	616.8	85.08
Sodium (Na^+)(mg/L)		25.50	21.00	17.50	9.50	16.50	10.80	18.70	13.90	19.30	28.00

Table 4 Results of water samples analysis for the second month

Parameter/unit)		**Sample**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**STR**
Depth to water(m)		2.3	2.5	1.1	4.5	6.2	5.3	5.1	4.0	5.5	ND
Depth to bottom(m)		4.1	3.8	1.9	5.2	7.5	6.1	6.2	4.9	6.3	ND
pH (no unit)		8.7	8.6	8.1	8.2	8.2	7.8	7.8	8.1	8.0	8.4
Temperature (^{0}C)		29	28	27	28	27	28	30	26	29	29
EC(µS/cm)		126	215	209	105	215	94	220	218	270	273
TDS(mg/L)		192.3	151.6	145	100.1	160	96.8	178.2	168.2	152.4	298
Alkalinity($CaCO_3$)(mg/L)		246	220	92	48	196	158	120	176	158	200
Calcium (Ca^{2+})(mg/L)		53.1	48.1	20.3	12.5	36.1	27.9	40.2	4.8	23.3	32.4
Magnesium											

(Mg^{2+})(mg/L)		3.2	1.9	3.3	1.6	3.6	5.3	5.3	3.9	0.5	4.7
Sulphate (SO_4^-)(mg/L)		32.34	7.28	5.26	20.72	5.16	2.00	10.48	4.52	14.64	29.20
Chloride (Cl^-)(mg/L)		92.24	58.00	42.54	56.72	30.34	751.5	156.3	42.54	601.4	84.62
Sodium (Na^+)(mg/L)		26.0	22.00	16.50	9.00	17.00	12.20	19.20	14.50	19.00	28.30

Table 5 Results of water samples analysis for the third month

Parameter		**Sample**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**STR**
Depth to water(m)		2.1	2.4	1.0	4.1	6.0	5.1	4.9	3.8	5.3	ND
Depth to bottom(m)		4.1	3.8	1.9	5.2	7.5	6.1	6.2	4.9	6.3	ND
pH (no unit)		8.5	8.5	8.0	8.0	8.1	7.5	7.6	8.0	8.1	8.3
Temperature		27	28	26	27	29	29	30	27	30	28
EC(^{0}C)		130	220	215	112	217	102	104	220	210	292
TDS(mg/L)		196	131.2	156	90.3	160	70.2	174	152.2	158.1	198
Alkalinity ($CaCO_3$)(mg/L)		250	216	98	52	200	162	116	174	164	223
Calcium (Ca^{2+})(mg/L)		50.2	44.7	21.3	11.8	36.9	28.4	39.6	5.3	24.3	30.0
Magnesium (Mg^{2+})(mg/L)		3.3	1.7	3.5	1.6	3.5	5.5	5.3	3.7	0.7	4.8
Sulphate (SO_4^-)(mg/L)		29.30	7.20	5.10	21.50	5.12	1.94	10.24	4.50	12.88	28.10
Chloride (Cl^-)(mg/L)		89.6	56.0	42.40	42.54	29.60	721.5	153.3	42.54	616.8	80.12
Sodium (Na^+)(mg/L)		26.50	19.00	14.00	9.00	17.50	11.00	19.10	13.60	18.70	28.00

Table 6 Mean physico- chemical parameter values of water sources

Parameter		Sample									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Stream**
Depth to water(m)		2.27	2.47	1.03	4.36	6.17	5.26	5.03	3.93	5.4	ND
Depth to well bottom(m)		4.1	3.8	1.9	5.2	7.5	6.1	6.2	4.9	6.3	ND
pH (no unit)		8.67	8.56	8.06	8.16	8.16	7.60	7.67	8.03	8.07	8.37
Temperature (^0C)		27.33	28.67	27.00	28.00	28.67	28.33	29.67	26.33	29.67	28.10
EC(µS/cm)		128.0	204.3	211.0	107.6	214.0	98.0	142.6	222.6	232.0	293.3
TDS(mg/L)		195.5	134.8	149.7	96.3	170.0	85.9	180.1	159.5	154.2	293.3
Alkalinity ($CaCO_3$)(mg/L)		248.7	221.3	91.3	48.0	198.0	157.3	122.0	177,3	158.0	213.0
Calcium (Ca^{2+})(mg/L)		51.63	46.23	21.30	11.87	37.20	28.17	40.20	4.9	23.57	31.67
Magnesium (Mg^{2+})(mg/L)		3.23	1.80	3.40	1.67	3.57	5.50	5.30	3.83	0.57	4.67
Sulphate (SO_4^-)(mg/L)		30.31	7.21	5.12	21.63	5.15	1.94	10.27	4.51	13.28	28.23
Chloride (Cl^-)(mg/L)		90.71	56.01	42.49	47.27	29.43	741.5	159.9	42.54	611.7	83.27
Sodium (Na^+)(mg/L)		26.00	21.00	16.00	9.00	17.00	11.00	19.00	14.00	19.00	28.10

Table 7 Comparison of WHO standards for various physico-chemical and biological parameters with value obtained

Parameters	Min	Max	Mean	Standard deviation	WHO Standard Max. Permissible	WHO Standard Highest Desirable	NSDQW	Wells exceeding permissible limit	Undesirable effect
Depth to water (m)	1.0	6.3	3.99	1.718	Nil	Nil	Nil	Nil	____
pH (no unit)	7.5	8.8	8.12	0.371	6.5-9.2	7.0-8.5	6.5-8.5	1,2,	Taste, Corrosion
Temp(^{0}C)	26	30	28.10	1.081					
EC(µS/cm)	94	298	185.3	63.110	1200	900	1300	Nil	
TDS(mg/L)	70.2	298	161.9	57.56	1500	1000	500	Nil	Gastro -intestinal irritation
Alkalinity (mg/L)	44	256	166.4	62.16				Nil	
Calcium (mg/L)	4.8	53.1	29.67	14.79	200	75	75	Nil	Scale formation
Magnesium (mg/L)	1.6	5.7	3.35	1.613	50	50	50	Nil	Scale formation
Sulphate (mg/L)	1.88	32.34	12.77	10.351	400	200	100	Nil	Laxative effect, Gastro intestinal irritation when ca and mg are present
Chloride (mg/L)	28.4	751.5	190.6	260.714	600	200	250	6, 9	Salty taste
Na (mg/L)	9.0	28.1	18.04	6.037	50	50	50	Nil	
Total coliform	4.0	1600	110.1	191.848	0	0	0	All	Disease outbreak

Table 8. Bacteriological quality of sampled wells and stream (first month)

Sample no	10ml	1ml	0.1ml	Interpretation of result	Biochemical test
1	3	3	3	1110^{+}(heavily polluted)	*E.coli, Shigella, Serratia*
2	3	2	2	210(polluted)	*Salmonella*
3	3	3	3	1110^{+} (heavily polluted)	*E.coli, Salmonella Serratia*
4	1	3	3	9 (slightly polluted)	*E.coli,*
5	2	2	2	35 (polluted)	*E.coliSalmonella Serratia*
6	3	3	3	1110^{+} (heavily polluted)	*E.coli SalmonellaSerratia*
7	3	3	3	1110^{+} (heavily polluted)	*E.coli*
8	3	2	2	1110^{+} (highly polluted)	*E.coli,*
9	0	1	0	3 (slightly polluted)	*Shigella, Serratia*
Stream	3	3	3	1110^{+} (heavily polluted)	*E.coli Salmonella , Serratia*

Table 8. Bacteriological quality of sampled wells and stream (second month)

Sample no	10ml	1ml	0.1ml	Interpretation of result	Biochemical test
1	3	3	3	1110^{+}(heavily polluted)	*E.coliShigellaSerratia*
2	3	2	2	210(polluted)	*Salmonella*
3	3	3	3	1110^{+} (heavily polluted)	*E.coli, Salmonella, Serratia*
4	3	2	2	1110 (highly polluted)	*E.coli,*
5	2	2	2	35 (polluted)	*E.coli, Salmonella , Serratia*
6	3	3	3	1110^{+} (heavily polluted)	*E.coli, Salmonella , Serratias*
7	3	3	3	1110^{+} (heavily polluted)	*E.coli*
8	3	2	2	1110^{+} (highly polluted)	*E.coli,*
9	3	3	3	1110^{+} (heavily polluted)	*Shigella, Serratia*
Stream	3	3	3	1110^{+} (heavily polluted)	*E.coli, Salmonella , Serratia*

Table 8. Bacteriological quality of sampled wells and stream(third month)

Sample no	10ml	1ml	0.1ml	Interpretation of result	Biochemical test
1	3	3	3	1110^{+}(heavily polluted)	*E.coli, ShigellaSerratia*
2	3	3	3	1110^{+} (heavily polluted)	*Salmonella*
3	3	3	3	1110^{+} (heavilypolluted)	*E.coli Salmonella , Serratia*
4	3	2	2	1110 (highly polluted)	*E.coli, Salmonella ,*

					Serratia
5	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Salmonella* , *Serratia*
6	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Salmonella*, *Serratia*
7	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Salmonella* , *Serratia*
8	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Ssalmonella*, *Serratia*
9	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Shigella*, *Serratia*
Stream	3	3	3	1110^{+} (heavily polluted)	*E.coli*, *Salmonella* *Serratia*

III. Results and discussion

The mean temperature is 28.10^{0}C with standard deviation of ±1.081, ranging from 26^{0}C to 30^{0}C. There is little or no difference in the temperature of wells and the stream. The temperature of the area is slightly above the WHO standard limit (25^{0}C). The mean total dissolved solids (TDS) is 161.9mg/L with standard deviation of ±57.56 and it ranges from 70.2- 298mg/L. The result showed that there is a wide difference from the mean and the range. Dissolved solids are the total quantity of mineral constituents dissolved from rocks and soils including organic matter and some water of crystallization.Generally TDS values can vary because of two major reasons. It could be physical or biological. Heavy rains and fast-moving water are erosive causing the dissolved constituents to move into the wells and stream. This can contribute to increase in the TDS as the samples were taken in the rainy season.Result obtained for TDS agreed with that obtained for Oyelami*et al.*(2013). In general, the total suspended solid for all the water samples are within the acceptable range of WHO standard limits.

The mean pH value of water samples is 8.12 with a standard deviation of ±0.371 and with a range of 7.5 – 8.8. Indicating a slightly alkaline (near neutral) as presented in Table 7. It was observed that almost all the water samples have the mean pH values within the permissible limit by WHO (6.5-8.5) except well 1 and 2.The pH in the area agrees with that obtained by Oyelami*et al.* (2013). Oyelami*et al.*(2013) attributed the underlying geology which has pegmatite rich in mica and feldspar to the result of thepH. The pH is affected not only by the reaction of carbon dioxide but also by organic and inorganic solutes present in water. Any alteration in water pH is accompanied by the change in other physico-chemical parameters. High values of pH may result from waste discharge to microbial decomposition of organic matter in the water body. In unpolluted water, pH is principally controlled by the balance between the carbon dioxide , carbonate and bicarbonate ions as wells as other natural compounds such as humic and fulvic acids(Chapman, 1994)

The mean chloride value of water samples is 190.6mg/L with a standard deviation of ±260.714 and with a range of 28.36 -751.5mg/L as shown in Table 7. It was observed that almost all the water samples have values within the permissible limit by WHO (250mg/L) except wells 6 and 9 which have 741.5mg/L and 611.7mg/L respectively on average. Chloride anions are usually presented in natural waters. The possibility of the increased concentration coming from human activities is not an over assumption. An excess of chloride in water is usually taken as an index of pollution and considered as tracer for groundwater contamination (Loizidou and Kapetanois, 1993).

A high concentration occurs in waters that have been in contact with chloride –containing geological formations (Agunwanba,2004). It is noted that sewage pollution causes increase in chloride and leachate pollution on underground aquifer also causes increase in chloride pollution.Oyelami*et al*. (2013) attributed the high chloride and sodium contents of groundwater around the dumpsite to the common practice of adding a disinfectant (sodium dichloroisocyanurate, ($C_3N_3O_3Cl_2Na$) commonly known as "water guard", but also to the weathering of feldspars, especially sodic-feldspar, which characterize the basement rocks underlying the area. Chloride in excess of 250mg/L gives rise to detectable taste in water.

Hardness is an important parameter in decreasing the toxic effect of poisonous element. The hardness is tested using calcium and magnesium for both the wells and the stream. The mean calcium value of water samples is 29.67mg/L with a standard deviation of ±14.79 and with a range of 4.8 -53.1mg/L. It was observed that all the water samples have values within the permissible limit by WHO. While the mean magnesium value of water samples is 3.35mg/L with a standard deviation of ±1.613 and with a range of 1.6 -5.7mg/L. It was observed that all the water samples have values within the permissible limit by WHO.

Bacteriological analysis.

The result of the microbiological analysis revealed a coliform count of the range above 1100 MPN which is interpreted as highly polluted and 1100^+ interpreted as heavily polluted in the third month. Organisms identified during biochemical test revealed *E.coli*, *Salmonella Shigella and Serratin*.The level of pollution is high with wells close to the dumpsites but in all the samples, none of the samples comply with WHO standard. .Coliform bacteria are considered as “indicator organism”, their presence in water may indicate contamination of water by fecal waste. *E.coli*were seen in almost all the samples and this is a big threat to the residents around the dumpsite because microbiological quality of drinking water has been implicated in the spread of important infectious and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis and diarrhea (one of the main course of morbidity and mortality among children), acute renal failure and haemolyticanemia(Ikotun and Awokola,2012). When compared to WHO standard for drinking water, all the sampled well in the area are not wholesome for drinking. These results apparently indicates contamination especially by fecal matter probably from the dumpsite or indiscrimate disposal of domestic wastes

IV. Conclusion and recommendation

The result of the bacteriological analysis has complimented the result of the study of the dumpsite by Oyelami*et al.*(2013). Results revealed that the wells around the dumpsite are seriously polluted from the leachate. Though most of the results do not exceed the maximum permissible by WHO, taking such water might be harmful to the health. The government should as a matter of urgency turned the dumpsite to a proper landfill as was planned. Residents of the area should ensure proper treatment of chlorination and or boiling. A constant monitoring of the wells around the area should be conducted routinely.

V. Acknowledgement

The author wish to acknowledge AKINLABI, Peter(an undergraduate student of OsunState University) for the role played in field work and in the laboratory. Also acknowledged is the staff of Osun State Waste Management Board for their cooperation during the course of study.

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