Hydrogeochemical Investigation of the Effect of Refuse Dumps on Groundwater Quality in Parts of IdoOsun, South Western Nigeria

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Abstract – This study investigates the effect of refuse dumps on the quality of groundwater within the vicinity of Aduramigba Estate, Ido, Osun State. Ten water samples were collected from wells in the neighborhood of Onibueja dumpsite in Aduramigba Estate, IdoOsun. Seven of the samples (sample 1,2,3,5,6,7 and 8) were taken close to the dumpsite ranging from distance 28.44m to 350m as main samples while three samples (sample 4,9 and 10) were taken from longer distance ranging from distance 500m to 1000m as control samples in order to know the extent at which the contamination from the dump as spread to.. The samples were analyzed for physicochemical parameters such as pH, alkalinity, temperature, electrical conductivity (EC), hardness, total dissolve solutes (TDS), turbidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), major ions and heavy metal among others using AAS, Iron Chromatographic and titrimetric methods. The result of both the main and control samples are as follows: pH value (6.67-7.84), Alkalinity (120-330mg/l), temperature (73.8-87.3of), Hardness (74-732mg/l), EC (0.212-1.952µS/cm), TDS (0.1431-1.4232mg/l), DO (0.8-1.8mg/l), Biochemical oxygen demand (BOD) (0.1-1.1mg/l), Chemical oxygen demand (COD) (0-195mg/l). Major ions: Cl- (28.8-72.0mg/l), NO3- (0.40-1.31mg/l), SO42- (0.16-2.11mg/l), HCO3 - (20.8-36.0mg/l), Ca2+ (17.60-333.5mg/l), Mg2+ (2.10-41.45mg/l), Na+ (5.0-106.0mg/l), K+ (0.77-24.10mg/l). And heavy metals: Fe2+ (1.69-2.20mg/l), Mn2+ (0.004-0.018mg/l), Cu2+ (0.14-0.78), Zn2+ (0-3.30 mg/l), Pb2+ (0.031-2.281 mg/l), Cd (0.002-0.025 mg/l) and Si (0.008-0.064 mg/l). From the result, the valuesof the analyzed parameters for both control and main samples indicated low contamination and fall within the acceptable limit for drinking water as recommended by World Health Organization except for Calcium and Potassium in sample one; Lead, Cadmium and Iron inall of the samples that are higher than the acceptable limit.Moreso, hardness and turbidity were higher than the acceptable limit in some of the samples. The high in contamination of some of the heavy metal in both the main and control samples isassociated to the percolation of leachates from the dumb into the groundwater in the area.

Keywords: Analyzed, Contamination, Cadmium, Dump, Leachates, Physicochemical, Water.

1. INTRODUCION

The problem of solid waste management in Nigeria has become a complex issue as a result of high population growth, accelerated urbanization and industrialization (Aguwamba 2003). Nkwocha and Emeribe (2008) identified a total of 150 authorized and illegal dumpsites in the urban and suburban areas of the South – East and South – South geopolitical zones of Nigeria. Their results show that most of these dumpsites were usually haphazardly located without careful consideration of environmental and public health. Landfill is a large area of land or an excavated site that is specifically designed to receive wastes (US EPA, 2003).However, poorly designed landfills can cause contamination of groundwater, soil, and air. The most commonly reported danger to the human health from these landfills is from the use of groundwater that has been contaminated by leachate (Rajkumar*et al.,* 2010*).* As water percolates through the landfill, contaminants are leached from the solid waste and infiltrate into the ground. This study was carried out to investigatethe effect of refuse dump on groundwater quality around onibueja dumpsite in Aduragbemi Estate Ido-Osun, a suburb of Osogbo, Southwestern Nigeria.

2. STUDY AREA

The study area is within Aduramigba Estate in Ido-osuna suburb of Osogbo, Southwestern Nigeria. It lies between longitude 07° 46' 35" N - 07 °48' 01" N and latitude 004° 29' 14" E-004° 30' 28" E (Figure 1). It's accessible by the Iwo-Osogbo major roads. The dumpsite is the only and most active dumpsite for the whole osogbo metropolis. The area is characterized by tropical rain forest and temperatures ranging from 19^0c to 34^0c. The average rainfall is about 350mm; the drainage pattern is dendritic due to a clayey, weathered surface layer overlying the complex basement rock. The streamsin the area flows NW-SE and discharging into the Osun River (Oyelami*et al.*, 2013).Regionally, the area is underlain by quartzite which is a member of the Precambrian Basement Complex rocks

of Southwestern Nigeria (Rahaman, 1988). The Basement Complex rocks have been classified into (1) Migmatite gneiss-quartzite complex, (2) slightly migmatized to non-migmatizedmetasedimentary and metaigneous rocks, and (3) members of the Older Granite Suite (Rahaman, 1988). These rocks constitute the prominent outcrops and inselbergs that define the topographic highlands in the area (Adediji and Ajibade, 2008).

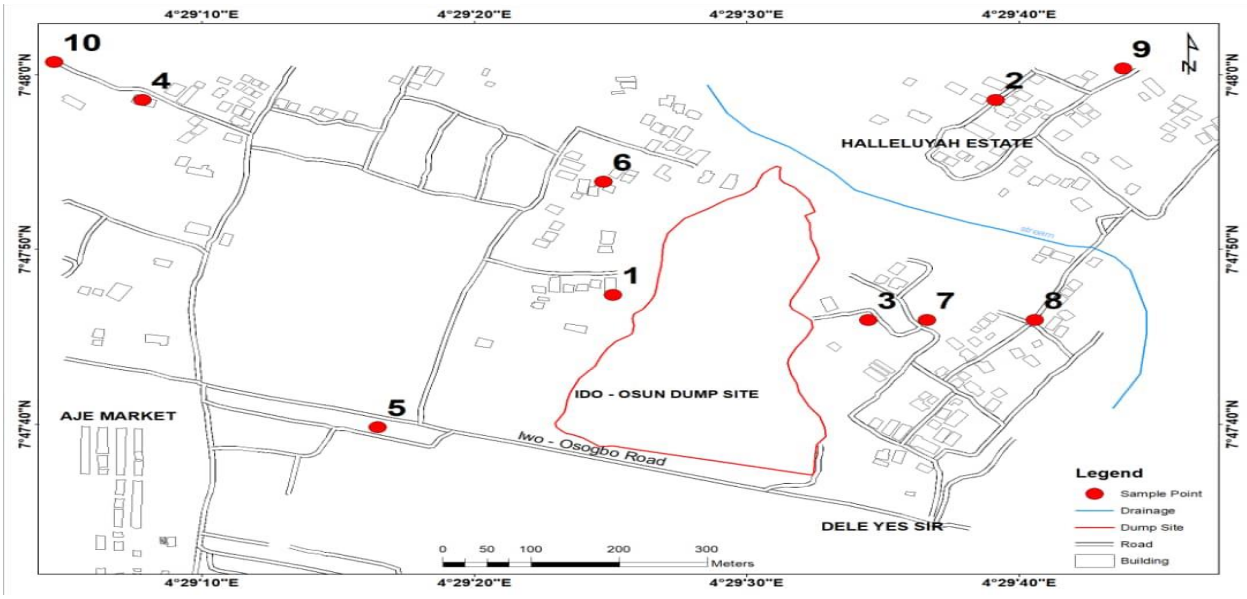

Figure 1: Locationmap of the Study Area showing the sampling points.

3. METHODOLOGY

Water samples were collected from Ten (10) wells in the neighborhood of Onibueja dumpsite, seven of the samples (sample 1,2,3,5,6,7 and 8) were collected close to the dumpsite at distance range from 28.44m to 350m for main samples and 500m to 1000m for control samples(sample 4,9 and 10) (table1).Parameters such as Temperature, colour, taste, Electrical conductivity (EC), and Total Dissolved Solid (TDS) were measured using the Ec/pH multi parameter instrument. Global Positioning System was used to perform geo-referencing of each sampling point. Cationsampling solutions were acidified with (HNO_3) to prevent metallic ions from adhering to the walls of the container and to homogenize the water sample. Samples were also refrigerated to prevent any reactivity. Laboratory analyzes were carried out within 48 hours at the Agronomy Departmental Analytical laboratory, University of Ibadan. Cations and heavy metals analyses were carried out using Atomic Absorption Spectrophotometer, while anion analysis was performed using Iron Chromatographic method (titrimetric method was used for SO4 and HCO3).All tests were carried out in accordance with the American Public Health Association recommendations (APHA). The Anions analyzed are nitrate (NO_3^-), bicarbonate (HCO_3^-), chloride (Cl^-), sulphate (SO_4^-); Cations are calcium, magnesium, potassium, sodium, manganese; while the heavy metals are iron, copper, zinc, silicon, cadmium, and lead.Other physicochemical parameters analyzed are Alkalinity, total hardness, bio-chemical oxygen demand (BOD),chemical oxygen demand(COD) and Dissolved oxygen (DO).

4. RESULT AND DISCUSION

4.1. Physical parameters

The result of the physical parameters of the analyzed samplesare presented in table 1 and 2. The result indicates that all the parameters falls within the acceptable standard for drinking water as recommended by the World Health Organization (WHO, 2011), except for hardness and turbidity that are above the standard in some of the wells. The hardness may be linked to geogenic factor such as weathering of the feldspars, especially sodic-feldspar, which characterized the basement rocks underlying the area while the samples that are high in turbidity value are due to soil and plant particles that fell into the uncovered well which later form suspension and also as a result of surface runoff into the wells. Moreso, some of the samples from the uncovered well were discovered to have odour and are reddish to brown in colour.

Table 1: Sample descriptions

Sample No	Distance From dump site (m)	Protection status	Nature of water	In use	Colour	Odour
1	28.4	uncovered	Well	Yes	Reddish	Has odour
2	350	Uncovered	Well	Yes	Colourless	Has odour
3	50	Covered	Well	Yes	Brown	Odourless
4	900	Covered	Well	Yes	Colourless	Odourless
5	250	Uncovered	Well	Yes	Brown	Has odour
6	150	Uncovered	Well	Yes	Colourless	Has odour
7	140	Covered	Well	Yes	Colourless	Odourless
8	300	Covered	Well	Yes	Brown	Odourless
9	500	Covered	Well	Yes	Colourless	Odourless
10	1000	uncovered	Well	Yes	Brown	Odourless

Table 2: Summary of physicochemical parameters

Sample no	D to W (m)	D to B (m)	Ele (m)	pH	Temp. (°f)	Ec (µS/cm)	Turb.	Alk.	Hardness	DO	BOD	COD	Comment on water and well
1	4.9	7.3	1026	7.10	87.3	1.719	<5	150	732	1.8	0.5	38	Reddish brown, uncovered
2	7.2	8.3	1042	7.25	78.7	0.385	>5	150	194	0.8	0.1	195	Reddish brown, uncovered
3	5.7	6.6	1026	6.7	-	0.212	<5	150	124	1.5	0.2	0	Colourless, covered
4	4.3	6.0	1051	7.75	78.4	0.348	<5	162	188	1.5	0.3	0	Colourless, odourless
5	4.7	6.3	1063	7.56	79.5	0.223	<5	120	108	1.1	0.3	82	Brown, uncovered
6	4.5	6.2	1040	7.01	73.8	0.627	>5	330	348	1.4	1.1	125	brown, uncovered, has odour
7	7.5	9.3	1055	7.11	-	0.231	<5	150	102	0.9	0.4	32	Odourless,colourless, covered
8	5.6	8.5	1021	6.67	-	0.236	<5	120	134	1.4	0.7	24	Colourless, covered
9	3.4	6.1	1033	7.81	78.5	1.952	<5	138	74	1.5	0.4	0	Colourless, covered
10	2.6	6.1	1036	7.84	81.1	0.404	>5	216	160	1.6	0.1	22	Brown, odourless, uncovered
WHO GDWQ	-	-	-	6.5-8.5	-	1400	5	-	200	-			

Note: D to B: depth to bottom, D to W: depth to water, Ele: elevation, Temp: temperature, EC: electrical conductivity, Turb: turbidity, Alk: alkalinity, DO: dissolved oxygen, BOD: biochemical oxygen demand, COD: chemical oxygen demand, WHO GDWQ: world health organization groundwater quality.

4.2 Anions and Cation

The results of the anion and cation analyzed are presented in table 3, the Anion and Cation parameters analyzed falls within the acceptable standard in accordance with the world Health Organization (WHO, 2011), except for calcium and Potassium that are above the acceptable standard in sample 1. The high concentration value of calcium

and potassium in sample 1 could be as a result of weathering of feldspars, especially sodic and calc-feldspar which characterized the basement rocks underlying the area into the groundwater.

4.3 Heavy metals

The results of the heavy metals analyzed are presented in table 3. Manganese, copper, silicon, and zinc concentration for all the ten (10) wells falls within the acceptable standard for drinking water as recommended by world Health Organization (WHO, 2011), except for Lead, cadmium and Iron concentration that are above the acceptable limit for all the wells. This could be attributed to the effect of the leachates from the refuse dump such as iron rod, electrical and electronic appliances that percolates into thegroundwater in the wells. Also the high in iron concentration could be attributed to the interaction of water with the metallic cover of the wells that goes into the wells.

Table 3: Result of anions, cations and heavy metals analyzed

	Cations				Heavy Metals							Anions			
Sample	Ca	Mg	K	Na	Mn	Fe	Cu	Zn	Cd	Pb	Si	NO_3	HCO_3^-	Cl^-	SO_4^-
1	333.50	41.45	14.50	106.00	0.010	2.02	0.72	0.02	0.008	0.031	0.064	1.23	61.0	28.8	2.11
2	46.30	4.82	24.10	4.50	0.014	2.01	0.78	0.01	0.007	0.071	0.021	0.56	36.0	43.2	0.51
3	26.40	2.13	1.30	15.00	0.018	2.12	0.14	0.00	0.016	1.005	0.008	1.31	20.8	72.0	0.23
4	66.70	7.93	3.42	5.00	0	1.97	0.30	3.30	0.015	0.872	0.020	1.11	24.4	43.2	0.19
5	23.00	2.19	9.20	9.50	0.026	2.20	0.68	0.17	0.009	0.280	0.010	0.68	48.4	43.2	0.86
6	31.30	7.54	16.80	4.00	0.017	2.13	0.40	0.01	0.021	2.281	0.013	1.01	21.3	48.0	0.16
7	22.60	3.97	8.50	7.40	0.004	1.69	0.54	0.09	0.002	0.260	0.010	0.40	30.5	61.2	0.43
8	20.00	8.85	0.77	8.10	0.015	1.94	0.16	0.05	0.025	2.175	0.014	0.90	26.5	35.5	0.30
9	17.60	2.59	1.47	14.00	0.012	2.06	0.18	0.07	0.013	1.209	0.010	0.68	24.8	72.0	0.36
10	59.00	2.10	4.89	8.40	0	1.96	0.30	0.00	0.011	1.175	0.009	0.90	30.0	61.2	0.23
WHO GDWQ	75	50	10	200	0.4	0.3	2	3	0.003	0.01	Nil	50	250	250	500

WHO GDWQ – World health organization groundwater quality

4.4 Statistical Analysis

The values from the statistical analysis are presented in table 4.

Table 4: Values of the statistical analysis of the physicochemical parameters of the groundwater

Parameters	Min	Max	Average	STDEV	Median
Alkalinity (mg/l)	120	330	168.6	62.70247	150
DO (mg/l)	0.8	1.8	1.35	0.317105	1.45
Hardness (mg/l)	74	732	216.4	196.6651	147
pH (mg/l)	6.67	7.84	7.262	0.421289	7.18
BOD (mg/l)	0.1	1.1	0.41	0.303498	0.35
COD (mg/l)	0	195	64.75	65.85861	35
TDS (mg/l)	0.1431	1.3176	0.32773	0.358491	0.1976
EC ($\mu S/cm$)	0.212	1.952	0.6337	0.647981	0.3665
Free copper (mg/l)	0.02	0.94	0.362	0.306297	0.27
Total copper	0.14	0.78	0.42	0.243676	0.35

(mg/l)					
Zinc (*mg/l*)	0	3.3	0.372	1.030165	0.035
Iron (*mg/l*)	0	1	0.285	0.355942	0.175
Manganese (*mg/l*)	0	0.026	0.012889	0.007705	0.014
HCO_3^{2-} (*mg/l*)	20.8	61	32.37	12.95557	28.25
Cl^- (*mg/l*)	28.8	72	50.83	14.96069	45.6
Sulphate (*mg/l*)	0.16	2.11	0.538	0.589667	0.33
Nitrate (*mg/l*)	0.4	1.31	0.878	0.296416	0.9
Si (*mg/l*)	0.008	0.064	0.0179	0.016809	0.0115
Fe (*mg/l*)	1.69	2.2	2.01	0.140079	2.015
Pb (*mg/l*)	0.031	2.281	0.9359	0.81235	0.9385
Cd (*mg/l*)	0.002	0.025	0.0127	0.006848	0.012
Ca (*mg/l*)	17.6	333.5	64.64	95.99694	28.85
Mg (*mg/l*)	2.1	41.45	8.357	11.9127	4.395
K (*mg/l*)	0.77	24.1	8.495	7.807347	6.695
Na (*mg/l*)	4	106	18.19	31.07459	8.25

Note: Min- minimum, Max- maximum, STDEV- standard deviation

5. CONCLUSION

This study had assessed the effect of waste dumps on the groundwater quality around Onibueja dumpsite in IdoOsun area of Oshogbo metropolis. Almost all the parameters analyzed for in both main and control samples indicates low contamination and falls within the allowable limit for drinking water as recommended by world health Organization (WHO, 2011)except for calcium and potassium in sample one; iron, lead and cadmium in all the samples that are above the limit. The contamination of lead and cadmium in the control samples is an indication that the effect of leachate that percolate into the groundwater from the dump has extended to some distance up to a thousand meter. It is recommended that the residence around Onibueja dumpsite due to high in contamination of the aforementioned heavy metal and some of the cation in their water should employ the use of lead treatment such as reverse osmosis, distillers and filters among others to keep their water safe for drinking and domestic purposes.

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