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PHYSICOCHEMICAL EVALUATION OF GROUNDWATER NEAR IKOT EFFANGA DUMPSITE, CALABAR, SOUTH EASTERN NIGERIA

ANTHONY N. UGBAJA, UDUAK A. UGBAJA, STANLEY U NWOSU AND VICTOR E NYONG

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ABSTRACT

The Ikot Effanga area of Calabar, Southeastern Nigeria, is located close to a municipal waste dump. The area is defined by latitudes $05^0 00^1$N and $05^0 25^1$N and longitudes $008^0 20^1$E and $008^0 25^1$E. The aim of the study was to assess the impact of the waste dump on the groundwater resources of the area. Groundwater samples were obtained from 10 boreholes located around the dump site. The samples were collected during the peak dry season and peak rainy season for comparison. Physicochemical parameters were analyzed. Static water level and surface elevation of the boreholes were used to determine the groundwater flow direction. Results obtained were compared with the NSDWQ and WHO standards. From the result, it was observed that groundwater in the area is acidic as the mean pH values were 4.03 and 3.57 for dry and wet season respectively. Other physicochemical parameters analyzed showed that there were no significant variations between the dry and wet season. Also, groundwater from the area was classified as fresh and suitable for domestic and agricultural purposes. The general flow direction of groundwater in the study area is NW-SE. While the present study showed that the dumpsite does not have significant impact on the groundwater resources either due to geology or natural attenuation

KEYWORDS: Groundwaters Evolutions. Contamination. Dumpsite. Nigeria

INTRODUCTION

Rapid urbanization, increased population, advancement in technology and the general improvement in the standard of living in many countries of the world have led to generation of large amount of municipal wastes. Disposal of these wastes is a global concern, most especially in the developing countries across the world, where less attention is paid on waste management due to poor funding leading to improper design and poor waste management technique (Doan, 1998). Dumpsite is the simplest and most cost-effective method of wastes disposal both in the developed and developing nations of the world. However, there has been a reduction in the number of landfills and the amount of municipal solid wastes over the years due to "Re-use and recycle" approaches to wastes (Ken et al, 1996, Aderemi et al, 2011). In an unlined sanitary landfill and in a fairly wet climate, leachate containing hazardous chemicals like Lead (Pb) at concentrations above permissible values for drinking water have been reported. This could persist in the environment for several thousand years (Kumar and Alappat, 2003). Leachate varies widely in composition depending on many interacting factors such as the composition and depth of waste, availability of moisture and oxygen, landfill design, operation and age (Aderemi et al, 2011) as well as degree of waste stabilization.

One important consideration on the quality of groundwater is the local geology (Edet et al, 2011). While sources, nature of waste, age of landfill and climate may be some important factors that affect the level of impact on groundwater, local geology, particle size, degree of compaction and site hydrology significantly affect groundwater quality around dumpsites. The disposal of wastes at Ikot Effanga dumpsite calls for concern due to the growing population which has led to the increased in the demand for potable

Anthony N. Ugbaja, Department of Geology, University of Calabar, PMB 1115 Calabar, Nigeria.
Uduak A. Ugbaja, Department of Chemistry, University of Calabar, PMB 1115 Calabar, Nigeria.
Stanley U. Nwosu, Department of Geology, University of Calabar, PMB 1115 Calabar, Nigeria.
Victor E. Nyong, Department of Geology, University of Calabar, PMB 1115 Calabar, Nigeria.

water supply to meet their domestic and other uses. This has resulted in the indiscriminate siting of boreholes in the area regardless of the dangers of the percolating leachates on groundwater resources.

The aim of the present study is to;

1. Evaluate the groundwater quality and
2. Determine the level of contaminations around the environs of the dumpsite.
3. Identify major sources of contamination to groundwater resources
4. Prepare groundwater flow direction for the area to map out the direction of flow of contaminant plume.

PHYSICAL SETTING, LOCATION AND GEOLOGY OF STUDY AREA

Ikot Effanga and its environs where Lemna dumpsite is located is part of Calabar Municipal, Cross River State, South Eastern Nigeria. The geographic coordinate of the study area lies between latitude $05^0 00$'N and $05^0 25$'N and longitude $008^0 20$'E and $008^0 25$'E. The elevation lies between 27m to about 82m above mean sea level.

Amah et al (2012) noted that the area is well drained by three major rivers; Calabar River, Great Kwa and Akpayafe Rivers. Climatic data shows a monthly temperature between 23.1^0C and 28.7^0C with an average precipitation between 26.7mm (February) to 459.1mm (July).

The geology of the area comprises of Tertiary to Recent continental sands, characterized by alternation of clays, sands, gravel and alluviums. The Calabar Coastal Plain sand is very important groundwater reservoir that underlies more than half of the basin sedimentary area. It consist of continental sands and lenses of shales and clays and the water table is generally high (Edet, 1993, Edet and Okereke, 2002, Edet and Worden, 2009).

Hydrogeologic unit of the study area is mainly Coastal plain sands and alluvium which receives a significant amount of recharge from precipitation as well as the network of rivers around. Investigation within the study area show three aquiferous units with a depth range of 120-180m (Ekwere 2015)

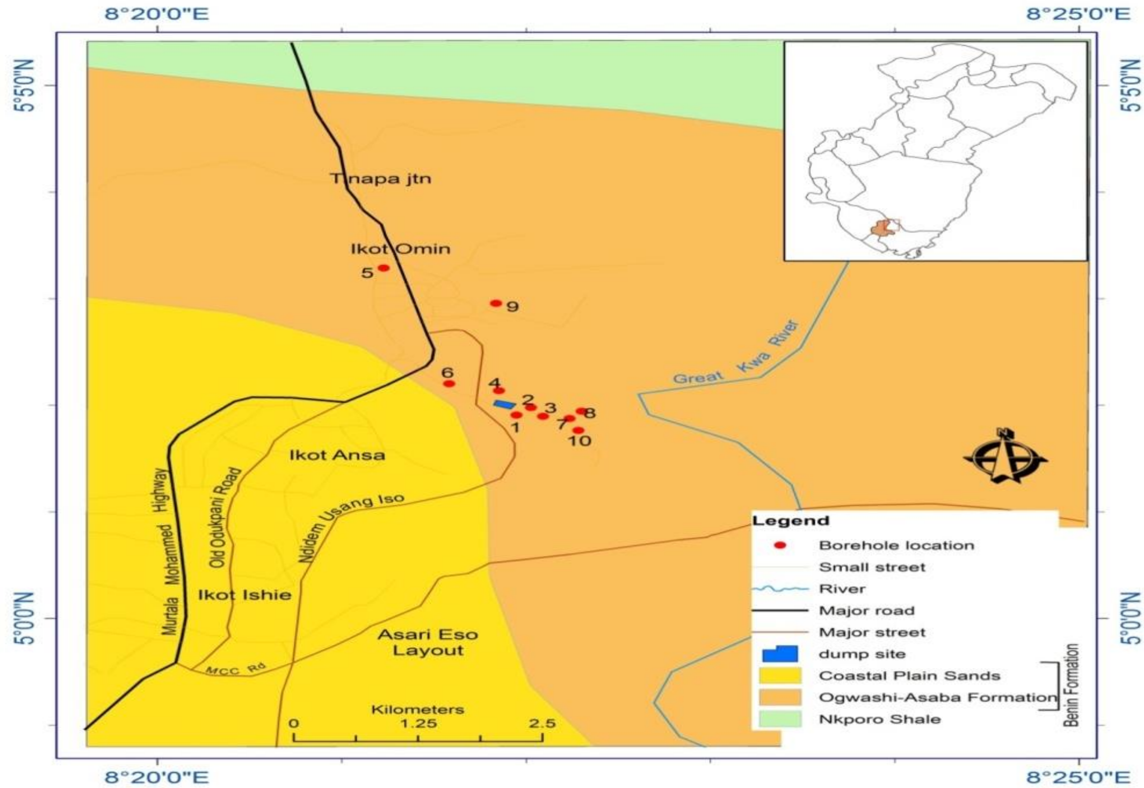

Fig. 1: Geologic map of study area showing dumpsite and sample locations (adapted from Nigerian geological survey agency, 2010).

METHODS AND METHODS

In an effort to study the level of groundwater contamination of the area, ten (10) water samples were collected from boreholes around the vicinity of the dumpsite (Table 1 and 2).

The samples were collected in clean 500ml plastic bottles, stored at temperature of 4^0C and transported immediately to the laboratory for analyses. All samples were analyzed for relevant physicochemical parameters according to internationally acceptable procedures and standard methods (ALPH, 1994). The parameters analyzed include pH, EC, TDS, Total Hardness (TH), Na^+, SO_4^{2-}, NH_4^+, Fe, Zn, Cd and Pb. The electric water logger (Dip meter) was used to determine the Static Water Level (SWL) of the cased boreholes while Garmin GPS map 78sc was use for surface elevation. The difference between the elevation and static water level gave the hydraulic head which is important in the determination of the groundwater flow direction. For us to achieve accuracy, we used three GPS in the field and took the average reading.

RESULTS

A statistical summary of the results of physicochemical parameters for samples from the study area taken at both dry and wet season, including the Nigerian Standard for Drinking Water Quality (NSDWQ, 2008) are presented in table 1 to table 4.

Table 1: Results of physcio – chemical parameters obtained during dry season**.**

Parameter Unit	LOC 1 Lemna Ds	LOC 2 Lemna Rd	LOC 3 Lemna Rd	LOC 4 Lemna Ds	LOC 5 Unique Sch	LOC 6 Northwest	LOC 7 Lemna Rd	LOC 8 Lemna Rd	LOC 9 Basin Guest House	LOC 10 ItuOkon	NSDWQ
Temp (oC)	28.6	28.9	28.8	28.7	28.6	28.6	28.3	28.3	28.6	28.6	Ambient
pH	4.0	3.7	4.1	3.9	4.0	4.0	4.4	4.2	4.2	4.0	6.5-8.5
Conductivity (µs/cm)	6.3	158.5	58.4	86.9	110.0	53.0	25.8	48.5	26.8	30.0	500
Turbidity (NTU)	0.2	0.1	0.1	0.2	0.1	0.1	0.3	0.1	0.1	0.03	5
Salinity (ppt)	0	0.1	0	0	0.1	0	0	0	0	0	4
DO (mgl)	13	17	19	24	14	16	13	23	13	14	14
TDS (mg/l)	37.8	95.1	35.0	52.1	66	31.8	15.5	29.1	16.1	18	1000
TSS (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1
Iron (mg/l)	0.02	0.01	0.01	0.04	0.07	0.06	0.09	0.16	0.19	0.23	0.3
Mn (mg/l)	0.1	0.1	0.2	0.3	0.2	0.1	BDL	0.4	0.3	0.1	0.05
Nitrate (mg/l)	5	7.3	2.7	7.7	6.8	BDL	6.6	1.4	1.8	1.5	10
Nitrite (mg/l)	0.001	0.003	BDL	BDL	0.002	BDL	BDL	BDL	BDL	BDL	0.1
Ammonia (mg/l)	0.2	0.2	0.19	0.14	0.12	0.17	0.07	0.12	0.09	0.12	1
Sulphate (mg/l)	6	49	18	15	BDL	BDL	6	BDL	BDL	BDL	100
Phosphate (mg/l)	120	24	11	7	8	159	11	9	9	7	100
Potassium (mg/l)	2.5	6.3	5.02	3.3	2.1	12	2.6	3.8	3.7	3.7	100
Copper (mg/l)	BDL	BDL	BDL	BDL	0.01	0.09	BDL	BDL	0.02	BDL	1
Nickel (mg/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.001
Cobalt (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
Zinc (mg/l)	0.09	0.52	0.09	0.11	0.14	0.13	0.09	0.08	0.12	0.11	5
Chromium (mg/l)	BDL	BDL	0.016	0.043	BDL	BDL	BDL	BDL	BDL	BDL	0.004
Calcium (mg/l)	5.28	5.68	10.62	11.92	20.88	14.56	16.4	11.6	17.6	13.12	
Magnesium (mg/l)	1.61	1.14	2.39	0.87	2.06	0.89	0.48	2.26	0.59	0.05	20
Total Hardness (mg/l)	6.89	6.82	13.01	12.79	22.9	15.45	16.88	13.86	18.19	13.17	100
Cyanide (mg/l)	BDL	0.001	0.001	0.001	BDL	BDL	BDL	BDL	BDL	BDL	
Ammonium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.5
Lead (mg/l)	0.005	0.003	BDL	BDL	BDL	0.01	0.01	BDL	BDL	BDL	0.004
Flouride (mg/l)	0.16	0.25	0.11	0.13	0.08	0.09	0.14	0.07	0.13	0.11	1.5
Chloride (mg/l)	3.08	10.7	3.11	6.4	9.71	2.5	2	4.6	2.06	3	100
BOD (mg/l)	9.3	12.5	12	14.7	9.6	12.5	8.3	8.1	7.2	9.1	
THC/100ml	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	3
TCCount/100ml	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	0
FCCount/100ml	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	0

TNTC – Too Numerous To Count
BDL – Below Detection Limit
NSDWQ – Nigerian Standard for Drinking Water Quality, 2008

Table 2: Results of physcio – chemical parameters obtained during wet season**.**

Parameter Unit	LOC 1	LOC 2	LOC 3	LOC 4	LOC 5	LOC 6	LOC 7	LOC 8	LOC 9	LOC 10	NSDWQ
Ph	3.6	3.33	3.6	3.69	3.41	3.02	3.9	3.38	3.76	3.96	Ambient
Temperature (^oC)	27	26.5	26.9	26.6	26.6	26.5	26.7	26.6	26.8	26.8	6.5-8.5
Conductivity (µs/cm)	453	580	378	360	745	1016	110.47	423	131	142.98	500
Turbidity (NTU)	0.53	0.436	0.429	1.08	0.491	0.424	6.31	0.454	0.496	6.83	5
Salinity(ppt)	0.2	0.3	0.2	0.2	0.4	0.5	0.1	0.2	0.1	0.1	4
DO (mg/l)	222	284	185	176	365	498	84	207	89	95	14
TDS (mg/l)	271.8	348	226.8	216	447	609.6	66.28	253.8	78.6	85.788	1000
TSS (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	0.285	BDL	BDL	0.331	0.1
Iron (mg/l)	0.01	BDL	0.03	0.02	0.01	0.03	0.36	0.26	0.08	0.67	0.3
Manganese (mg/l)	0.02	BDL	0.02	0.03	0.03	0.02	0.06	0.02	0.03	0.6	0.05
Nitrate (mg/l)	7	7.9	7.93	5.5	11.7	6.8	1.8	5.8	1	3.2	10
Nitrite (mg/l)	0.062	0.01	0.015	0.01	0.014	0.01	0.014	0.013	0.006	0.011	0.1
Ammonia (mg/l)	0.78	0.5	0.21	0.19	0.25	0.17	0.16	0.36	0.23	0.13	1
Sulphate (mg/l)	7	9	15	9	BLD	26	5	3	55	5	100
Phosphate (mg/l)	7.86	5.07	4.86	3.17	2.36	7.07	5.17	10.51	9.38	4.29	100
Potassium (mg/l)	3.6	5.1	3.05	3.04	1.5	6.5	2.05	6.3	8.2	6.2	100
Copper (mg/l)	0.02	0.03	0.1	0.01	0.11	0.05	0.07	0.04	0.03	0.1	1
Nickel (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.001
Cobalt (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
Zinc (mg/l)	0.18	0.22	0.13	0.18	0.21	0.11	0.19	0.17	0.14	0.19	5
Chromium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
Calcium (mg/l)	28.72	16.48	17.36	21.04	28.16	12.4	23.9	13	25.5	11.62	
Magnesium (mg/l)	2.54	2.01	1.39	1.17	0.26	4.7	10.3	4.1	8.7	5.5	20
Total Hardness (mg/l)	31.26	18.49	18.99	22.21	28.42	17.1	34.2	17.1	34.2	17.1	100
Cyanide (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
Aluminium (mg/l)	0.222	0.321	0.795	0.443	0.536	0.325	0.699	0.238	0.278	0.293	0.5
Lead (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.004
Flouride (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.5
Chloride (mg/l)	16.5	22.1	9.6	8.82	9	44.7	76.5	5.6	16.8	10.2	100
BOD (mg/l)	7.05	7.1	6.4	7.32	6.98	7.19	6.01	6.95	7.48	6.09	
THC/100ml	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	3
FCC/100ml	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	0
TCC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC	0
Alkalinity	6.11	5.79	6.11	6.11	5.89	5.36	6.41	5.86	6.28	6.46	

TNTC – Too Numerous to Count
BDL – Below Detection Limit
NSDWQ – Nigerian Standard for Drinking Water Quality, 2008

Table 3: Mean, minimum, maximum and standard deviation of physcio – chemical parameters for dry season.

Parameters	Samples	Mean	Minimum	Maximum	Std. Dev
	10	28.6	28.3	28.9	0.18856
pH	10	4.037	3.65	4.36	0.19368
Cond	10	66.085	25.77	158.5	42.06369
Turb	10	0.1293	0.029	0.321	0.07505
Salinity	10	0.02	0	0.1	0.04216
DO	10	16.6	13	24	4.14193
TDS	10	39.651	15.46	95.1	25.23849
Fe	10	0.088	0.01	0.23	0.07885
Mang	10	10.18	0.1	0.1	31.55971
NO_3	10	14.08	1.4	1.4	30.29422
Ammo	10	0.142	0.07	0.2	0.04614
SO_4	10	59.4	6	6	44.39519
Phosphate	10	36.72	7.03	158.9	55.63084
K	10	4.502	2.1	12	2.91243
Ni	10	0.0957	0.071	0.13	0.02214
Zinc	10	0.148	0.08	0.52	0.13214
Cal	10	12.766	5.28	20.88	4.92935
Mag	10	1.234	0.05	2.39	0.80674
TOT_Hard	10	13.996	6.82	22.9	4.85821
Pb	10	60.0028	0.003	100	51.63616
Flouride	10	0.127	0.07	0.25	0.05143
Chlo	10	4.716	2	10.7	3.18224
BOD	10	10.33	7.2	14.7	2.43358

Table 4: Mean, Minimum, Maximum and Standard deviation of physico-chemical parameters for wet season.

Parameters	Samples	Mean	Minimum	Maximum	Std.Dev.
temp	10	26.7	26.5	27	0.17
ph.	10	3.565	3.02	3.96	0.2857
Cond	10	433.945	110.47	1016	288.1027
Turb	10	1.748	0.424	6.83	2.5518
Salinity	10	0.23	0.1	0.5	0.1337
Do	10	220.5	84	498	132.0852
TDS	10	260.3668	66.28	609.6	172.8618
TSS	10	80.0616	0.285	100	42.0338
Fe	10	10.147	0.01	100	31.5719
Mang	10	10.083	0.02	100	31.5941
NO_3	10	5.863	1	11.7	3.198
NO_2	10	0.0165	0.006	0.062	0.0162
Ammo	10	0.298	0.13	0.78	0.2019
SO_4	10	23.5	3	101	31.4015
Phosphate	10	5.974	2.36	10.51	2.6541
K	10	4.6	1.5	8.2	2.2
Cu	10	0.06	0.01	0.11	0.04
Ni	10	100	100	100	0
Cobalt	10	100	100	100	0
Zine	10	0.17	0.11	0.22	0.04
Chro	10	100	100	100	0
Cal	10	19.8	11.6	28.7	6.5
Mag	10	4.067	0.26	10.3	3.3
TOT_Hard	10	23.907	17.1	34.2	7.3
Cyanide	10	100	100	100	0
Al	10	0.4	0.2	0.8	0.2
Pb	10	100	100	100	0
Flouide	10	100	100	100	0
Chlo	10	22	5.6	76.5	22
BOD	10	6.9	6.0	7.5	0.5

DISCUSSION

PHYSICAL CHARACTERISTICS OF GROUNDWATER FROM THE STUDY AREA

Temperature of groundwater from the study area ranges from 28.3^{0}C to 28.6^{0}C during the dry season but varies between 26.5^{0}C to 27^{0}C with mean of 26.7^{0}C during the wet season. The elevated temperature during the dry season is as a result high evaporation as compared to the wet season. Temperature influences biological activities and equally affects chemical reactions. Increased temperature increases mineral dissolution in rocks/soils (Hems, 1986).

The mean value for pH was 4.04 for dry season and 3.57 for wet season. The increased acidity during the wet season is attributed to higher precipitation with increased weathering and dissolution of silicate, carbonate and sulphide minerals as well as contribution from the atmosphere into the groundwater (Ekwere, 2010). The pH of groundwater from the study area is generally lower than WHO/NSDWQ standards for drinking water which ranges from 6.5 to 8.5. Groundwater in the area is acidic. The pH represents acidic activity at locations with high human population density (Edet and Okereke, 2005, Edet and Ekpo, 2008). While low acidity in groundwater does not pose any health challenge to human other than sour taste, related effects include corrosion of well casings and pipes and release of toxic metals, some of which are carcinogenic. The mean value for EC in the study area for dry season was 66.08µs/cm while that of wet season was 433.95µs/cm. Generally, EC increases with temperature while corrosivity of groundwater increases with EC (Mona, 2013). Data on the study area indicate higher EC during the wet season which could be attributed to low evaporation and higher water-rock interaction (Edet and Worden, 2009). TDS in the study area gave values less than the 1000mg/l recommended by NSDWQ, 2008. This means the groundwater in the area can be classified as fresh. Increased TDS in wet season compared dry season is due to higher intensity of weathering. Dissolved Oxygen (DO) in the study area varied from 13-24mg/l with mean value of 16.6mg/l during the dry season and mean value of 220.5mg/l during wet season.

CHEMICAL CHARACTERISTICS OF GROUNDWATER FROM THE STUDY AREA

Salinity measures the mass of dissolved salts in a given mass of solution. The ions include; Sodium (Na^+), Chloride (Cl^-), Nitrate (NO_3^-), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Bicarbonate (HCO_3^-) and Sulphate (SO_4^{2-}). In the study area, salinity varied from 0.01ppt to 0.5ppt with the mean value of 0.2ppt for dry season and 0.23ppt for wet season. The salinity of groundwater from the area falls within the NSDWQ (2008) recommendation limit for drinking water. The slightly higher values observed during the wet season can be attributed to higher intensity of weathering and dissolution. Low salinity as observed in the study area equally suggest that groundwater in the area can be used for agricultural purposes. High concentration of nitrate in the study area though below the NSDWQ standard suggests anthropogenic sources.

Total hardness (TH) depends on the presence of dissolved calcium and magnesium salts or multivalent metal ions which dissolve in water. TH of water from the area varied from 6.82 to 22.9mg/l with the mean value of 13.9mg/l during dry season. The mean TH for wet season was 23.9mg/l. using the NSDWQ (2008) which gives total hardness as 100mg/l for drinking water, the water can be classified as soft Hem (1986). Potassium (k^+) varied from 2.1 to 12mg/l with mean of 4.5mg/l for dry season and mean 4.51mg/l for wet season. k^+ concentration for both dry and wet seasons was within the WHO (2009) standard for drinking water. Edet and Worden (2009) gave similar values for the area. Carbonate rocks like limestone and gypsum readily dissolve to add Ca^{2+} to water. The rate of dissolution may be higher where the precipitation available is acidic. In the study area, the mean value of Ca^{2+} was 12.77mg/l for dry season and 19.84mg/l for wet season. Mg^{2+} varied from 0.05 to 2.39mg/l with mean value of 1.23mg/l for dry season and mean of 4.07mg/l for wet season.

The trend of dominance of cations and anions in groundwater samples from the study area include; $Ca^{2+} > k^+ > Mg^{2+} > SO_4^{2-} > NO_3^- > Cl^- > NH_4^+$. The average content of cations and anions showed little variation for both seasons. However, slight variations observed are attributed to concentration of solutes resulting from higher temperature regimes and evaporation during dry season as well as dissolution effects from the influx of surface run-off in the wet season (Ekwere *et al,* 2011).

EVOLUTION AND WATER CHEMISTRY

The trilinear diagram (Piper, 1994) is used to determine the groundwater facies. It consists of two triangular describing the relative composition of cations and anions. From the plots (Fig 2 and 3), there were no significant variations in samples obtained from wet and dry seasons. This suggests that the groundwater originated from the similar source. The dominant groundwater facies within the study area were Na+K-Cl groundwater type and Mg+Ca-Cl type.

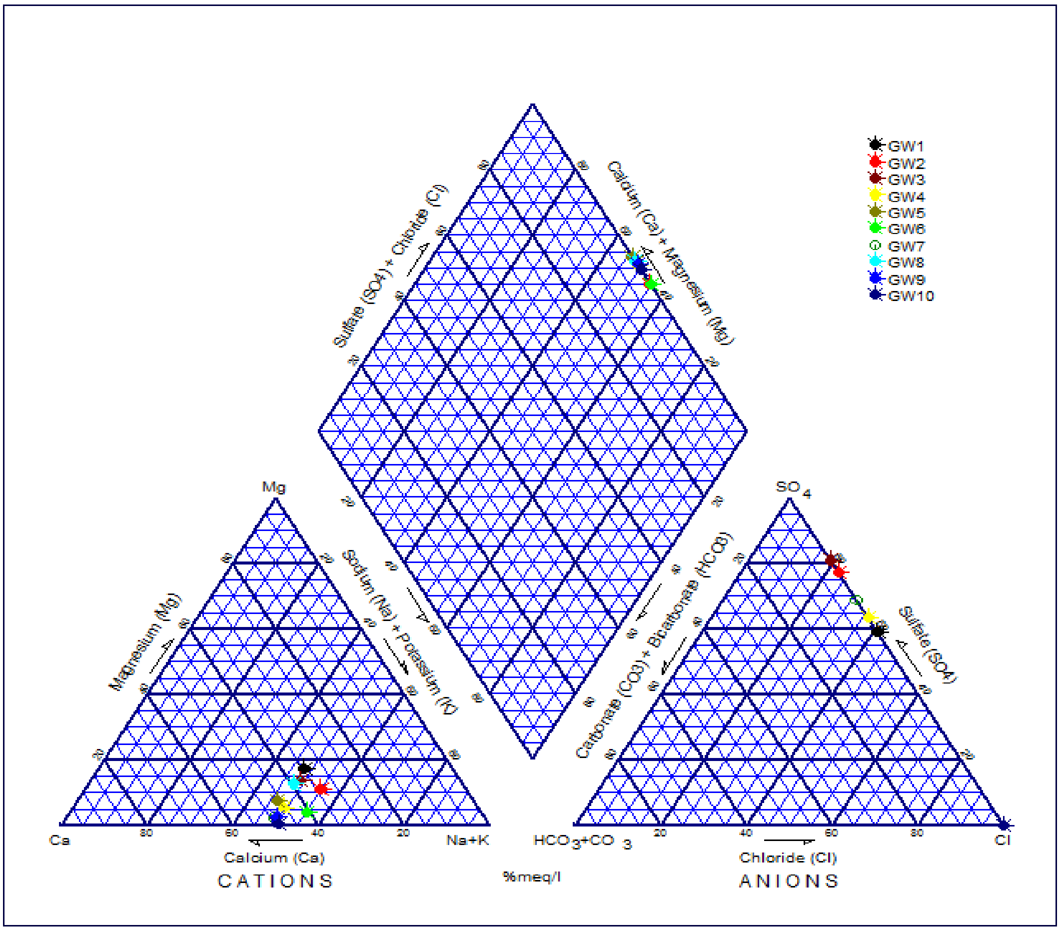

Fig. 2: Piper diagram generated using data obtained during Dry season

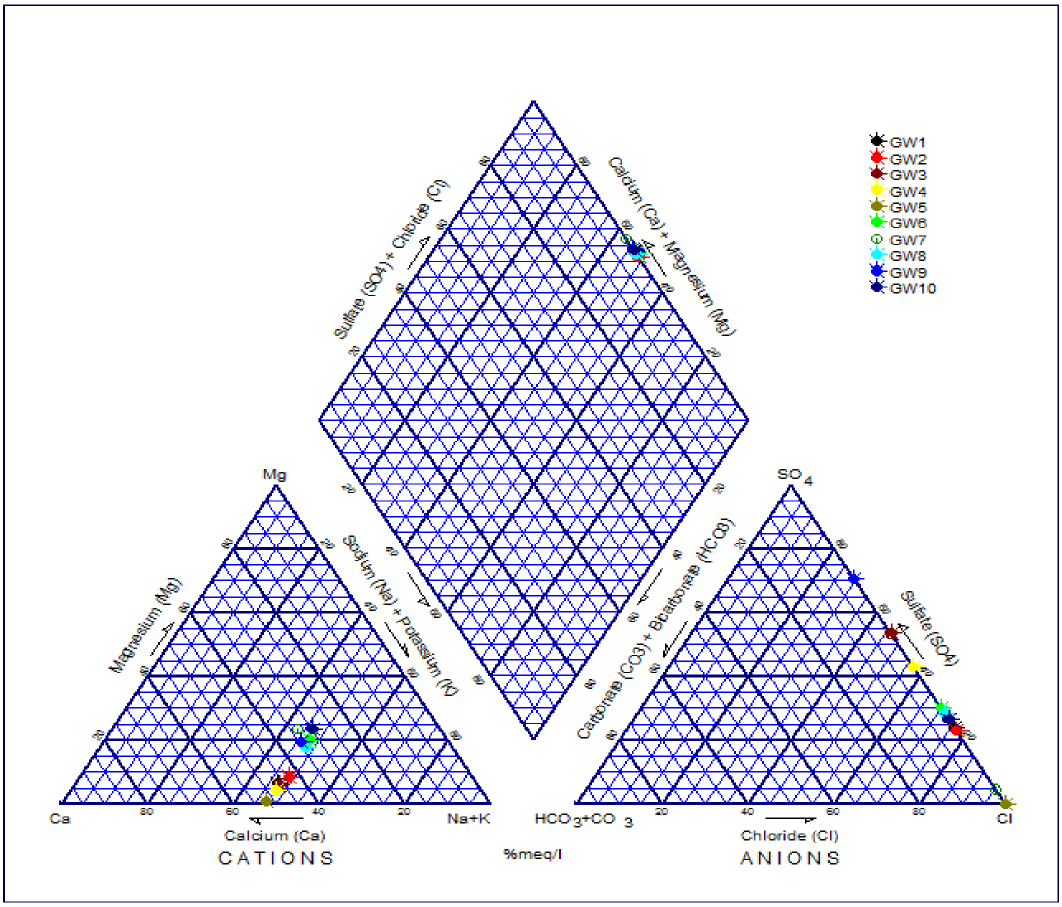

Fig.3. Piper diagram generated using data obtained during wet season

GROUNDWATER FLOW DIRECTION

Groundwater flow direction was constructed to ascertain the direction of movement of plumes down gradient from the dumpsite. Table. 5 gives borehole elevation and static water level (SWL) used in defining the flow direction. In the area, groundwater generally flow in the NW-SE direction (Fig 4 and 5)

Table 5: Borehole locations with elevations and static water level.

S/N	Street Name	Longitude	Latitude	Elevation(m)	Static Water Level (m)
1	De-event centre	008^{0}22'00E	05^{0}01'38N	24	15.0
2	Engr. Akptere's residence	008^{0}22'25E	05^{0}01'30N	44	35.4
3	Pastor Ojehonnon's residence	008^{0}22'12E	05^{0}01'35N	22	11.2
4	Pastor Amu's residence	008^{0}22'17E	05^{0}01'46N	44	29.6
5	Bar. ItaNdarake residence	008^{0}22'16E	05^{0}01'58N	33	23.1
6	Mr Akan's residence	008^{0}22'00E	05^{0}01'56N	20	10.1
7	Mrs Duncan residence	008^{0}21'37E	05^{0}02'15N	64	44.4

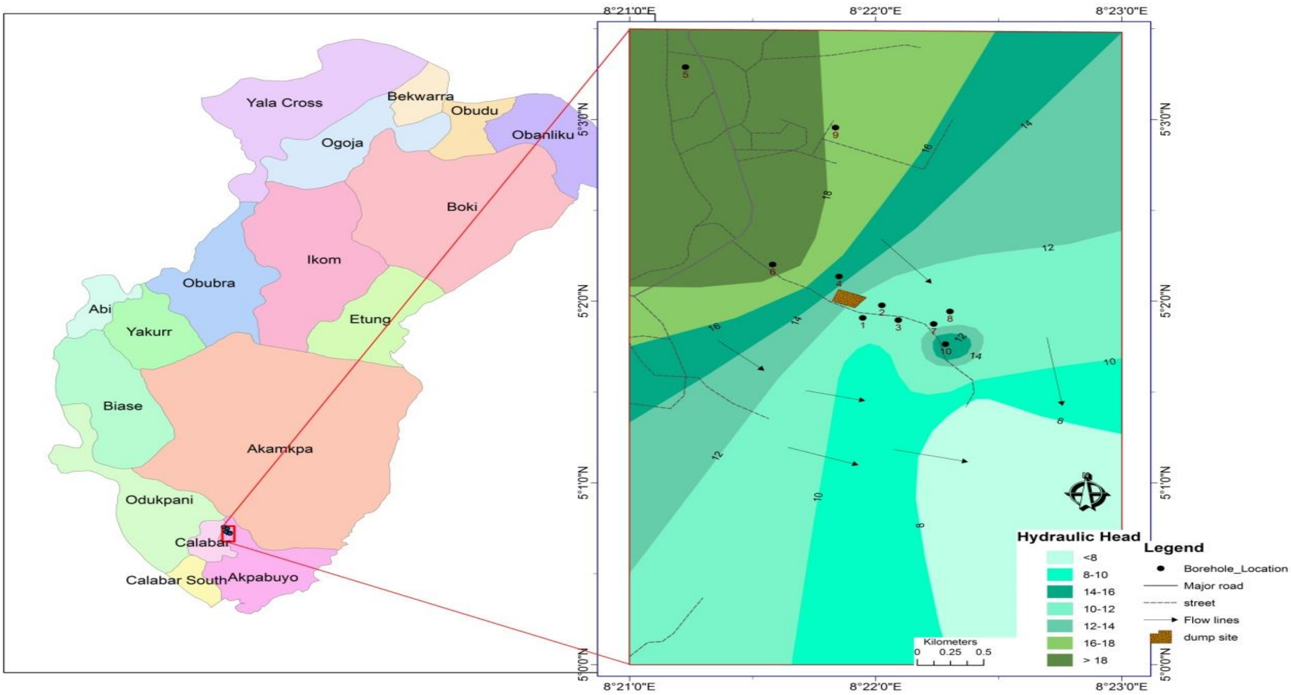

Fig. 4: 2 – D Map showing groundwater flow directions within the study area

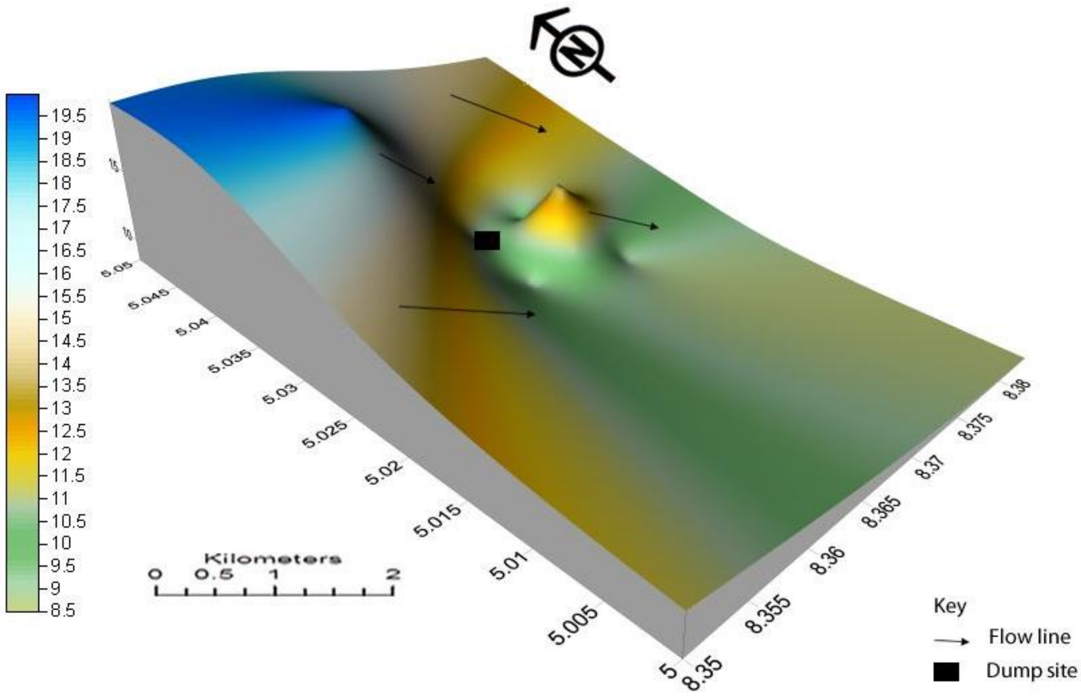

Fig. 5: 3-D map showing groundwater flow direction in the study area

Wells located around the SE parts of the study area may be prone to leachate contamination. However, study from the groundwater chemistry from the location shows that as at present, the groundwater is safe for domestic use. Natural process like attenuation and impermeable layer prevent the groundwater in the area from contamination.

CONCLUSION

The results obtained in the study area shows that the dumpsite has minimal impact on the groundwater quality based on the current study. This may be as the result of geology which favours natural attenuation. A study of the relationship between the geology of the dumpsite and the quality of groundwater is recommended. It is also advised that the water from the wells sited in the vicinity be treated before drinking as biological contamination may be high. Leachate pollution study and geology of the area can be used to predict the groundwater quality of the area in the future. In conclusions Ikot Effanga dumpsite in Calabar has minimal impact on the groundwater quality of the Area due to underling Geology.

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