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GEOCHEMICAL EVALUATION OF SOILS AND GROUNDWATER AROUND UPPER EKEHUAN DUMP SITE, EKEHUAN ROAD, BENIN CITY, NIGERIA

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ABSTRACT

Indiscriminate dumping of solid wastes has a major environmental and health impacts on Soils and Groundwater quality around the dumpsites which have been observed overtime to have significant deterioration. To this end, Soils, groundwater and leachate samples around Upper Ekehuan (Asoro) dumpsite on coordinates $6^0$19'' 20 N – 6^0 19'' 40 N and 5^0 35' 0''E - 5^0 35'20''E in Ovia North -East Local Area in Benin were collected in order to investigate the impact of the dumpsite on soils and groundwater. A total of twenty-two(22) samples consisting of twelve(12) soils, eight(8) groundwater and two(2) leachate samples were analyzed using Atomic Absorption Spectrophotometer(AAS) PG550model with air acetylene flame to determine the physicochemical parameters. The result revealed that the pH values of soil samples collected range between 4.98-5.43 while that of groundwater range between 5.24-5.87 indicating that the soils and groundwater are slightly acidic. The result of soil samples show that the concentration of Cd(0.69mg/kg), Cr(2.87mg/kg), Cu(1.25mg/kg), Pb, Mn and Ni(14.60mg/kg) were much lower than permissible limits of WHO standards and also that the samples collected close to dumpsites have been moderately impacted as application of environmetric treatment such as Contamination factor (Cf), Geo-accumulation Index (Igeo) and Enrichment factor (Ef) Analyses further affirms that the dumpsite affected the soils significantly. Heavy metals such as Ni(2.86-10.01mg/l), Cd(0.26-0.88mg/l), Cr(1.20-4.19mg/l), and Pb(0.49-1.73mg/l) analyzed for groundwater were observed to have concentration above the World Health Organization's (WHO) and Nigeria Standard for Drinking Water Quality(NSDQW) maximum permissible limits. It is recommended that the water from boreholes in the residences around the dumpsites should be treated before consumption. Dumpsites should be sited far away from residential area.

Key word: Groundwater Quality, Contamination/ Enrichment Factor, Geoaccumulation Index, WHO, NSDQW, Upper Ekehuan, Ovia North East

INTRODUCTION

The rate at which the world population increases rapidly leads to rapid growth of waste generated as a quest for human development. Waste disposal is a problem as a result of this growth. Waste simply refers to refuse or garbage, sludge generated from a waste treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi solid or contained gaseous materials resulting

from industrial, commercial mining and Agricultural operations USEPA (1991).

According to World Health Organization WHO (1992), waste refers to something the owner no longer want at a given time and space which has no current or perceived market use. This has given rise to urban degradation (Ehiorobo and Izinyon, 2011).

A visible form of environmental degradation is waste disposal through open surface landfill or open dumps. These can be cleaned up, but a most visible and potential environmental degradation includes soil erosion and gully sites used as waste dumping points. Both soils and ground water qualities can be costly and challenging to remediate. Akujieze (2004), also went further to state that gully erosion gnaws away massive earth system of an area, apart from geomorphological distortion, it opens up the geology and renders the ground water systems highly vulnerable to contamination and pollution especially when such open sites are used for waste disposal. Soil is very important in the ecosystem research as it is the place where many types of interaction take place between minerals, air, water and biota. In recent, the soil system has been subjected to physical stress by impute of foreign substances such as heavy metals. Natural source of heavy metals include rocks, magmatic explosions, dead plants and animals while anthropogenic source of heavy metals are through waste dump, Agricultural activities, industrial effluent, municipal (domestic) waste, etc. The presence of heavy metal in soil can result to degradation of soil organic matter and lowering of the fertility of the upper soil layer due to erosion. Generally, soil reacts much more slowly to external influences than water and air and it is able to bind substances into complexes (Ukpebor *et al*. 2003). Soils close to dumpsite have been reported to have high level of organic matter and heavy metal concentration, the uncontrolled dumping of solid waste contains hazardous materials such as heavy metals (Imeokparia *et al*., 2009; Imasuen and Omorogieva 2013). The contamination of soils with heavy metals even at low concentration are known to have potential impact on environmental quality and human health as well as posing a long term risk to ground water ecosystem (Omorogieva *et al*. 2013). The sources of these heavy metals ranges from industrial to municipal generation, automobiles, Agriculture and land practices.

The sedimentary units of Benin shows that there is an unconfined aquifer system devoid of clayey stringers which is significant in giving way to free downward percolation of water contaminants (Akujieze and Irabor, 2014). Dumpsite being where waste materials are disposed, is the oldest form of waste disposal. Historically, dumpsites have been the most common method of unorganized waste disposal and remains so in many places around the world. Most dumpsites are located within the vicinity of the living communities and wet lands. They are prone to release pollutants to a nearby water e.g surface or groundwater or both. Pollution of the surface and underground water spread thereby rendering them unsuitable for man's consumption or use. Waste handling facilities lacking in many highly populated areas in most developing countries due to cost and lack of enforcement of relevant legislature, poor regional and urban planning, lack of enforcement of relevant laws and edicts on waste disposal. This inevitably results to the discharge of household sewage and refuse into the environment untreated thereby leading to water, soil and plant contamination.

In Nigeria, it is generally believed that individuals, Government and Environmental Impact on Waste Disposal and management

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pay little or no attention to the environmental impact of waste disposal management. Agencies like the defunct Federal Environmental Protection Agencies (FEPA), which long ago has been replaced by National Environmental Standards Regulations Enforcement Agency (NESREA), Ministry of Environment and local authorities are responsible for planning a defined line of action for the disposal and management of wastes generated on a daily basis in our society. The study exposes the chemical interaction in dumpsites with the underground water and the consequences on human health and also will be centered on the understanding of waste materials, the impacts of heavy metals on soil and ground water around the dumpsite. Thus objective of the study to provide baseline information on the environmental and health impacts of indiscriminate dumping of solid waste on groundwater and soil in Upper Ekehuan and environs in Ovia North -East Local Govt Area of Edo State using applied and multivariate geostatistical approach.

MATERIALS AND METHODS

Study Area

The study area is located within Upper Ekehuan Area (Asoro Quarters), on in Ovia North-East Local Area, Edo State of Nigeria on latitude $6^0$19'' 20 N – 6^0 19'' 40 N and longitude 5^0 35' 0''E - 5^0 35'20''E in the South -South geopolitiical zone of Nigeria. The study area comprises of a relatively sloppy terrain with a basin-like shape. Refuse and other waste materials are being dumped around. The middle of the dumpsite contains stagnant leachate suspected to have gotten its origin from leaching of waste materials. This may be having a direct contact with the ground water body. All storm water which drains along Ekehuan road find their way into the dumpsite.

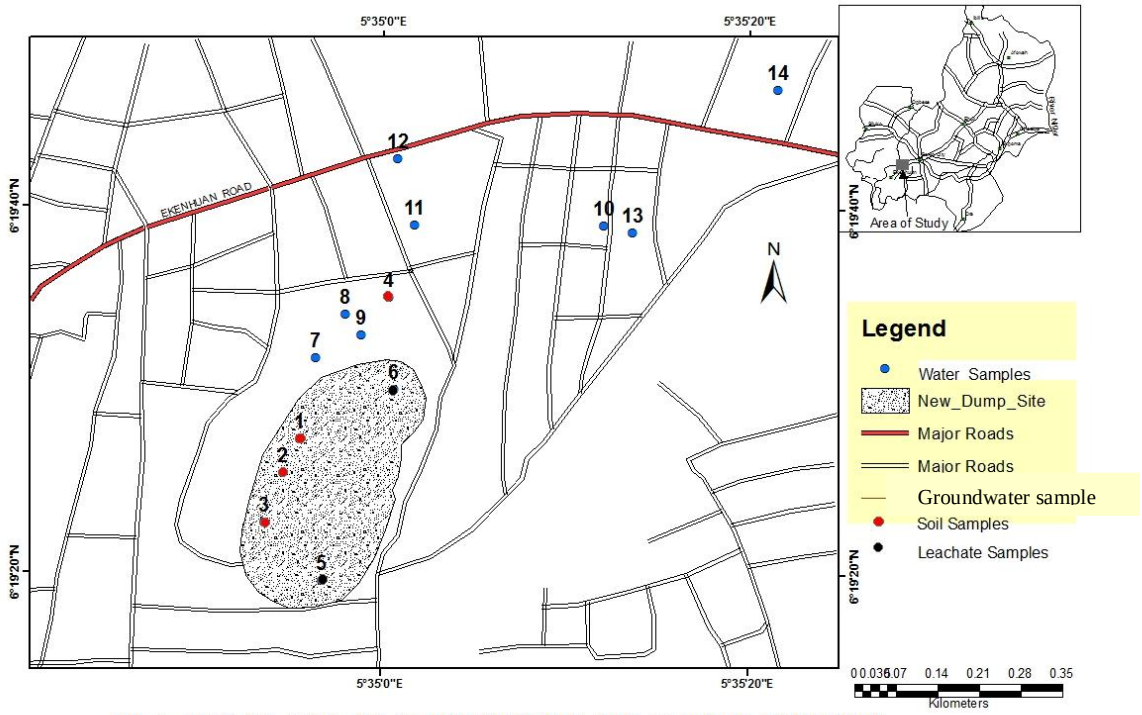

FIG. 1: MAP OF AREA OF STUDY SHOWING THE SAMPLED LOCATIONS

Geology of the Study Area

The study area is underlain by sedimentary Benin Formation which has been described severally in Short and Stauble (1967), Akujieze (2004), Akujieze and Oteze (2006). Drifts and soil-cover characterized the formation over lateritized reddish brown clayey sand capping highly porous friable white sands, pebbly sands and clay stringers with basal indurated ferruginous pebbly - coarse grained sandstone. The Benin Formation is poorly bedded and occasionally cross - bedded at greater depths. The Benin formation extends from the west across the whole Niger-Delta. The soil is characteristically ferruginous sand which possesses the color reddish brown with clay lenses occurring at some intervals. It also consist of coarse grained, gravelly, locally fine grained, poorly sorted, sub angular to well-rounded and bears lignite streaks and wooden fragments. It has the characteristics of being fine with an average size of 0.125mm in diameter. (Short and Stauble 1967)

Benin formation is found to be the uppermost and the shallowest part of the Niger Delta Stratigraphic sequence. The formation is about 2100m thick comprises of yellow and white sand pebble intervals, subterranean beds of familiar age range from deltaic fragmental molluscs. In origin, this operation is partly marine and partly deltaic and fluvio Lacrustrine It extends from the west across the whole Niger delta area and southwards beyond the present coastline. It is over 90% sandstone while the remaining 10% constitute some intercalations of Shale. (Reyment, 1965).

A profile of the Benin Formation reveals deposits as being arranged starting with coarse sandy deposit and ending with marine clay to the south. It is coarse grained, gravelly, locally fine grained, poorly sorted, sub angular to well round and the north eastern part bears lignite. Benin Formation is a continental deposit or probably upper deltaic depositional environment. Various structural units are levees, back swamp deposit and oxbow fills. This indicates the variability of the shallow water depositional medium (Short and Stauble, 1967). In the sub surface in the north, it is Oligocene age becoming progressively younger towards the South. Very little hydrocarbon has been associated with it (Kogbe, 1976).

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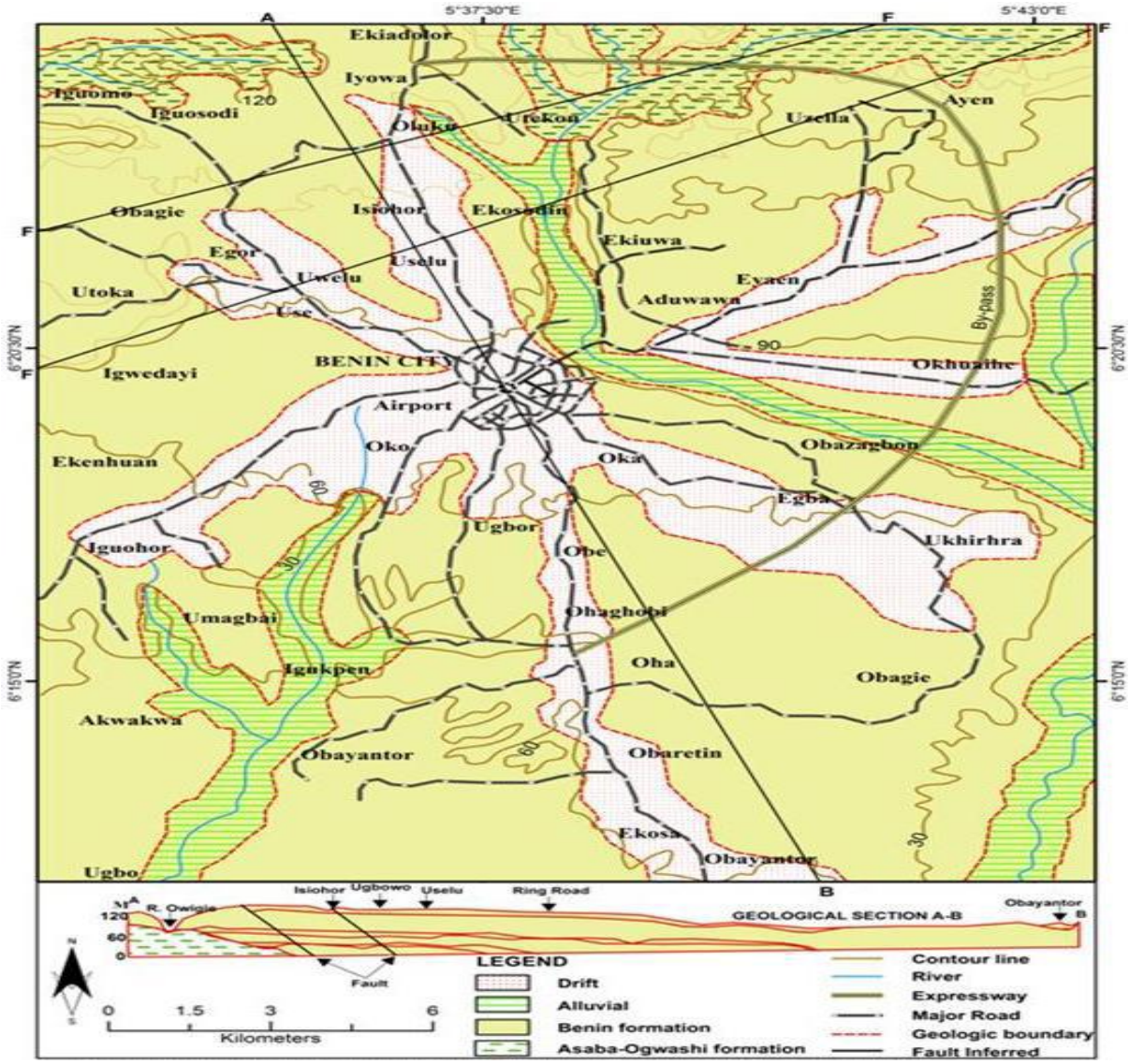

Figure2. Geological map of Benin City and environs. Source: (Akujieze, 2004).

Hydrogeology of the Study Area

Benin City consists of lowland and Plateau regions which dips from NE to SW. Ikpoba hill forms an integral part of this Plateau. The plateau contains a number of deeply cut river valleys running from Ondo State into Benin River and then to the sea. The Ogba River which occur in the south east drains the south eastern parts. The relative sloping terrain of north eastern portion makes the surface run-off so fast that it causes gully erosion.

Benin Formation is almost entirely composed of sand sized sediments with good porosity and permeability and can be termed as a good aquifer or water bearing formation, apart from the intercalations of clay and sandy clay which occur at some levels (Kogbe, 1976). In the areas and regions where this occur, they slow down infilteration. Large amount of water can be obtained from it at depths ranging from 40m to 60m confirming its viability. It flow rate ranges from 2m to 3m/hr in some other areas.

Benin Formation contains soft water with pH range of between 5 and 6.5 because of its viability, it is better and more advisable to drill holes into the aquifer than to construct dams (Oteze, 1974).

Sample Collection

Twelve (12) soil samples were collected with the aid of a soil auger and the various depths were measured and GPS coordinates taken. Three (3) sample locations were on a straight line in the dumpsite at an interval of 50m apart. The depths were 0-10cm, 10-20cm and 20-30cm respectively for each sample location. A control sample was taken about 600m away from dumpsite at the same depths of samples collected in dumpsite. GPS (Global Positioning System) readings were taken at the four sample locations respectively. Two (2) leachate samples were collected at 2 different locations in the dumpsite where it was observed to have gathered through seepage from the top of the dumpsite. Eight (8) groundwater samples from boreholes at different locations around the dumpsite and further away from the dumpsite were also collected and GPS readings taken at various sample locations. They were collected with plastic containers. The global positioning system (GPS) was utilized for taking the various coordinates at points samples were collected from. Soil pH was measured in a soil – water ratio 1:2.5 (Davey and Coyers 1988), Electrical Conductivity (EC), total organic carbon content, moisture content and total nitrogen (TN) were determined using the method described by Chopra and Kanzar (1988), Nelson and Sommers (1982), and Bremner (1965) respectively. Particle size distribution, available phosphorous content was analyzed using the methods of Bray and Kurtz (1945) while soil particle size was determined using the hydrometer method (Bouyoucos, 1962). Determination of Sodium (Na), Potassium (K), Magnesium (Mg) Calcium(Ca) were analyzed by Flame photometry as described by Mc Lean (1982)

Physiochemical Analysis Groundwater and Leachate Samples

The pH and Electrical conductivity of the samples was determined using a digital pH meter model GMBH D4040 NEUSIS and a conductivity meter; Radiometer Copen-Hagen CDM83.The turbidity of the water samples was ascertained at a specified wavelength using a HACH DR 2010 datalogging spectrophotometer. The total dissolved solids of the sample were determined using gravimetric procedure as described by Ademoroti, (1996). The total hardness, total alkalinity and sulphate content of the samples were evaluated using titrimetric and turbidimetric methods as stated by Ademoroti, (1996). The nitrate and chloride values of the samples were determined using colorimetric method APHA, (1993) and Mohr' method APHA, 1993 respectively. The phosphate content of the samples was evaluated using the ascorbic acid reduction method described by ASTM, (1990). The heavy metals ; Cu, Cr, Ni, Pb, Cd, V, Zn, Fe, and Mn concentration of the water samples were determined with the aid of an absorbance spectrophotometer(AAS); BUCK SCIENTIFIC Model 210 VGP USA. Chemical Oxygen Demand was determined.

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RESULTS

Table 1: Results of soil analysis

	Units	SL 1 0-10cm	SL1 10-20cm	SL1 20-30cm	SL20-10cm	SL2 10-20cm	SL220-30cm	SL3 0-10cm	SL3 10-20cm	SL3 20-30cm	SL40-10cm	SL4 10-20cm	SL4 20-30cm
pH		5.43	5.35	5.33	5.15	5.27	5.12	5.28	5.19	5.32	4.98	5.22	5.41
EC	µS/cm	64.00	59.00	52.00	87.00	72.00	69.00	86.00	74.00	63.00	92.00	77.00	83.00
Cl	mg/kg	23.04	21.24	18.72	31.32	25.92	24.84	30.96	26.64	22.68	33.12	27.72	29.88
SO_4^2	mg/kg	7.68	7.80	6.24	10.44	8.64	8.28	10.32	8.88	7.56	11.04	9.24	9.96
NO_3	mg/kg	3.20	2.95	2.60	4.35	3.60	3.45	4.30	3.70	3.15	4.60	3.85	4.15
PO^3_4	mg/kg	1.28	1.18	1.04	1.74	1.44	1.38	1.72	1.48	1.26	1.84	1.54	1.66
Na^+	mg/kg	11.52	10.62	9.36	15.66	12.96	12.42	15.48	13.32	11.34	16.56	13.86	14.94
K^+	mg/kg	16.64	15.34	13.52	22.62	18.72	17.94	22.36	19.24	16.38	23.92	20.02	21.58
Mg^{2+}	mg/kg	2.56	2.36	2.08	3.48	2.88	2.76	3.44	2.96	2.52	3.68	3.08	3.32
Ca^{2+}	mg/kg	0.96	0.89	0.78	1.31	1.08	1.04	1.29	1.11	0.95	1.38	1.16	1.25
CEC	Meq/100g	3.168	2.921	2.574	4.307	3.564	3.416	4.257	3.663	3.119	4.554	3.812	4.109
Fe^{3+}	mg/kg	99.2	91.45	80.6	134.85	111.6	106.95	133.3	114.7	97.65	142.6	119.35	128.65
Zn^{2+}	mg/kg	4.48	4.13	3.64	6.09	5.04	4.83	6.02	5.18	4.41	6.44	5.39	5.81
Cu^{2+}	mg/kg	1.28	1.18	1.04	1.74	1.44	1.38	1.72	1.48	1.26	1.84	1.54	1.66
Ni^{2+}	mg/kg	13.44	12.39	10.92	18.27	15.12	14.49	18.06	15.54	13.23	19.32	16.17	17.43
Cd^{2+}	mg/kg	0.64	0.59	0.52	0.87	0.72	0.69	0.86	0.74	0.63	0.92	0.77	0.83
V^{2+}	mg/kg	3.84	3.54	3.12	5.22	4.32	4.14	5.16	4.44	3.78	5.52	4.62	4.98
Cr^{6+}	mg/kg	2.94	2.71	2.39	4.00	3.31	3.17	3.96	3.40	2.90	4.23	3.54	3.82
Pb^{2+}	mg/kg	1.22	1.12	0.99	1.65	1.37	1.31	1.63	1.41	1.20	1.75	1.46	1.58
Org C	%	3.54	2.76	2.16	4.76	1.89	2.06	3.11	1.97	1.43	2.54	2.21	1.34
Org M	%	6.09	4.75	3.72	8.19	3.25	3.54	5.35	3.39	2.46	4.37	3.80	2.30
T.N	%	0.42	0.33	0.26	0.57	0.23	0.25	0.37	0.24	0.17	0.30S	0.27	0.16
Sand	%	50.68	53.54	49.56	53.65	49.56	53.65	50.68	53.54	49.56	53.65	48.68	50.54
Silt	%	23.80	13.30	18.50	12.90	21.50	12.90	18.80	13.30	22.50	19.90	20.80	16.30
Clay	%	25.52	33.16	31.94	33.45	28.94	33.45	30.52	33.16	27.94	26.45	30.52	33.16

Table 2: Concentration of Heavy Metals Mg/kg in Top Soil Samples in Refuse Dumps in Benin City. Adapted from; Imeokparia et al. (2009)

Dumpsite	Distance from dumpsite	Metal concentration in mg/kg							
		Zn	Ni	Cu	Pb	Cr	Cd	Mn	Fe
Iyaro	0.00	-	130±3.3	30±1.0	159.541±4.22	120±3.30	10.20±1.20	294.5	-
	50.0	-	11.4±7.0	13.25±1.02	26.41±1.98	11.15±1.3	10.0±1.4	40±1.58	-
Siluko	0.00	-	708.0±17	16.70±0.64	63.90±2	24.0±2.3	29±0.98	344±15	-
	50.0	-	62.0±2.0	11.051±1.22	4.8±0.09	9.2±0.94	6.9±0.82	211±11.46	-
West	0.00	-	54.0±1.74	30.02±2.36	80±3.22	35.0±3.0	7.30±0.99	228±4.4	-
Circular	50.0	-	15.1±11.0	5.90. ± 0.64	18.0±1.30	6.15±0.8	5.00±0.78	54.0±2.27	-

Table 3: Result of Contamination Factor analysis at depth 0-10cm

	CONTAMINATION FACTOR											Degree of Contamination	Modified Degree of Contamination	Pollution Load Index
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N			
SL 1	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	1.39	1.39	1.40	9.75	1.08	0.84
SL2	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.94	1.87	1.87	1.90	13.21	1.47	1.14
SL3	0.93	0.93	0.93	0.93	0.93	0.93	0.94	0.93	1.22	1.22	1.23	11.16	1.24	1.01

Table 4: Result of Contamination Factor analysis at depth 10-20cm

	CONTAMINATION FACTOR											Degree of Contamination	Modified Degree of Contamination	Pollution Load Index
	Fe^{3+}	Zn^{2+}	Cu^{2+}	$\mathbf{Ni^{2+}}$	$\mathbf{Cd^{2+}}$	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N			
SL1	1.22	1.22	1.22	1.22	1.22	1.22	1.22	1.22	0.68	0.68	0.70	11.83	1.31	1.04
SL2	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.26	0.71	0.71	0.73	12.19	1.35	1.08
SL3	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.30	0.80	0.80	0.82	12.86	1.43	1.14

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Table 5: Result of Contamination factor analysis at depth 20-30cm

	CONTAMINATION FACTOR											Degree of Contamination	Modified Degree of Contamination	Pollution Load Index
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N			
SL1	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.32	0.95	0.95	0.96	9.87	1.10	0.81
SL2	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	0.66	0.66	0.65	11.29	1.25	0.98
SL3	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	0.62	0.62	0.62	9.27	1.03	0.83

Table 6: Average of Soil Contamination Factor analysis

	CONTAMINATION FACTOR											Degree of Contamination	Modified Degree of Contamination	Pollution Load Index
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	$Pb2^{+}$	Org C	Org M	T.N			
SL1	0.694	0.694	0.694	0.694	0.694	0.694	0.693	0.695	1.389	1.390	1.383	9.718	1.079	0.83
SL2	0.904	0.904	0.904	0.904	0.904	0.904	0.904	0.903	1.430	1.430	1.438	11.53	1.281	1.025
SL3	0.884	0.884	0.884	0.884	0.884	0.884	0.885	0.885	1.068	1.069	1.0684	10.28	1.143	0.931

Table 7: Result of Geoaccumulation Index at depth 0-10cm

	GEOACCUMMULATION INDEX										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL 1	-1.11	-1.11	-1.11	-1.11	-1.11	-1.11	-1.11	-1.11	-0.11	-0.11	-0.10
SL2	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	0.32	0.32	0.34
SL3	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.68	-0.69	-0.29	-0.29	-0.28

Table 8: Result of Geoaccumulation Index at depth 10-20cm

	GEOACCUMMULATION INDEX										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL1	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.29	-1.13	-1.13	-1.11
SL2	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26	-0.25	-1.07	-1.07	-1.04
SL3	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.91	-0.91	-0.87

Table 9: Result of Geoaccumulation Index at depth 20-30cm

	GEOACCUMMULATION INDEX										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL1	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	-1.26	0.10	0.11	0.12
SL2	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85	-0.86	0.04	0.04	0.06
SL3	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98	-0.49	-0.49	-0.50

Table 10: Result of Enrichment factor analysis at depth 0-10cm

	ENRICHMENT FACTOR										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.01
SL2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.98	1.98	2.01
SL3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.31	1.31	1.32

Table 11: Result of Enrichment Factor analysis at depth 10-20cm

	ENRICHMENT FACTOR										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.56	0.56	0.57
SL2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.57	0.57	0.58
SL3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.61	0.61	0.63

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Table 12: Result of Enrichment Factor analysis at depth 20-30cm

	ENRICHMENT FACTOR										
	Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
SL1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.57	2.58	2.59
SL2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.85	1.85	1.88
SL3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.41	1.41	1.40

Table 13 Result of Groundwater and leachate Physicochemical analyses

	Units	**GW1 100m**	**GW 150m**	**GW 160m**	**L1**	**L2**	**GW4 500m**	**GW5**	**GW6**	**GW7**	**GW8**
Ph		5.47	5.53	5.78	5.36	5.24	5.87	5.68	5.55	5.67	5.71
EC	µS/cm	172	134	129	210	176	115	121	121	98	112
Cl^-	mg/l	19.80	13.68	19.36	34.12	45.48	12.60	31.68	32.76	14.40	18.00
SO^2_4	mg/l	6.60	4.56	3.12	10.04	15.16	4.20	10.56	10.92	4.80	6.00
NO^-_3	mg/l	2.75	1.90	1.30	9.35	12.15	1.75	4.40	4.55	2.00	2.50
PO^{3+}_4	mg/l	1.10	0.76	0.52	11.34	8.66	0.70	1.76	1.82	0.80	1.00
Na^+	mg/l	9.90	6.84	4.68	12.06	17.74	6.30	5.84	6.38	7.20	9.00
K^+	mg/l	14.30	9.88	6.76	17.42	11.18	9.10	22.88	23.66	10.40	13.00
Mg^{2+}	mg/l	2.20	1.52	1.04	2.68	1.72	1.40	3.52	3.64	1.60	2.00
Ca^{2+}	mg/l	0.83	0.57	0.39	1.01	0.65	0.53	1.32	1.37	0.60	0.75
Fe^{3+}	mg/l	5.25	8.90	4.30	103.85	66.65	4.25	6.40	1.05	2.00	7.50
Zn^{2+}	mg/l	3.85	2.66	1.82	4.69	3.01	2.45	6.16	6.37	2.80	3.50
Cu^{2+}	mg/l	1.10	0.76	0.52	1.34	0.86	0.70	1.76	1.82	0.80	1.00
Ni^{2-}	mg/l	6.05	4.18	2.86	7.37	4.73	3.85	9.68	10.01	4.40	5.50
Cd^{2+}	mg/l	0.55	0.38	0.26	0.87	0.93	0.35	0.88	0.91	0.40	0.50
V^{2+}	mg/l	3.30	2.28	1.56	4.02	2.58	2.10	5.28	5.46	2.40	3.00
Cr^{6+}	mg/l	2.53	1.75	1.20	3.08	1.98	1.61	4.05	4.19	1.84	2.30
Pb^{2+}	mg/l	1.05	0.72	0.49	2.27	3.82	0.67	1.67	1.73	0.76	0.95
COD	mg/l	47.85	33.06	22.62	58.29	37.41	30.45	76.56	79.17	34.8	43.5
TDS	mg/l	27.50	19.00	13.00	33.50	21.50	17.50	44.00	45.50	20.00	25.00

Table 14: NSDWQ and WHO Standard in comparison with the result of water analysis

	Units	**GW1 100m**	**GW 150m**	**GW 160m**	**L1**	**L2**	**GW4 500m**	**GW5**	**GW6**	**GW7**	**GW8**	**NSDWQ**	**WHO**
pH		5.47	5.53	5.78	5.36	5.24	5.87	5.68	5.55	5.67	5.71	6.5-8.5	6.90-9.50
EC	Us/cm	172	134	129	210	176	115	121	121	98	112	1000	1200
Cl^-	Mg/l	19.80	13.68	19.36	34.12	45.48	12.60	31.68	32.76	14.40	18.00	0.01	250
SO^{2+}_4	mg/l	6.60	4.56	3.12	10.04	15.16	4.20	10.56	10.92	4.80	6.00	100	500
NO3	mg/l	2.75	1.90	1.30	9.35	12.15	1.75	4.40	4.55	2.00	2.50	50	50
PO^{3+}_4	mg/l	1.10	0.76	0.52	11.34	8.66	0.70	1.76	1.82	0.80	1.00	-	-
Na^+	mg/l	9.90	6.84	4.68	12.06	17.74	6.30	5.84	6.38	7.20	9.00	-	-
K^+	mg/l	14.30	9.88	6.76	17.42	11.18	9.10	22.88	23.66	10.40	13.00	-	-
Mg^{2+}	mg/l	2.20	1.52	1.04	2.68	1.72	1.40	3.52	3.64	1.60	2.00	-	-
Ca^{2+}	mg/l	0.83	0.57	0.39	1.01	0.65	0.53	1.32	1.37	0.60	0.75	-	-
Fe^{3+}	mg/l	5.25	8.90	4.30	103.85	66.65	4.25	6.40	1.05	2.00	7.50	0.3	1.0
Zn^{2+}	mg/l	3.85	2.66	1.82	4.69	3.01	2.45	6.16	6.37	2.80	3.50	3.0	5.0
Cu^{2+}	mg/l	1.10	0.76	0.52	1.34	0.86	0.70	1.76	1.82	0.80	1.00	1.0	2.0
Ni^{2-}	mg/l	6.05	4.18	2.86	7.37	4.73	3.85	9.68	10.01	4.40	5.50	0.02	0.02
Cd^{2+}	mg/l	0.55	0.38	0.26	0.87	0.93	0.35	0.88	0.91	0.40	0.50	0.003	0.005
V^{2+}	mg/l	3.30	2.28	1.56	4.02	2.58	2.10	5.28	5.46	2.40	3.00	-	-
Cr^{6+}	mg/l	2.53	1.75	1.20	3.08	1.98	1.61	4.05	4.19	1.84	2.30	N/S	0.05
Pb^{2+}	mg/l	1.05	0.72	0.49	2.27	3.82	0.67	1.67	1.73	0.76	0.95	0.01	0.05
COD	mg/l	47.85	33.06	22.62	58.29	37.41	30.45	76.56	79.17	34.8	43.5	N/S	N/S
TDS	mg/l	27.50	19.00	13.00	33.50	21.50	17.50	44.00	45.50	20.00	25.00	500	1500

NSDWQ- Nigerian Standard for Drinking water Quality (2004), WHO (2006)

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DISCUSSIONS

Results of soil physicochemical analysis show that the soil in the dumpsite is slightly acidic with pH value ranging from 4.98-5.93 and an average of 5.25. From the various charts on some of the soil physiochemical parameters, Fig.3, Fig.4, Fig. 5, Fig. 9, Fig. 10 and Fig. 13 show that the control sample (SL4) have concentrations higher than other sample locations at the various depths for Fe^{3+}, Cu^{2+}, Cr^{6+}, Zn^{2+}, Pb^{2+} Ni^{2+} and V^{2+} while others are observed to have concentration higher than that of the control sample. Ordinarily, the control sample is supposed to have concentrations lower than the samples from dumpsite locations but this can be attributed to the fact that mineralization arising from area being used as a dumpsite in time of old might have taken place around the place where the control samples were collected from. The result revealed that the area under investigation is composed of sand in the same proportion as a combination of clay and silt. This coupled with the cation exchange capacity is capable of facilitating chemical reaction and average metal mobility in the soil. Result of soil analysis was compared to published standard on dumpsite by Imeokparia *et al*, (2009) for Cadmium, Chromium, Copper, Lead, Manganese and Nickel. Cadmium was observed to have an average of 0.69mg/kg as against 10.00± 1.14 , 6.90± 0.82 and 5.0 ± 0.78implying a low concentration. Chromium was observed to have an average concentration of 2.87mg/kg as against 11.15 ± 1.30, 9.20 ± 0.946.15±0.80 also observed to be low. Copper was observed to have an average lower concentration of 1.25mg/kg against 13.25 ± 1.02, 11.05 ± 1.22 and 5.90±0.64. Lead and Manganese are also seen from the table 4.1 to be having lower concentrations when also compared. Nickel was observed to have an average concentration of 14.60mg/kg against 11.40 ± 0.70, 62.10 ± 2.00 and 15.00± 1.18 for three different dumpsite according to Imeokparia *et al*, (2009).Total Nitrogen: This is the sum of the nitrate-nitrogen ($N0_3$-N), Nitrite-Nitrogen (No_2-N), ammonia-nitrogen (NH_3-N) and organically bonded Nitrogen. It can be observed from Fig.7 that sample location 2 (0-10cm) has the highest value of T.N of 0.57mg/kg. Sample location 4 which is the control sample (0-10cm) and 20-30cm tend to have concentrations lower than samples collected in the dumpsite.

Environmetric Analysis

Heavy metal and Organic content parameters from soil analysis were subjected to Contamination Factor analysis, Geoaccumulation Index and Enrichment Factor analysis**.**

Fe^{3+}	Zn^{2+}	Cu^{2+}	Ni^{2+}	Cd^{2+}	V^{2+}	Cr^{6+}	Pb^{2+}	Org C	Org M	T.N
99.2	4.48	1.28	13.44	0.64	3.84	2.94	1.22	3.54	6.09	0.42
134.85	6.09	1.74	18.27	0.87	5.22	4.00	1.65	4.76	8.19	0.57
133.3	6.02	1.72	18.06	0.86	5.16	3.96	1.63	3.11	5.35	0.37
142.6	6.44	1.84	19.32	0.92	5.52	4.23	1.75	2.54	4.37	0.30
						1.438776	1.434426	0.717514	0.71757	

Contamination Factor

Contamination factor (CF) is simply defined as CF= metal concentration/background values in which case is categorized as;
CF<1 = Low Contamination
CF ≥CF ≥ 3=Moderately Contaminated
3≥CF≥6= Considerably Contaminated

(According to *Adaikpoh et al*., 2005; *Ameh et al*., 2014), CF > 6 is Very High Contamination) Tables 3 shows that there is a reasonable low contamination of the soil by Fe, Zn, Cu, Ni, Cd, V, Cr, and Pb in the three locations at depth 0-10cm as values ranged between 0.70-0.94 following the classification by (Hakanson 1980) with modified degree of contamination found to be moderate.

Table 4 shows that there is a moderate contamination of soil still for Fe, Zn, Cu, Ni, Cd, V, Cr and Pb while Org C, Org M and T.N, reveals a low contamination following the definition above for soil sample collected at 10-20cm depth in the three different locations with values of 1.2 for heavy metals and 0.68 for Org. C Table 4 reveals the same contamination as seen in Table 3. On the average, soil samples collected were observed to be moderately contaminated as seen in Table 5

Geo-accumulation Index (Igeo)

This method aims at estimating the enrichment of the metal concentration above background or baseline concentration is to calculate the geo-accumulation index (I_{geo}) as proposed by Muller (1969).
The Geo-accumulation index is given as

$I_{geo} = \log_2 C_n = 1:5 B_n$ ……(1)

Where C_n is the concentration of the element in the enriched samples, and the B_n is the background or pristine value of the element. The factor 1.5 is introduced to minimize the effect of sediments (Abrahim and Parker, 2007)
Sutherland (2000) summarized Igeo Index and Pollution intensity as follows possible variations in the background values which may be attributed to lithologic variations in the

Igeo	Pollution Intensity
0	Background concentration
1	Unpolluted
1-2	Moderately unpolluted
2-3	Moderately polluted
3-4	Moderately to highly polluted
4-5	Highly polluted
>5	Very highly polluted

Tables 7, 8 and 9 shows result obtained from this work at Upper Ekehuan / Asoro Quarters.

The Igeo method was used to calculate the metal concentration levels. The negative Igeo values found in the above tables are the results of a relatively low levels of contamination for the different parameters.

Enrichment Factor

The magnitude of the contaminants in the soil can be evaluated by the Enrichment Factor (EF) for the 3 different locations at various depths. It was done to ascertain the degree of contamination and distribution of elements of anthropogenic origin (Ameh *et al.,* 2014; *Atgrin et al*., 2000; *Mohiuddin et al*., 2010) *Tomilson et al*., 1980 gave a summary the EF and the degree of enrichment as follows:

$EF = M_x X Fe_b = M_b X Fe_x$, …… (2)

where M_x and Fe_x are the sediment sample concentrations of the heavy metal and Fe (or other normalizing element), while M_b and

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Fe_b are their concentrations in a suitable background or baseline reference material (Salomons and Förstner,1984)

EF= ≤1 Background Concentration
EF=1-2 Depletion of mineral enrichment
EF=2-5 Moderate enrichment
EF=5-20 Significant enrichment
EF=20-40 Very high enrichment
EF= > 40 Extremely high enrichment.
Sample location 2 at depth 0-10cm is also moderately enriched with T.N.

Table 10 shows a background concentration of < 1 for Org. M, Org. C, and T.N.

Table 12 also shows a moderate enrichment in sample location 1 at depth 20-30cm for Org. C, Org. M and T.N and mineral depletion in Sample Location 2 and 3.

Results from soil physiochemical analysis subjected to Contamination, Geo-accumulation index and Enrichment Factor analysis all shows that the soil is moderately From Tables, 10,11 and 12, it can be observed that $Fe^{3+,}$ Zn^{2+}, Cu^{2+}, Ni^{2+} Cd^{2+}, V^{2+} Cr^{6+} and Pb^{2+} ions in the different locations at all depths have an enrichment factor of 1.00. This implies that there is a depletion of minerals when compared to (*Tomilson et al.,* 1980) Enrichment factor.

Sample location 1 depth 0-10cm at shows a moderate enrichment for Org M, Org C and T.N. in Upper Ekehuan, Asoro Quarters dumpsite. Contaminated by the heavy metals specified heavy metals,

Physicochemical analysis of water

The pH is the measure of the molar concentration of hydrogen ions in the solution and as such a measure of acidity and alkalinity of a solution. Results of water physicochemical analysis reveals that the pH of water samples around the dumpsite ranges from 5.53-5.87.This simply shows that they are far below the highest desirable and maximum permissible limits of NSDWQ (2007) and WHO (2006). From the range of values, it can be seen that the water is slightly acidic. Leachates are also observed to be acidic and this could be an influencing factor. Acidity can cause water to have a sour taste and not desirable for consumption. All the water samples collected fell between 98-172μS/cm the electrical conductivity for all ground water samples is seen to be lower than the WHO maximum permissible limit and NSDWQ limits. The electrical conductivity is the measure of the ability of water to conduct electric current. This is in most cases influenced by dissolved salts such as sodium chloride and potassium chloride.The value ranges from 13.68-32.76mg/l for 8 water samples while leachates samples were observed to be 34.12mg/l and 45mg/l. The water samples had chloride content lower than the WHO limit and far above the NSDWQ limit.

Chloride is a very important parameter in water that affects taste especially when present in high concentration. Values of sulphate for all 8 water samples here are seen to be far lower than that of the NSDWQ and WHO limits. Leachates are observed to have higher concentration of sulphate. Here, though the concentration of sulphate is far below the standards, high levels of sulphate and give water a bitter or astringent taste and laxative effect when consumed. Nitrates are the most water soluble of all salts and play a major role in nitrogen cycle and nitrate pollution. Their presence in water is usually caused by seepage of human sewage from private

septic tank systems. Nitrate ranges from 1.30-4.55mg/l for all water samples collected with a mean value of 2.64mg/l.

The leachate samples happen to have the highest content of nitrate but still far below the WHO and NSDWQ standard as seen in the Table 14**.** For groundwater samples collected, the values range from4.68-9.9mg/l. it is very essential in drinking water but should not be in concentration that exceed the maximum permissible limit. Here. Iron ranges from 1.05-8.90mg/l for water samples with a mean value of 4.95mg/l. All water samples collected have higher content of iron than the WHO maximum permissible limit and the NSDWQ limit for water. Iron content in the 2 leachate samples are 103.85mg/l and 66.65mg/l with a mean value of 85.25mg/l. Leachate remains the major source by which iron is introduced into the subsurface water system. Results show a very high level of iron as compared to WHO standard and NSDWQ. Iron is an essential element in the human body but when the concentration is beyond the tolerable limit, it becomes toxic and contributes to hardness of water.

The range of Zinc falls between 1.82-6.37mg/l having a mean value of 3.70mg/l. It is observed from Table 13. above that GW1, GW2, GW3, GW4,GW7 and GW8 all fall below the WHO limit of 5.0mg/l. while GW3,GW4 and GW7 fall under the NSDWQ limit for drinking purpose. The average of all water samples is a little above the NSDWQ limit while less than WHO standard. Carlos *et al (*1997) reported that the consumption of Zn in excess of WHO recommended value may lead to gastrointestinal disturbances such as cramping, pain, nausea and vomiting. The range of copper content in the water samples ranges from 0.52-1.82mg/l the mean value for this is 0.96mg/l. Values of 1.34mg/l and o.86mg/l were obtained for leachate samples L1 and L2 respectively. Results from all water samples fall below the WHO Limit while the average of the results from all samples fall below the NSDWQ limit. High level of Cu in water has been traced to gastrointestinal symptoms such as Nausea, abdominal pain, diarrheoa and vomiting. Nickel ranges from 2.86-10.01mg/l for all groundwater samples collected at various locations around the dumpsite with a mean value of 5.81mg/l. These results are far above the WHO and NSDWQ for potable water. Leachate samples have values of 7.37 and 4.73mg/l. The concentration of leachate could also be an influencing factor in the presence of high concentration of Nickel in the water. Cadmium ranges from 0.26-0.88mg/l for 8 groundwater samples. Leachate samples have values of values of 0.87 and 0.93mg/l. Groundwater samples were observed to have concentration of Cadmium far higher than the WHO maximum permissible limit and the NSDWQ limits respectively. Here, results show high concentration of Cadmium in ground water for the different Groundwater samples with GW5 and GW6 having higher concentrations. Cadmium is a highly toxic metallic pollutant which does not have any metabolic benefit.

Excess consumption from drinking water may lead to renal tubular disease. Chromium ranges from 1.20-4.19mg/l for all samples collected with a mean value of 2.43mg/l. These are far higher than the WHO limit. Leachate samples were also observed to have values of 3.08 and 1.98mg/l respectively. Chromium is not known to have any biological function. It is very toxic and capable of lowering energy

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levels of vital organs of the human system. The lead content in the ground water samples ranges from 0.49-1.73mg/l as shown in Table 13 above. GW6 is observed to have the highest value of lead and GW3 the lowest. The mean value of all water samples analyzed for lead was found to be 1.005mg/l. This is higher than the WHO maximum permissible limit for lead in potable water. Lead is known to be very toxic and can be very harmful L1 and L2 are seen to have very high concentration of lead and this may be the reason why other ground water samples are reflecting extremely high concentration of lead above the WHO limit for lead in water**.** The Values of total dissolved solids of both organic and inorganic matter is found to be far lower than the NSDWQ (500) and WHO(1500) maximum permissible limits for all water samples.

The study has critically investigated the impact of Upper Ekehuan /Asoro dumpsite on soils and groundwater around the dumpsite. In general, it was observed from physicochemical analysis of groundwater around the dumpsite not just slightly acidic but also contains heavy metals like Iron, Zinc, Nickel, Cadmium, Chromium and Lead in higher concentrations higher than the WHO and NSDWQ. This may have also been influenced by the leachate that is being washed down slope from waste materials arising from anthropogenic activities which include dumping of refuse, waste water and faeces. Results of soil physicochemical analyses revealed that the soil was slightly acidic. It was subjected to environmetric analysis and it was observed that the soils around the dumpsite were moderately contaminated and enriched by heavy metals such as Iron, Zinc, Copper, Nickel, Cadmium, vanadium and Lead. The soil presently pose threat to food crops around the dumpsite especially those that are edible to residents living within the vicinity of the dumpsite.

After a careful and thorough investigation of the area of study, the following conclusions were deduced that the Contamination of the environment has an anthropogenic source. Hence, continuous dumping of waste will soon render the land completely useless and may cost a lot of money to remediate if not attended to immediately. There is tendency of high risk in the environment as a result of the continuous leaching of waste materials from the top of the heap of waste materials to the bottom through the sloppy terrain and could have been the main source of the contamination of groundwater through seepage. Heavy metals and other forms of contaminants may find their way into groundwater body. Agricultural activities such as growing of food crops should be discouraged even when soil tend to be moderately contaminated and slightly acidic. The dumpsite is very offensive to sight. Farming around dumpsites should be discouraged ad also, water from boreholes around the dumpsite should be subjected to treatment before drinking, Okojie ,2016).

Treatment should be given to water from boreholes in the homes of residence around the dumpsite. This is simply to treat ground water thoroughly before use particularly for drinking purpose. Toxic metals like lead, cadmium can bioaccumulate in the body over time and result in adverse health effects. People over time have been very ignorant of the hazardous effects of dumpsite close to residential buildings as such, there should be effective sensitization of residents living close to open dump. Government should ensure that the

generation of waste is minimized and also make the necessary effort to provide waste disposal facilities. Recycling of refuse materials such as polythene and metals should be encouraged. Government should ensure that there is sufficient fund for waste management. Bioremediation of soil should be employed in the removal of heavy metals from the soils and should be adopted in the area studied. There should be regular monitoring of the environment to ensure that compliance to laws is done at regular intervals.

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