Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol. 3, No.9, 2013

Leachate Characterization and Assessment of Groundwater and Surface Water Qualities Near Municipal Solid Waste Dump Site in Effurun, Delta State, Nigeria

Ohwoghere–Asuma, O.,[1] and Aweto, K.E
Department of Geology, Delta state University, Abraka, Nigeria
1 Corresponding Author. ohwonero@hotmail.com

Abstract

Leachate, groundwater and surface water samples were collected from trenches dug into refuse dump site, hand dug water wells and borehole as well as surface water in the vicinity of the Effurun refuse dump site. Some physico- chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS) were determined in-situ. While other such as chloride (Cl^-), sulphate (SO_4), nitrates (No_3), ammonia-N (NH_3-N), Pb, Zn, Cu, Cr, K, Na, Mg and Ca, COD and BOD were analyzed in the laboratory in accordance with standard laboratory procedures. The ratio of BOD_5/ COD is less than 0.5mg/l for leachates from shallow trenches and 0.1mg/l from deeper trenches, an indication of the impact of depth on the landfill stabilization. The leachate has no significant impact on groundwater quality as all parameters analyzed were below the WHO and Nigerian standard for drinking water quality (NSDWQ), except the concentration of NH_3- N that is above the WHO standard but less than the NDWWQ, also the influence of landfill leachate on groundwater quality is dependent on the distance and depth of water wells. There was increase in the amount of the parameters analyzed for surface water, a reflection of pollution. The study concludes that in spite of absence of pollution, the Groundwater beneath the landfill has the tendency of being polluted in the distant future except the refuse dump site is upgraded to a well engineered standard landfill which is lacking in the whole of the delta state of Nigeria.

Key words: leachate, landfill, groundwater, surface water and pollution

Introduction

Landfills or open dumps have been demonstrated by several workers to pose serious threat to groundwater and surface water resources (Fatta et al., 1999; USEPA 1984), especially those constructed and operated without impermeable layers to reduce the potential of contamination. The degree of threat is strongly influence by the composition of the wastes in the landfill and the volume of leachates generated, as well as the location of the landfill from water bodies; groundwater and surface water (Slomwcznska and Slomcyznski, 2004). The decomposition of wastes in landfill is enhanced by moisture from precipitation, the physical, chemical and biological processes. Present in the landfill are solid phase, liquid phase (leachate) and the gas phase. The gas phase consists of carbon dioxide (CO_2) and methane (CH_4), while the liquid phase is very complex chemically and its composition is characterized by the presence of different types of dissolved organic compounds, inorganic compounds and heavy metals. This liquid is called leachate, which accumulates at the bottom of the landfill and subsequently percolated slowly into the soil to contaminate aquifer beneath it and adjacent surface water bodies. The solid waste composition, particle size, degree of compaction, the hydrology, age of the landfill, moisture, temperature and available oxygen are the controlling factors that determine the rate of production and characteristics of the leachate.

In the course of waste stabilization, the organic constituents of leachate tend to decompose and stabilize with time and the inorganic constituents remain even long after stabilization has taken place (Jhamnani and Singh, (2009), and Longe, (2010). The age of the landfill controls the quantity of leachate produced in the landfill. Old landfill tends to generate leachates that are either weakly alkaline or neutral in nature, which are characterized by pH of 7.0 and 7.6. According to Slomwcznska and Slomcyznski, (2004), the very old landfill produces leachates that are alkaline in nature, whose pH ranges from 8.0 to 8.5. However, those landfill whose leachates' pH ranges from 3.5 to 6.5 indicate leachates that are generated in the initial period of decomposition of waste. The acidic nature also indicates the presence of carboxylic acids or carbonate ions in the leachate.

Several studies (Longe, 2010; Esmail et al, 2009; Longe and Enekwechi, 2007) have shown that leachates outflow and percolation are source of groundwater and surface water pollution adjacent to landfill sites.

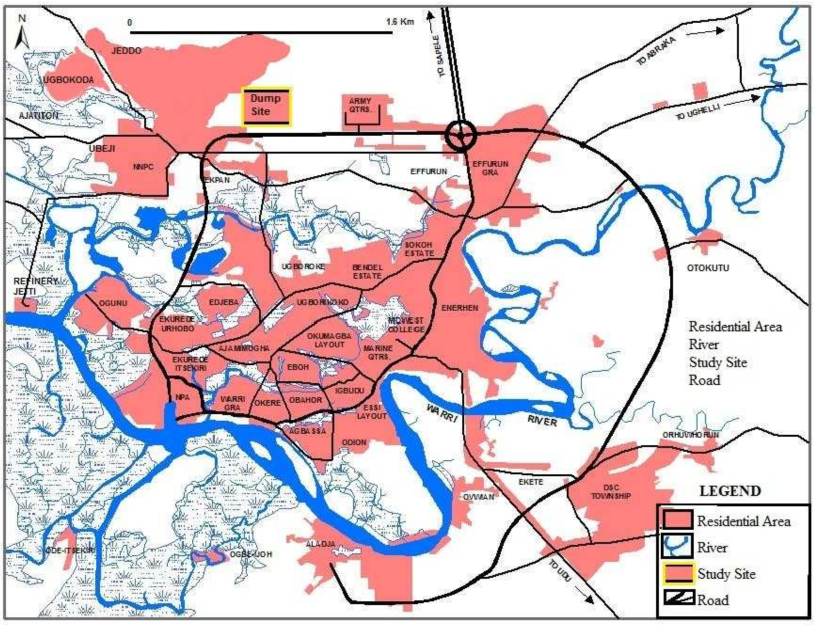
Consequently, landfill constitutes potential health hazards and environment problem. In spite of these deleterious effects of landfills, they remained the cheapest and most widely accepted methods of deposing municipal solid waste (MSW) in most part of the world (El-Fadel et al., (1997); Dsakalopoulous et al., (1998); and Jhamnani et al., (2009). The solution to health hazards related to open dump site inevitably lies in the use of standard engineered landfills and recycling of waste, which are lacking in most developing countries, like Nigeria.

Solid waste management is a serious problem in Nigeria, as most cities lack standard engineered landfills. The lack of provision of proper engineered sanitary landfills for disposal of wastes by the local government authorities and the state governments has given room for the proliferations of open dumps that are scattered in every in nook and crannies. These scattered refuse dump sites found everywhere have become eyesore to first time visitors to most cities in Nigeria. The twin city of Effurun and Warri is not an exception in this regards and being the heart of the hydrocarbon industry in the western Niger Delta of Nigeria, has experienced massive influx of population in the last five decades. Majority of the people in this city depends on shallow groundwater wells and boreholes for their portable water need, which is promoted by lack of public water supply infrastructures. The provisions of groundwater in the study area are often done by non-geologists and non-hydrogeologists and the potential of groundwater contamination by refuse dump sites, septic tanks are often not taken into consideration when water wells are being drilled. These coupled with the high infiltration rates and high hydraulic conductivity of aquifers prevailing in the area tends to make shallow wells prone to contamination by landfills and other non-source points. The consumption of groundwater from contaminated aquifers goes with health hazard implication. The aim of this paper is to characterize leachates from the Effurun municipal solid dump waste site and delineate the impact of it on both groundwater and surface water qualities in the vicinity of the dump site.

Materials and Methods

Site Description

Effurun is one of the towns geographically located within the western Niger Delta. It is situated some few kilometres away from the Atlantic Ocean. The Warri refinery, petrochemical company and other oil and gas companies are jointly located in Effurun and Warri, thus making it a twin city. The town is highly populated and characterized by high commercial activities. The municipal solid dump site is located along kilometer 30, Edjeba express road, Effurun in Uwie local government area of Delta state. It measures about 520m x 245m and it emanated from indiscriminate dumping of wastes about 30 years ago. It receives estimated quantity of 120 tons municipal solid wastes daily. The waste type consists of organic, non-organic, hazardous and non-hazardous. These wastes may have originated from domestic, agricultures, industrial and electronic wastes



MAP OF WARRI - EFFURUN SHOWING STUDY SITE

Figure1. Map of Warri- Effurun showing study area

Sampling

Groundwater samples were collected from two shallow hand dug wells and a borehole that are located down gradient of the dumpsite, they were designated GW1, GW2 and GW3. Leachate samples were collected from trenches dug into the dumpsites and designated LCH1, LCH2 and LCH3. Also surface water samples were collected from bodies of water close to the dumpsite, are designated SW1, SW2 and SW3. Samples containers were washed with detergent and rinsed with de-ionized water, thereafter rinsed with samples fluids prior to collection. Rinsing with sample waters was a precautionary measure taken to avoid any interference that may arose from using contaminated samples containers. To preserve samples for heavy metals, COD, nitrates and ammonia analysis, few drop of concentrated hydrochloric acid was added to separate samples containers. Water samples were preserved in a cool box and subsequently taken to the laboratory for chemical analysis.

Laboratory analysis

The chemical analysis was initiated immediately as soon as the samples arrived at the laboratory without delay in accordance with the APHA (1994) methods. The various physico-chemical parameters analyzed for all the samples include pH, total dissolved solids (TDS), electrical conductivity (EC), Sulphates (SO_4), chlorides (Cl^{-1}), nitrates (NO_3^-), phosphates(PO_4), ammonium(NH_3-N),biological oxygen demand (BOD), chemical oxygen demand (COD), Sodium(Na^+), Magnesium(Mg^+),Calcium(Ca^+), potassium(K^+). Heavy metals analyzed include iron(Fe^{3+}), lead(Pb^+), Zinc(Zn^+), copper(Cu^{3+}), chromium(Cr^{3+}) and manganese(Mn^+).

Results and Discussion;

The results obtained from the physico-chemical analysis of leachate, groundwater and surface water near the Effurun city municipal dumpsite are summarized in Table 1.

The pH values for the three leachate samples examined ranged from 5.2 to 6.8, with mean value of 6.3. The low value of pH is a strong reflection of an acid producing phase during the decomposition of wastes, the low value of pH measured, according to Alloway (1995) is an indication of leachate undergoing anaerobic or methanogenic phase. Kjeldsen et al., (2002) described this phase of decomposition of wastes characterized by increased of pH from 6.0 to 8.0 with the production of volatile fatty acids and carbon dioxide. Similarly, Fatta et al., (1998) observed that the initial period of leachate formation is characterized by very low pH values and later with higher pH values at the methanogenic phase. The leachate LCH3 with a pH of 5.2 is therefore more acidic than the other two samples, LCH 1 and LCH2 respectively. The electrical conductivity (EC) values for the three leachate samples depict different values, in which LCH1 has the highest value of 4336.0µS/cm, followed by LCH3 with value of 1240µS/cm, while the lowest value of 961µS/cm was recorded for the LCH2 leachate sample.

	EC µS/cm	TDS mg/l	Ca^{3+} mg/l	Mg^{3+} mg/l	Fe^{3+} mg/l	Na^+ mg/l	K^+ mg/l	No_3^- mg/l	Po_4^- mg/l	So_4^{3-} mg/l	Cl^- mg/l	NH_4 mg/l	pH	BOD_s mg/l	COD mg/l
GW1	1200.0	765.37	38.00	1.50	1.90	65.40	32.2	56.00	8.25	24.30	225.00	0.90	6.3	16.40	35.00
GW2	75.59	37.80	14.20	0.45	0.03	14.398	6.260	0.43	0.08	8.00	14.00	0.12	6.9	6.50	5.00
GW3	20.24	9.67	11.38	0.10	0.001	10.71	5.79	0.08	0.00	0.00	8.90	0.00	7.1	0.00	0.00
SW1	586.00	80.30	8.00	12.00	0.08	65.89	49.19	0.87	3.60	61.00	40.50	1.23	7.0	8.00	88.00
SW2	628.00	314.80	39.00	19.00	1.82	113.16	45.91	1.25	35.50	105.00	195.20	3.24	6.8	8.90	55.00
SW3	694.50	694.50	28.00	24	1.08	118.72	47.87	1.02	50.34	100.	240.60	1.02	7.0	6.80	95.00
LCH1	4336.0	2176	30.00	22.80	25.50	741.12	285.08	74.60	110.70	750.00	950.00	36.83	6.9	1040	10200.
LCH2	961.90	281.50	12.60	14.00	8.25	174.90	86.29	88.00	89.00	170.	192.00	22.50	6.8	40.00	200.00
LCH3	1240.0	620.50	19.90	10.25	18.74	2043.8	78.42	89.00	67.00	200.	250.00	31.24	5.2	65.00	248.00

Table 1: Physicochemical Characteristics of groundwater, surface water and leachate of the Edjeba expressway waste dumpsite. GW = Groundwater sample, SW =Surface water sample, LCH = leachate. All units are in mg/l except conductivity which is µS/cm and pH.

These values reflect the presence of anions or inorganic materials in the leachate samples. There is significant variation in the values of total dissolved solid (TDS) among the three leachate samples, of which LCH1 has the highest value of 2176.00mg/l, LCH2 with a value of 281.00mg/l and LCH3 with value of 620.50mg/l.

The value of BOD_5 in leachate tends to indicate the maturity of the landfill/dumpsite. The values of are relatively different for all leachate samples. Of the three, LCH1 has a maximum value of 1040mg/l, LCH3 with a value of 65.40mg/l and LCH2 with the minimum value of 40.00mg/l. Similarly, the COD values are in the same trend but with higher values, with LCH1 having a 10200mg/l, LCH2 with a value of 200mg/l and LCH3 with a value of 248.00mg/l. These values obtained for both BOD_5 and COD are consistent with those of (Ehrig, 1989 and Christensen et al., 2001) as normal range for a typical municipal landfill leachate. The high values of BOD_5 observed for LCH 1 is explained by microbial activity in the decomposing leachate yet to attained stability. The calculated ratio of 0.1mg/l for BOD_5/COD suggests high organic strength for LCH1 and this ratio is similar to those obtained by (Amina, 2004; Baha, 2005; Yoshida et al., 2002). The ratio of BOD_5/COD also indicates the oldness of the landfill, as portrayed by Curi et al., (1994), they reported that ratios of BOD_5/COD which vary from 0.4mg/l to 0.6mg/l is a characteristic of a young landfill and this ratio decreases to 0.05mg/l to 0.2mg/l for a matured landfill. In addition Iren, (1994) asserted that as the BOD_5/COD ratio decreases, the age of the landfill increases. The above assertion is applicable to landfills that have been closed and no longer receive wastes. It is suggested in this study that BOD_5/COD ratio is probably dependent on the depth at which leachate samples are collected for an open dumpsite that continues to receive wastes. In this case decomposition of waste is a continuous process as more wastes are dumped into the open dumpsite, which gives rise to different leachates that infiltrate into the subsurface. In the study LCH1 has a BOD_5/COD ratio of 0.1mg/l within a 3m depth of collection, LCH2 has a BOD_5/COD ratio of 0.2mg/l within 1.5m depth of collection and LCH3 collected from the near surface.

The concentration of nitrate (NO_3^-) in the leachate ranged from 19.47mg/l to 28.70mg/l. The highest observed in LCH3, with a value of 28.70mg/l and the lowest value was observed in LCH1. According to Fatta et al., (1999) nitrates are conservative contaminants as they are not affected by biochemical processes and natural decontamination processes taking place inside the landfill as well as their infiltration into the vadose zone. This explains why nitrates are potential threat to groundwater pollution. The value of ammonia (NH_3^+) ranged between 22.50mg/l to 36.83mg/l for all three samples of leachate. The high content of ammonia in LCH1 is adduced to anaerobic condition that existed in the landfill and this may enhanced the decrease of nitrate towards ammonia gas phase. The values of ammonia obtained in the study are relatively low and not high enough to inhibit the activities of microorganisms that promote anaerobic processes. Other anions analyzed include Chlorides (Cl^{-1}), sulphates (SO_4^-) and phosphates (PO_4^-). The value of Cl^{-1} ranged between 170mg/l and 950mg/l, LCH3 has the highest value of 950mg/l and LCH2 has the lowest value of 170mg/l. Chloride is similar to nitrate in being a conservative contaminant and therefore poses serious threat to groundwater pollution. Sulphates values for the three samples of leachate examined are quite variable and may have emanated from oxidation of iron sulphide present in the dump. The maximum value obtained is 750mg/l for LCH 1 and the minimum value is 170mg/l. The values of phosphate is also variable as the value of LCH1 is 110mg/l, which is the leachate with the highest value and followed by LCH2 with a value of 89mg/l and LCH3 the least, with a value of 67mg/l. The presence of PO_4^- in a leachate is dangerous as its presence in water increases eutrophication and correspondingly promotes the growth of algae.

Table 2: Heavy metals characteristics of Groundwater, surface water and Leachates

	Pb	Zn	Fe	Cu	Cr	Mn
GW1	<0,001	1.20	1.45	0.25	0.07	0.04
GW2	<0.001	<0.001	0.01	0.094	0.094	<0.001
GW3	<0.001	<0.00	<0.001	<0.00	<0.001	<0.001
SW1	<0.001	<0.001	1.25	0.74	0.125	<0.001
SW2	<0.001	<0.001	1.87	0.43	0.180	<0.001
SW3	<0.001	<0.001	1.08	0.25	0.135	<0.001
LCH1	0.210	0.875	25.5	5.24	0.529	0.257
LCH2	0.005	0.425	8.25	2.01	0.349	0.085
LCH3	0.050	0.111	18.74	4.85	0.416	0.109

The heavy metals content of the leachate samples obtained from the laboratory analysis include lead (Pb), zinc (Zn), iron (Fe^{2+}), copper (Cu), chromium (Cr) and manganese (Mn). Similar results have also been detected in leachate samples by Christensen et al., (1994). (Fe^{2+}) has the highest concentration of 25.5mg/l of all the heavy metals present in the leachate, followed by copper with value of 5.24mg/l, whereas the lowest level is Pb, with concentration of 0.005mg/l, followed by manganese value of 0.085mg/l. The maximum concentration values of all the heavy metals examined is highest in LCH1. The high level of (Fe^{2+}), in the leachate samples is evidence of dumping of iron and steel scraps wastes in the dumpsite and the high content of iron present in shallow groundwater aquifers in Niger delta. The quantity of Pb, though small, is attributed to availability of Pb related wastes such as batteries, paints and photography processing chemicals in the dump site (Moturi et al., 2004; Mor et al., 2005). On the other hand, the concentration of Zn depicts the dumping of batteries and fluorescent lamps in the dumpsite. Also detected in the leachate samples are Mn, Cr and Cu. The presence of Cr in the leachate samples may have originated from the emission of automobile exhaust of diesel tanker vehicles which use the vicinity of the dumpsite as a garage and other vehicle which ply the road that leads to oil refinery in the city. Cu is thought to have originated from the dumping of waste related to cement like bags in the dumpsite (Masoud et al., 2009). The different heavy metals detected is indication that the Effurun open dumpsite receives variety of wastes that reflects the origin of Pb, Zn, Fe, Cu, Cr and Mn (Moturi et al., 2004; Mor et al., 2005).The low value of heavy metals obtained maybe attributed to the dumping of mainly municipal wastes and small percentage of industrial wastes.

Quality characteristics of groundwater and surface water

Under normal circumstance there should be no variation in the concentration of the constituents of water. On the contrary variation in the ionic concentration of groundwater is expected in the direction of groundwater flow. The pH value for groundwater samples is slightly acidic to neutral in which the range is from 6.3 – 7.0. These values are consistent with the World Health Organization (WHO) and the Nigeria standard for drinking water quality (NSDWQ) permissible limit for portable drinking water, except GW1 with a pH value of 6.3. The pH of the surface water samples ranged from 6.9– 7.0. The upstream surface water (SW1) sample has lower value than the downstream surface water samples (SW2 and SW3). The pH value of water has no obvious effects on the consumers. The normal pH of pristine water ranges from 6.5 – 8.5, pH values beyond this range is a strong indication of abnormality in the quality of water (Psecod, 1992). The electrical conductivity (EC) of water is reflection of the quantity of ionic constituents dissolved in it. The obtained EC ranges between 20.24 and 1200µS/cm for groundwater samples, whereas the surface samples have values that varied from 586.00 – 694.50 µS/cm. The maximum value of 1200 µS/cm was measured for GW1; this value is higher than the recommended standard by (WHO) and (NSDWQ) for portable water. GW1 that has the highest value of EC is actually the closest to the dumpsite than GW2, shallow as GW2 but shallower than GW3. The high value recorded for GW1 is probably an indication of the effect of leachate on its quality. The high level of EC may be attributable to the percolation of leachate from the unlined refuse dumpsite into the groundwater beneath it. For surface water sample, the maximum value of EC measured is associated with the downstream sample (SW3), with a value of 694.50µS/cm and a minimum value of 586.00µS/cm for the upstream sample (SW1). These values are high and they must have been caused by outflow of leachate into these bodies of surface water enhanced by precipitation. The concentration of total dissolved (TDS) in water assist to know the nature of quality and or its salinity. The obtained concentrations of TDS in groundwater in the study area vary between 9.67 and 765.37mg/l, whereas those for surface water range between 80.30 and 694.50mg/l. A high value of 765.37mg/l was measured for GW1, followed by GW2 with a value of 37.80mg/l and least value of 9.67mg/l for GW3. According to (WHO, 2004) high level of TDS may be responsible for reduction in the palatability of water, inflict gastro-intestinal inconveniences in human and may also cause laxative effect particularly upon transits. These TDS values tend to decrease with distance of groundwater wells from the refuse dumpsite, along groundwater flow paths in down gradient direction and with depth at which the samples were collected. This is consistent with other results obtained by Olayinka and Olayiwola, (2000) and Longe and Balogun (2009) from landfills located in Ibadan and Lagos respectively. In addition, the work of Olaniya and Saxena (1977) has established measurable high level of TDS concentration as an indication of contamination of groundwater near refuse dumpsite. The concentration of Ca^{++} and Mg^{++} ions in natural water influences its hardness, which is the ability of the water to form lather with soap. Total hardness actually reflects the total concentration of Ca^{++} and Mg^{++} in mg/l, equivalent $CaCO_3$. In terms of hardness, the groundwater samples in this study are predominantly soft on the Durfor and Becker (1964) classification scheme. The value of Ca^{++} ranged from 11.38 to 38mg/l, the highest recorded value, is for GW1 and the least value for GW3. The concentration of Ca^{++} is below permissible range of (WHO,2004) and (NSDWQ) standards for portable groundwater, it has been known that consumption of water with very high concentration of Ca^{++} may leads to concretion in kidney or bladder stone and also causes irritation in urinary passage (Suman et al., 2006).

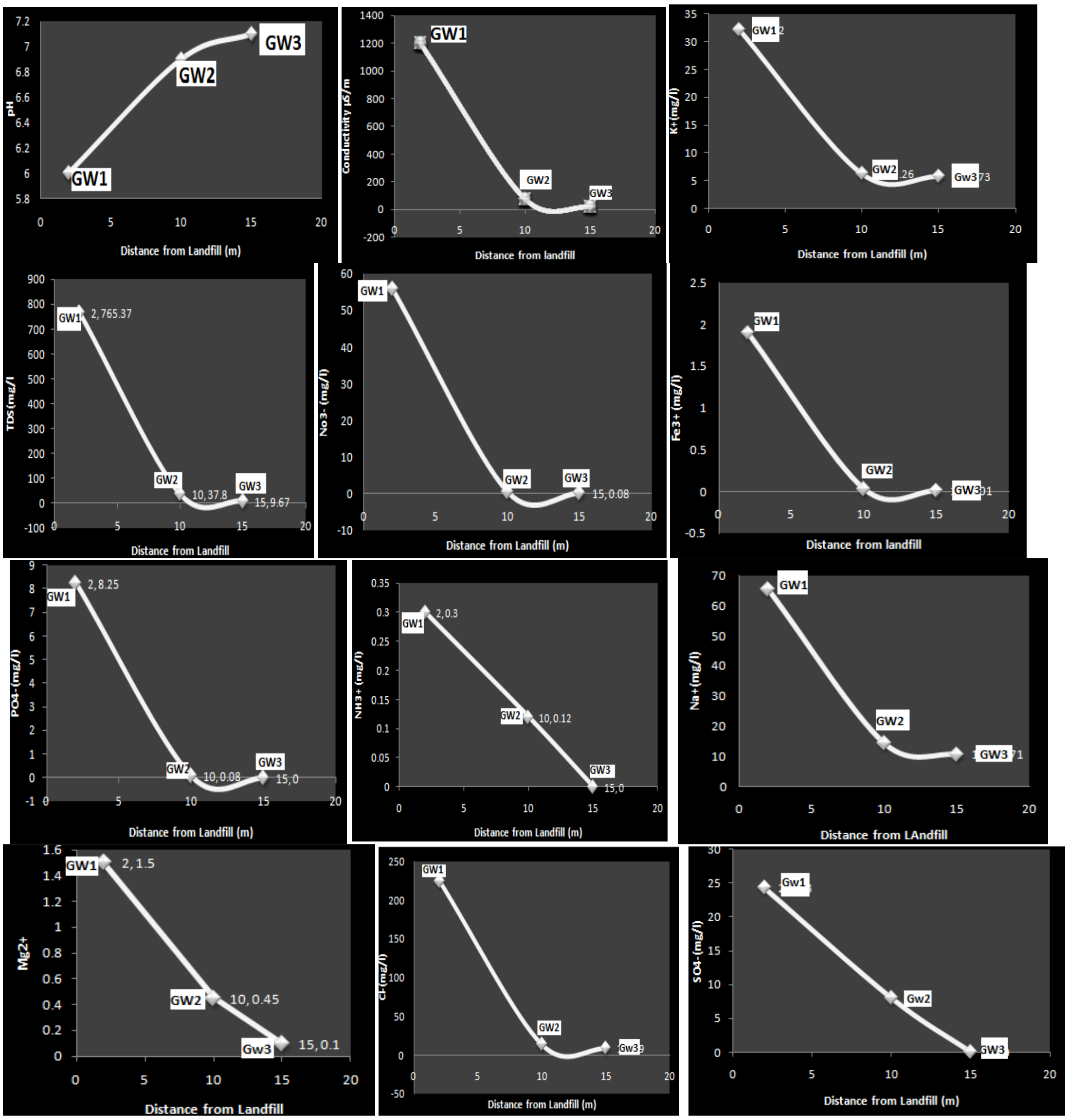


Fig 2: Influence of leachate on groundwater quality as a function of the distance from dumpsite.

The content of Mg^{++} ions in the groundwater ranged from 0.10 to 1.5, these values are lower than (WHO, 2004) and (NSDWQ, 2007) standards. However, water with very high concentrations of Mg^{++} may be responsible for laxative effects due to its diuretic and cathartic nature, whereas insufficient of which may cause structural and functional changes. The value of Na^+ ions in the water samples varied from 10.71 to 65mg/l. The higehst value is associated with GW1; the high value may have been influenced by leachate. The consumption of water with high concentration of Na^+ ions is inimical to people with cardiac, renal and circulatory diseases. On the other hand, the values for the surface water are relatively higher than those of groundwater samples. They ranged from 65-118.72mg/l, with SW3 having the maximum value. The high values obtained for these surface water samples may be adduced to leachate effects. Ellis (1980) has demonstrated the presence of K^+ in groundwater sample to the effect of leachate. The value of K^+ in the groundwater samples varied from 5.79 to 32.2mg/l and 45.91 to 49.19mg/l. The values for groundwater samples are quite low when compared to those of the surface water, which may be due to impact of leachate. The concentration of NO_3^- in the groundwater samples ranged from a level of 0.08mg/l to 56.00mg/l. These values except GW1 are below the permissible level allowed for a drinking water of 10mg/l recommended by WHO. In addition, GW1 concentration is slightly above the permissible of NSDWQ of 50mg/l, the high concentration of NO_3^- may have been influenced by leachate from the dump site. The values obtained for surface water ranged from 0.87 to 1.25mg/l, although low, they indicate some level of pollution by leachate. The occurrence of nitrate in groundwater may originate from different sources such as municipal waste disposal, engineered landfill and industrial wastewaters. High concentration of NO_3^- is known to inhibit the distribution of oxygen within the human body (Chapman, 1992, Lee and Jones-Lee, 1993: Alsabahi et al., 2009). Ammonia concentration in the groundwater samples has the range of not detected (ND) to 0.9mg/l. The highest value of 0.9mg/l was measured for GW1, which was above the limit of 0.5mg/l stipulated by WHO and lower than the standard of NSDWQ, while it was not detected in the GW3; which is from a borehole deeper than GW1 and GW2 respectively. The concentration of Ammonia in GW1 shows that it has been affected by leachate from the waste dump site. Phosphate values ranged from not detected to 8.25mg/l, with GW1 having the maximum value of 8.25mg/l, GW2 with a minimum value of 0.08 and not detected in GW3. While the concentrations of phosphate in surface water are significantly above those of groundwater; with values that ranged from 3.60 to 50.34mg/l. The high values of phosphate in samples GW1, SW2 and SW3 are strong reflection of the impact of leachate. The phosphate content of GW1 may pose a serious threat to groundwater than those of GW2 and GW3. A minute value of phosphate as low as 0.01mg/l in groundwater may result in the water being slimy and also promotes the growth of algal (Adekunle et al, 2007).The abundance of algal and slime in surface water samples in SW2 and SW3 underscore the above statement. The range of the concentration of sulphates in groundwater samples varied from 8.90mg/l to 24.00mg/l and was significantly higher in GW1 than the other. The obtained values are lower than the standard of 100mg/l stipulated by WHO and NSDWQ for portable drinking water. On the other hand, the concentrations obtained for the surface water samples were evidently higher than those of groundwater; this value varied from 61 to 105mg/l and was essentially higher in SW2. High quantity of sulphate in water is dangerous as it causes dehydration and diarrhea in children than adults (Longe et al, 2010). The concentrations of Cl^- were in the range of 8.40 to 225mg/l and significant proportion was found in GW1. Whereas the measured value obtained for surface water varied from 40.50 to 240.50mg/l. These values are evidently low when compared to the standard stipulated by NSDWQ and WHO of 250mg/l recommended for portable drinking water. High quantity of Cl^- concentrations in water is utilized as proxy for pollution and as tracer for groundwater contamination (Loizidou and Kapetanois, 1993). Domestic effluents, fertilizers, septic tank and natural sources such as rainfall and dissolution of fluid inclusion are some of the sources that may contribute to high Cl^- concentration in groundwater and pollution. According to the (WHO, 1997) high concentration of Cl^- is detrimental to people with heart diseases and Kidney problem. The concentration of COD in water expresses the quantity of oxygen that is equal to the organic matter content of it, which is prone to oxidation by a strong chemical oxidant. Consequently, COD can be utilized as a proxy for organic pollution in water. COD concentration varied from not detected (ND) to 35.00mg/l for groundwater and was significantly higher in GW1. While those for surface water varied from 55 to 95mg/l and the maximum value was recorded in SW3. These values reflect the presence of organic contaminants in both surface water and groundwater, which may have been caused by the leachate from the waste dumpsite.

Heavy metals in surface water and groundwater

Among the heavy metals analyzed, Fe^{2+} has the maximum concentration of 1.45mg/l. The obtained value for GW1 is evidently higher than the 0.3mg/l standard requirement for portable drinking water but GW2 and GW3 fall within the standard stipulated by the NSDWQ and WHO for portable drinking water. The concentration of Fe^{2+} in the surface water samples ranged from 1.08 to 1.87mg/l and the maximum value obtained is 1.87mg/ for SW2, which is down gradient of the dump site. The colour of GW1 was brownish in colour compared to GW2 and GW3 that were colourless; this however conforms to Rowe et al., (1995) findings, that a change in colour is often expected in groundwater which contains Fe^{2+}. This strongly indicates that the leachates from the landfill may have impacted on the quality of GW1 and surface water; SW1, SW2 and SW3. Minute concentrations of the following heavy metals were detected in the groundwater samples and are below the required standard for portable drinking water of NSDWQ and WHO. This includes Cu with a concentration of 0.25mg/l, Zn with concentration of 1.20mg/l, Pb concentration was very insignificant as it value is <0.001 and Manganese with a concentration of 0.04mg/l. These concentrations may not pose health threat to the quality of the groundwater found near the waste dump site. The corresponding values of Pb, Zn, and Mn in surface water samples were also lesser than 0.001mg/l as in groundwater samples, except Cu with concentration of 0.74mg/l for SW1, 0.43mg/l and 0.25 for SW2, and Cr values of 0.125mg/l for SW1, 0.180mg/l for SW2 and 0.135mg/l for SW3. These concentrations are slightly higher than those of groundwater samples. The very low concentrations of heavy metals recorded in the study underpin the roles played by the occurrence of organic soils and clayey soils underneath the municipal waste dump site in the sorption of heavy metals (Suman et al., 2006 and Ohwoghere – Asuma, 2012). Heavy metals tend to be immobile in the waste or waste- rock interface due to redox controlled reaction (Yanful et al., 1988). Also, the mobility of heavy metals is influenced by the physical sorptive mechanism and landfills posses' intrinsic in-situ ability in minimizing the mobility of toxic heavy metals (Pohlands et al, 1993). These processes influencing the mobility of heavy metals in waste or soil have effect of attenuating the risk associated with the consumption of groundwater polluted by leachates.

Conclusion

The BOD5/COD ratios revealed that leachate from the refuse dump site vary partially from being young to mature in age. The variation in age of the different leachates samples is basically influenced by the depth at which they are collected from and the continuing decomposition of refuse, as result of new wastes that are being added on daily bases.

The quality of surface water near the refuse dump site contained more ions and cations than the groundwater samples. During wet season, decomposing refuses mixed with precipitation and subsequently flows as runoff to contaminate surface water bodies nearby.

The analyzed groundwater samples obtained from the vicinity of the refuse dump site did not evidently reflect water quality that is affected by the leachates from the refuse dumpsite. Nevertheless the slightly elevated values of EC, TDS, NO_3, Ammonia, PO^-_4 and COD obtained, strongly depict the influence of leachates on the groundwater quality and may pose serious threat to groundwater quality in the distant future.

Iron and chromium concentrations are relatively higher than the permissible limit of WHO, 2004 and NSDWQ but other heavy metals are quite negligible. This is attributed to the presence of organic soils and the stratigraphy of the soil at Effurun waste dump site, which is responsible for retention and absorption of heavy metals.

The distance and depth of the sink from the source of leachate has greater impact on the degree and extent of contamination of groundwater and surface water. The shallow wells in the proximity of the waste dumpsite has more concentrations of ions, cations and organic than those farther from it.

Finally, it is suggested that the waste management board of the state and the Uvwie Local government council should partner to upgrade the Effurun city refuse dump site and others into well engineered sanitary landfills.

References

Adekunle, I.M., M.T. Adetunji, A.M. Gbadebo and O.B.Banjoko, 2007. Assessment of groundwater quality in a typical rural settlement in Southwest, Nigeria. Int. J. Environ. Res. Public Health, 4(4): 307-318.

Al-Sabahi, E. Abdul Rahim, S. Wan Zuhairi, W.Y. Al-Nozaily, F., and F. Al-Shaebi. 2009. “The haracteristics of Leachate and Groundwater Pollution at Municipal Solid Waste Landfill of Ibb City, Yemen”. American Jour. of Environ. Sci. 5(3): 256-266.

Alloway, B, J. 1995. Heavy metals in soils second edition. London: UK. Chapman and Hall.

Alsabahi, E., S. Abdulrahim, W.Y. Zuhairi, F. Al-Nozaily and F. Alshaebi, 2009. The Characteristics of leachate and groundwater pollution at municipal solid waste landfill of Ibb City, Yemen. Am. J. Environ.Sci., 5(3): 256-266.

Chapman, D., 1992. Water Quality Assessments. A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring. 1st Edn., UNESCO/ WHO/UNEP, Chapman and Hall, London.

Christensen, T. H., Kjeldsen, P., Albrechtsen, H.-J., Heron, G., Nielson, P. H., Bjerg, P. L. and P.E. Holm, 1994. Attenuation of Landfill Leachate Pollutants in Aquifers. *Critical Reviews in Environ. Science and Technol.* 24, 119-202.

Christensen, T.H., P. Kjeldsen, P.L. Bjerg, D.L. Jensen, J.B. Christensen, A. Baun, H.J. Albrechtsen and G. Heron, 2001. Biogeochemistry of landfill leachate plumes. Appl. Geochem., 16: 659-718.

Daskalopoulos, E., O. Badr and S.D. Probert, 1998. Annintegrated approach to municipal solid waste management. Res. Cons. R ec., 24(1): 33-50.

Durfor, C.N. and Becker, E. 1964. Public water supplies of the 100 largest cities in the US. US-Geol. Sur. Water Supply Paper 1812 : 364.

EHS, 2005. Towards resource management: A consultation on proposals for a new waste management strategy. http://www.ehsni.gov.uk/pubs/ publications/towardsresourcemanagement.pdf

Ehrig, H.J. 1989. Leachate quality: In Christensen, H,T, Stegmann,A, and Cossu (ed).
Sanitary landfilling: Process, Technology and Environmental Impact. London. Academic Press. P (20-40).

El-Fadel, M., A.N. Findikakis and J.O. Leckie, 1997. Environmental impacts of solid waste landfilling. J.Environ. Manage., 50(1): 1-25.

Ellis, J., A 1980. Convenient parameter for tracing leachate from sanitary landfills. Water Res., 14, 1283-1287.

Fatta, D. C, Voscosa, A. Papadopouls and M. Lizidou, 1998. Leachate quality of a MSW
landfill. *Journal of Environmental Science and Health* 33(5):749-763.

Fatta D., A Papadopoulos and M., Loizidou, 1999. A study on the landfill leachate and its impact on the groundwater quality of the greater area. Environ. Geochem. Health 21 (2): 175-190.

Jhamnani, B. and S.K. Singh, 2009. Groundwater contamination due to Bhalaswa Landfill site in New Delhi. Int. J. Enviorn. Sci. Eng., 1(3):121-125.

Kjeldsen, P., M.A. Barlaz, A.P. Rooker, A. Baun, A. Ledin, and T.H. Christensen, 2002. Present and long term composition of MSW landfill leachate: A review. Critical Rev. Environ. Sci. Tech., 32(4): 297-336.

Lee, G.F. and A. Jones-Lee, 1993. Groundwater pollution by municipal landfills. Leachate composition,detection and water quality significance. Proceeding of the 4th International Landfill Symposium, Sardinia, Italy, pp: 1093-1103.

Longe, E.O. and L.O. Enekwechi, 2007. Investigation on potential groundwater impacts and influence of local hydrogeology on natural attenuation of leachate at a municipal landfill. Int. J. Environ. Sci. Tech., 4(1):133-140.

Loizidou, M., and E. Kapetanios, 1993. Effect of leachate from landfills on underground water quality. Sci.Total Environ., 128, 69–81.

Longe, E.O. and M.R. Balogun, 2010. "Groundwater Quality Assessment near a Municipal Landfill, Lagos, Nigeria". *Res. Jour. of Applied Sci., Eng. and Technol*. 2(1):39-44.

Mor, S., Ravindra, K., Vischher, A. R. P. Dahiya and A. Chandra, 2005. Municipal Solid Waste Characterisation and its assessment for potential methane generation at Gazipur Landfill Site, Delhi: A case study. Bioresource Technology, Communicated.

Moturi, M. C. Z., Rawat, M., and V. Subramanian, 2004. Distribution and fractionation of heavy metals in solid waste from selected sites in the industrial belt of Delhi, India. Environ. Monit. Assess. 95, 183-199.

NSDQW, 2007. Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard NIS 554, Standard Organization of Nigeria, pp: 30.

Olaniya, M. S. and K. L. Saxena, 1977. Ground water pollution by open refuse dumps at Jaipur. *Ind J. Environ. Health* 19, 176-188.

Pescod, M, B. 1992. *W*astewater treatment and use in agriculture. Food and Agriculture Organization (FAO).

Pohland, F. G., Cross, W. H. and J. P. Gould, 1993. Metal speciation and mobility as influenced by landfill disposal practices. In: *Metals in Groundwater* (edited by Allen, H. E., Perdue, E. M. and Brown, D. S.). Lewis Publishers, Boca Raton, 411-429.

United States Environmental Protection Agency (USEPA), 1984. Office of Drinking Water, A Ground Water Protection Strategy for the Environmental Protection Agency, pp.11.

USEPA, 2007. Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2006. EPA-530-F-07-030. http://www.epa.gov/osw//nonhaz/municipal/pubs/msw06.pdf

SEPA, 2007. EU Wastes Statistics Regulation Scotland Report 2004. http://www.sepa.org.uk/pdf/publications/wds/wdd_5.pdf

Slomczynka, B. and T. Slomczynski, 2004. Physicochemical and toxicological characteristics of leachates from MSW landfills. Polish J. Environ. Stud., 13(6): 627-637.

WHO, 2004. Guidelines For Dinking W ater Quality. 3rd Edn. Vol. 1 Recommendation, Geneva, 515.

WHO (World Health Organization). 1997. Guideline for drinking water quality, 2nd ed., Vol 2 Health criteria and other supporting information, World Health organization, Geneva, pp 940-949.

Yanful, E. K., Quigley, R. M. and H. W. Nesbitt, 1988. Heavy metal migration at a landfill site, Sarnia, Ontario, Canada - 2: metal partitioning and geotechnical implications. *Applied Geochemistry* 3, 623-629.

Yoshida, M, Ahmed, S, Nebil, S. & Ahmed, G. 2002. Characterization of leachate from Henchir El Yahoudia close landfill. Water, Waste and Environment Research 1(2): 129-142.

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** http://www.iiste.org/journals/ The IISTE editorial team promises to the review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Recent conferences: http://www.iiste.org/conference/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar