Implementing Innovative Ideas in Structural Engineering and Project Management
Edited by Saha, S., Zhang, Y., Yazdani, S., and Singh, A.

ISBN: 978-0-9960437-1-7

GROUNDWATER ASSESSMENT IN A CITY SUBURB

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Owode, a sprawling water catchment area better known for its commercial activities in metal and iron casting and fabrication, is located off the Lagos Lagoon and the Ajuwon River, in Lagos State. The extensive iron and steel work along with seasonal flooding of the area and the habits of the people in this area is considered a threat to its groundwater integrity. Samples designated SW1, SW2, and SW3 for stream water WW1, WW2, and WW3 for well water and BH1, BH2, and BH3 for samples collected from boreholes were collected and analyzed to determine the presence of certain physicochemical elements and heavy metals. Including pH, EC, TDS, DO, SO_4^{2-}, Cl, NO_3^-, and PO_4^{3-}. Heavy metals analyzed include Fe, Pb, Zn, Cu, Cr, Cd, and Mn. The findings showed that while a number of parameters when compared with the WHO and NADWQ stipulated maximum acceptable concentration fell within acceptable limits, others especially the heavy metals had trace elevations above the maximum acceptable levels which if not checked could have serious future groundwater contamination implications.

Keywords: Contamination, Groundwater integrity, Heavy metals, Flooding, Parameters, Diversity.

1 INTRODUCTION

Groundwater is the major source of about 90% of the world's fresh water supply and provides domestic water to a vast majority of people. Man's activity over time however, has threatened the quality of groundwater causing it to undergo gradual deterioration. The aquifers, which are the major source of groundwater, are not only being depleted but are also becoming heavily polluted. Owode a sprawling water catchment area best known for its commercial activities in metal and iron casting and fabrication, located off the Lagos Lagoon and the Ajuwon River, in the Kosofe area of Lagos State, is a typical example considering the activities carried out here. For several years the Owode iron market has been a major recipient of all kinds of scrap metals ranging from used and accident disfigured cars, trucks, generating sets, machine parts, refrigerators, iron bars and building materials brought there for refurbishing or disposal, and could therefore be considered a typical metal scrap yard. There is a great possibility of surrounding groundwater contamination with heavy metals; because of the potential of leachates originating from this site such contamination of groundwater resource poses a substantial risk to users.

Heavy metals exist in water in particulate, colloidal or dissolved phases (Adepoju-Bello *et al.* 2009) and occur in water bodies either from anthropogenic origin caused basically from human activities or through the natural eroding of minerals such as ore deposits (Marcovecchio *et al.* 2007). Heavy metals such as Iron, Copper, Cobalt, Manganese and Zinc may be required at low levels to act as catalyst for enzyme activities (Adepoju-Bello *et al.* 2009), while others such as Potassium, Magnesium, Calcium and Sodium are essential for the sustenance of both plants and animal life. However excess exposure to certain heavy metals in small doses over a period of time could be toxic and fatal.

Past studies have concentrated majorly on the impairments of groundwater quality through leachates outflow and infiltration from landfill operations in Lagos state (Longe and Balogun 2010, Longe and Enekwechi 2007). This study however seeks to assess the groundwater quality along the Owode axis of Lagos state, considering the metal activities carried out there.

2 RESEARCH METHODOLOGIES

2.1 Environmental Background

Owode is located in Kosofe area of Lagos, Nigeria (Figure 1). It is located in the south-west region of Nigeria, spanning the Guinea coast of the Atlantic Ocean for over 180 km, from the Republic of Benin on the west to its boundary with Ogun state in the east. It extends approximately from latitude 6°23' North to 6°41' North, and from longitude 2°42' East to 3°42' East. It has a total area of 3577 km^2 with about 787 km^2 i.e., 22% of the total area being water. The entire area is low-lying and is characterized by two major climatic seasons, a dry season and wet season. Lagos is made up of Coastal Plain Sands and Recent Alluvial Deposits (Longe *et al*. 1987). The latter which consists of littoral and lagoon sediments of the coastal belt is characterized by Mangrove (saltwater) and freshwater swamps where aquifers, are readily recharged by copious rainfall; making them vulnerable to leachate contamination, with the lithological deposition of the aquifers giving rise to artesian and sub-artesian conditions. In the Lagos metropolitan area, the Coastal Plain Sands are the major aquifers generally exploited for water supply (Longe *et al*. 1987).

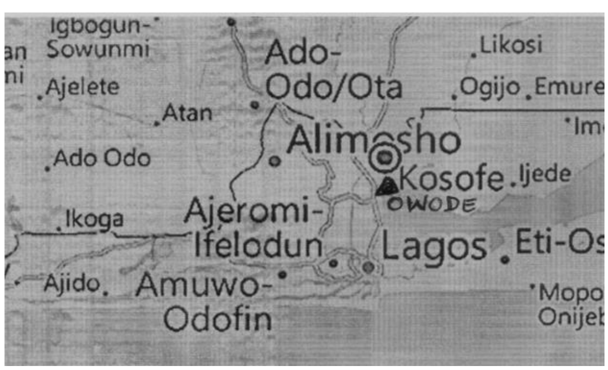

Figure 1. Map of Lagos state showing area of study.

2.2 Sampling Procedure

Groundwater samples were collected from nine (9) different points within and around the vicinity of the point source: including a slow flowing stream very close to the iron/metal market considered the point source, boreholes and wells, located down gradient from the point source and within residential areas. They are designated SW1, SW2, and SW3 for collected stream water representing upstream, midstream and downstream, samples collected from wells are designated WW1, WW2, and WW3, while samples collected from boreholes are designated BH1, BH2, and BH3. The collection points are shown in Figure 2. The collection containers were washed thoroughly and rinsed with de-ionized water and sample fluids prior to collection. Concentrated hydrochloric acid was added to the containers in small quantities to preserve samples for heavy metals analysis. Precautionary measures were taken as per the standard guidelines, to avoid any possible contamination. In the case of the stream and wells the samples were collected by lowering the bottle at depth of about 1 foot below the surface and then opening the cap to collect the water while for the boreholes the tap was fully opened and allowed to run to waste for about 5 minutes, then the sample was collected in the sterile sampling bottles. Sampling was carried out in the in the month of May, 2014 at the out start of the raining season. During sampling all the Water samples were preserved in a cool box and subsequently taken to the laboratory for analysis. Chemical analysis was initiated immediately the samples arrived at the laboratory without delay in accordance with the APHA (1992) methods. The coordinates of the sampling points was determined using the Global positioning system (GPS) Garmin 76 device in order to have a clear view of the area.

Figure 2. Collection points for samples from left to right: stream, open well, and borehole.

The various physicochemical parameters analyzed for all the samples include pH, Electrical conductivity (EC), Total dissolved solids (TDS), Dissolved oxygen (DO), Sulphates (SO_4^{2-}), Chlorides (Cl), Nitrates (NO_3^-), Phosphates (PO_4^{3-}). Heavy metals analyzed include Iron (Fe), Lead (Pb), Zinc (Zn), Copper (Cu), Chromium (Cr), Cadmium (Cd), and Manganese (Mn).

3 RESULTS AND DISCUSSION

Results of physicochemical characteristics of the samples from the stream, wells and boreholes as well as that for heavy metal determination are presented in Tables 1 and 2 respectively. The pH value of the stream sample was in a range between 6.0 and 7.7, while that of the well and borehole samples range between 5.40 and 7.60 with a mean value of 6.44 indicative of the fact that there is some level of acidity in the groundwater samples which is confirmed by (Longe *et al*. 1987, Yusuf, 2007). The mean dissolved oxygen concentration from SW is 4.9mg while that of WW and BH has a range of 2.02 - 5.7, with a mean concentration of 4.06 mg. These values indicate a fairly high level of dissolved oxygen in the samples above that stipulated by World Health Organization (WHO). The results indicate some form of interaction between the stream and groundwater sources. Concentrations of all other parameter including TDS, SO_4^{-2}, Cl, NO_3^-, and PO_4^{3-} in SW 1-3, WW 1-3, and BH 1- 3 are all within acceptable levels as specified by WHO and Nigerian Standard for Drinking Water Quality (NSDQW) standards for drinking water quality. Sulphate which is capable of causing dehydration and diarrhea in children was mostly found in traces in SW 1-3 and BH 3. Heavy metals are also present in traces except Fe, Zn and Mn which have levels exceeding WHO and NADWQ standards in SW1-3 and BH1. Cu is elevated in SW3 and BH1 while Pb is found in higher levels than stipulated by WHO an NADWQ in BH1.

Table 1. Physicochemical characteristics of the leachate and groundwater.

	pH	**EC (µS/cm)**	**TDS (mg/L)**	**DO (mg/L)**	**SO_4^{2-} (mg/L)**	**Cl (mg/L)**	**NO_3^- (mg/L)**	**PO_4^{3-} (mg/L)**
Stream								
SW1	6.0	372	229	4.2	11	90	3.02	0.03
SW2	7.7	539	360	4.6	17	120	4.22	0.03
SW3	7.7	1012	400	6.0	32	30	8.26	1.60
Well								
WW1	6.26	50.8	220	3.91	ND	14	1.3	0.77
WW2	6.32	428	201	2.95	ND	12	1.4	2.84
WW3	5.4	59.5	330	5.1	ND	118	1.3	1.75
Borehole								
BH1	7.6	480	320	4.8	16	14	4.10	0.02
BH2	7.3	104.79	98.30	2.02	ND	54	1.4	4.42
BH3	5.8	150.18	110.2	5.56	ND	30	4.90	0.64
WHO	6.5 - 8.5	1.0	500	3.0	400	250	50	NS
NADWQ	6.5 - 8.5	1000	500	NS	400	250	50	NS
Mean	6.44	212.2	213.3	4.06	2.67	40.3	2.4	1.74

ND – Not Detected

Table 2. Heavy metal characteristics of the leachate and groundwater.

	Fe (mg/L)	**Pb (mg/L)**	**Zn (mg/L)**	**Cu (mg/L**	**Cr (mg/L)**	**Cd (mg/L)**	**Mn (mg/L)**
Stream							
SW1	2.85	ND	4.29	0.72	ND	ND	0.06
SW2	8.14	ND	3.28	1.52	ND	ND	0.44
SW3	24.30	0.008	8.69	2.89	ND	ND	0.87
Well							
WW1	0.2571	0.0005	0.0107	ND	ND	0.0013	0.0080
WW2	0.2842	0.0001	0.0004	ND	ND	0.0002	0.0097
WW3	0.0325	0.0004	0.0023	ND	ND	0.0003	0.0067
Borehole							
BH1	4.92	1.05	4.46	1.88	ND	ND	0.49
BH2	0.3101	0.0000	0.0005	ND	ND	0.0001	0.0001
BH3	0.0300	0.0012	0.0069	ND	ND	0.0003	0.0043
WHO	0.3	0.01	1.5	1.0	0.05	0.002	0.2
NADWQ	0.3	0.01	03	2.0	0.05	0.003	0.05
Mean	0.967	0.175	0.747	0.313	ND	0.0003	0.086

ND – Not Detected

4 CONCLUSIONS

From the analysis and results obtained it is clear that contaminants including heavy metals are gradually finding their way into the surrounding groundwater, and by extension into the water sources used for consumption and domestic purposes. Though a number of parameters tested when compared with the WHO and NADWQ stipulated maximum acceptable concentration fell within acceptable limits, others especially the heavy metals had trace elevations above the maximum acceptable levels this if not checked with proper mitigating mechanisms put in place, could have serious future groundwater contamination consequences and by extension severe health implications.

Acknowledgements

The assistance of S. Emunemu, D. Oladipo, and D. Rilwan in the carryout of the field work and the availability of facilities at the Lagos State Environmental Protection Agency (LASEPA) contributed immensely towards the success of this research. They are highly appreciated.

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