Groundwater Quality Assessment for Domestic Uses in the Micro-Geomorphological Units of Lagos, Nigeria

Ayeni, A. O. and A. S. O. Soneye
[1]Department of Geography, University of Lagos, Lagos – Nigeria
aayeni@unilag.edu.ng, asoneye@unilag.edu.ng
08053620311

Abstract

This study focused on physic-chemical and trace metals concentrations in hand dug wells across four micro geomorphological units of Lagos Nigeria. Water samples were collected from 12 selected wells used for domestic purposes in the metropolis between November 2009 and March 2010. Four (4) parameters – pH, EC, DO and salinity were determined with portable pH/conductivity meters, handheld M90 Mettler Toledo AG DO meter and handheld Omega salinity meter respectively. The remaining seven (7) parameters - total dissolved solids (TDS), total hardness (TH), chloride (Cl^-), nitrate (NO_3^-), iron (Fe), manganese (Mn) and zinc (Zn) were determined using atomic spectrophotometer, gravimetric, chlorometric and titrimetric methods. The results reveal that pH levels ranged between 5.2 and 8.2 with mean of 6.4±0.90, EC between 34.0 and 340.0mg/l with mean of 177±121mg/l, DO between 1.7 and 4.0mg/l with mean of 2.6±0.7mg/l, TDS between 5 and 241mg/l with mean of 88.1±95mg/l, TH between 6.3 and 109mg/l with mean of 39.7±27.2mg/l, salinity between 17.0 and 497.0mg/l with mean of 111±168mg/l, Cl^- between 3.5 and 55mg/l with mean of 20±19.9 mg/l, NO_3^- between 7.7 and 62.0mg/l with mean of 26.1±19.6mg/l, Fe between 0.02 and 1.5mg/l with mean of 0.2±0.41mg/l, Mn between 0.02 and 0.2mg/l with mean of 0.1±0.05mg/l, and, Zn between 0.0 and 0.3mg/l with mean of 0.1±0.08mg/l. EC, TDS, TH, salinity, Cl^- and Zn concentrations in all sampled wells fall within the WHO recommended limits. NO_3^- and Fe concentrations ranged above WHO limits in some cases. The results suggest that the variation in concentrations could be attributed to the surrounding geomorphological units except heavy metals which are traced to leachates around landfill areas. Nevertheless, the results of concentration of the analyzed parameters, heavy metals in particular do not follow a significantly identified trend across the geomorphological units

Key words: *Groundwater, physic-chemical, trace metals, geomorphic units, Lagos*

Introduction

Water is fundamental to life. About 60 per cent of human body is water (Fasunwon *et al.*, 2010). Of significance in the uses of water are industrial, domestic and agricultural activities. Ground water is widely distributed and most common use in terms of spatial access, storage and management (Alexander, 2008). It accounts for about 90% of the world freshwater resources and constitutes about 80% of safe drinking water in urban and rural areas of Nigeria. It is obtained from boreholes and shallow hand-dug wells (Adekunle *et al.*, 2007; Yerima *et al.,* 2008; Adebo and Adetoyinbo, 2009). In most African countries, groundwater is the most suitable for public water supply source and not easily exposed to contaminant compared to surface water (Alexander, 2008 and Fasunwon *et al.*, 2010). Groundwater is of excellent natural quality and usually free from pathogens, colouration and turbidity (Jain *et al.,* 1995). Hence, it can be consumed directly without treatment.

Constituents of groundwater-bearing rocks influence the physic-chemical properties of the water. They are compounded by seepages of uncontrolled solid wastes and sewages, agricultural wastes, urban runoffs and liquid discharges and therefore unsafe for domestic purposes if not treated (Isiorho and Oginni, 2008; Dada, 2009; Fasunwon *et al.*, 2010; Ayeni, *et al.*, 2011). To Amadi *et al.* (1989) and Yerima *et al.* (2008), the impacts are more in rural areas. Yet, groundwater still remains the only source of water supply especially in low income neighborhoods where the socio-economic characteristic do not favour pipe borne water sources.

The focus of the study is assessment of the physic-chemical characteristics of groundwater for domestic purposes across the geomorphological units of Lagos. The concentration levels of pH, Electric conductivity (EC), Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Hardness (TH), Salinity, Chloride (Cl^-), Nitrate (NO_3^-), Iron (Fe), Manganese (Mn) and Zinc (Zn) are focused upon.

Exposure to high levels of these constituents in drinking water particularly, when they are outside permissible limit(s) is one of the most environmental issues that endanger human health. It can be disastrous where large populations consume the contaminated water without adequate treatment (Adekunle *et al.,* 2007).

The Study Area

Lagos is in a sedimentary coastal plain around the Gulf of Guinea (Fig. 1). The vegetation naturally is dominated by mixed swamps of wetland fresh water and mangroves. The rainfall pattern is double maxima. It ranges between 1400mm and 1800mm and last between March and November. The temperature is in excess of 30^0C all year round. The geological information reveals that Lagos lies solely within the extensive Dahomey basin which extends almost from Accra to Lagos. The basin thickness increases from north to south (down dip) and from east to west. The littoral and lagoon deposit of recent sediment underlies the area. The coastal belt varies from about 8km near the Republic of Benin border to 24 km towards the eastern end of the Lagos Lagoon (Adegoke, 1969, Agagu, 1985; Nton, 2001; Alabi *et al.,* 2010; Fasunwon *et al.,* 2010; Ayeni and Adedayo, 2012). The area is underlain by clay, unconsolidated sands and mud with coarse unsorted sand clay lenses and occasional pebble beds of the alluvial deposit (Nton, 2001; Alabi *et al.,* 2010). The area is further divided into various geomorphological units including coastal plain sand (Alfisols), Deltaic basins, tidal flats and most recent mixed alluvium-coastal plain sand. Open waterbodies of lagoons and creeks covers about 22% of the 3,577km^2 of the state of Lagos in Nigeria. Fasona *et al* (2005) noted that the metropolis covers about 37% of the land area of the state. Officially, the State has a population of about 9.2million (NBS, 2007) out of a national estimate of 120million. Based on UN survey and the State Regional Master Plan, however the state is estimated to have about 17 million inhabitants. The metropolitan area accommodates over 85% of the population.

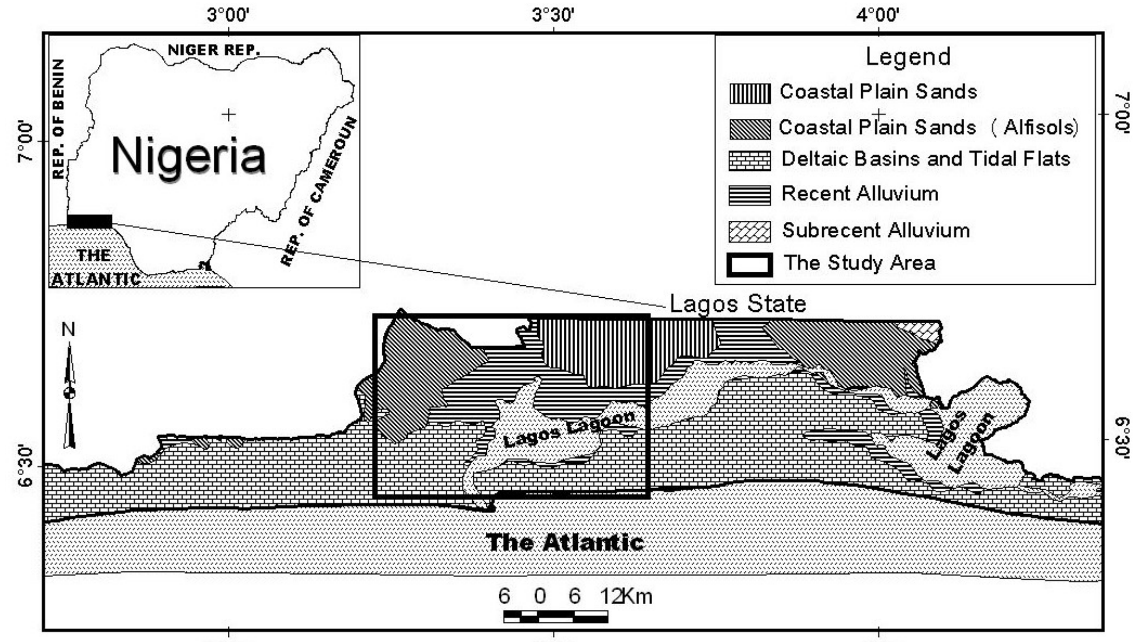

Fig. 1: Geomorphological units of Lagos (Modified after Billman, 1976 and NGSA 2006)

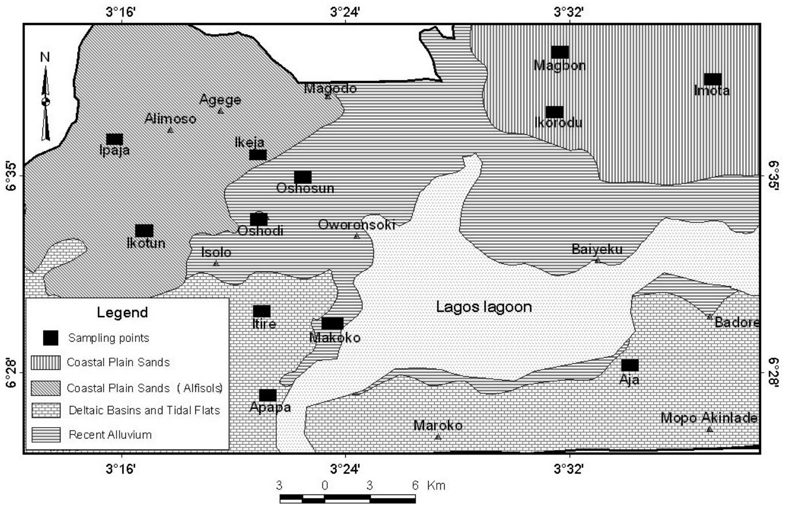

Fig. 2: The Sampling points across the geomorphological units

Materials and Methods

Groundwater samples were collected from 12 randomly selected hand-dug wells between November 2009 and March 2010 across the geomorphological units of the metropolis (Fig. 2).

Details of the wells are presented in Table 1 along with their coordinates which were determined using a hand-held Global Positioning System (GPS). Primarily, the levels of usage for domestic purposes were the main consideration in the choice of the sampled wells. For each location four parameters - Acidity (pH), Electrical conductivity (EC), Dissolved oxygen (DO) and salinity were measured in-situ. The values pH and EC were determined with portable pH/conductivity meters while DO and salinity were measured with handheld

M90 Mettler Toledo AG DO meter and handheld Omega salinity meter respectively. Using APHA (1998) standard methods of water collection and analysis, two (2) litres of water from each location were collected in clean bottles, labeled and transported to laboratory for analysis of total dissolved solids (TDS), total hardness (TH), salinity, chloride (Cl^-), nitrate (NO_3^-), iron (Fe), manganese (Mn) and zinc (Zn) (Table 1). The analyses were carried out using atomic absorption spectrophotometer, gravimetric, choromrtric and titrimetric methods (Table 1). The results were compared with World Health Organization (WHO 1993 & 2006) drinking water standard.

Table 1: APHA (1998) methods & procedures for laboratory analysis of water quality

S/n	Parameters	Methods & Procedures
1	TDS	*Gravimetry (Analytical balance and Oven):* A 100cm^3 of the filtrate was evaporated in an ignited and weighed petridish using a hot plate. The sample was kept under the boiling point range while heating. The dish was re-weighed after drying and the weight of the residue was calculated.
2	*TH*	*EDTA titration:* A 100cm^3 of water sample was measured into a 250ml conical flask and 2.0ml buffer solution was added and mixed. Eight drops of Erichrome black T indicator was introduced followed by titration with 0.01 EDTA solutions. At the end solution changes from wine red to pure blue.
3	Cl^-	*Titration using Mercury Nitrate method:* A 100ml of water sample was measured into a 250ml conical flask. 1ml bromophenol blue indicator was added followed by titration with 0.014 mercuric nitrate solutions.
4	NO_3^-	*Chlorometric method using phenol disulphuric acid:* 25ml of water sample was measured into 250ml beaker and 4ml of 0.25m NaOH, 12.5ml of reduction mixture were added and shaken vigorously and allowed to stand for 45minutes. 6ml of 0.1MHCL, 1m EDTA, disulphuric acid were added and mixed thoroughly, then allowed to stand for 5 minutes. On treatment with 1ml of sodioum acetate, it was allowed to stand for 10 minutes. The concentration was read on spectrometer at 520nm (Model: Spectronic 20D+)
5	Fe, Mn and Zn	*Atomic Absorption Spectrophotometer (AAS):* 100ml of thoroughly well mixed water sample was pour into a beaker and 5ml concentrated nitric acid was added. The sample is accurately weighed and then dissolved, often using strong acids. The resulting solution is sprayed into the flame of the instrument and atomised. Light of a suitable wavelength for a particular element is shone through the flame, and some of this light is absorbed by the atoms of the sample. The amount of light absorbed is proportional to the concentration of the element in the solution

Results and Discussions

Acidity (pH): pH values range from 5.2 to 8.2 with mean value of 6.4±0.90. The pH values of Ikotun (5.5), Ikeja (5.7), Ipaja (6.1), Imota (5.8), Apapa (5.2) and Makoko (6.3) wells fall below the range of 6.5 to 9 WHO limits (Table 2 & Fig 3). The mean concentration of pH is lowest in the coastal plain sand (Alfisols) and highest in the recent alluvium. The values are 5.7±0.4 and 6.8±0.6 respectively. The lowest value is at Apapa (5.2). Compared to the WHO limits the pH values in the Coastal plain sand (Alfisols) and deltaic basin/tidal flat are slightly acidic. The acidic nature of the well water can be attributed to existing waste dump sites in the area. Nonetheless, the pH values, which give the indication of acidity and alkalinity, show that the wells are safe for domestic uses.

Table 2:Physic-chemical Parameters of groundwater quality data from the study area

S/n	Geology	Sampling location	Latitude	Longitude	pH	EC (µs/cm)	DO (mg/l)	TDS (mg/l)	TH (mg/l)	Salinity (mg/l)	Cl- (mg/l)	NO_3^- (mg/l)	Fe (mg/l)	Mn (mg/l)	Zn (mg/l)
1	CPS (Alfisols)	Ikotun	6° 33′ 3.6″	3° 17′ 27.6″	5.3	107.0	2.7	51.0	109.0	19	15.4	19.7	0.15	0.14	0.27
2	”	Ikeja	6° 36′ 36.0″	3° 21′ 3.6″	5.7	133.0	2.5	211.0	12.0	21	15.0	15.0	0.10	ND	0.00
3	”	Ipaja	6° 27′ 3.6″	3° 21′ 28.8″	6.1	245.0	3.0	13.0	38.0	17	55.0	58.0	0.03	ND	0.00
		Unit mean			*5.7±0.4*	*161.7±73*	*2.7±0.3*	*91.7±105*	*53.0±50.2*	*19.0±2.0*	*28.5±23*	*30.9±23.6*	*0.1±0.06*	*0.14±*	*0.1±0.16*
4	CPS	Ikorodu	6° 37′ 19.2″	3° 31′ 12.0″	7.1	251.0	3.1	198.0	38.0	27	7.0	9.0	0.09	0.09	0.04
5	”	Imota	6° 38′ 31.2″	3° 37′ 15.6″	6.9	336.0	4.0	211.0	6.3	31	3.5	20.0	0.14	0.16	0.08
6	”	Magbon	6° 39′ 54.0″	3° 32′ 2.4″	5.8	287.0	2.1	5.0	38.0	54	3.5	48.1	0.12	0.07	0.05
		Unit mean			*6.6±0.7*	*291.3±42*	*3.1±1.0*	*138±115*	*27.4±18.3*	*37.3±15*	*4.7±2.0*	*25.7±20.2*	*0.1±0.03*	*0.1±0.05*	*0.1±0.02*
7	DB/TF	Aja	6° 28′ 12.0″	3° 34′ 12.0″	6.8	38.0	1.9	34.0	40.0	412	5.5	7.7	0.17	0.02	0.02
8	”	Apapa	6° 36′ 39.6″	3° 16′ 1.2″	5.2	56.0	3.2	19.0	42.0	494	8.7	7.9	1.50	0.10	0.01
9	”	Itire	6° 30′ 43.2″	3° 20′ 20.4″	8.2	37.0	3.4	28.0	31.0	17	55.0	62.0	0.12	0.08	0.02
		Unit mean			*6.7±1.5*	*43.7±11*	*2.8±0.8*	*27.0±7.6*	*37.7±5.9*	*308±255*	*23.1±28*	*25.9±31.3*	*0.6±0.8*	*0.1±0.04*	*0.1±0.01*
10	RA	Olushosun	6° 35′ 27.6″	3° 22′ 8.4″	6.5	259.0	1.7	41.0	67.0	19	12.5	16.2	0.05	0.19	0.17
11	”	Oshodi	6° 33′ 39.6″	3° 21′ 0.0″	7.5	340.0	1.8	241.0	15.0	28	9.2	15.2	0.02	ND	0.00
12	”	Makoko	6° 30′ 3.6″	3° 23′ 24.0″	6.3	34.0	1.8	5.0	40.0	191	45.0	34.0	0.20	0.06	0.00
		Unit mean			*6.8±0.6*	*211±159*	*1.8±0.1*	*96±127.1*	*40.7±26.0*	*79.3±97*	*22±19.8*	*21.8±10.6*	*0.1±0.10*	*0.1±0.09*	*0.1±0.10*
		WHO limits			6.5 - 9	1500	-	500	500	1000	250	10	0.3	0.05	3
		Min			5.2	34.0	1.7	5.0	6.3	17.0	3.5	7.7	0.02	0.02	0.00
		Max			8.2	340.0	4.0	241.0	109.0	494.0	55.0	62.0	1.5	0.19	0.27
		Overall Mean			*6.4±0.90*	*177±121*	*2.6±0.75*	*88.1±95*	*39.7±27.2*	*111±168*	*20±19.9*	*26.1±19.6*	*0.2±0.41*	*0.1±0.05*	*0.1±0.08*

Note: CPS = Coastal Plain Sands, CPS (Alfisols) = Coastal Plain Sands (Alfisols), DB/TF = Deltaic Basins and Tidal Flats, RA = Recent Alluvium, ND = Not Determined

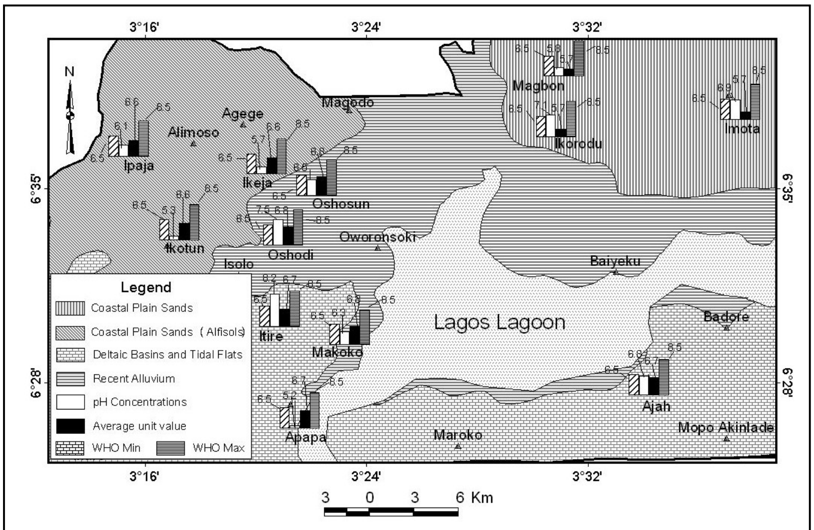

Fig. 3: pH Concentrations (in mg/l)

Electrical Conductivity (EC): The values of EC across all the geomorphological units ranged between 34.0 and 340.0mg/l with mean value of 177±1.21mg/l. In the Recent Alluvia Unit, Makoko has the lowest EC value of 34.0µs/cm followed by Itire (37.0µs/cm) and Aja (38.0µs/cm) in Deltaic Basin/Tidal Flat unit (Table 2 & Fig. 4). The highest value of 340.0µs/cm also falls within the Recent Alluvia Unit, followed by Imota (336.0µs/cm) and Magbon (287.0µs/cm). On the average, coastal plain sand unit has the highest mean value of 291.3±42µs/cm, followed by recent alluvium with mean value of 221±159µs/cm and coastal plain sand (Alfisols) with mean value of 161.7±73µs/cm while deltaic basin/tidal flat unit has the least mean value of 43.7±11µs/cm. Compared to the WHO limits the concentrations in all sampling points were below the permissible limit (Table 2). In this study, it was discovered that the EC values of all sampled wells were generally low compared to WHO regulatory limits of (1500µs/cm) and may likely be due to contents of soluble minerals of the geomorphic units.

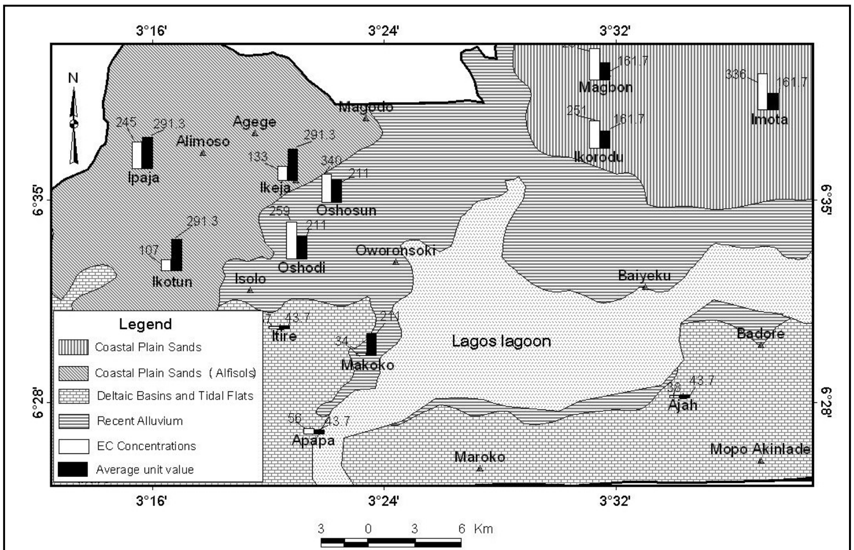

Fig. 4: Electrical Conductivity Concentrations (in mg/l)

Dissolved Oxygen (DO): DO values across all the geomorphological units ranged between 1.7 and 4.0mg/l with mean value of 2.6±0.75mg/l. The wells in the recent alluvia geomorphological unit have the lowest concentration of DO with mean of 1.8±0.1mg/l. Imota well in the coastal plain sand unit has a highest value of 4.0mg/l (Table 2 & Fig. 5). The wells in coastal plain sand unit have highest mean of 3.1±1.0mg/l. Generally, the DO levels of all sampled wells are quite low with mean of 2.6±0.75mg/l compared to the DO levels in moving water e.g. stream, tap water. The low levels in sampled wells may due to poor atmospheric re-aeration, low water temperature and photosynthetic activities in the wells

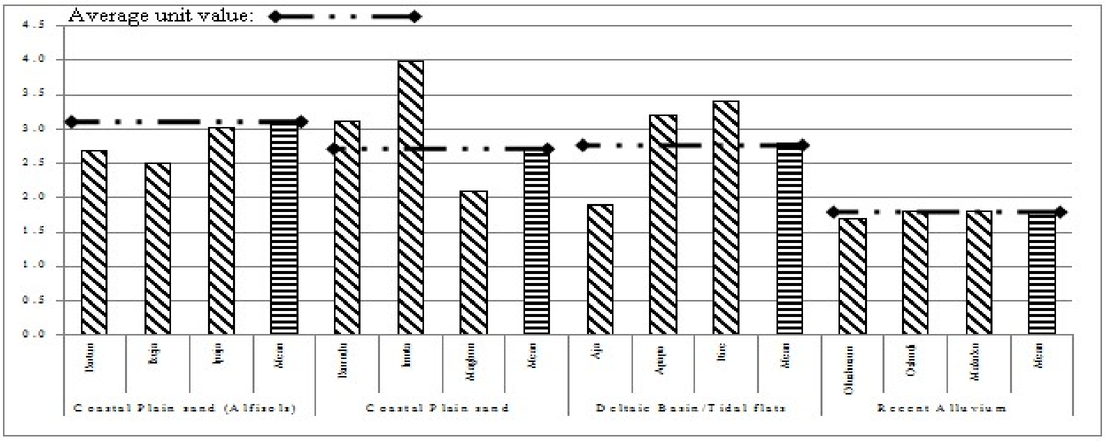

Fig. 5: Dissolved Oxygen Concentrations (in mg/l)

Total Dissolved Solid (TDS): TDS values across all the geomorphological units ranged between 5.0 and 241.0mg/l with mean value of 88.1±95mg/l. TDS indicate the amount of chemical substances dissolved in the water. The TDS values of all sampled wells in the area were below 500mg/l WHO limits for drinking water (Table 2 & Fig. 6). The mean concentration of TDS is highest in coastal plains sand with 138.0±115mg/l. Oshodi well in the unit has the highest value of 241mg/l. Deltaic basin/Tidal flat has a lowest mean concentration of 27.0±7.55mg/l. Makoko and Magbon wells of Alfisols and Recent Aluvium, respectively have the lowest of 5.0mg/l each. Some treatments such as addition of coagulants may be required to make these waters suitable for domestic purposes.

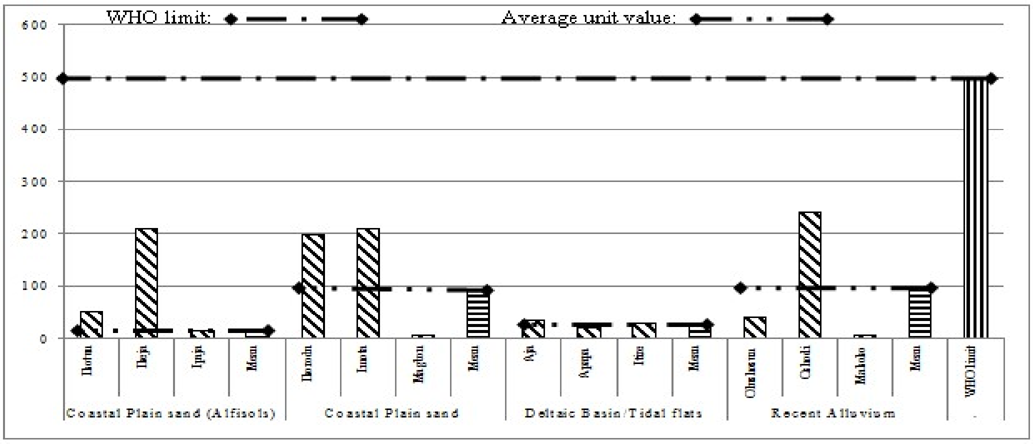

Fig. 6: Total Dissolved Solid Concentrations (in mg/l)

Total Hardness (TH): The values of TH across all the geomorphological units ranged between 6.3 and 109.0mg/l with mean value of 39.7±27.2mg/l. TH levels are generally low compare to WHO limits of 500mg/l (Table 2 & Fig.7). The highest concentration of 109.0mg/l is detected around Ikotun in the coastal plains sand (Alfisols) unit, it is followed by Olushosun with 67.0mg/l. The two (2) sites are close to landfill sites at Siluos and Ojota, respectively. The lowest value of 6.3mg/l is in Imota in coastal plains sand. On the average, coastal plains sand (Alfisols) unit has the highest value of 53.0±50.21mg/l while coastal plains sand unit has the lowest mean value of 27.4±18.3mg/l.

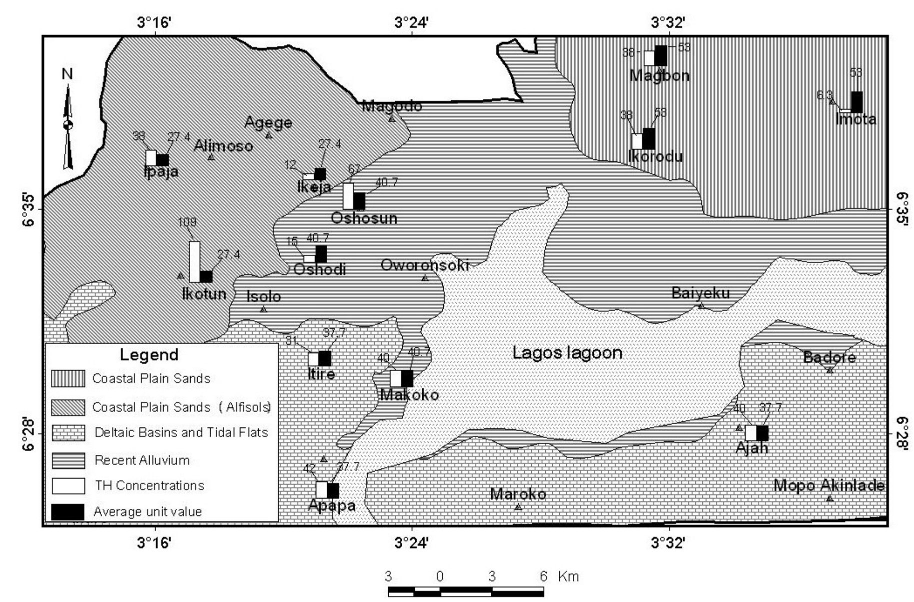

Fig. 7: Total Hardness Concentrations (in mg/l)

Salinity: Salinity values ranged between 17 and 494mg/l with mean value of 111±168mg/l. The salinity concentrations in all samples fall below the WHO regulatory limits of 1000mg/l (Table 2 & Fig. 8). This is highest in the wells (Apapa and Aja) closest to the Atlantic Ocean and Lagos Lagoon. Apapa and Aja wells have 494mg/l and 412mg/l, all in the delta basin/tidal flat unit. Wells in delta basin/tidal flat unit have a value of 308±255mg/l while coastal plains sand (Alfisols) has lowest value of 19.0±2.0mg/l (Fig. 8). The result implies that the sampled wells are not saline.

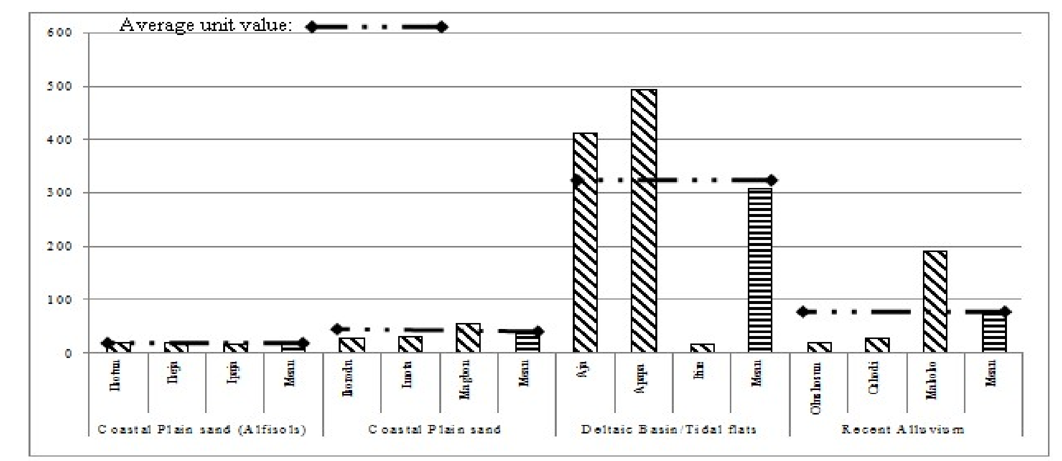

Fig. 8: Salinity Concentrations (in mg/l)

Chloride (Cl^-): The values of Cl^- across all the geomorphological units ranged between 3.5 and 55.0mg/l with mean value of 20±19.9mg/l, therefore, all selected wells fall below WHO recommended limits of 250mg/l (Table 2 & Fig.9). Ipaja and Itire wells in coastal plains sand (Alfisols) and delta basin/tidal flat units respectively have a maximum of 55mg/l. The coastal plain sand (Alfisols) has the highest mean value of 28.5±22.97mg/l. Coastal plain sand has the lowest mean value of 4.7±2.01mg/l. Magbon and Imota wells have the lowest value with just 3.5mg/l each.

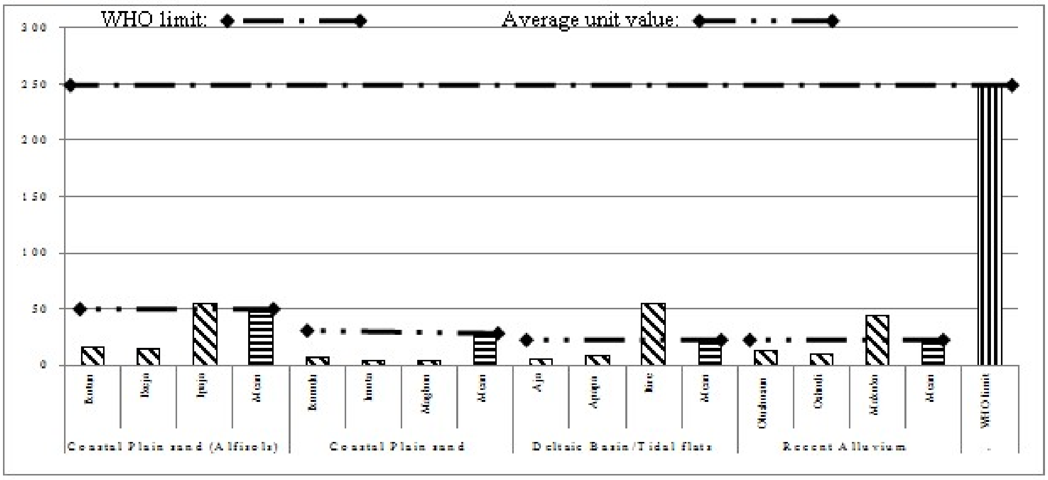

Fig. 9: Cl⁻ Concentrations (in mg/l)

Nitrate (NO^-_3): The values of NO^-_3 across all the geomorphological units ranged between 7.7 and 62.0mg/l with mean value of 26.1±19.6mg/l. The wells at delta basin/tidal flat and Ipaja in coastal plains sand (Alfisols) have highest concentration of nitrates. Their values are 62.0mg/l and 58.0mg/l respectively. Recent alluvium unit has the least mean value of 21.8±10.6mg/l while coastal plains sand (Alfisols) unit has the highest mean value of 30.9±23.6mg/l (Table 2 & Fig. 10). Nonetheless, the three (3) wells vis-a-vis Ikorodu in coastal plains sand unit, Aja and Apapa in delta basin/tidal flat unit have the lowest values of 9.0mg/l, 7.5mg/l and 7.9mg/l respectively fall below WHO recommended limits of 10mg/l. The major sources of high nitrates in drinking water are runoff from urban and agricultural, septic tanks seepage, sewage, and erosion of natural deposits. The use of water from nine (9) wells (Ikotun, Ikeja, Ipaja, Imota, Magbon, Itire, Olusosun, Oshodi and Makoko) associated with high nitrate concentration could pose serious health problems if not treated. Nitrate concentrations above the recommended limits are dangerous to pregnant women and pose a serious health threat to infants less than 3 months of age because of their ability to cause Methaemoglobinaemia or "Blue Baby Syndrome" in which the blood loses its ability to carry sufficient oxygen (Alberta Health Services 2011).

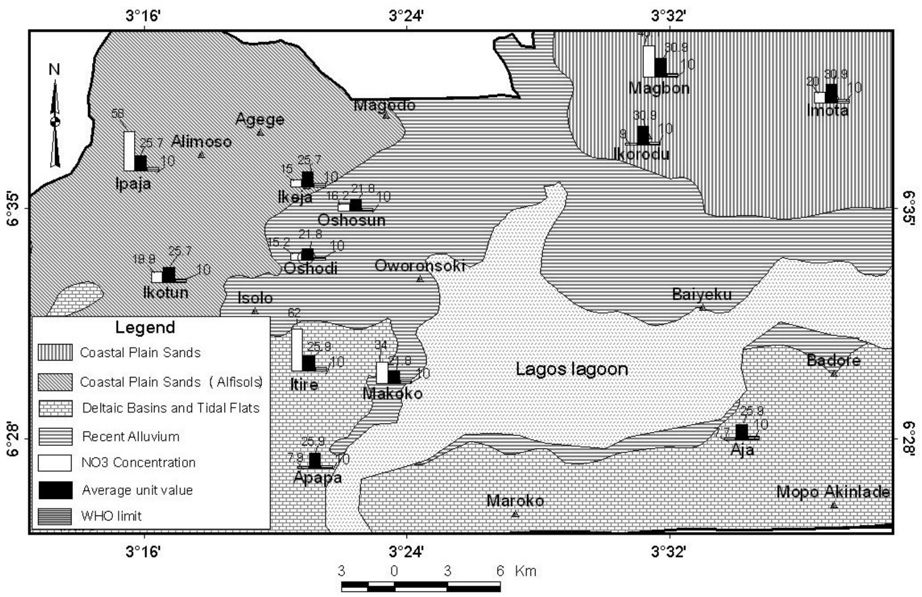

Fig. 10: NO_3 Concentrations (in mg/l)

Iron (Fe): The values of Fe across all the geomorphological units ranged between 0.02 and 1.5mg/l with overall mean value of 0.2±0.41mg/l. The values of all the sampled wells are below WHO regulatory limits of 0.3mg/l except Apapa well (Table 2 & fig.11). Apapa well in delta basin/tidal flat unit has the highest value of 1.5mg/l. All the other wells have values below 0.2mg/l. Coastal plain sand (Alfisols) and recent alluvium have the lowest average values of 0.10mg/l while delta basin/tidal flat unit has the highest mean value of 0.6±0.8mg/l. Iron is not hazardous to health, it is essential for good health. Iron helps transport oxygen in the blood. Nonetheless, it problem gives a metallic taste to water, and can affect foods and beverages – for example turning coffee, tea black.

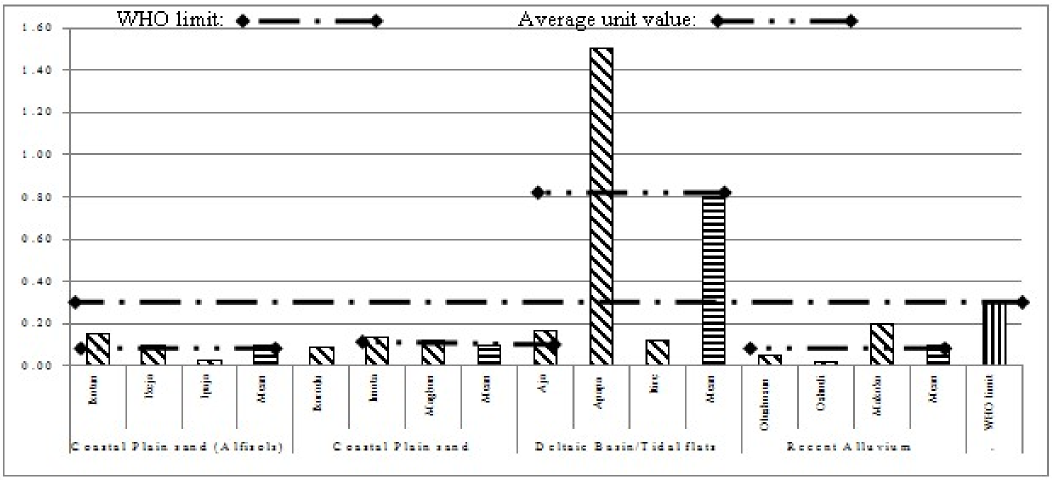

Fig. 11: Iron Concentrations (in mg/l)

Manganese (Mn): The values of Mn across all geomorphological units ranged between 0.2 and 0.19mg/l with mean value of 0.1±0.05mg/l. Mn concentrations varied across the four geomorphological units (Table 2 & Fig. 12).Three (3) of the wells (Ikeja, Ipaja and Oshodi) have no trace of Mn concentration. The values of Mn from 8 wells (Ikotun, Ikorodun, Imota, Magbon, Apapa, Itire, Oluhosun and Makoko) were above the WHO recommended limits of 0.05mg/l. Mn concentration is highest in Olushosun (Recent alluvium unit) with a value of 0.19mg/l. Next are Imota (Coastal plain sand) with value of 0.16mg/l and Ikotun (Alfisols) with value of 0.14mg/l. Mn exists in well water as a naturally occurring groundwater mineral, but may also be present due to underground pollution sources.

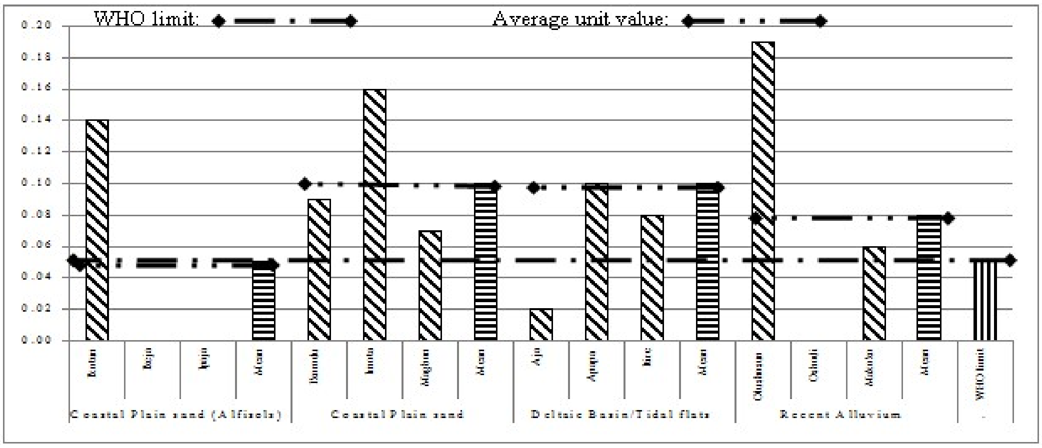

Fig. 12: Mn Concentrations (in mg/l)

Zn: The values of Zn across all geomorphological units ranged between 0.001 and 0.27mg/l with mean value of 0.1±0.08mg/l. The mean concentration of Zn in coastal plains sand, coastal plains sand (Alfisols), delta basin/tidal flat and recent alluvium are 0.1±0.16mg/l, 0.1±0.02mg/l, 0.1±0.01mg/l and 0.1±0.01mg/l respectively with least value of 0.0mg/l observed at delta basin/tidal flat (Table 1 and Fig 13). Compared to WHO limits of 3.0mg/l, the Zn concentration in all layouts are generally below the limits.

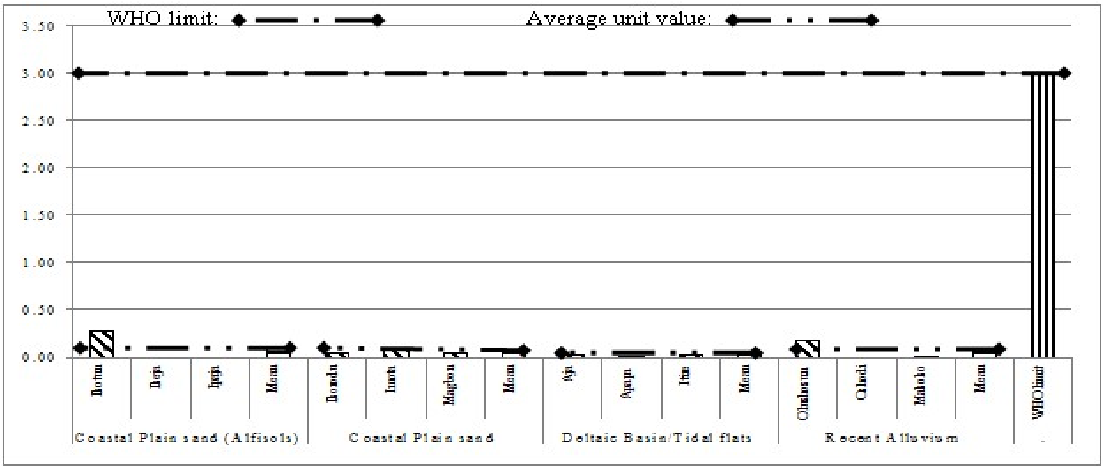

Fig. 13: Zinc Concentrations (in mg/l)

The findings revealed that the values of all parameters evaluated significantly varied and do not follow identified pattern across all geomorphic units. As examples, in Oshodi and Makoko the minimum and maximum values of EC are within same Recent Alluvia unit. A similar observation is made for TDS in Oshodi and Makoko wells of the unit with 241.0mg/l and 5.0mg/l; NO_3^- in Itire and Aja wells of Deltaic basin/tidal flat unit with 62.0mg/l and 7.7mg/l; Zn in Ikotun and Ikeja wells (Alfisols unit) with 0.27mg/l and 0.0mg/l; as well as Mn in Olushosun and Oshodi (Recent Alluvia) with 0.19mg/l and 0.0mg/l. In addition, most parameters as revealed in table 2 are within the WHO limits except for

- pH at Ikotun (Alfisols unit) and Apapa (Deltaic basin/tidal flat unit)
- NO_3^- at Ikotun, Ikeja and Ipaja (Alfisols unit), Imota and Magbon (Coastal plain sand unit), Itire (Deltaic basin/tidal flat unit), Olushosun, Oshodi and Makoko (Recent Aluvium unit),
- Fe at Apapa (Deltaic basin/tidal flat unit) and
- Mn at Ikotun (Alfisols unit), Ikorodu, Imota and Magbon (Coastal plain sand unit), Apapa and Itire (Deltaic basin/tidal flat unit) and, Olushosun and Makoko (Recent Aluvium unit).

Conclusion

The quality assessment of water from selected wells across geomorphological units of Lagos Nigeria revealed that the concentration levels do not follow a significantly identified trend. The variants in levels of concentration may be as a result of different soil types, agriculture and industrial waste / waste water, leachate from various landfill / dumpsites and different human activities across the geomorphological units. The implication is that none of the groundwater of different unit should be consumed without treatment.

The result therefore suggests that almost all the wells of alfisols, coastal plain sand and recent alluvium units need serious treatment before drinking. In order of significance Ikotun, Magbon, Apapa and Olushosun wells require more parameters to be treated - NO_3^-, Mn, pH and salinity are outside WHO limits mostly in that order. The solution therefore calls for feasible alternatives and efforts through public pipe borne water (stand pipes) and deep boreholes along streets. In addition, since water contamination after collection, transportation and storage processes are recognized as important issue of public health, the water from Lagos geomorphological units' wells should be subjected to treatment such as boiling or treatment before drinking. Also public education / awareness on safe drinking water and implementation of regulations by regulatory standards (National and international) will go a long way to reduce the implication of unsafe water sources and the associated water borne diseases.

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