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HYDROGEOCHEMICAL CHARACTERIZATION OF SURFACE WATER AROUND CANAL AND LAGOON IN PARTS OF LAGOS, SOUTHWESTERN, NIGERIA

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Abstract
A hydrogeochemicals study of water from the drainage canal in industrial and residential parts of Ikeja and lagoon of southeastern suburbs of Lagos was carried out. The physico-chemical parameters of the water including TDS, EC, pH, Salinity Ca, Mg, Na, K, HCO_3, CO_3, Cl, SO_4, NO_3 and heavy metals were determined for characterization of the water. The water samples were processed and analyzed using atomic absorption spectrophotometry and inductively coupled plasma-mass spectrometry respectively. The results shows that canal water are slightly acidic-neutral with pH range of (6.48-7.14), while the lagoon water are alkaline with pH range of (7.83-8.25). The lagoon water are brackish-marine with salinity range between (11-32) % while the canal water are fresh waters with salinity values generally less (<1) %. The lagoon water have constant TDS value of (2000 ppm) and EC value of (3999 ms/cm), whereas the canal water have low TDS value ranging from (77-460 ppm) and EC range of (151-917 ms/cm). Based on the Geoaccumulation indices, both water from the canal and lagoon are considered to be unpolluted with respect to Zn, Cu, As, Ni, Co, Cr, Cd, Pb, and Fe. Hg is the only pollutant in both canal and lagoon water. While the lagoon water is moderately contaminated with respect to Hg, the canal water is very highly polluted. The canal water is Ca-Mg-$HC0_3$ water type, while the lagoon water is Ca-Mg-Na-SO_4- Cl water type. Possible contamination sources are industrial and anthropogenic. These need to be monitored and controlled effectively.

Keywords: Hydrogeochemical, Heavy Metals, Lagoon, Canal, Industrial and Anthropogenic.

Introduction

Water is an important part of the earthly environment, covering about ¾ of the earth's surface. It occurs as surface water in streams, rivers, lakes and the world's seas and oceans and as groundwater when it accumulates beneath the ground (Elueze, et al., 2004). The pollution of surface water and ground water by waste products may be industrial and / or agriculcultural waste products (Alao and Ige, 2003). Problems of high concentration of contaminants in urban areas have been a challenging concern to both surface and groundwater management in the last few years. Therefore, any study that can aid in identifying new sources or threats to water resources is desirous not only around the study area but anywhere. Notable among the few researchers on the Lagos lagoon are Okoye (1989); Udochi (1999) and Okoye et al., (1991). These researchers studied the heavy metal contents in the Lagos lagoon sediments. Jegede (1977) worked on the Ikeja Ojota canal (a.k.a Iyaalaro).

In Nigeria like many other developing countries, rapid population increase due to rural-urban migration in the last three decades, characterize most of the big cities and urban centres. Unfortunately, lack of proper land use plans, poor sanitary and waste/sewage disposal facilities as well as low public awareness in terms of environment health issues had led to systematic deterioration of the environment.

Based on the above facts, this study focused on the hydro-geochemical assessment of water of a biaxial canal of Allen and Sheraton, jointly known as" Iyaalaro" using Lagos lagoon as control, within Lagos metropolis, southwestern Nigeria. The area under study became necessary because of its location and function. These monitored streams are canals into which industrial waste and incessant domestic water are being disposed.

Preliminary assessment of the impact of uncontrolled industrial discharge, indiscriminate dumping of refuse on the drainage system among others with respect to major ions and trace elements were carried out on the surface water of study areas.

Physical Setting of Study Area

The study area falls within Latitudes (6˚31′33.5″N and 6˚27′39.0″N) and Longitudes (3˚19'02.3″E and 3˚22′35.5″E). The Ikeja canal is a biaxial stream that runs one of its arms via Allen to Ikeja industrial estate, while the second arm passes behind Sheraton Hotel and truncate just before Toyin Street, Ikeja. Both arms

intercept about 250m from Ojota- Maryland bridge (a.k.a. Iyaalaro bridge). Other tributaries such as Mende drain, Shomolu drain were also connected to it before discharging into the Lagos lagoon. The dominating low-lying marshy belt that runs east west is a remnant of the northern uplands that lies further northern around Abeokuta. The area falls into two distinct topographic features, the southern up lands (Jones and Hockey, 1964) that stand a little above 30metres, above sea level and low-lying coast, several points virtually close to sea level (Asiwaju Bello and Akande, 2001).

River systems that drain into the Lagoon are River Ogun, Majidun, Shasha and Oluwa. They are connected to river Benin by series of cracks (Ajayi and Mombeshora, 1990). Other rivers include Opomu and Abesan, all flowing in a south ward direction into the Lagoon and cracks system.

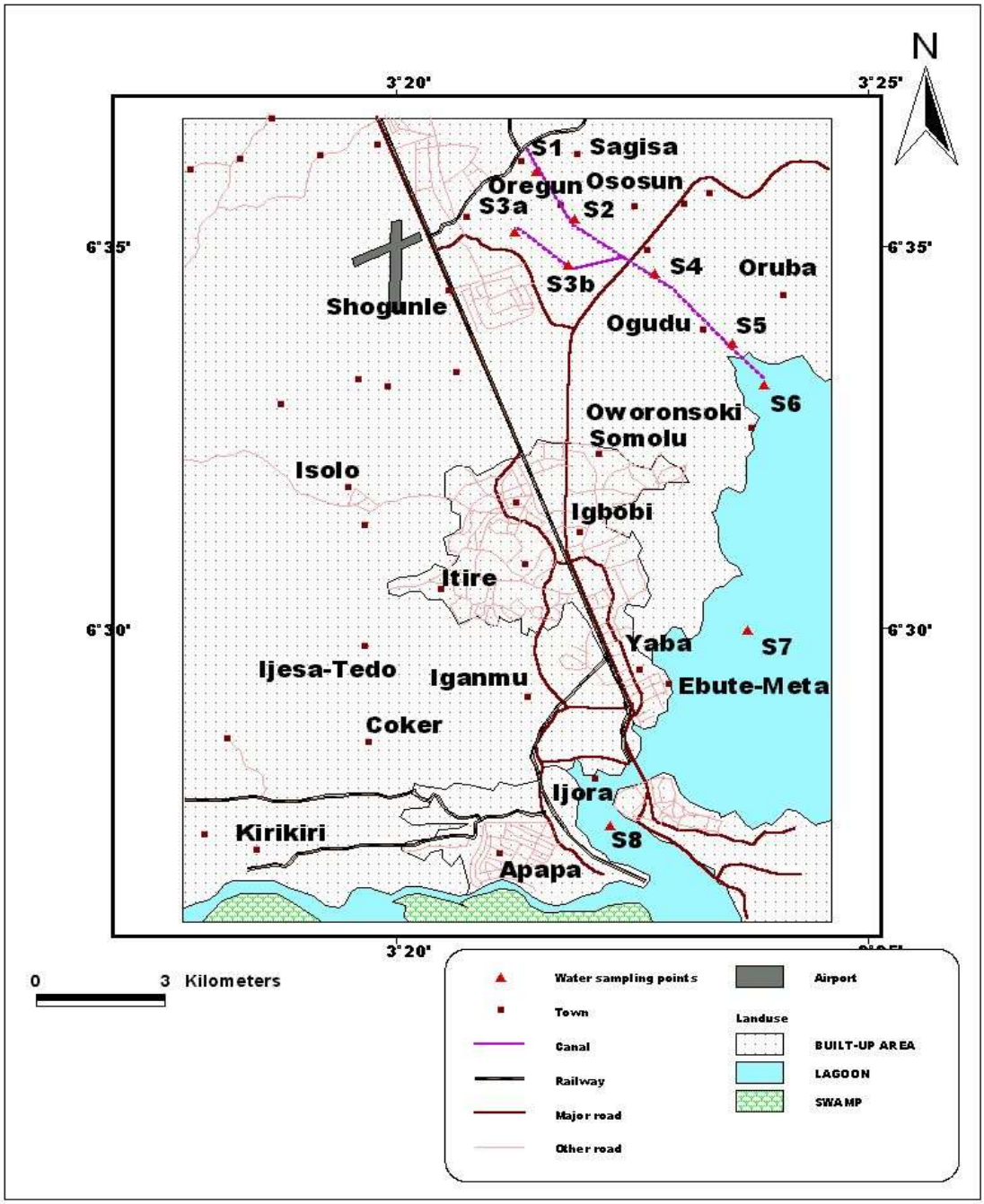


Figure 1: Location Map of Study Area

Geology and Hydrogeology

The lithological character of the sedimentary outcrops of southwestern Nigeria signifies the nature and extent of the aquiferic zones found in Lagos metropolis. There are four aquiferous systems in the metropolis (Oyegoke, 1986). The upper aquifer extends from ground level to 12m below the ground and consists of alternating layers

of sand and clay. The second aquifer is 20m -70m below sea level, in the Northern part of Lagos and 40m-100m deep near the coast lines.
The third aquifer is found in the central part at a depth range of 130m and 160m dipping towards the coast, where it depth ranges between 170m-210m with thickness ranging from 15m-30m. The fourth aquifer is reached at 450m deep; it is separated from the third by a thick layer of shale of the Ewokoro formation. The thickness of the shale layer separating the second and third horizon is up to 130m in several parts of Lagos.

Materials and Methodology
The hydro chemical assessment of water samples obtained from some streams and lagoon in Lagos was carried out between 7th and 9th of April 2014. The area studied covers Ojota, Ikeja, Allen Avenue, Maryland, Ogudu, (all classified as Ojota axis a.k.a. Iyaalaro) and also Iwaya Ijora. About twenty seven water samples were collected from both canal and lagoon respectively. The sample locations are Allen Avenue, Opebi, Sheraton, Ojota, Ogudu Iwaya, and Ijora. Sample bottles were thoroughly washed and rinsed before sampling. The collected water samples were labeled to avoid mix-up and are refrigerated to avoid contamination by foreign materials degradation and for good and error free analytical results. Physical parameters such as conductivity, salinity, temperature, TDS, pH, were determined at the points of sampling.
The laboratory studies entailed determination of ionic concentrations in the water samples. Heavy metal concentration in water (dissolved) samples was also carried out and analyzed at Petroc laboratory in Ibadan.
In carrying out a successful hydrogoechemical assessment of the surface water of the area under study, certain instruments were used so as to take measurement of some physical parameters such as Salinometer, Global Positioning System (GPS), pH Meter, Sample Graber, Sample Bottle, Sample Bag, Timer**.** The water samples were processed and analyzed for their chemical contents using atomic absorption spectrophotometry and inductively coupled plasma-mass spectrometry respectively.

Results and Discussion

Physical Results
The pH of canal water are slightly acidic with pH range of (6.48-8.25) with Ojota (L4) and Ogudu (L5) being an exception, this may reveal the effect of the connecting tributaries on the canal. While the lagoon water were alkaline with pH ranges between 7.83-8.25, and, this alkalinity increases seawardly. However, the pH values from both canal and lagoon are within the permissible limit of 6.5-8.5, of (WHO, 1996 and 2006).
Generally, the acidity of the canal may be attributed to anthropogenic input mostly effluents from industries while the alkalinity in the lagoon waters confirmed sea impact on the lagoon. The measured conductivity values of the investigated water varied between (151-917) µms/cm, in the canal. The lowest value was recorded at Sheraton canal (L3a). Contrarily, the Lagoon water has constant value of 3,999µms/cm through the entire length studied. The variations in the EC values across the length of the canal, is a reflection of differential high dissolution of solids in those water. While the EC mean value of 530.5 recorded for the Canal falls within the WHO standards, the Lagoon waters with average value of 3999µms/cm is above the recommended standards.
The observed constant value of 2000ppm for TDS across the length of the Lagoon may be due to upper specification of the instrument used. The Canal water range between (77-460) ppm with the lowest value of 77ppm recorded at Sheraton Spring (L3b). The low TDS value of <500mg/l recorded in the Canal is a characteristics of fresh water. However, the mean value of 302.8 ppm for the Canal, fall within the WHO standards, while the average value of 2000mg/l of the lagoon is above the WHO specifications. Also, the Canal, water can be classified as freshwater with low level while the Lagoon water could however be classified as slightly saline water with moderate hazard level UNESCO/FAO (1973), Okafor, 1994. The salinity values of the Lagoon water range from (11-32)% , the value which increases steadily towards the sea and, this may be due to evaporation (Gibb's, 1970). Generally, salinity values in the Canal were found to be <1, while gradual salinity increase seawardly in the Lagoon water may be attributed to oceanic impact on the Lagoon which is the main source of sodium and chlorine. More than ¾ of the total amount of Cl present in the earth's outer crust, atmosphere and hydrosphere is in solution in the ocean as Cl^- ion (Johl, 1979).

Table 1: Natural Physical Parameters from the Study Area.

S/No	Location	Description	Coordinate		TDS (ppm)	EC (µms/cm)	Temp (°c)	Salinity (‰)	Refractive Index	pH	Water Depth	Time
1	L1	Allen Junction canal	6º31'33.5"N	3º19'02.3"E	402	804	31.2º	>1	1.3330	6.82	0.5m	9.05am
2	L2	Oregun canal	6º35'29.2"N	3º21'54.4"E	338	683	31.2º	>1	1.3330	6.87	0.5m	10.10am
3	L3a	Sheraton canal	6º35'19.1"N	3º21'53.7"E	302	151	28.4º	>1	1.3330	6.95	0.5m	11.15am
4	L3b	Sheraton spring	6º34'52.0"N	3º21'50.0"E	77	153	29.1º	>1	1.3330	6.48	0.2m	11.18am
5	L4	Ojota Iyaalaro canal	6º34'35.3"N	3º22'29.53"E	238	475	29.5º	>1	1.3330	7.04	0.85m	12.18am
6	L5	Ogudu canal	6º33'49.2"N	3º23'52.5"E	460	917	30.8º	>1	1.3330	7.14	0.35m	1.15pm
7	L6	Ogudu lagoon	6º33'45.5"N	3º24'15.9"E	2000	3999	31.5º	11	1.3350	7.83	35m	12.12pm
8	L7	Iwaya lagoon	6º29'59.0"N	3º24'03.4"E	2000	3999	31.8º	28	1.3390	7.86	1m	1.35pm
9	L8	Ijora lagoon	6º27'39.0"N	3º22'35.5"E	2000	3999	32º	32	1.3390	8.25	4.25m	2.24pm

NB: TDS = total dissolved solids

Table 2: Results of Major ions concentrations in Canal and Lagoon water samples.

	Sample locations	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	F (mg/l)
CANAL	Loc1	58	16	420	140	20	4	240	200	180	1.96
	Loc2	56	14	420	140	18	2	235	210	160	1.80
	Loc3a	12	3	90	30	10	2	200	44	33	2
	Loc3b	6	20	60	20	8	1.5	75	20	1.50	1.80
	Loc4	40	10	300	100	12	2	240	72	54	1.50
	Loc5	24	6	180	60	8	1	225	100	78	1.20
	Maximum	58	20	420	140	20	4	240	210	180	2
	Minimum	6	3	60	20	8	1	75	2	1.50	1.20
	Range	6 – 58	3 – 16	60 - 420	2 - 140	8 - 20	1 – 4	75 - 240	20 - 21	15 - 18	1.2 - 2
	Mean	32.67	11.50	245	81.67	12.67	2.10	202.50	107.67	84.42	1.71
	WHO 1996 & MPL*	200	15	200	150	600	400	100	600	120	1.5
LAGOON	Loc6	1750	44	430	1313	2327	465	245	80	60	0.08
	Loc7	6500	163	1625	4875	8643	1728	230	40	30	0.45
	Loc8	7000	175	1750	5250	9308	1862	218	48	36	0.65
	Maximum	7000	175	1750	5250	9308	1862	245	80	60	0.75
	Minimum	1750	44	430	1313	2327	465	218	40	30	0.08
	Range	1750 - 7000	44 – 175	430 - 1750	1313 - 5250	2327 - 9308	465 – 1862	218 - 245	40 - 80	30 - 60	0.08 - 0.65
	Mean	5083.30	127.30	1268.30	3812.7	6759.30	1351.70	231	56	42	0.39
	WHO 1996 & MPL*	200	15	200	150	600	400	100	600	120	1.5

* Maximum Permitted Level

Table 3: Heavy metals concentrations in Canal and Lagoon water samples.

Code No	Description	Pb	Zn	Cu	As	Co	Cr	Cd	Hg	Fe	Ni
L1	Allen canal	0.010	0.009	1.387	0.630	0.005	0.019	0.452	0.420	1.390	0.005
L2	Oregun canal	7.950	0.010	1.799	0.030	0.015	0.026	0.002	1.070	255.040	0.405
	Ojota/Iyaalaro canal	0.010	0.008	1.889	0.030	0.025	0.030	0.002	1.140	608.630	0.205
L3											
	Maximum	7.950	0.010	1.889	0.630	0.025	0.030	0.452	1.140	608.630	0.405
	Minimum	0.010	0.008	1.387	0.030	0.005	0.019	0.002	0.420	1.390	0.005
	Mean	2.660	0.010	1.690	0.230	0.020	0.030	0.150	0.880	288.350	0.210
L6	Ogudu lagoon	13.420	0.170	0.043	0.030	0.115	0.200	0.002	0.000	12.130	0.105
L7	Iwaya lagoon	6.580	0.065	0.839	0.756	0.025	0.150	0.002	0.000	14.380	0.805
L8	Ijora lagoon	0.010	0.230	0.069	0.057	0.025	0.350	0.781	1.790	16.240	1.705
	Maximum	`13.420	0.230	0.840	0.760	0.120	0.350	0.780	1.790	16.240	1.710
	Minimum	0.010	0.070	0.040	0.030	0.030	0.150	0.000	0.000	12.130	0.110
	Mean	6.670	0.160	0.320	0.280	0.060	0.230	0.260	0.600	14.250	0.870
	WHO Standard 2006	0.05 mg/l	5 mg/l	1 - 15	0.1 mg/l	0.050	0.050	0.010	0.000	0.03 - 1	0.0005
	World River Mean	0.003	0.015	0.005	0.001	-	-	1E-04	-	0.500	-

Table 4: Index of Geoaccumulation values for water samples (Igeo)

	LOCATIONS													
Elements	CANAL			LAGOON			RANGES		MEAN		STD		SUMMARY OF CONTAMINATION	
Metals	L1	L2	L4	L6	L7	L8	Canal	Lagoon	Canal	Lagoon	Canal	Lagoon	Canal	Lagoon
Pb	-10.88	-1.24	-10.88	-0.47	-1.52	-10.88	-10.88 - - 1.24	-10.88 - -0.47	-7.67	-4.29	4.54	4.6795	Pratically contaminated	Pratically contaminated
Zn	-13.51	-13.36	-13.68	-9.27	-10.70	-8.83	- 13.38 - -13.36	-10.70 - -8.83	-13.52	-9.60	0.13	0.7983	Pratically contaminated	Pratically contaminated
Cu	-5.72	-5.38	-5.38	-10.78	-6.38	-10.10	-5.72 - -5.32	-10.78 - 6.38	-5.49	-9.09	0.16	1.9339	Pratically contaminated	Pratically contaminated
As	-2.12	-6.51	-6.51	-6.51	-1.84	-5.57	-6.51 - -2.12	-6.51 - 1.84	-5.05	-4.64	2.07	2.0167	Pratically contaminated	Pratically contaminated
Ni	-14.47	-8.12	-9.21	-10.07	-7.12	-6.04	-14.47 - -8.12	-10.07 - -6.04	-10.60	-7.74	2.77	1.7033	Pratically contaminated	Pratically contaminated
Co	-12.70	-11.09	-10.36	-8.16	-10.36	-10.36	-12.70 - -10.36	-10.36 - -8.16	-11.38	-9.63	0.98	1.0371	Pratically contaminated	Pratically contaminated
Cr	-12.91	-12.52	-12.29	-9.59	-9.97	-8.16	-12.91 - -12.29	-9.97 - 8.76	-12.57	-9.24	0.26	0.7793	Pratically contaminated	Pratically contaminated
Cd	1.01	-6.83	-6.83	-6.83	-6.83	1.80	-6.83 - -1.01	-6.83 - 1.8	-4.22	-3.95	3.70	4.0682	Pratically contaminated	Pratically contaminated
Hg	3.81	5.16	5.25	0.00	0.00	5.90	3.81 - 5.25	0.00 - 5.90	4.74	1.97	0.66	2.7813	Highly - very highly contaminated	Moderately contaminated
Fe	-15.84	-8.29	-7.06	-12.70	12.44	-12.29	-15.84 - -7.06	-12.70 - -12.29	-10.40	-4.18	3.88	11.7557	Pratically contaminated	Pratically contaminated

Estimated total hardness (TH) in Canal water has a range between (232-1624) mg/l with mean value of 947.33 mg/l., while the Lagoon water has value of 18802.8mg/l. The very high total hardness value of the Lagoon is expected being a brackish water body. The total hardness of the Canal water is very hard except Sheraton Spring (L3b), while the Lagoon water are exceptionally very hard.

Chemical Results

In the Lagoon water (L6, L7 and L8), there are gradual increase in concentrations of Na, Ca, Mg, Cl and SO_4 seawardly. The presence of high concentration of Na^+, Mg^{2+} and Cl^- follow the high salinity of the lagoon water. Generally, while other parameters increases towards the sea, bicarbonate and carbonate decreases and this may be due to evaporation, which increases salinity and to precipitation of $CaCO_3$ from solution, which increases the relative proportion of Na to Ca both from the tributaries and in the main stream.

However, the constituents of the Canal water is uniquely distinguished from that of the Lagoon water in that lower value were measured for the Canal. The observed trend in the Canal revealed that, all the parameters from (L1, L2, L4 and L5), concentrations of the ions reduces away from industrial area; this may be an indication of anthropogenic input from industrial effluent, while the very low values obtained in (L3a and L3b) for the major cationic and anionic constituents is a reflection of less polluted, non-industrial arm of the Canal. The bicarbonate and carbonate remain as the dominant anions. Thus, the abundance and ubiquity of these anions in the Canal water may be derived from atmospheric carbon dioxide, organic matter and, particularly the consequent industrial anthropogenic input, while the requisite pH range of 6.48-7.04 maintain its stability in Canal water. Consequently, the observed high SO_4 concentrations in the Lagoon water is derived from the atmospheric precipitation, with SO_4 being the major constituents of the atmospheric precipitation.

Generally, the major ionic concentrations in the Lagoon water are higher than the Canal water with the exception of bicarbonate and carbonate. Both Canal and Lagoon water have comparable high values of NO_3, which were generally <200ppm with the exception of Sheraton Spring (L3b) in the canal. The observed high nitrate value is an indication of anthropogenic input. The mean cationic and anionic concentrations from both media are in the following order:

Canal water: Cations Ca>Mg>Na>K, Anions NO_3>HCO_3>CO_3>Cl>$S0_4$ whereas the

Lagoon water: Cations Na>Mg>Ca>k, Anions: Cl>$S0_4$>NO_3>HCO_3>CO_3

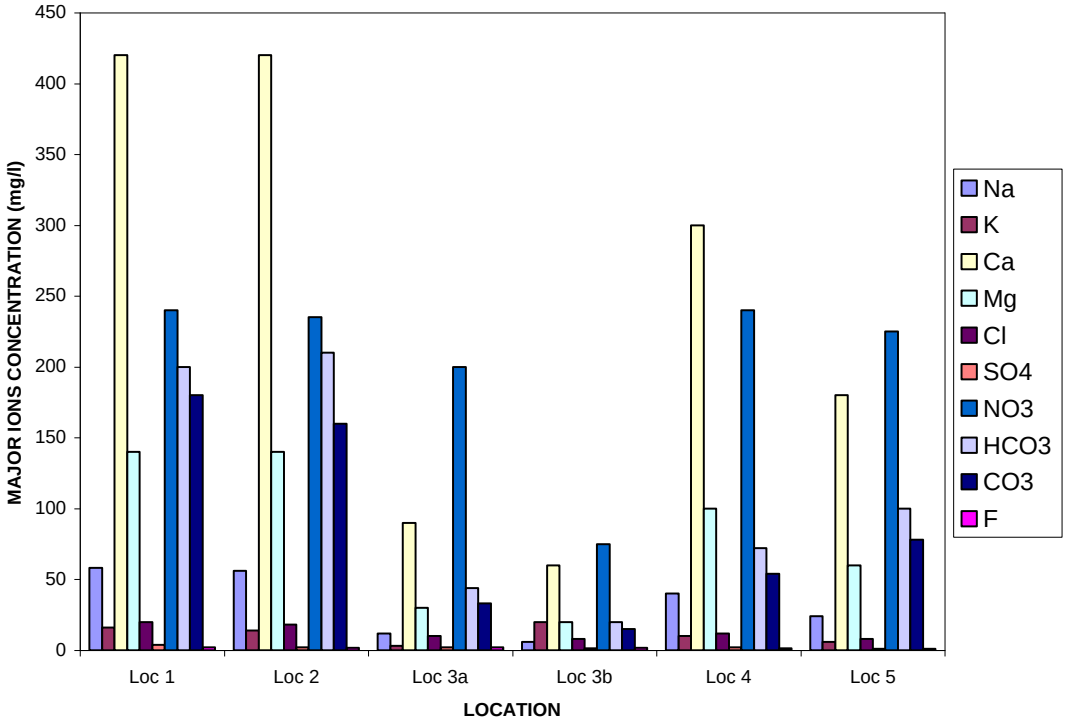


FIG. 2: HISTOGRAM PLOTS OF MAJOR IONS CONCENTRATION IN THE CANAL WATER SAMPLE

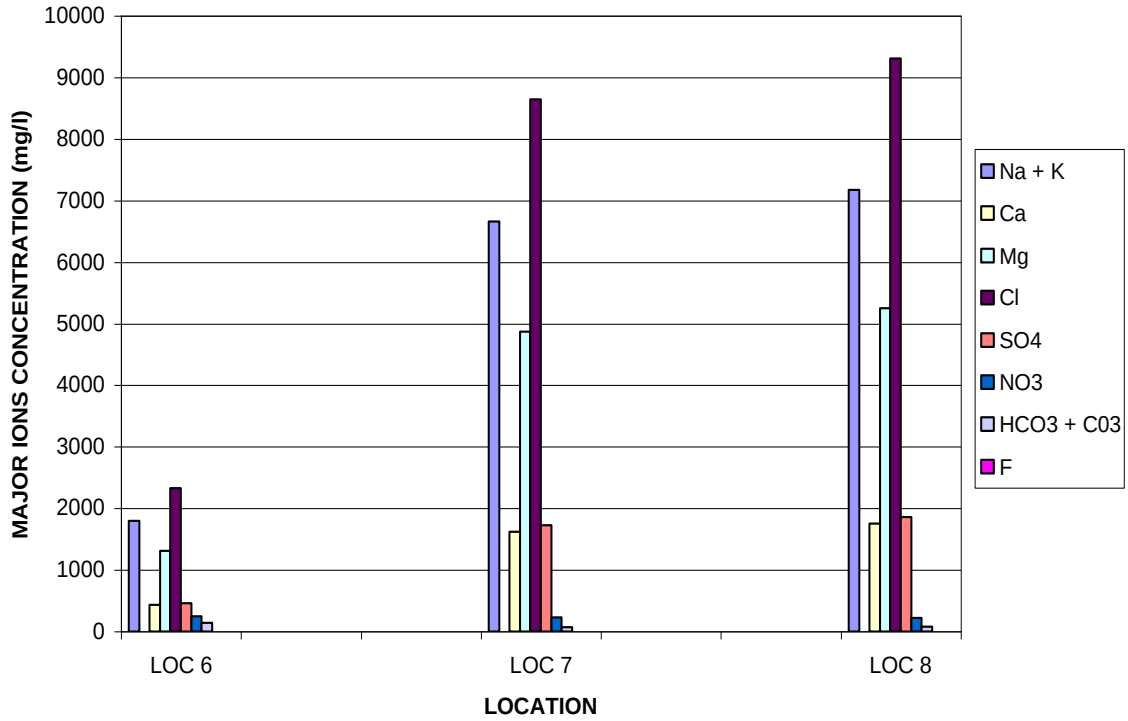


FIG. 3: HISTOGRAM PLOTS OF MAJOR IONS CONCENTRATION IN THE LAGOON WATER SAMPLE

Hydrochemical Facies

The chemical data have been presented according to (Langguth, 1966) and Schoeller diagrams to provide visual inspection in a convenient manner. Each of these diagrams permits the cations and anions compositions of many samples to be represented on a single graph in which a major groupings or trends in the data can be discerned visually.

While the Schoeller diagram showed that both water have widely different concentrations of cations and anions, the Langguth 1966 also revealed that both waters belong to different hydrochemical facies.

However, the concept of hydrochemical facies shows that the cations in the Canal and Lagoon can be classified as Ca-Mg facies and Ca-Mg-Na facies, while the anions for both Canal and Lagoon can be classified as Bicarbonate type facies and chloride type facies. Canal water, were seen to plot into the Earth -alkaline fresh water group with bicarbonate as predominant anions while the lagoon water however, plot into the Earth-alkaline water with high alkaline particularly chlorine content.

The concentrations of each of the heavy metals (Zn, Cu, As, Co, Cr, Cd, Hg and Ni) in the canal waters were generally low (<2mg/l). Pb and Fe occur in much higher concentrations of 7.95mg/l and 608.6mg/l respectively. Similarly in the lagoon waters, the heavy metals with the exception of iron (Fe) and lead (Pb) also occur in concentrations generally less than 2mg/l. They vary with the maximum concentration of 0.115mg/l for Co, to 1.79mg/l for mercury. Iron (Fe) and lead (Pb) occur in exceptionally high (maximum) concentrations of 13.42mg/l and 16.42mg/l respectively. The average concentrations in the canal water with exception of zinc are in order of 100 times that of mean composition of the world rivers (MCWR). Similarly, in the lagoon waters, the average concentrations are in order of 10times relative to the mean composition of the world rivers (MCWR) with Zn, Cu and Fe being exception. Thus, this is an indication of contamination of both Canal and Lagoon waters relative to MCWR.

The order of concentrations in both phases was as follow:

Canal waters: Fe> Pb> Cu> Hg> As> Ni> Cd> Cr> Zn> Co

Lagoon waters: Fe> Pb> Ni> Hg> Cu> As> Cd> Cr> Zn> Co

Also, these metals exhibit very strong positive correlation to very strong negative correlations with one another and, as well with EC and TDS. This may be attributed to the fact that dissolution of metals in aqueous phase is controlled by the Chemical character and solubility (mobility) of the respective metal as well as other chemo thermodynamic conditions.

However, when compared with the WHO standards and (Bowen 1979) for drinking water, the observed range of concentrations of the heavy metal in the canal water are generally above the permissible limit, exception being zinc. Also, a similar trend occurred in the lagoon waters, although with the exception of zinc and copper which are below the allowable level for drinking water. Nonetheless, indication of anthropogenic contamination was confirmed by high EC and NO_3 concentrations in the canal and lagoon waters.

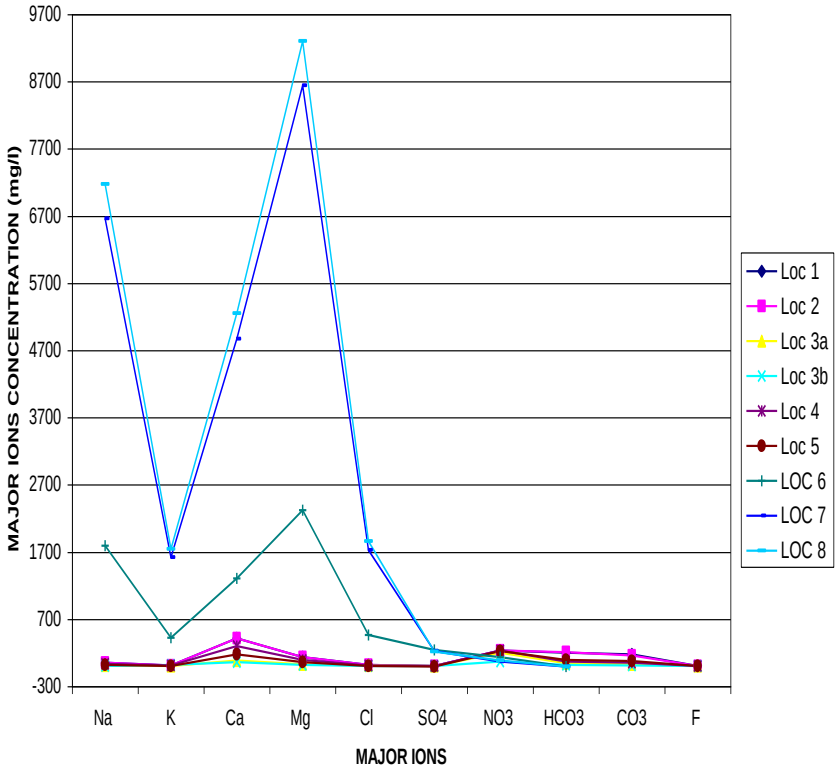


FIG. 4: SCHOLLER DIAGRAM SHOWING VARIATION IN THE MAJOR IONS CONCENTRATION IN THE WATER OF CANAL AND LAGOON SAMPLE.

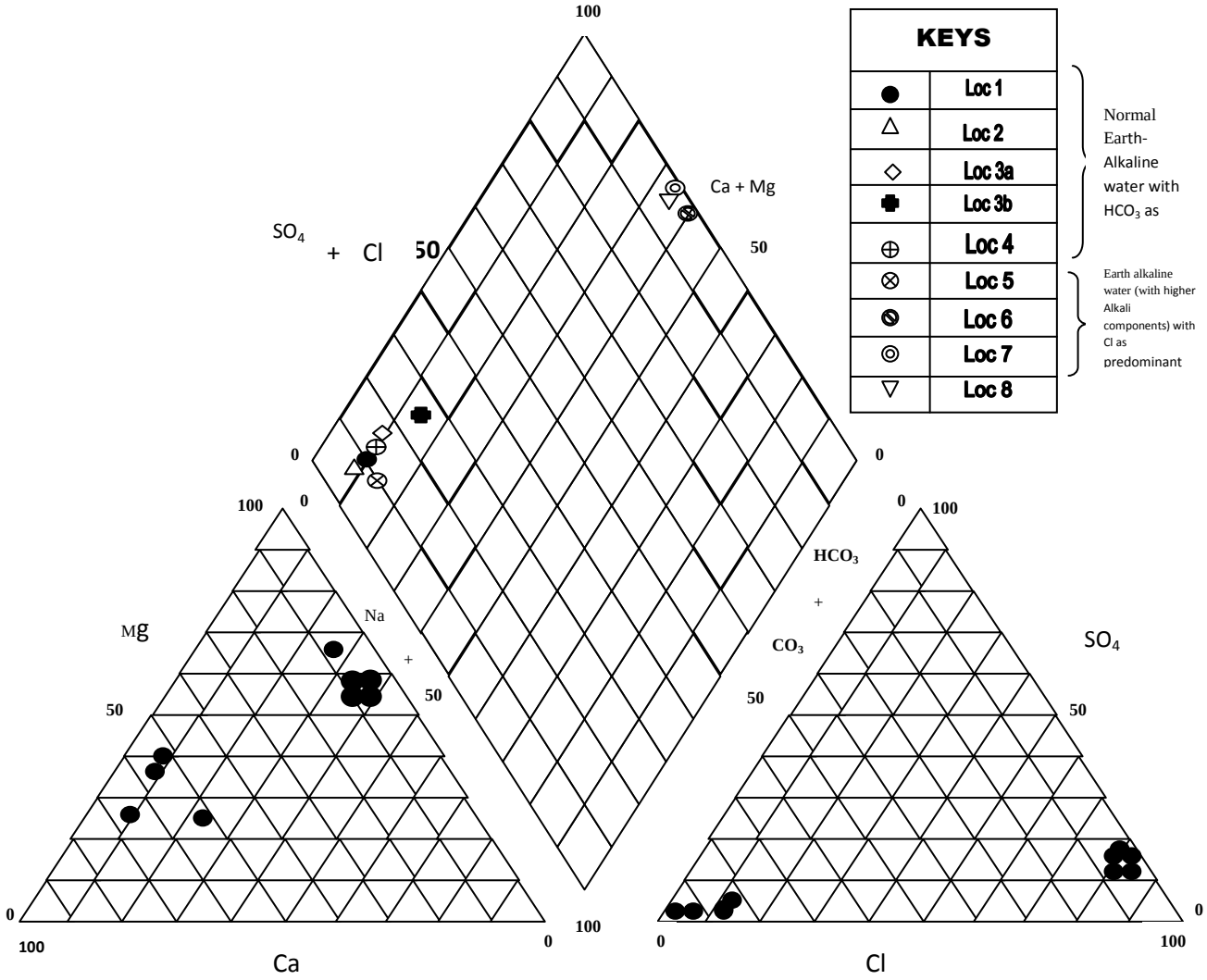


Fig. 5 Trilinear diagram of the major ions showing the water types in the canal and lagoon.

Conclusions and Recommendations

The chemical components of surface water in parts of Lagos lagoon and waste water canals of Ikeja- Ogudu axis of Lagos have been undertaken. Common constituents of the waters include Na, Mg, Ca, K, SO_4, Cl, CO_3, HCO_3 and NO_3 were determined to characterize the water and assessing their pollution status.

The lagoon water are brackish - marine with salinity value range from (11-32) % while the canal water are fresh with salinity generally less than 1 (<1%). It has been seen that contamination of the water by a lot of impurities has resulted into high TDS and conductance (EC). These were seen to be consistent throughout the length of the lagoon studied. Systematic variations for both TDS and EC were observed in the canal water. These values being highest at Allen (L1) decrease towards the lagoon suggesting industrial sources. However, Ogudu (L5) with highest TDS and EC values has been a product of Ikeja- Ogudu axis canal (system 1) and Shomolu drain (system 2). The major cations in the canal is Ca^{2+} and, in the lagoon is Na^{+} which is an indication of fresh waters and saline water respectively. The major ionic concentrations in the Canal waters were seen to be decreasing from Allen (L1)- Ogudu (L5) may also be a reflection of industries as the main source of pollution. Also the major ionic concentration increases seawardly in the Lagoon with the exception of bicarbonate and carbonate and, this may be due to precipitation of carbonate at the expense of sodium. However, two water types have been identified. The canal waters are Ca- Mg- HCO_3 water type while the lagoon waters are Ca- Mg- Na- SO_4-Cl water type. The plot of total mineralization revealed that both waters studied possessed characteristic of fresh water of tropical regions of Africa and South America. Comparison ionic concentrations with WHO standards for drinking water showed that all major elements in the canal waters are within the permissible limit with the exception of Ca, F and NO_3. In the lagoon water, the major ions show significant pollution with the exception of HCO_3 and CO_3. The strong positive correlation between all the parameters as well with TDS and EC in both Canal and Lagoon waters is a strong indication of common anthropogenic sources.

In comparison with the WHO limits, both the canal and lagoon water are unsafe for drinking purpose. In view of the expected increase in industrialization and urbanization in Lagos metropolis, it is important to formulate pollution control policies that take into account the need to regulate discharges of contaminants into aquatic

systems. It is also important to add that, as part of the objectives of pollution control, emphasis should be placed on the need to minimize waste generation. Industries should be encouraged to adopt low and non waste technologies (LNWT) at all stages of products life i.e. raw material extraction, production, use and disposal.

A periodic small scale scientific survey like this one should be encouraged from where baseline data are generated. This is hoping to further provide information, which enables the society and government to plan and react to environmental problems before they become serious, uncontrollable and catastrophic

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