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TEMPORAL VARIATION IN THE ECOLOGY OF KURAMO WATER, LAGOS NIGERIA

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Abstract

Temporal variation in the ecology of Kuramo water was studied in the Lagos lagoon complex. Physico-chemical parameters and heavy metals concentration were analyzed. Eight sites were marked using the geographical positioning system (GPS model-12). Water chemistry was determined for 8 months and sampling was done along designated transects. Water pH (9.51±0.74), Dissolved Oxygen (8.53±1.54 mg/L) and Temperature (29.31±1.03^{0}C) were the most stable of the measured variables. $S0_4^{-2}$ (69.17±17.66 mg/L), COD (13.67±1.46 mg/L), Fe (0.23±0.16 mg/L), Ca2+ (409.82±6.66 mg/L) and Cu (0.38±0.14 mg/L) were also relatively stable. In contrast, Salinity (1.66±2.08‰), Conductivity (1043.10±164.59ìS/cm), Cl- (111.76±21.35mg/L), TDS (521.45±82.36mg/L), TH (542.67±91.73mg/L), BOD (6.22±1.02 mg/L), Alkalinity (46.54±16.77 mg/L), TSS (11.10±7.91 mg/L), and $N\text{-}NO_3$- (1.77±1.67mg/L) temporally varied and values of all analyzed variables were significantly different over the period of eight months ($p<0.05$). There were no significant variations across sampling stations (Spatial). These fluctuating, unstable variables explained in a great deal the influence of: anthropogenic impacts, season, and its geomorphological proximity with the Atlantic Ocean (< 100m apart). Conductivity showed high significant correlation with TDS, TH, Ca^{2+}, and $S0_4^{-2}$. During the rainy season, an immense volume of salt water enters the Kuramo water, therefore making it incorrect to refer to the Kuramo as fresh water body. Life in this water system is thus subject to temporal variation; from fresh in January - April (0.3 - 0.5 ‰) to brackish condition between May and July (5.1 - 5.3 ‰). Thus, only euryhaline species can survive such variabilities.

Key words: Temporal variation, ecology, Kuramo, anthropogenic impacts, correlation coefficient matrix, euryhaline.

Introduction

Nigeria (100N, 80E) has an extensive coast line of 960km, and 15% of the 925,000km^2 land areas consists of inland waters such as rivers, streams, swamps, and natural and man-made lakes (Akin-Oriola *et al* 2006). These water bodies have multiple uses including irrigation, aquaculture, drinking water supply, hydroelectric power generation, fisheries, flood control and recreation, among others (Anetekhai *et al* 2004). The Nigerian climate is tropical, consisting of rainy season (April – October) and a dry season (November - March): Diurnal temperatures are high, reaching 34^{0}C-40^{0}C. Elevation levels of relative humidity prevail

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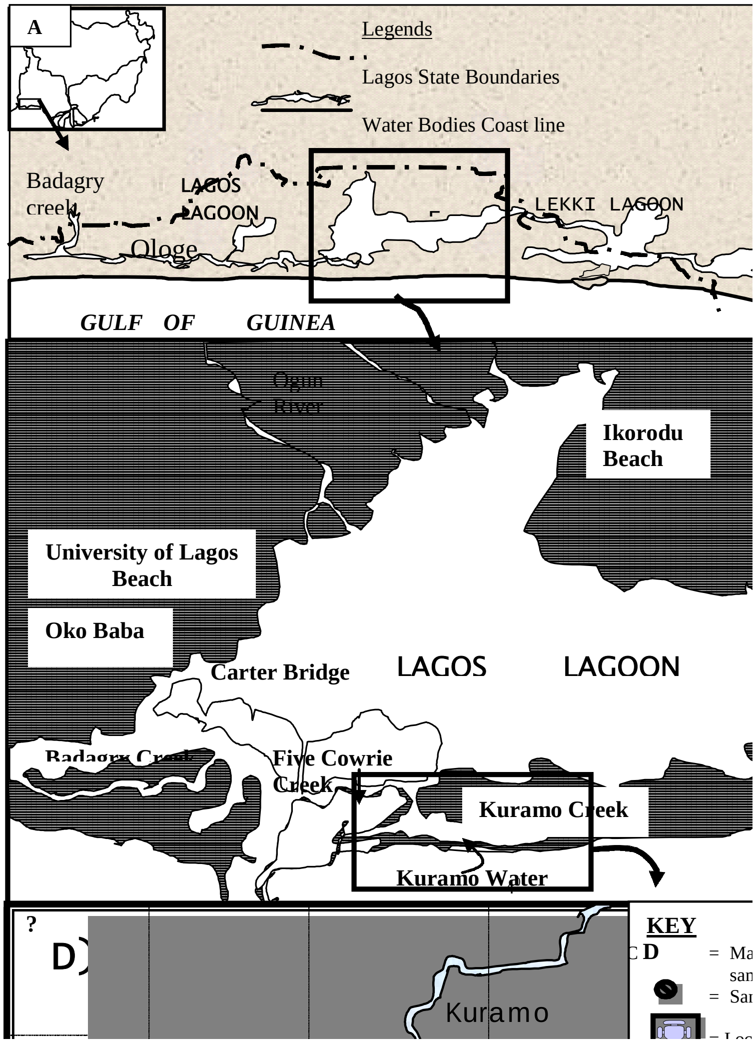
throughout the year, rarely dropping below 60%. High rainfall of between 3000mm and 4000mm is experienced from May- September with a short break in August (Awosika *et al.* 2002).

The high level of urbanization and industrialization of the city of Lagos and its environs with the inevitable generation of domestic and industrial waste, have led to biological consequences in the Nigerian coastal aquatic environment. Since the past two decades, the Lagos lagoon complex has served as the ultimate sink for the disposal of untreated domestic sewage, with the Kuramo lagoon (Figure 1) being the worst culprit. It is surrounded by large hotels, sophisticated restaurants and hundreds of huts built along its bank; playing host to thousands of homeless sex workers and touts. Primary concerns are the effects of domestic and industrial effluents on the general health of aquatic life, the maintenance of viable artisanal commercial fisheries and the safety of the humans occupationally exposed to the pollution. Much information is available on the plankton, fish and fisheries of the Lagos lagoon (Fagade 1969, Ezenwa 1981, Balogun 1987). Hill & Webb (1958) pointed-out that water flow of the lagoon is limited, tidal movements therefore are greatly reduced and the salinity changes very gradual. Also, monthly reading showed that salinity ranged from a minimum of 15 ‰ in October to a maximum of 24‰ in April. It is evident; however, that the salinity changes in Kuramo water are due in part to other causes other than tidal water. The barrier beach separating it from the sea is very narrow and in rough weather at high tide waves occasionally breaks over the beach and salt water may find its way into the lagoon thus raising the salinity. It is also possible that some salt water may find it way into the lagoon by seepage through the beach sand. Evaporation from the surface of the lagoon in the dry season must also contribute to a rise in salinity. On the other hand, the drainage of rain from local storms will reduce salinity during the wet season.

Pollution-related studies in the Lagos lagoon complex have been reported by Ajao, *et al.* 1996, Ajao and Fagade 1990). However, earlier studies could not have captured the several anthropogenic activities now surrounding the lagoon system. The aim of this study therefore, is to provide current and adequate information on the trend of temporal variation and pollution being evident in the interrelationships of the physicochemical parameters and the heavy metal indices.

Materials and Methods

Study site: Nigeria has a coastline of 853km bordering the Atlantic Ocean in the gulf of guinea. It has a maritime area of 46,500km^2 between 0-20m depth and an exclusive economic zone of 210,900km^2 (World resources, 1990). The total brackish water area is estimated as 12,940km2 with mangrove comprising 9700km^2 and the saline swamps of the Niger delta occupying 750,000 hectares. Lagos state is a coastal state, which covers an area of about 3,577 square kilometers, thus, occupying about 0.4% of the total land area of Nigeria (Shekoni 1997). The town of Lagos is built upon an island and lies between Lagos Harbour and Lagos Lagoon. The southern margin of Lagos and Ikoyi is bounded by Five Cowrie Creek, a waterway connecting the harbour to Lagos lagoon (Figure 1).


A
Legends
Lagos State Boundaries
Water Bodies Coast line
Badagry creek
LAGOS LAGOON
Ologe
LEKKI LAGOON
GULF OF GUINEA
Ogun River
Ikorodu Beach
University of Lagos Beach
Oko Baba
Carter Bridge
LAGOS LAGOON
Five Cowrie Creek
Kuramo Creek
Kuramo Water
?
D)
Kuramo
KEY

The Creek at the centre joins Badagry Creek a few miles from the Harbour. Immediately behind the barrier beach to the east of the harbour lies a long and narrow lagoon known as Kuramo water. This lagoon is connected to Five Cowrie Creek by a narrow and tortuous channel running the mangroves (Hill and Webb, 1958).

Sampling programme and Analysis

Sites characteristics and geographical positioning of sampling stations were shown in Table 1 (using the GPS system, Model -12, January-June 2008) having the Kuramo water between Latitudes $06^{0}28$'N-$06^{0}30$'N and Longitudes $03^{0}42$'E-$03^{0}47$'E. Sampling was carried out along designated transects from specific sites in horizontal direction with 8 sample stations marked. The water samples were analyzed according to the criteria prescribed by the GEMS/WATER operational guide (1977) on Global Water Quality Monitor. Ambient water temperatures were determined in-situ using calibrated Mercury-in-glass thermometer, while the water transparency was measured using the Secchi disc. Horiba U-10 and hydro-lab water quality checker were used for the analysis of each water sample collected for conductivity, pH, dissolved oxygen, temperature, salinity, turbidity and Secchi disc for transparency in-situ measurements. Also, the concentrations of heavy metals; cadmium, chromium, copper, iron, lead Nickel, Zinc, and other physico-chemical parameters were measured according to standard methods (APHA, 1998). Rainfall data for the period of sampling were obtained from the Nigerian Meteorological Station Oshodi, Lagos.

Statistical Analysis: Physico-chemical parameters were analyzed using Pearson's correlation matrix to examine intercorrelation of parameters and analysis of variance for differences in the water quality parameters and heavy metals concentration with respect to sampling stations and seasons. Mean separation was achieved using the Duncan multiple range post-hoc test.

Results

Water Quality Parameter in Space and Time

Temporal variations of water quality parameters in space and time (geographical positions) are summarized with respect to the eight sampling stations in Table 2. Physico-parameters studied (20) were statistically different among the eight (8) sampling stations throughout the period of study (Table 3). Conversely, in Table 2, the parameters were stable (no significant difference) between January and March 2008, with the exception of Fe. The highest value of COD and BOD occurred in May and June; 14.53±1.92mg/l and 14.91±2.39 mg/l (Table 2).

Intercorrelation of Parameters

Table 5 shows that twenty-two (22) out of 136 correlation coefficients (16%) are most significant ($p<0.05$). With the exception of salinity, all variables exhibited significant correlations with at least one other variable. Conductivity positively correlated with TDS ($r = 0.997$, $p<0.05$) and nitrate ($r = 0.583$, $p<0.05$). Total hardness also exhibited positive correlation with calcium ($r = 0.993$, $p<0.05$) and sulphate ($r = 0.700$, $p<0.05$). DO however, showed negative correlation with salinity ($r = -0.220$, $p<0.05$), turbidity ($r = -0.219$, $p<0.05$), and COD ($r = -0.099$, $p<0.05$). Chemical oxygen demand (COD) and Biological oxygen demand (BOD) exhibited significant correlation with pH ($r = 0.569$ and $r = 0.527$).

Heavy-metals in water

Heavy-metal values in Kuramo water, Lagos lagoon were: Fe =0.24 mg/L, Cu =0.38 mg/L, Zn =0.4 mg/L, Pb =0.05 mg/L, Cd =0.02 mg/L, Cr =0.2 mg/L and Ni =0.1 mg/L. These values were relatively significant during the period of study.

GPS, Model –12 Measurements								
Sample stations	1	2	3	4	5	6	7	8
(Geographical Positions) Longitudes	06^{0}28'N	06^{0}30'N	06^{0}30'N	06^{0}30'N	06^{0}29'N	06^{0}29'N	06^{0}29'N	06^{0}29'N
Latitudes	03^{0}42'E	03^{0}43'E	03^{0}44'E	03^{0}46'E	03^{0}47'E	03^{0}46'E	03^{0}44'E	03^{0}45'E
Altitude (ASL).	18.30m	24.01m	22.57m	23.18m	22.27m	29.4m	31.20m	35.99m
Mean Depth (m)	0.9	1.2	1.9	2.4	3.2	3.5	5.7	2.6
Mean Transparency (cm)	25.5	24	28	32	52.5	25	20.5	23.5
Mean Surface Temperature (^{0}C)	29	31.5	31.5	32	32	31	29	31
Point/non-point Sources	Up-stream With dung-hill	Hotel outlet (e.g. Eko Hotel Int.)	Entrance from Lagos lagoon and environs.	Mid-stream (fishing)	Kuramo lagoon exit	Direct human impact	Centre point (least impact)	Combination of dung-hill & human density

Abbreviations: *ASL = Above Sea Level, m = meter, cm = centimeter, ^{0}C = degree centigrade.*

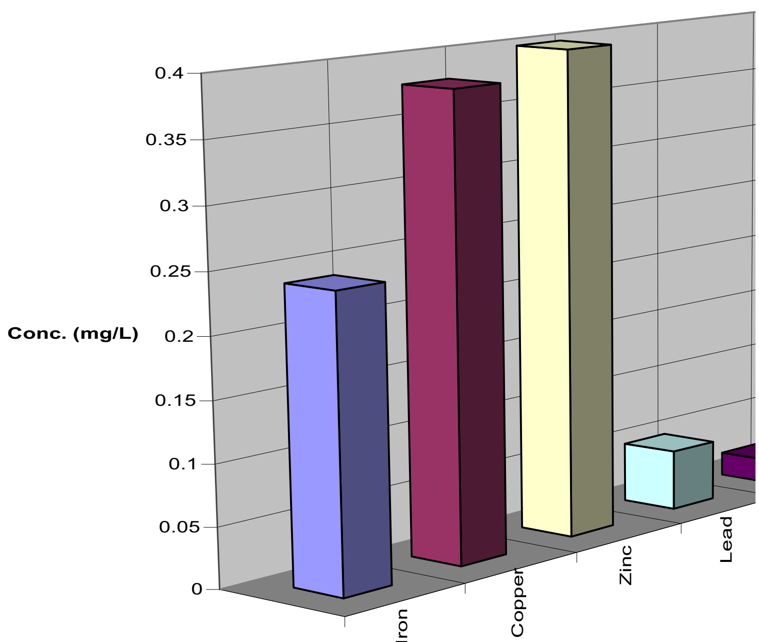


Fig. 2: Mean distribution of heavy metals concentration in Kuramo water (n = 64). Error bars represent ±SD and are not visible when smaller than the symbol

Table 2: Mean monthly variation in water quality parameters within the period of study.

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Temperature (^{0}C)	27.94±0.48^{a}	29.04±0.86^{a}	29.71±1.26^{a}	29.9±1.26^{a}	29.9±0.38^{a}	28.87±0.64^{a}	29.44±1.10^{a}	29.71±1.26^{a}
Conductivity (ìS/cm)	866.63±50.83^{a}	1092.87±240.95^{a}	1012.62±89.16^{a}	1287.5±60.41^{a}	969.87±23.33^{a}	973.75±19.9 9^{a}	1129.0±183.92^{a}	1012.61±89.16^{a}
Total dissolved solid (mg/L^{-1})	433.37±25.47^{a}	546.5±120.35^{a}	506.62±40.64^{a}	643.75±30.2^{a}	485.0±11.68^{a}	485.12±10.0^{a}	564.62±91.92^{a}	506.62±44.64^{a}
Dissolved oxygen (mg/L^{-1})	9.33±1.85^{a}	8.3±0.92^{a}	7.3±1.64^{a}	10.18±0.79^{a}	8.18±0.44^{a}	8.2±0.4^{a}	9.42±1.51^{a}	7.30±1.64^{a}
pH	9.91±0.67^{a}	8.88±0.99^{ab}	9.88±0.66^{ab}	9.65±0.21^{ab}	9.07±0.68^{ab}	9.1±0.51^{ab}	9.71±0.63^{ab}	9.88±0.66^{ab}
Salinity (‰)	0.38±0.03^{a}	0.43±0.10^{a}	0.47±0.04^{a}	0.56±0.05^{a}	5.14±0.13^{a}	5.36±0.2^{a}	0.51±0.08^{a}	0.47±0.04^{a}
Turbidity (NTU)	2.37±0.91^{a}	7.87±5.98^{a}	3.87±1.8^{ab}	3.5±0.75^{ab}	4.12±3.18^{ab}	4.87±1.55^{ab}	3.5±0.75^{ab}	3.87±1.8^{ab}
Total hardness (mg/L^{-1})	452.75±47.74^{a}	553.62±120.37^{a}	527.62±50.6^{a}	683.75±30.2^{a}	501.5±35.38^{a}	501.5±25.38^{a}	593.0±104.99^{a}	527.62±50.60^{a}
Calcium (mg/L^{-1})	339.62±36.35^{a}	415.12±90.23^{a}	395.5±37.8^{a}	513.0±22.58^{a}	387.62±5.42^{a}	387.62±5.42^{a}	444.62±78.89^{a}	395.5±37.80^{a}
Magnesium (mg/L^{-1})	114.25±12.00^{a}	279.12±169.91^{a}	132.25±12.6^{a}	171.0±7.5^{a}	126.37±7.98^{a}	126.37±7.98^{a}	148.62±26.02^{a}	132.25±12.60^{a}
Chloride (mg/L^{-1})	120.50±3.07^{a}	129.0±43.99^{a}	120.5±3.07^{a}	107.5±12.45^{a}	89.37±3.42^{a}	89.37±3.42^{a}	116.62±12.22^{a}	120.87±3.35^{a}
Sulphate (mg/L^{-1})	59.37±2.32^{a}	71.12±17.10^{a}	86.12±16.99^{a}	72.87±12.75^{a}	51.87±3.09^{a}	51.87±3.09^{a}	74.0±15.97^{a}	86.12±16.99^{a}
Nitrate (mg/L^{-1})	1.80±0.96^{a}	4.31±1.98^{a}	1.43±0.57^{a}	2.52±1.33^{a}	0.60±0.83^{a}	0.6±0.38^{a}	1.5±0.86^{a}	1.43±1.57^{a}
Phosphate (mg/L^{-1})	0.46±0.32^{a}	1.81±1.01^{a}	0.25±0.14^{a}	1.09±0.43^{a}	0.12±0.05^{a}	0.12±0.05^{a}	0.76±0.58^{a}	0.25±0.14^{a}
Total suspended solid (mg/L^{-1})	7.0±2.39^{a}	7.37±3.62^{a}	8.62±3.96^{a}	26.5±8.19^{a}	7.75±5.03^{a}	9.5±5.15^{a}	13.5±7.23^{a}	8.62±3.96^{a}
Chemical oxygen demand (mg/L^{-1})	13.50±0.92^{a}	13.03±0.91^{bc}	13.59±0.96bc	12.62±0.93^{cb}	14.53±1.92^{bc}	14.91±2.39^{a}	13.62±1.0^{c}	13.59±0.96^{ac}
Biological oxygen demand (mg/L^{-1})	5.22±0.98^{a}	5.43±0.58^{ab}	6.5±1.07ab	6.71±0.69ab	6.46±0.88^{abc}	6.46±0.88$^{a\ b}$	6.44±1.09^{ab}	6.50±1.07^{ab}
Alkalinity (mg/L^{-1})	64.00±4.44^{a}	51.62±10.78^{a}	39.75±15.51a	64.25±4.92a	29.25±2.37^{a}	29.25±2.37^{a}	54.5±16.8^{a}	39.75±15.51^{a}
Colour	70.0±5.20^{a}	56.75±17.18^{a}	51.75±10.83a	42.37±18.06a	70.25±5.25^{a}	70.0±4.24^{a}	51.0±11.79^{a}	51.75±10.83^{a}
Fe (mg/L^{-1})	0.19±0.05^{a}	0.19±0.01^{ab}	0.23±0.05ab	0.28±0.06bc	0.21±0.05^{bc}	0.21±0.05^{a}	0.25±0.06^{a}	0.23±0.05^{a}

Values along the same row bearing the same superscripts are not statistically different at 5% probability level using the Duncan Multiple Range test.

Table 3: Spatial mean value of water quality parameters within the period of study.

	Sampling stations							
Parameters								
1	2	3	4	5	6	7	8	
Temperature (0C)	29.35±1.12	29.56±0.85	29.15±0.83	29.55±0.79	29.95±0.79	29.47±1.00	28.93±0.78	28.67±1.32
Conductivity (iS/cm)	1068.62±161.03	1049.87±165.51	931.12±161.51	1060.75±148.90	1116.0±152.11	1103.0±175.94	999.0±167.60	017.37±176.74
Total dissolved solid (mg/L^{-1})	534.12±80.90	525.25±82.59	465.5±80.77	530.12±74.48	557.75±76.43	551.12±88.26	499.5±83.99	508.62±88.24
Dissolved oxygen (mg/L^{-1})	8.33±2.21	7.99±1.45	7.82±1.78	8.21±1.62	8.53±1.87	8.72±0.69	8.94±1.07	9.58±0.96
pH	9.45±0.98	9.28±0.61	9.49±0.77	9.69±0.54	9.76±0.53	9.30±0.69	9.69±0.87	9.61±0.79
Salinity (‰)	1.65±2.13	1.67±2.18	1.58±2.17	1.70±2.28	1.70±2.22	1.72±2.27	1.67±2.23	1.65±2.22
Turbidity (NTU)	5.87±3.44	4.87±4.18	3.50±1.19	3.37±0.91	4.25±3.95	4.87±4.54	4.00±0.53	3.25±1.75
Total hardness (mg/L^{-1})	556.75±83.51	549.0±87.0	474.25±94.59	524.87±101.13	595.37±66.64	576.75±93.35	523.75±96.31	529.37±102.43
Calcium (mg/L^{-1})	418.75±61.70	414.62±63.09	365.25±70.05	412.50±59.79	446.50±49.94	432.37±70.09	392.0±72.52	397.25±76.78
Magnesium (mg/L^{-1})	138.0±21.95	134.37±24.74	142.75±48.65	177.62±120.20	188.50±115.70	185.12±124.36	131.75±23.82	132.75±25.42
Chloride (mg/L^{-1})	119.37±28.56	115.21.79	104.87±14.21	113.75±19.80	102.75±26.68	118.87±29.23	108.50±10.19	110.75±15.22
Sulphate (mg/L^{-1})	77.87±19.61	74.62±18.54	64.62±18.38	69.62±18.70	71.62±20.65	72.0±19.16	61.5±12.31	61.25±12.46
Nitrate (mg/L^{-1})	2.73±2.80	1.99±1.47	1.84±1.83	1.34±1.29	1.30±1.44	1.43±1.69	1.40±1.35	2.22±1.03
Phosphate (mg/L^{-1})	0.66±1.07	0.62±0.73	0.88±0.99	0.46±0.60	0.60±0.80	0.60±0.58	0.56±0.51	0.48±0.29
Total suspended solid (mg/L^{-1})	15.0±5.95	8.75±4.92	9.75±5.97	8.0±4.65	11.75±10.70	12.62±12.36	11.12±9.24	11.55±7.61
Chemical oxygen demand (mg/L^{-1})	14.94±2.88	14.20±1.27	13.3±0.99	13.26±1.11	13.51±1.10	14.18±0.97	13.04±0.70	13.21±0.99
Biological oxygen demand (mg/L^{-1})	6.28±0.72	7.01±0.52	5.57±0.96	6.01±1.14	6.50±0.92	7.14±0.64	5.83±0.38	5.58±1.27
Alkalinity (mg/L^{-1})	39.0±10.63	40.0±17.88	44.37±16.43	47.87±16.83	46.25±16.85	45.62±20.56	55.12±16.79	54.87±15.41
Colour	49.75±23.18	54.87±10.82	61.50±14.77	55.00±14.68	56.25±15.54	61.12±16.03	63.12±7.66	60.50±10.77
Fe (mg/L^{-1})	0.24±0.08	0.27±0.05	0.22±0.06	0.21±0.07	0.19±0.03	0.24±0.02	0.25±0.04	0.25±0.09

The Duncan Multiple Range test shows that values along the same row are all statistically different at 5% probability level

Table 4: Grand mean, standard deviation and range of physico-chemical properties within the study period (n = 64)

Physico-chemical Parameters	Grand mean±Standard Deviation	Range Minimum	Maximum
Temperature (^{0}C)	29.31±1.03	27.05	31.01
Conductivity (ìS/cm)	1043.10±164.59	669.0	1360.0
Total dissolved solid (mg/L^{-1})	521.45±82.36	335.0	680.0
Dissolved oxygen (mg/L^{-1})	8.53±1.54	5.73	12.34
pH	9.51±0.74	7.35	10.48
Salinity (‰)	1.66±2.08	0.20	5.60
Turbidity (NTU)	4.25±2.94	1.0	16.0
Total hardness (mg/L^{-1})	542.67±91.73	340.0	720.0
Calcium (mg/L^{-1})	409.82±66.6	255.0	540.0
Magnesium (mg/L^{-1})	153.78±76.79	95.0	488.0
Chloride (mg/L^{-1})	111.76±21.35	50.0	180.0
Sulphate (mg/L^{-1})	69.17±17.66	40.0	100.00
Nitrate (mg/L^{-1})	1.77±1.67	0.05	7.5
Phosphate (mg/L^{-1})	0.61±0.70	0.06	3.0
Total suspended solid (mg/L^{-1})	11.10±7.91	2.0	40.0
Chemical oxygen demand (mg/L^{-1})	13.67±1.46	11.56	20.35
Biological oxygen demand (mg/L^{-1})	6.22±1.02	3.67	7.99
Alkalinity (mg/L^{-1})	46.54±16.77	24.0	72.0
Colour	57.98±14.88	0.0	85.0
Fe (mg/L^{-1})	0.23±0.16	0.10	0.40

Table 5: Pearson's correlation matrix for the Physico-chemical Parameters

Parameter	NO_3^{-2}	Cond.	TDS	DO	Ph	Salinity	Turbidity	TH	Calcium	Mg	Cl-	SO_4^{2-}	PO_4^{3-}	TSS	COD	BOD	Alkalinity
Nitrate	1.00																
Cond.	.587*	1.00															
TDS	.583*	.997*	1.00														
DO	.314	.489	.496	1.00													
Ph	.205	.507	.504	.328	1.00												
Salinity	-.601	-.214	-.186	-.220	-.170	1.00											
Turbidity	.663*	.423	.421	-.219	-.067	.052	1.00										
TH	.537	.992*	.996*	.536	.528	-.187	.343	1.00									
Calcium	.486	.980*	.990*	.522	.532	-.079	.354	.993*	1.00								
Mg	.919*	.593	.597	.121	.050	-.291	.885*	.534	.515	1.00							
Chloride	.743*	.536	.531	.180	.749*	-.473	.444	.505	.477	.614*	1.00						
Sulphate	.559	.708*	.709*	.072	.782*	-.395	.350	.700*	.679*	.484	.864*	1.00					
Phosphate	.981*	.633	.631	.378	.098	-.536	.681	.586	.538	.934*	.626	.465	1.00				
TSS	.020	.387	.405	.583	-.157	-.226	-.343	.454	.426	-.074	-.327	-.075	.139	1.00			
COD	-.138	.248	.238	-.099	.569	.568	.293	.223	.294	.025	.328	.323	-.176	-.563	1.00		
BOD	-.156	.656	.663	.082	.527	.388	.100	.681	.731	-.011	.141	.508	-.123	.175	.623	1.00	
Alkalinity	.677	.656	.643	.691	.752	-.539	.125	.651	.611	.440	.814	.661	.624	.092	.176	.147	1.00

*correlation is significant at $p < 0.05$ level (2-tailed)

Discussion

Metabolic rate and the reproductive activities of aquatic life are controlled by water temperature. As metabolic activities increases with an increase in temperature, fish's demand for oxygen increases. Grand mean temperature (29.31^{0}C) recorded in this study falls within the range (20 - 30^{0}C) suggested by Boyd and Lichkoppler (1985), and the Nigeria's Federal Environmental Protection Agency (FEPA, 1999) for adequate support and propagation of tropical fishes. This indicated favourable condition for occurrence, growth and multiplication of overall aquatic resources; biodiversity of the Kuramo water especially during the dry season.

The mean dissolved oxygen of 8.53mgL^{-1} recorded for the sampling stations buttressed the recommendation of Boyd and Lichkoppler (1985) that DO level of 3- 4mgL^{-1} is required for fish growth. This is also supported by Agboola, et al. (2008) who reported mean DO level of 4.81mgL^{-1} in Badagry creek, Nigeria. Comparatively the DO level in Kuramo water is well above the minimum 5.0mgL^{-1} suggested by Erondu (1991) and the 6.8 mgL^{-1} standard suggested by FEPA for the survival of fish and other aquatic organisms. Lower oxygen dissolved in water could drastically adversely affect aquatic organisms e.g., fish kill as well as their eggs and larvae. However, dissolved oxygen in this study remained stable throughout sampling period. Onsets of rainfall lead to introduction of biodegradable and non-biodegradable contaminants which was evident in the rise of BOD and COD in May. This did not only cause complete change of water status but also brought pollutants of carcinogenic properties from point and non-point sources (Tables 1 and 2).

Salinity values were relatively stable during the dry season. (< 0.50/00) but displayed a sharp increase in its concentration as rainfall levels rises; turning water system from fresh water body to brackish; with a peak value of 5.360/00 in June. This sudden and unusual change in salinity may be due to the close proximity of the Atlantic Ocean to Kuramo; with an approximate geographical distance of 100m. Chemical oxygen demand (<15.24 mg/l) was relatively high when compared with the DO (< 9.33mg/l), but the Biological oxygen demand was stable (<7.05mg/l). The information on values of water chemistry determined monthly was greatly influenced by temporal variation. The result shows that Kuramo water system being an off-shoot of the Lagos lagoon poses an unusual combination of physicochemical characteristics, a view which has posed earlier by Hill and Webb (1957). For instance, during the rainy season, an immense volume of marine water from the Atlantic Ocean (figure 1) enters the Kuramo water, therefore making it difficult to refer to the Kuramo as fresh water body. Life in this water system is thus subject to temporal variation; from fresh in January - April (0.3 - 0.5 ‰) to brackish condition between May and July (5.1 - 5.3 ‰). Thus, only euryhaline species can survive such variabilities.

Changes in water chemistry (ion concentration) are visibly noticed from one sample station to another; and there are also point sources of contaminants from domestic and recreational activities on daily basis, thus contributing to the water system, non-biodegradable substances (e.g. nylon sachet, paint containers, mosquitoes repellant containers, etc.), organic wastes from large hotel outlets dumped directly into the water. These substances are carcinogenic with the potential of causing brain damage among other effects.

Heavy-metal values in Kuramo water, Lagos lagoon were relatively significant during the period of study, although all heavy-metals analyzed are within the permissible standard limits of FEPA (1999).

Kuramo water appears to have 'safe levels' of heavy-metal pollution, activities that could increase theses concentrations should be guided against.

Therefore, Environmental standards should be enforced to protect this water body from becoming potential threat to the health and well-being of the locals in future.

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