Research article

A MULTIVARIATE APPROACH TO THE INTERACTION OF PHYSICOCHEMICAL PARAMETERS OF WATER SAMPLES FROM SELECTED COASTAL AREAS OF LAGOS, NIGERIA.

*OMALE, P. E., OKENIYI, S. O. AND FARURUWA, M. D.

CHEMISTRY DEPARTMENT

NIGERIAN DEFENCE ACADEMY, KADUNA.

*(CORRESPONDENT AUTHOR)

E-mail: omalepeters@ymail.com, drokeniyisok@yahoo.com

ABSTRACT

The physicochemical of parameters of water samples collected from selected coastal areas of Lagos, Nigeria over a period of two seasons (wet and dry) were determined. The results obtained for the physicochemical parameters of the collected samples includes; Total Dissolved Solids (TDS) which varies between 0.17 ± 0.02—14.36 ± 0.39 mg/l in dry season samples and 1.69 ± 0.02—25.16 ± 0.30 mg/l in the wet season samples, Electrical Conductivity (EC) varied between 0.37 ± 0.04—2.13 ± 0.30 and 0.29 ± 0.02—1.24 ± 0.02μscm-1 for dry and wet season respectively. Total Suspended Solids (TSS) also varied between 0.93 ± 0.05—5.50 ± 0.28mg/l (dry season) and 0.10 ± 0.00—2.58 ± 0.10 mg/l (wet). pH values varied between 6.50 ± 0.30—7.73 ± 0.06 (dry) and 6.86 ± 0.24—7.47 ± 0.15 (wet); while

Temperature values variedin the range of 30.00±0.20—30.83±0.76 oC dry season samples and 29.37±1.10—30.64±0.15oC for wet season samples. All the values obtained were below the permissible levels except for the COD which gave values ranging from 30.71±1.29—91.71±0.50 (dry season) and 20.67±0.48—61.27±2.88 mg/l (wet season); far above the WHO standard of 10mg/l.   **Copyright © acascipub.com all rights reserved.**

KEYWORDS: Radionuclides, Algae, Physicochemical parameters.

_____

INTRODUCTION

The introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem; i.e. physical systems or living organisms. Pollution can take the form of chemical substances, or energy, such as noise, heat or light energy. Pollutants, the elements of pollution, can be foreign substances or energies, or naturally occurring; when naturally occurring, they are considered contaminants when they exceed natural levels. (Goldberg, 1972). The release of waste products and contaminants into surface water into river systems, leaching into ground water, liquid spills, waste water discharges, eutrophication littering and atmospheric deposition could cause water pollution.

Pollution of the marine environment can be caused atmospheric deposition from both natural and manmade sources. Though globally, manmade pollutants from combustion, construction, mining, agriculture and warfare are increasingly significant (UNCHE, 1972). Motor vehicle emissions are one of the leading causes of air pollution, (EPR, 2001) in China, United States, Russia, Mexico and Japan. Principal stationary pollution sources include chemical plants, coal-fired power plants, oil refineries, petrochemical plants, nuclear waste disposal activity, incinerators, large livestock farms (dairy cows, pigs, poultry, PVC factories, metal production factories, plastic factories and other heavy industries. Agricultural pollution comes from contemporary practices which include clear felling and burning of natural vegetation as well as spraying of pesticides and herbicides ((Beychok, 1967,Carlson, 2003). Some of the soil pollutants include chlorinated hydrocarbons, heavy metals (such as chromium, cadmium found in rechargeable batteries and lead (Pb) found in lead paint, aviation fuel and still in some countries, gasoline), zinc, arsenic and benzene. Municipal landfill are also the source of many chemical substances entering the soil environment (and often ground water), emanating from wide variety of refuse. There have also been some unusual releases of polychlorinated dibenzodioxins, commonly called dioxins. Pollution can also be the consequence of

natural disasters. For example, hurricanes often involve water contamination from sewage and petrochemical spills from ruptured boats or automobiles. Larger scale and environmental damage is not uncommon when coastal oil rigs or refineries are involved. Some sources of pollution, such as nuclear power plants or oil tankers, can produce widespread and potentially hazardous releases when accidents occur (Croft and Hutchinson, 1999).

 Physicochemical-parameters are characteristics which measures the alteration of the composition matter (Air, Water, Soil), such alteration often referred to as the gross contamination of an environment causing harmful or potentially harmful effects to human life or other life forms in the total ecological community. The introduction of a substance into an environment causes impairment to it, (Ademoroti, 1996). The following characteristics are hereby considered: total dissolved solids (TDS), total suspended solid, (TSS), chemical oxygen demand (COD), degree of acidity or alkalinity (pH), temperature and electrical conductivity (EC). Water is the most abundant liquid on earth; it covers three quarters of the earth's surface. Human activities and settlements hinge on the availability of water. Our physical and biological environments hinge on water. As vapour, water absorbs radiation to influence the heat balance and temperature of the environment and brings moisture to the continents. As liquid, water erodes and shapes the land, transports and concentrate minerals and moderate climate. As solid (ice), water gouges glacier valleys and lakes, pulverizes rocks by expanding when it freezes and thereby creates soils. Water plays another material role for man. It carries away his waste. As the most abundant liquid on earth water runs steadily to the sea along a vast network of rivers. It is a receptacle for sewage; it can be used to rinse away grime or toxic chemicals; or remove waste heat from boilers, (Ademoroti, 1996). The main aim is to assess the physicochemical parameters of water samples from the selected coastal areas of Lagos-Nigeria to highlight and ascertain possible pollution.

EXPERIMENTALS

SAMPLING

Samples were collected in the month of February, (dry season) and August, (wet   season) respectively from six designated areas in the Lagos metropolis namely: Bar beach   (BB), Lekki beach (LK.B), Mile 2 Canal (ML2.C). Lagos Harbour (LG.HB), Apapa   Canal (AP.C), and Ijeh Canal (IJ.C) as shown in figure1.

The water samples were collected in polyethylene plastic containers. The containers were washed with soap solution rinsed with dilute HCl acid solution in ratio 1:1. The acid washing was done by adding 100ml of the acid solution

into the bottles and then rinsed with deionised water and dried, (Greenberg, 1992). Ten water samples, at a particular site were sampled by taking water from the surface and at a depth of about two metres below the surface at a distance of twenty metres then mixed together to form a composite sample. This was repeated for all locations to get six composite samples. In-situ determination of some physicochemical parameters such as TDS, Temp, Electrical Conductivity, (EC) and pH (Franson 1995) was carried out using Hach Model 44600 meter on the spot. The COD and TSS were determined at the Monscience Laboratory in Lagos. About two litres of each sample was preserved with 20ml of conc. nitric acid (HNO_3) to suppress bacterial activity (pH<2). This was also to ensure stability of samples, maintain the oxidation state of the elements and prevent metals from adhering to the walls of the container. Total suspended solids was determined by the filtration method, (IITA, 1990). The area under study is Lagos metropolis, the state capital of
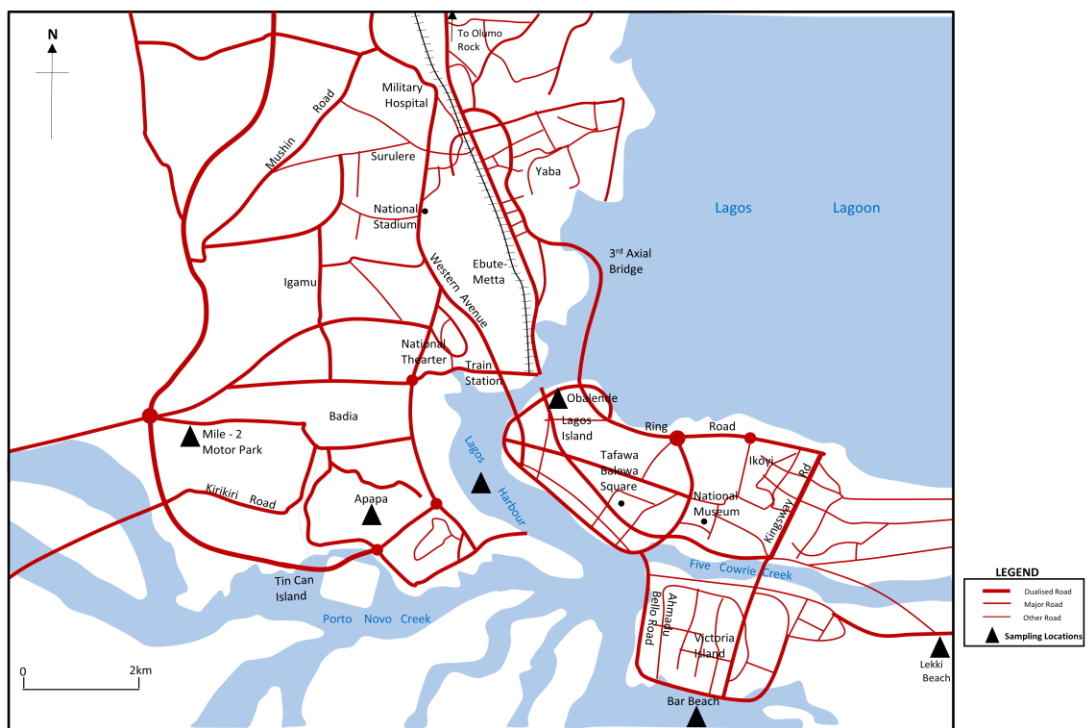

Figure. Lagos Showing Sampling Locations.
Source: Geological Survey Dept.Lagos,2006.

Figure 1: Map of Lagos Sampling Locations . Δ

Lagos state, former administrative Federal Capital of Nigeria and current Commercial Federal Capital. It lies on latitude $+6^0$ 27' 11'' and longitude $+3^0$ 23' 45'' to the south western part of Nigeria. It shares boundaries with Ogun

state in the North and East and with Republic of Benin in the west. It stretches for 180km along the coast of the

Atlantic Ocean in the south. Lagos state, occupies an area of 3,577 Sq km. 22% or 787 Sq km, part of which consists

of lagoons and creeks (canals) is influenced by the sub-equitorial climate with a rainfall of 2500mm per annum. It

has a double maxima of rainfall-June/July and September/October with conventional rainfall. It has temperature of

about 27^oC, with a low annual range of 2-3 ^oC and a relative humidity of 90%. It has a long period of wet season

between 6-8 months and 3-4 months of dry season. All the rivers e.g.Ogun, Osun, Osse, Niger and Benue, drain into

the Atlantic Ocean with all the transported pollutants. The Atlantic Ocean is kinetic and due to its non-static nature

transports pollutants from other parts of the world and as such the coastal samples from these sites are equally

polluted, hence could be useful in pollution studies.

The following physicochemical parameters were determined: Total Dissolved Solids (TDS); Total Suspended

Solids, (TSS); Chemical Oxygen Demand (COD), pH, Temperature and Electrical conductivity

PREPARATION OF STOCK REAGENTS

The stock reagents were prepared as follows:

(a). 0.1M $KMnO_4$

3.951 g of $KMnO_4$ previously dried at 103 ^0C was dissolved in distilled water in 250 cm^3 flask and made up to

mark. The resulting solution was kept in the dark to prevent photochemical degradation.

(b) 1% Ammoniun Oxalate

1 g of Ammoniun Oxalate, $(NH_4)_2C_2O_4.H_2O)$ was dissolved in distilled water in 100cm^3 flask and made up to mark.

This was filtered to remove undissolved solids.

(c) 2% ammonium pyrolidine—dithiocarbamate (APDC)

2 g of ammonium pyrolidine dithiocarbamate was dissolved in distilled water in 100 cm^3 and made up to mark.

(d) 25% H_2SO_4

25% H_2SO_4 acid was prepared from the concentrated H_2SO_4 solution (specific gravity 1.80g/cm^3 and 98%) by measuring 25 cm^3 of the conc acid and was diluted with distilled water in 100 cm^3 volumetric flask and made up to mark.

(a) DETERMINATION OF TDS, pH TEMP, AND ELECTRICAL CONDUCTIVITY

These parameters were determined on the spot using the HACH Complete water Laboratory model DREL/3900 instrument attached with a probe. 100 cm^3 of water samples were taken in 250 cm^3 pyrex beaker and repeated for all the sampled locations. TDS, pH, Temp., and Electrical Conductivity were determined and recorded.

(b) DETERMINATION OF COD AND TSS

These two parameters were determined as follows;

(i) COD

25 cm^3 of the water sample was taken. 10 cm^3 of 0.1M KMnO$_4$ and 2 cm^3 of 25 % H_2SO_4 were added. It was then mixed and refluxed for about an hour and cooled to room temperature. 1 % ammonium oxalate was added drop wisely until the solution turned colourless. The solution obtained was then titrated with 0.01M KMnO$_4$ and the COD were calculated using:

COD (mg/l) = (b-a) x M x 16000

      Vol. of sample

Where b = titre value with blank   M = molarity of KMnO$_4$

a = Titre value with sample   16000 = molar mass of oxygen per litre

(ii) TOTAL SUSPENDED SOLIDS (TSS)

A clean filter paper, 5.5 cm in diameter was dried, to constant weight at 103 – 105 ^{o}C in an oven and cooled to room temperature in a desiccator. The weight was noted. The buckner flask was prepared with the filter paper for filtration. The sample was thoroughly mixed. 25 cm^3 of the mixture was withdrawn using a pipette and filtered. Using a pair of tongues, the filter paper and residue was carefully removed from the flask and dried to constant

weight at 103 – 105 ^{o}C. the weight of the filter paper was subtracted from the weight of sample and filter paper to obtain the weight of the suspended solids which is given by

SS (mg/l) = mg.(SS) x 1000

    Vol. of sample

 mg(SS)=weight of SS on filter paper.

RESULTS AND DISCUSSION

The results of the physiochemical parameters and its seasonal analysis of the sampled water during dry and wet seasons are presented in Tables 4.1(a), 4.1(b) and4.1(c) respectively. Temperature is an important factor that influences the chemical, biochemical and biological characteristics of an aquatic system. The ambient temperature values (^{o}C) of the sample sites at   both dry and wet (rainy) seasons varied between 29.37±1.10–30.83±0.76. This temperature might be responsible for its level of dissolved solids, chemical oxygen demand and conductivity in the locations because of enhanced solubilty. The temperature from the sample sites remained relatively constant during the dry season (30.0±0.02-30.83±0.76) ^{o}C, this could be due to increased domestic activities and industrial effluents, and increased evaporation. The temperature at the sample sites during the wet (rainy) season varied between 29.9±1.10–30.64±0.15^{o}C. Temperature for both seasons have common independent variation and this can be seen as a   negative correlation (Table4.1b) but have significant % RSD (Table 4.1c). This can be attributed   to   the effect of the Coastal tides from the Atlantics Ocean and the unpredictable level of humidity. This value compares favourably with a similar work done by Boari *et al.*, 2002.

The pH value usually affects both the chemical and biochemical reactions in the sampling locations. The pH values obtained varied from a minimum of 6.50±0.30 to a maximum of 7.47±0.15^{o}C in all the sampled locations. This variation falls within the permissible range   specified WHO (6.6 – 8.5) for (assumed) polluted water, (WHO 1994). The pH value obtained in the water samples at Ijeh Canal and Lekki beach during the wet (rainy) season are 6.86±0.24 and 6.93±0.07 respectively. These value revealed that the samples are weakly acidic, while the pH at other locations such as Apapa Canal, LG.HB, BB, ML.2 Canal during the same season indicated   a   very   mild alkalinity. The pH value of samples from Lekki beach during the dry season (7.06±0.13) indicated a slightly neutral nature, 6.93±0.07 during the wet (rainy) season. This variation in the pH value may be attributed to increased

dilution of the sea, due to frequent rainfall, turbulent effects of the tides resulting in the thorough mixing of its salt contents. The pH for dry and wet season at IJ.C, though low but similar variations (Table 4.1b) and significant %RSD (Table 4.1c). This could be due to increased human population and effluents from the mechanics. The observed pH values in all the water samples could be due to the presence of some inorganic (nitrates, phosphates, sulphates) and organic (carboxylic acids and phenols) substances within the aquatic system that are acidic and alkaline in nature (Lema *et al*, 1988).

The results obtained for Total Suspended Solids (TSS) varied between 0.104±0.00 and 5.50±0.28 mg/l. From this result, LK.B gave the lowest value of suspended solids (0.104±0.00 mg/l) during the wet season. At AP.C (wet & dry) for both seasons showed similarity but significant % RSD (table 4.1c). This could be due to influx of surface soil and salts. This is also factor that could affect other locations. This variation might be attributed to increased flow of water to the Atlantic Ocean. Quinition and Rickson, (1993) reported a relationship between suspended solids and environmental damage in which they claimed that a high level of suspended solids is an indication of availability of materials to be washed away by rain, percolation or tidal effects due to movement of passenger ferries and commercial activities.

Table 4.1(a). Physicochemical parameters of coastal water sampled during dry & wet seasons

Parameters		AP.C	LG.HB	LK.B	IJ.C	BB	ML2.C
TDS	Dry	0.64±0.02	14.36±0.39	0.17±0.02	0.28±0.02	17.26±0.07	0.40±0.02
mg/l	Wet	1.69±0.02	3.13±0.02	15.36±0.57	2.43±0.13	25.16±0.30	10.29±0.10
Conduct.	Dry	2.13±0.15	1.23±0.07	1.07±0.12	0.37±0.04	1.15±0.13	0.57±0.04
μS/cm	Wet	1.24±0.02	1.04±0.05	0.29±0.02	0.52±0.05	1.05±0.05	0.79±0.01
TSS	Dry	5.50±0.28	1.42±0.04	1.01±0.00	1.66±0.15	0.93±0.05	0.96±0.48
mg/l	Wet	2.58±0.10	0.90±0.08	0.104±0.00	0.80±0.12	0.18±0.06	0.24±0.02
COD	Dry	30.71±1.29	80.59±0.55	91.708±0.53	82.22±0.35	59.28±0.41	59.67±0.05
mg/l	Wet	20.67±0.48	61.24±2.88	42.17±0.28	50.26±0.22	43.37±0.42	43.52±0.60
pH	Dry	7.27±0.25	6.67±0.15	7.060±0.13	6.50±0.30	7.71±0.09	7.73±0.06
	Wet	7.47±0.15	7.34±0.41	6.93±0.07	6.86±0.24	7.22±0.17	7.39±0.03

| Temp | Dry | 30.83±0.76 | 30.03±0.06 | 30.27±0.64 | 30.00±0.20 | 30.07±0.81 | 30.67±0.58 |
| ^{0}C | Wet | 29.37±1.10 | 30.00±0.10 | 30.53±0.31 | 30.27±0.21 | 30.52±0.39 | 30.64±0.15 |

Key: AP.C-Apapa Canal; LG.HB- Lagos Harbour; LK.B- Lekki Beach; IJ.C- Ijeh Canal; BB- Bar

Beach; ML2.C- Mile2 Canal

Table 4.1(b): Comparative analysis of physicochemical parameters of water sampled at the various

locations.

TDS	Dry	BB> LG.HB> AP.C> ML2.C> IJ.C>LK.B
	Wet	BB> LK.B >ML2.C>LG.HB>IJ.C>AP.C
COND	Dry	AP.C> LG.HB>BB> LK.B> ML2.C>IJ.C
	Wet	AP.C> BB> LG.HB>ML2.C>IJ.C>LK.B
TSS	Dry	AP.C> IJ.C> LG.HB> LK.B> ML2.C> BB
	Wet	AP.C> LG.HB>IJ.C> ML2.C> BB> LK.B
COD	Dry	LK.B> IJ.C> LG.HB> ML2.C>BB>AP.C
	Wet	LG.HB> IJ.C> ML2.C> BB> LK.B>AP.C
TEMP	Wet	AP.C> ML2 .C> LK.B> BB> LG.HB> IJ.C
	Dry	ML2.C> LK.B> BB> IJ.C> LG.HB> AP.C
$_P$H	Dry	ML2.C> BB > AP.C> LK.B> LG.HB> IJ.C
	Wet	AP.C> ML2.C> LG.HB> BB> LK.B> IJ.C

Table 4.1(c): *% RSD of physicochemical parameters for dry and wet seasons.

		Seasons		
	Parameters	**Dry**	**Wet**	**Observation**
1.	TDS	16.45	7.19	Significant
2.	Conductivity	21.02	30.53	Significant
3.	TSS	20.35	4.03	Significant
4.	COD	50.34	50.95	Significant
5.	pH	5.28	1.12	Significant
6.	Temp.	3.61	2.31	Significant

*Percentage Relative Standard Deviation

The results obtained for Total Dissolved Solids (TDS) varied from a minimum of 0.17 ± 0.02 mg/l during the dry season at Lekki beach to a maximum of 25.16 ± 0.30 mg/l during the wet season at bar Beach. The lowest value of TDS was obtained during the dry season at Lekki beach (0.17 ± 0.02 mg/l). These results showed fluctuations in the values of dissolved solids in all sample locations. This may be as a result of temperature changes in the samples sites which may have resulted due to slight changes in the coastal climate. Changes in temperature can at times be associated with microbial activities. The value of dissolved solids recorded for all samples were much lower than the WHO permissible limit for drinking water (800mg/l), (WHO, 1994). For both seasons (dry & wet) showed similar increases at BB and IJ.C and significant % RSD (Table 4.1c). This could be attributed to Atlantics Ocean and commercial /domestic activities from the Obalende end of IJ.C respectively. It has been observed that the main factors that influence the deterioration of coastal water quality especially in the Lagos area include agricultural, domestic, municipal, commercial and industrial wastes, (Ademoroti, 1996).

The COD results obtained from samples at all sites during the wet (rainy) season, ($30.07\pm1.29-91.71\pm0.53$ mg/l) showed higher values over the dry season samples ($20.67\pm0.48-61.24\pm2.88$ mg/l). The levels of chemical oxygen demand in all the samples were high and this is in agreement with the findings of Tchobanoglous and Shrieder, (1985). The COD values are higher than the WHO permissible limit for drinking water (10 mg/l), (WHO, 1994). IJ.C and AP.C also showed marked similarity for both season and less significant % RSD (Table 4.1c). This could be due to increased inflow of organic /inorganic wastes which could require more oxygen.

Electrical conductivity (EC) depends largely on dissolved salts present in the sample and is a measure of the ability of the conductor to convey electrical charges. The electrical conductivity of polluted water is due to the presence of

dissolved ionic solutes. So, the magnitude of the conductivity is a useful indicator of the total concentration of ionic solutes. The result obtained for the electrical conductivity (EC) of samples from all sites ranged from 0.37±0.04 – 2.13±0.15 µS/cm during the dry season and from 0.29±0.02 to 1.24±0.02 µS/cm during the rainy (wet) season. The values obtained are lower than those reported for fresh water environment in the Niger Delta, (Courant et al; 1985). A low TDS of 0.64±0.03 mg/l during the dry season from Apapa canal and conductivity of $2.13±0.15\mu S/cm$ from the same location and season explains that more ionic solutes are present in the water body. At AP.C (Wet & Dry) showed similarity in   ionic content and significant % RSD (Table 4.1c). This could be due to industrial effluents. There is a linear relationship between electrical conductivity and total dissolved solids in the environment (Todd, 2000) interact systematically to give a balanced environmental system, (Egborge, 1979).

Statistical analysis of the results obtained from sampling sites during the two seasons, showed that there is the tendency of the two variables (wet & dry) to differ from each other. All results obtained showed high covariance (Table 4.1.1a) which is an indication of independence of the two seasons and the nature of pollutant that seeps into the coastal waters. For instance, the COD result obtained during wet season (176.6783) in the water sample varied significantly with what was obtained in the dry season (500.7353). Higher covariance between the sample shows efficiency between the two variables (Dry and Wet). These observations are consistent and compare favourably with the work done by Kapadia and Andison, 2007; Pryon 2004, Oladipo 1987, Massant and Kaufura 1983.

Table 4.1.1(a): Covariance of physicochemical parameters (wet & dry)

	TDS-DRY	TDS-WET	COND.-DRY	COND.-WET	TEMP.-DRY	TEMP.-WET
TDS-DRY	64.41642					
TDS-WET	33.46063	86.31399				
COND.-DRY	0.68179	-0.70173	0.37879			
COND.-WET	1.43130	-0.41801	0.14473	0.12990		
TEMP.-DRY	-1.56704	-0.75921	0.10481	0.04100	0.12674	
TEMP.-WET	0.33086	2.90621	-0.23147	-0.10566	-0.06582	0.22718
pH-DRY	0.53271	3.08185	0.05191	0.05977	0.09525	0.07095

pH-WET	0.48162	-0.34347	0.09061	0.07764	0.05620	-0.05504
TSS-DRY	-4.47339	-8.90479	0.85965	0.35101	0.40213	-0.78565
TSS-WET	-1.69380	-5.75848	0.42664	0.20296	0.17456	-0.43464
COD-DRY	7.06041	22.41845	-8.92073	-6.34827	-5.90079	6.28493
COD-WET	47.65938	1.53017	-5.22353	-1.40796	-3.76864	3.07948

	pH-DRY	pH-WET	TSS-DRY	TSS-WET	COD-DRY	COD-WET
pH-DRY	0.26503					
pH-WET	0.06637	0.06350				
TSS-DRY	-0.03809	0.20571	3.17271			
TSS-WET	-0.08868	0.11296	1.62216	0.87328		
COD-DRY	-6.33131	-4.29293	-30.15157	-14.55644	500.73551	
COD-WET	-3.11837	-1.12380	-18.20753	-7.57260	231.00387	176.67830

Correlation coefficient, (Table 4.1.1b) shows the level of relationship between pairs of observation. Values close to 1 with $P<0.05$ shows high positive correlation and values close to 1 with $P<0.05$ are highly negatively correlated. Values close to zero with $P>0.05$ shows no correlation. In the table above, samples with -0.925 (TSS – Dry), -0.976 (TSS-Wet),and 0.975 (TSS-Wet) showed negative and positive correlation respectively.

Table 4.1.1(b): Correlations of physicochemical parameters (wet & dry)

	TDS-DRY	TDS-WET	COND-DRY	COND-WET	TEMP-DRY	TEMP-WET
TDS-WET	0.449					
	0.372					
COND-DRY	0.138	-0.123				
	0.794	0.817				

COND-WET	0.495	-0.125	0.652			
	0.318	0.814	0.160			
TEMP-DRY	-0.548	-0.230	0.478	0.320		
	0.260	0.662	0.337	0.537		
TEMP-WET	0.086	0.656	-0.789	-0.615	-0.388	
	0.871	0.157	0.062	0.194	0.447	
pH-DRY	0.129	0.644	0.164	0.322	0.520	0.289
	0.808	0.167	0.756	0.534	0.291	0.578
pH-WET	0.238	-0.147	0.584	0.855	0.626	-0.458
	0.650	0.782	0.223	0.030	0.183	0.361
TSS-DRY	-0.313	-0.538	0.784	0.547	0.634	-0.925
	0.546	0.271	0.065	0.262	0.176	0.008
TSS-WET	-0.226	-0.663	0.742	0.603	0.525	-0.976
	0.667	0.151	0.091	0.206	0.285	0.001
COD-DRY	0.039	0.108	-0.648	-0.787	-0.741	0.589
	0.941	0.839	0.164	0.063	0.092	0.218
COD-WET	0.447	0.012	-0.639	-0.294	-0.796	0.486
	0.374	0.981	0.172	0.572	0.058	0.328

	pH-DRY	pH-WET	TSS-DRY	TSS-WET	COD-DRY
pH-WET	0.512				
	0.300				
TSS-DRY	0.042	0.458			
	0.938	0.361			
TSS-WET	-0.184	0.480	0.975		
	0.727	0.336	0.001		
COD-DRY	-0.550	-0.761	-0.756	-0.696	

	0.259	0.079	0.082	0.124	
COD-WET	-0.456	-0.336	-0.769	-0.610	0.777
	0.364	0.516	0.074	0.199	0.069

**Cell Contents: Pearson correlation**

 P-Value

The descriptive statistics (table 4.1.1c) of the sample locations showed highest mean value recorded were temp (wet) and temp (Dry) with a standard error of; 0.03 and 0.08 respectively. This shows the error during the experimental and calculation is very minimal (less than 1). The standard deviation of each sample location is very minimal. This shows that the efficiency of the sample location value to each other.

Table 4.1.1(c) : Descriptive Statistics of physicochemical parameters (wet & dry)

Variable	Mean	SE Mean	StDev	CoefVar	Median
TDS-WET	9.65	3.81	9.32	96.54	6.67
CON-DRY	1.047	0.230	0.563	53.80	1.000
CON-WET	0.820	0.137	0.336	40.97	0.900
TEMP-DRY	30.033	0.0333	0.0816	0.27	30.000
TEMP-WET	30.167	0.0843	0.207	0.68	30.200
pH-DRY	7.168	0.148	0.362	5.05	7.155
pH-WET	7.340	0.141	0.347	4.72	7.350
TSS-DRY	1.983	0.737	1.806	91.07	1.252
TSS-WET	0.943	0.362	0.887	94.08	0.883

COD-DRY	68.64	9.02	22.10	32.19	73.84
COD-WET	44.50	5.76	14.11	31.72	44.67

Generally, the results obtained between the two seasons show no significant positive correlation. There was need to study how these seasons interact. Okoro 2005, Tok-hoglu and Kartal 2006; and Wenchuan et al, 2001 have used cluster analysis to study coastline pollution and seasonal interactions. This is a tool of exploratory data analysis that attempts to assess interaction among variable by organizing them into groups or cluster, such that, samples within a cluster are similar chemically to each other than are samples belonging to different groups or clusters. The results of cluster analysis can be used to classify and compress data. The results of the cluster analysis are presented in the form of a dendrogram. On dendrogram, x-axis represents the variables and y-axis the corresponding level of similarity. Figure 4.1.1 is a clustering analysis of the interaction of physicochemical parameters of the sampling points.
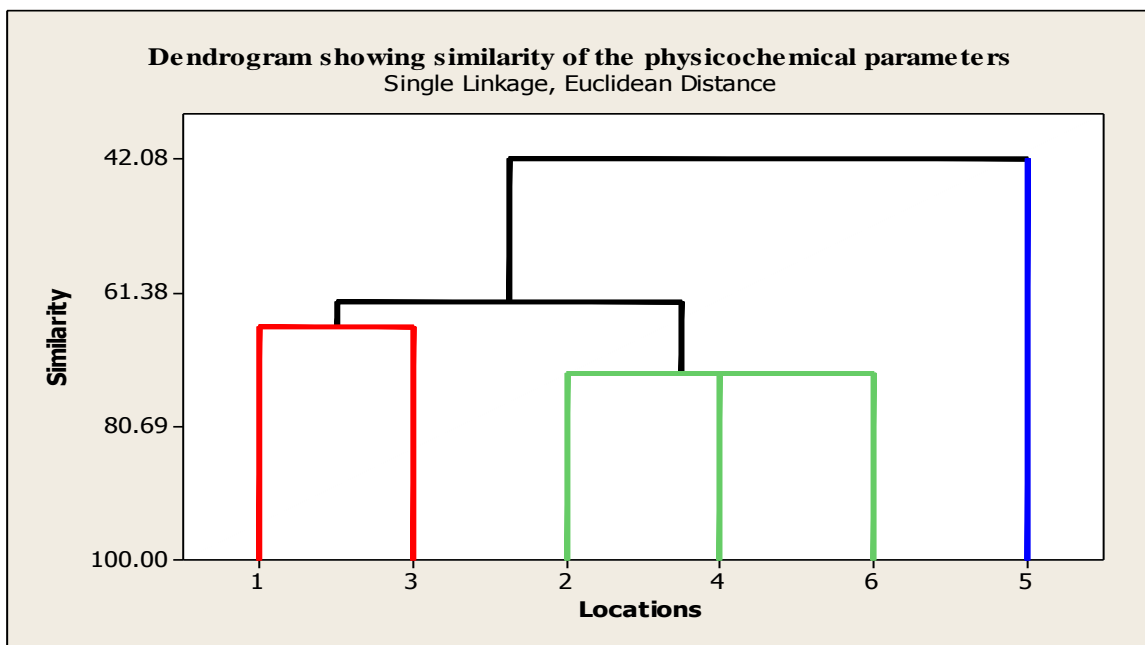
*1-AP.C; 2-LG.HB; 3-LK.B; 4-IJ.C;5-BB; 6-ML2.C

Fig. 4.1.1(a): Showing clustering of the interactions of physicochemical parameters of the sampling locations.

Two main clusters were formed. Highest similarity was observed between LG.HB, IJC and ML2. Another similarity was observed between AP.C and LK.B. But the result shows that there is closer dissimilarity between the rest of the variable and BB.

Cluster A (1 and 3) with an estimated similarity of 65.00

1. AP.C - COND, TSS, COD, pH

3. LK.B - COND, TSS, TEMP, pH

Cluster B (2,4 and 6) with estimated similarity of 70.00

2. LG.HB - COND, TSS, COD, TEMP

4. IJ.C   - TDS, COND, TSS, COD, TEMP

6. ML2.C - TDS, COND, TSS, COD, TEMP, pH

Outlier C with a similarity of 42.08 to other variables:

5. BB   – TDS, COND, TSS, COD, TEMP, pH

This grouping implies that there are similarity in properties between LG.HB, IJC and ML2 sampling sites. These is also similar properties between AP.C and LK.B no evidence of similarity between BB and the rest of the variables.

The parameters in fig 4.1.1(b) have interacted and grouped into three main clusters with an outlier. Group 1 comprises of TDS-Wet Temp-Wet are pH-dry; group 2: Con-dry, TSS-dry, TSS-wet, Con-wet and pH-wet. Group 3 is made of two parameters, COD-dry and COD-wet Temp-dry is an outlier.

Members of group one showed fairly strong similarity between70-75; group two varied from 85-90, group 3 showed similarity of about 88. Temperature of the water medium during the dry season showed dissimilarity with all other parameters. This can be seen from table 4.1.1(a)

Generally, the criteria for grouping the locations in clusters is that those with minimum variance are within the same cluster and maximum variance between clusters.
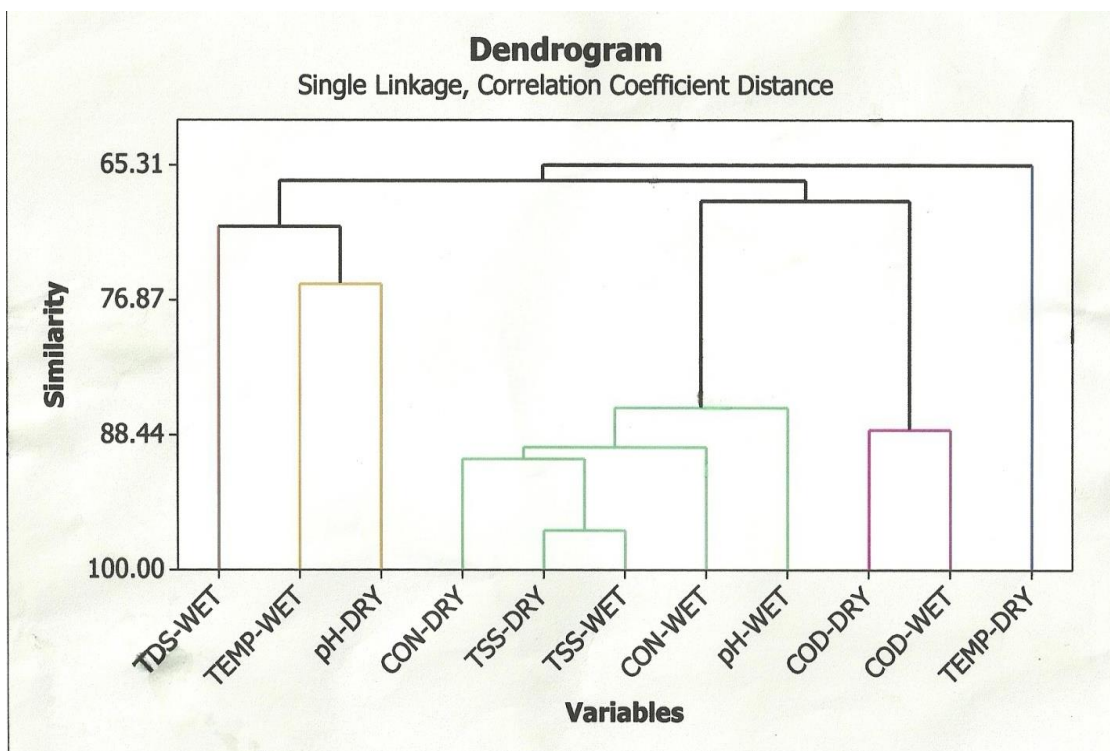
Fig. 4.1.1(b): Clusters showing interaction of physicochemical parameters of dry and wet seasons.

Table 4.1.1(d): Physicochemical parameters showing similarity and coefficient of variation for

figure 4.1.1(b)

Parameter	Season	Estimated similarity	Coeff Variation
TDS	Wet	70	96.54
Temp.	Wet	76.87	0.68
pH	Dry		5.05
Cond.	Dry	89.00	53.83
TSS	Dry	97.00	91.07
TSS	Wet		94.08
Cond.	Wet	88.00	40.97
pH	Wet		4.72
COD	Dry	88.44	32.19
COD	Wet		31.72
Temp.	Dry	65.31	0.27

CONCLUSION

Water, being the media for the interaction and biochemical reactions was investigated for its physicochemical parameters, the values obtained were within the permissible levels except the values of COD obtained are above the WHO permissible levels (10ppm). The descriptive statistics of the physicochemical parameters showed that the sampling technique was adequate. The physicochemical parameters (TDS, COND., TSS, COD, pH, Temp.) determined in both seasons were within permissible limits except for the COD (>10 mg/l) values and may have no health implication on the environment and persons living around the Coastal areas. Significant percentage relative standard deviation (% RSD) were observed for all the parameters for both seasons. The statistical study of the seasonal variables showed that there was no correlation between them. This culminated to the use of multivariate analysis. The dendrograms showed (clusters) that the seasons in the coastal areas especially Lagos has no clear cut boundaries and overlap is a common occurrence. The wave movement from the Atlantic Ocean enhances constant motion and dilution/mixing of pollutants in all directions.

ACKNOWLEDGEMENT

REFERENCES

[1] Ademoroti, C.M.A., (1996): Environmental chemistry and Toxicology, Foludex Press Ltd, 1:4-5.

[2] Beychok M.R., (1967): Aqueous wastes from petroleum and petrochemical plants (1st Ed.) John Wiley a son LCCN 67019834

[3] Boari G., Mancin, I.M and Spinosa L., (2002): Treatment of sewage sludge. Thermophillic aerobic digestion and processing requirements. UK Elsevier applied Science publishers, pp 434

[4] Carlson, R., (2003): History of the clean air act American meteorological society. http://www.ametsoc

[5] Courant R, Powell B. and Michael J. (1985): Watertype classification for Niger Delta Rivers and Creeks waters. The petroleum industry and the Nigerian Environment: Proceeding of the 1985 conference organized by the Federal Ministry of Works, and Housing and Nigeria National Petroleum Corporation, 259-319.

[6] Croft S. and I.G. Hutchinson. (1999): The measurement of U,Th,and K concentration in building materials; Applied Radiation and Isotopes. 51. 5. 483-492.

[7] Egborge,A.B.M,,(1979); Observation on the diurnal changes in some physicochemical variable of lake Asejire-Nigeria; Polskie Archiwum Hydrobiologic, 9 (3), 310-311.

[8] Franson. M.A (1995): standard method is for the examination of water and waste water, 14th Ed. 150-156,235 and 252.

[9] Goldberg, E.D (1972) In: the changing chemistry of the ocean "Willey Inter Sc. Div, New York, 1032.

[10] Greebeng E. A., (1992): Standard methods for Examination of water and waste water. American Health Association. 18th Edition 1015. 15 street NWL. Washington DC. 2005.

[11] IITA, (1990) Selected methods for soil and Plant Analysis, International Institute for Tropical Agric. 6.

[12] Kapadia, R. and Anderson, G. (2007). Statistics Explained –Basic Concepts and method. Revised Edition Horwood Ltd, Chichester 25.

[13] Lema, J.N., Mendez R. and Blazues,R. (1988). Factors determining the characteristics of urban waste waters. Water, air and solid pollution 40, (3-40), 223-250.

[14] Massart D., and Kaufman I (1983): The interpretation of analytical chemical data by use of cluster analysis, Wiley, New York, 1983

[15] Oladipo, M. O. A., (1987): Trace element analysis of Corinthian Pottery and related clays. Ph.D. Thesis, University of Manchester.

[16] Okoro D., (2005): Polynuclear aromatic hydrocarbons and heavy metals levels in surface water, sediment and fauna in creeks of the Warri River. Ph.d. Thesis, University of Benin, Benin City, Nigeria

[17] Quiniton, J.N and Rickson, R.I., (1993): The role of soil erosion in the movement of Pollutants. Solid Monitoring, 21 (5), 141-156.

[18] Tchobanoglous, G. and Shrieder, E. (1985): "water quality", Addison –Wesley, Reading, MA. 445

[19] Tokahoglu, S., and Kartal S., (2006): Evaluation of the results of metal analysis for lake sediment samples: A multivariate statistical approach. Chem. Anal. (Warsaw), 47, 627

[20] UNCHE, (1972): Declaration of UN conference on the human environment. 12

[21] Wenchaun, Q., Dickman, M., and Sumin, W. (2004): Multivariate analysis of heavy metal and nutrient concentrations in sediments of Taihu Laka, China. Hydrobiologia, 450 (1-3), 83-89

[22] WHO/WAS/71.41, (1994); WHO guidelines for waste water. Canada 5-14