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Research

THE EFFECTS OF EGBIN POWER STATION ON THE GEOCHEMISTRY OF IJEDE ECOSYSTEM (IKORODU) OF LAGOS LAGOON.

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Abstract

Geochemical survey of the coastal water bordering Ijede town of Lagos Lagoon in Ikorodu, Lagos, Nigeria was carried out to assess the effect of the cooling activities of the thermal power station on the geochemical characteristics of the ecosystem. Water and bottom sediments samples were collected from six (6) different stations, perpendicular to the shoreline for geological and chemical analyses. Granulometric analysis gave an insight to the grain size which is an indication of the overall competence of the transport dynamic system. The water-sample were analyzed for pH, conductivity , turbidity, salinity, alkalinity ,dissolved oxygen, total suspended solid, temperature and total dissolved solid. The hydrogen ion concentration (pH) range recorded in the study stations is lightly basic. The values range between 7.99 and 7.80. The highest turbidity value of 21 was recorded at station 4, while the lowest value of turbidity recorded was -3 at station 6. Dissolved Oxygen (DO) for the study stations ranged from 5.20mg/l to 8.00mg/l. The temperature of the study area (within the 3m depth) range from 33ºC to 38ºC, with the mean value of 35.42ºC. This value was consistent through out the depth of the study area, which was considered to be too high for a natural ecosystem according to WHO standard for brackish water. The reason for the high temperature recorded may be due to the cooling activity of the power station. Sediments distribution ranged from very fine to medium grained, poorly sorted coarsely skewed with a leptokurtic distribution. This is an indication of short distance of transportation or rapid sedimentation and possible weak alongshore current.

KEY WORDS: leptokurtic skewness, geochemical, thermal, temperature, conductivity

Introduction

Egbin thermal station is a steam turbine plant comprising of six 220MW independent boiler turbine units. This is located at Ikorodu suburb of Lagos, along the Lagos lagoon. The first unit of the plant was commissioned in July 1985, while the last was commissioned in September 1986 (MBendi.com 2009). The station is of reheat type with high intermediate low pressure impulse reaction turbine designed and a hydrogen cooled generator. Thermal water effluents discharge from power stations has

been a major source of pollution of some parts of the Lagos lagoon. THERMAL POLLUTION is the rise or fall in the temperature of natural body water caused by human influence. This is caused by addition of hot effluents and hot water bodies. Warm water contains less oxygen. So, there is decrease in rate of decomposition of organic matter. Green algae are replaced by less desirable blue green algae. Many aquatic animals fails to multiply, change in ecosystem composition and migration of aquatic organisms. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water is used as a coolant is returned to the natural environment at a higher temperature, the change in temperature impacts organism by (a), decrease oxygen supply and (b), affecting ecosystem composition.

It is known that temperature changes of even one to two Celsius can cause significant change in organism metabolism and other adverse cellular, biological effects. Principal adverse changes can include rendering cell wall less permeable to necessary osmosis, coagulation of cell proteins and alteration of enzymes metabolism. These cellular level effects can adversely affects mortality and reproduction. Primary producers are affected by warm water because higher temperature increase plant growth rate, resulting in shorter lifespan species overpopulation. This can cause the algae bloom which reduces the oxygen level in the water. The higher plant density leads to an increase plant respiration rate because the reduced light intensity decreases photosynthesis. This is similar to the eutrophication that occurs when watercourses are polluted with leached agricultural inorganic fertilizers. A large increase in temperature can lead to the denaturing of life supporting enzymes by breaking down hydrogen and disulphide bonds within the quaternary structure of the enzymes. Decreased enzymes activity in aquatic organism can cause problem such as the inability to break down lipids, which leads to malnutrition.

In limited cases, warm water has little deleterious effect and may even lead to improve function of the receiving aquatic ecosystem, this phenomenon is known as THEMAL ENRICHMENT.

The Lagos lagoon is the largest of the eight lagoon systems of the Gulf of Guinea (Ajao et al, 1996, Edokpayi, 2010); it stretches for about 257km from Cotonou in the Republic of Benin to the Western edge of the Niger

delta. The Lagoon borders the forest belt and receives a number of important large rivers (Yewa, Ogun, Ona and Osun). It is a shallow expanse of water with restricted circulation in a micro tidal environment. This aquatic resource of multiple usage receives inputs of domestic sewage, industrial waste water's, sawdust and particulate wood waste, petroleum hydrocarbons, cooling water from a thermal power station and emissions from automobile exhaust. Micro-pollutants examined in the water, sediment and biota includes organic wastes, trace heavy metals and chlorinated hydrocarbons. Concentrations detected have identified "hot spot" and relatively unpolluted area for the difference contaminants in the Lagoon.

Detailed Description of the Studied Area

This exercise was carried out in coastal water of Egbin. Six stations were established at different locations (06^o 33'26".7N, 03^o 36' 32.6" E, 06^o 33'33".9N, 03^o 36' 02.6" E, 06^o 33'35".3N, 03^o 35' 47.5" E, 06^o 33'38".1N, 03^o 35' 37.5" E, 06^o 33'38".0N, 03^o 35' 25.4" E, 06^o 33'41".7N, 03^o 35' 07.6" E). The distance of each location from the shoreline was calculated starting with location 1, which has a distance of 530.62metres away from the shoreline, followed by location 2 with a distance of 83.75meters from the shoreline, location 3 with a distance of 126.02meters, location 4 with a distance of 139.3meters away from the shoreline, location 5 with a distance of 1,126.81meters from the shoreline, and lastly location 6 with a distance of 174 meters from the shoreline. Station 1 is 967.20 meters away from station 2, station 2 is 463.78metres away from station 3, station 3 is 327.61 meters away from station 4, station 4 is 1,001.00 meters away from station 5 and lastly station 5 is 1,174.26meters away from station 6. Detailed survey was done in all the locations which involve some Physico-chemical parameters measured in-situ and others determined at the laboratory. Sediments were collected from all the stations for description and granulometric analysis. Collection of samples was performed once at the sites.

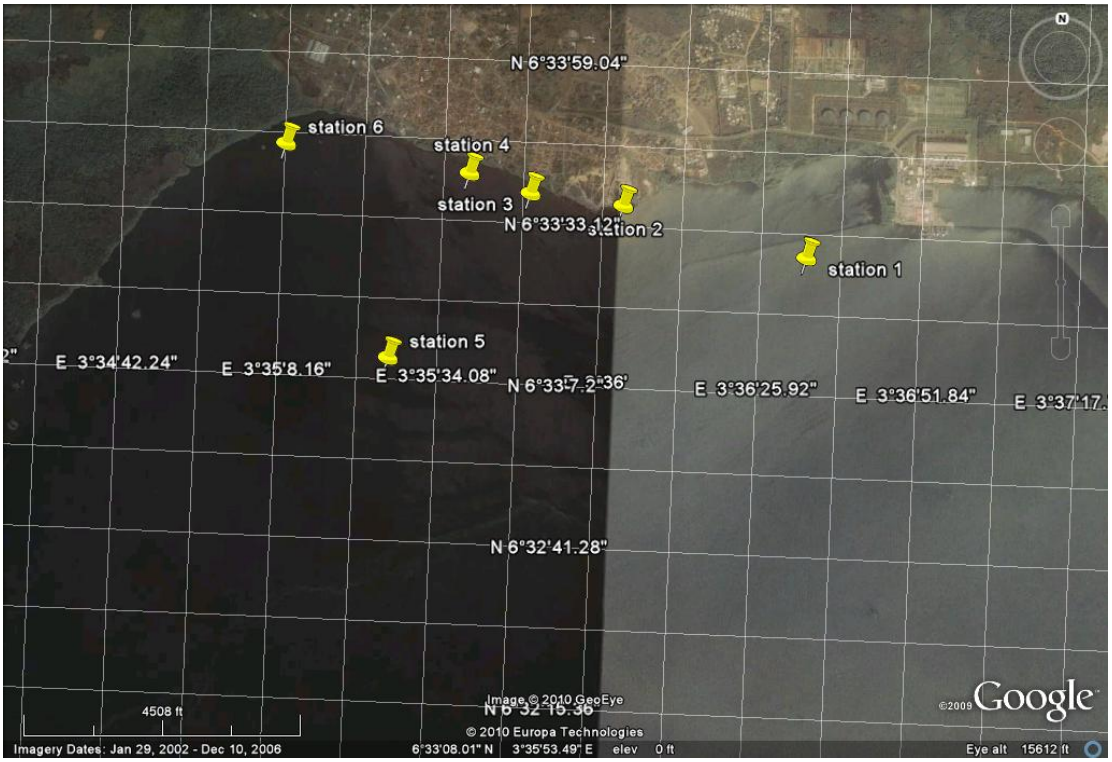


Figure1. Satellite Imagery of the stations

Materials and Methodology

Granulometric Analysis: A geological survey of the coastal water bordering Ijede town involved collection of six bottom sediment samples from different stations (Fig 1) perpendicular to the shoreline using a Van Veen grabs. At each station, the depth and co-ordinates were taken using calibrated stick because of the shallow depth of the study areas and GPS respectively. Sampling was done once but for future monitoring there can be regular sampling. The whole samples were selected for grain size analysis, mechanical sieving method was employed based on Folk (1974). 70 grams of each sample was oven dried and then subjected to standard Rotap shaker for 15 minutes. Fractions of sample retained on sieve were weighed, while weight values obtained were converted to cumulative weight percentages. The statistical parameters (Mean standard deviation, skewness, and kurtosis) were calculated from the graphic curve obtained according to Folk (1974).

The Water Physico-Chemistry: Surface water samples were collected below 0.5m using glass Winchestar bottles held in a

stainless steel frame and operated by hand line and this was done once at a site. Oxygen was fixed according to Winkler's method using Manganus sulphate and-alkaline Potassium iodide. Physico chemical parameters such as pH, temperature, conductivity, turbidity, salinity, and TDS were measured insitu using HoribaU-10. Alkalinity was determined using titrimetric method.

Results

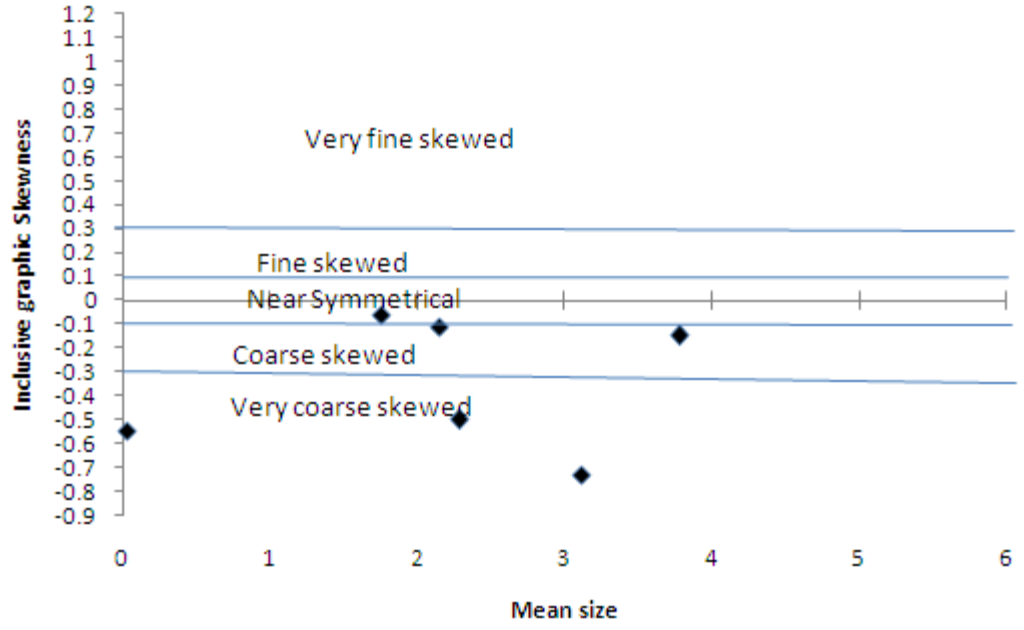
Soil Analysis: The mean grain size is an indication of the overall competence of the transport dynamic system while the standard deviation and skewness are environmentally sensitive indicators. Very positive skewed sediment with leptokurtic distribution belong to deposit with a high degree of textural maturity and reworking, negatively skewed sediment characterized inter tidal environment (foreshore). Symmetrical and poorly sorted distribution indicates fine settling pathway, where as positively skewed coarse and well-sorted sediment point to occasional extension of suspended sediment.

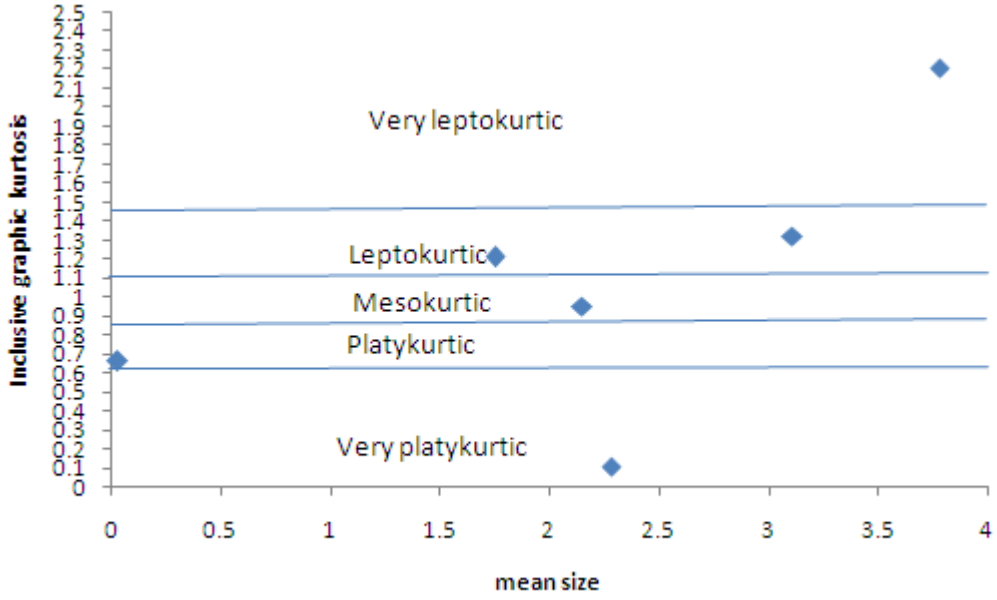
Table 2: Result of the grain size analysis

Sample stations	Visual Description	Mean	Standard Deviation	Skewness	Kurtosis	Inference from calculation
1	Brownish sand with lots of shells	2.15	1.41	-0.11	0.95	Fine sand, poorly sorted, coarse skewed, mesokurtic
2	Brownish fine-medium grained sand with traces of flora	1.75	1.19	-0.06	1.21	Medium sand, poorly sorted, near symmetrical, leptokurtic
3	Greyish muddy sand with lots of shells	2.28	0.86	-0.50	0.11	Fine sand, moderately sorted, strongly coarse skewed, very platykurtic
4	Brownish coarse grained sand with flora and shells	0.03	0.77	-0.55	0.66	Coarse sand, moderately sorted, strongly coarse skewed, very platykurtic

5	Darkish muddy sand with shells	3.11	1.20	-0.73	1.32	Very fine sand, poorly sorted, strongly coarse skewed, leptokurtic
6	Darkish muddy sand	3.78	2.29	-0.15	2.21	Very fine sand, very poorly sorted, coarse skewed, very leptokurtic

Characteristics of the sediments of Ijede, Lagos lagoon



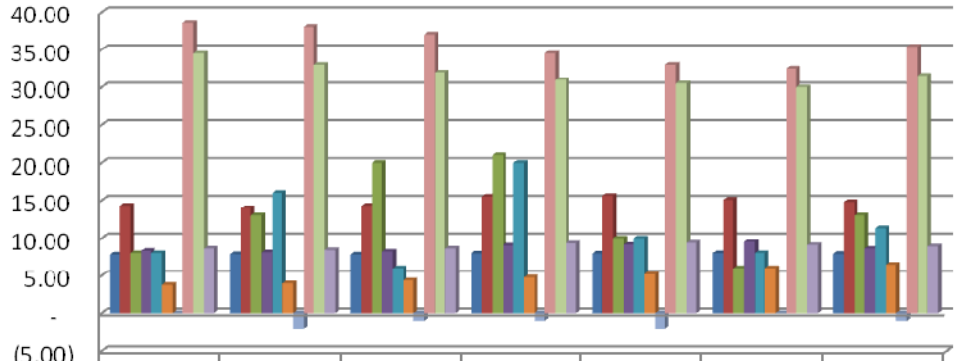


The Water Physico-Chemistry

The hydrogen ion concentration (pH) range recorded in the study stations is lightly basic. The highest value of 7.99 was recorded at station 6, while the lowest value of 7.80 was recorded at station 1. The pattern of fluctuation in electrical conductivity was not too different. The highest value of 15.60µm/sec was recorded

at station 5, while the lowest value of 14.00µm/sec was recorded at station 2.The highest turbidity of 21NTU was recorded at station 4. While the lowest value of turbidity recorded is -3NTU at station 6. Slight temporal and spatial variation existed in the total suspended solids of the sampling stations. The highest value of 0mg/L was recorded at station 6, while the lowest value of -2 mg/L was recorded at station 2 and 5. There was no significant difference in the TSS values in the sampling stations. The highest value-of-salinity (9.50 ‰) was recorded in station 6, while the lowest value 8.10 ‰ was recorded in station 2.Dissolved oxygen highest value of 6.00mg/L was recorded at station 6 while the lowest value of 3.80 mg/L was recorded at station 1.

WATER ANALYSIS OF EGBIN THERMAL STATION



	ST 1	ST 2	ST 3	ST 4	ST 5	ST 6	MEAN
pH	7.80	7.87	7.82	7.93	7.93	7.99	7.89
COND.(µm/sec)	14.30	14.00	14.30	15.50	15.60	15.10	14.80
TURB. (NTU)	8.00	13.00	20.00	21.00	10.00	6.00	13.00
SAL. (‰)	8.30	8.10	8.20	9.00	9.10	9.50	8.57
ALK. (mg/L)	8.00	16.00	6.00	20.00	10.00	8.00	11.33
DO (mg/L)	3.80	4.00	4.40	4.80	5.20	6.00	6.47
TSS	-	(2.00)	(1.00)	(1.00)	(2.00)	-	(1.00)
WATER TEMP. (ºC)	38.50	38.00	37.00	34.50	33.00	32.50	35.42
AIR TEMP. (ºC)	34.50	33.00	32.00	31.00	30.50	30.00	31.58
TDS (mg/L)	8.58	8.40	8.58	9.30	9.36	9.06	8.88

Discussion

The general interpretation from the data shows that sediments distribution ranged from very fine to medium grained, poorly sorted, coarsely skewed with a leptokurtic distribution. This is an indication of short distance of transportation or rapid sedimentation and possible weak alongshore current. Negative skewness indicates the

dominance of coarse sized fractions in the sediment sample, kurtosis ranged between 0.66 and 2.21 phi (platykurtic to leptokurtic), with most of the values within the range of the leptokurtic for the lagoon sediment. Coarse skewness and poorly sorted distribution of sediments in Lagos lagoon indicates fine settling pathway.

The mean variation in the physical and chemical characteristics of the water samples at the study stations are presented in figure1. The variations in air and water temperature are very close with similar pattern from the study stations. The highest air temperature of 34.5^0C was observed at station 2, while the lowest temperature of 30^oC was recorded at station 6. The highest water temperature of 38.5^oC was observed at station 1, while the lowest temperature value of 32.5^oC was recorded at station 6.

A careful observation reveals a striking strong positive correlation which exists between salinity and electrical conductivity. While conductivity is sensitive to variations in the dissolved solids, salinity is the total amount of dissolved solids in grams of water. An increase in one parameter therefore, leads to an increase in the other and vice-versa which agrees with the work of Onyema et al. (2009). Salinity showed no significant difference in the six sampling stations, while conductivity on the other hand was significantly different between stations 2 and 5 within the study area.

Conclusion

The relationship that exists between the dissolved oxygen (DO) and the biochemical oxygen demand of water shows either the water body is being depleted or utilized by the micro-organisms or enriched. It therefore, entails that a high value of biochemical oxygen demand will imply a low level dissolved oxygen and vice-versa. However, the dissolved oxygen within the study area ranges between 5.20 and 8.00mg/l which are within WHO standard, and quite adequate for aquatic organism.

The high turbidity recorded in station 3 and 4 are related to high anthropogenic activities at those sampling stations. Turbidity is controlled by the concentration of suspended solids and hence high total suspended solids results to high turbidity. Turbidity was significantly different at the study stations. However the Total suspended solids (TSS) showed no significant difference between the stations.

The temperature of surface waters of the tropics is usually about 25-28^{o} C but where there is large area of shallow water; the temperature is about 28 – 32^{o} C (wickstead, 1965). Water temperature affects other properties such as rate of chemical reactions, solubility of gases, buoyancy mechanism (density / viscosity) of plankton. Water bodies will naturally show changes in temperature seasonally and daily; however, man made changes to change water temperature will affect fish's ability to reproduce. Many lagoons and rivers will exhibit vertical temperature gradients as the sun will warm the upper water while deeper water will remain cooler. The water temperature of the study area range from 32.5 to 38.5ºC, with the average value of 35.42ºC. These values are consistently higher than 32 ºC indicated as the highest for shallow surface water temperature within the tropics by Wickstead, 1965. Also this is considered to be too high for a natural ecosystem. Effort was made to catch fish but it was a futile exercise. The reason for the high temperature recorded may be due to the cooling activities of the power station which has changed the physicochemical properties of the area. Little or no aquatic biota survives within the study locations. Fishing activity in this area is remote likewise recreational activities, such as swimming cannot be performed due to high water temperature.

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