Available online @ www.actasatech.com

*acta*SATECH **4**(2): 133 - 144 (2013)

Research

HYDROCHEMISTRY AND BENTHOS AROUND EGBIN POWER STATION, SOUTH WESTERN NIGERIA

Shelle R.O.D, Akinnigbagbe A.E. & Adeleye A.O.
Nigerian Institute for Oceanography and Marine Research [NIOMR]
3, Wilmot Point Road, Victoria Island,
P.M.B. 12729, Lagos,
Nigeria.
*Correspondence author <rodshele@gmail.com >

Abstract

Thermal water effluents discharge from power stations has been a major source of pollution of some parts of the Lagos lagoon. Water chemistry and benthos around Egbin Power Plant located in the North Eastern axis of Lagos lagoon, South West Nigeria was investigated for five days during the periods of the study. Water and benthic samples were collected daily between 1000 and 1200 hours during the period of study. Highest water temperature (38.83 ^{0}C) was recorded at station 2 which correspond with the lowest dissolved oxygen (5.20mg/l) while the lowest water temperature (33.23^{0}C) correspond with the highest dissolved oxygen (8.00mg/l) in station 6. Apart from turbidity, other parameters of the water shows no significant differences (P>0.05) among the sampling stations. A total of 3 phyla comprising of 4 classes, 14 genera, 15 species and 946 individuals were recorded in the period of the study for all the sampling stations. The gastropods recorded the highest number (642) constituting about 67.9% of the total individuals sampled during the period of study. The polychaetes recorded the lowest number of individual (2) constituting only 0.2% of the total number of individual sampled. Station 6 recorded the highest number of individual (261) constituting of (27.6%) of individuals sampled in all the stations. All the four classes of benthic macro-invertebrates were represented in Station 3. The thermal pollution by the power plant might be responsible for the general low biodiversity of the study area.

KEY WORDS: Water chemistry, thermal pollution, benthos, biodiversity

Introduction

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.

Benthic macro invertebrates are animals without backbone that live on or in the sediment of the water body or attached to rocks or debris at the bottom. The minimum size is 0.55mm in diameter. They include crustaceans, molluscs, aquatic worms and larval forms of aquatic insects. They are important in the aquatic ecosystem because they form part of the aquatic food chain. They are also used to assess water quality and as pollution indicators.

Description of Study Site

Egbin Power Plant (Figure 1) is located on the north eastern axis of the Lagos lagoon which is the largest of the nine lagoon systems of the Gulf of Guinea. Egbin power station is a steam turbine plant comprising of six 220 MW independent boiler turbine unit. The first unit of the plant was commissioned in the year 1985 and the last was commissioned in the year 1986. The station is reheat type with high-intermediate low pressure reaction turbine designed and a hydrogen cooled generator.

The Egbin Power Plant with an installed capacity of 1320MW is the biggest power plant in Sub-Sahara Africa and has been the main stay of power generation located in Ikorodu, suburb of Lagos, along Lagos lagoon. The sampling stations and their coordinates are shown in Table 1.

This study seeks to investigate the impact of thermal water effluents from the power plant on the water chemistry and benthic macroinvertebrates assemblage.

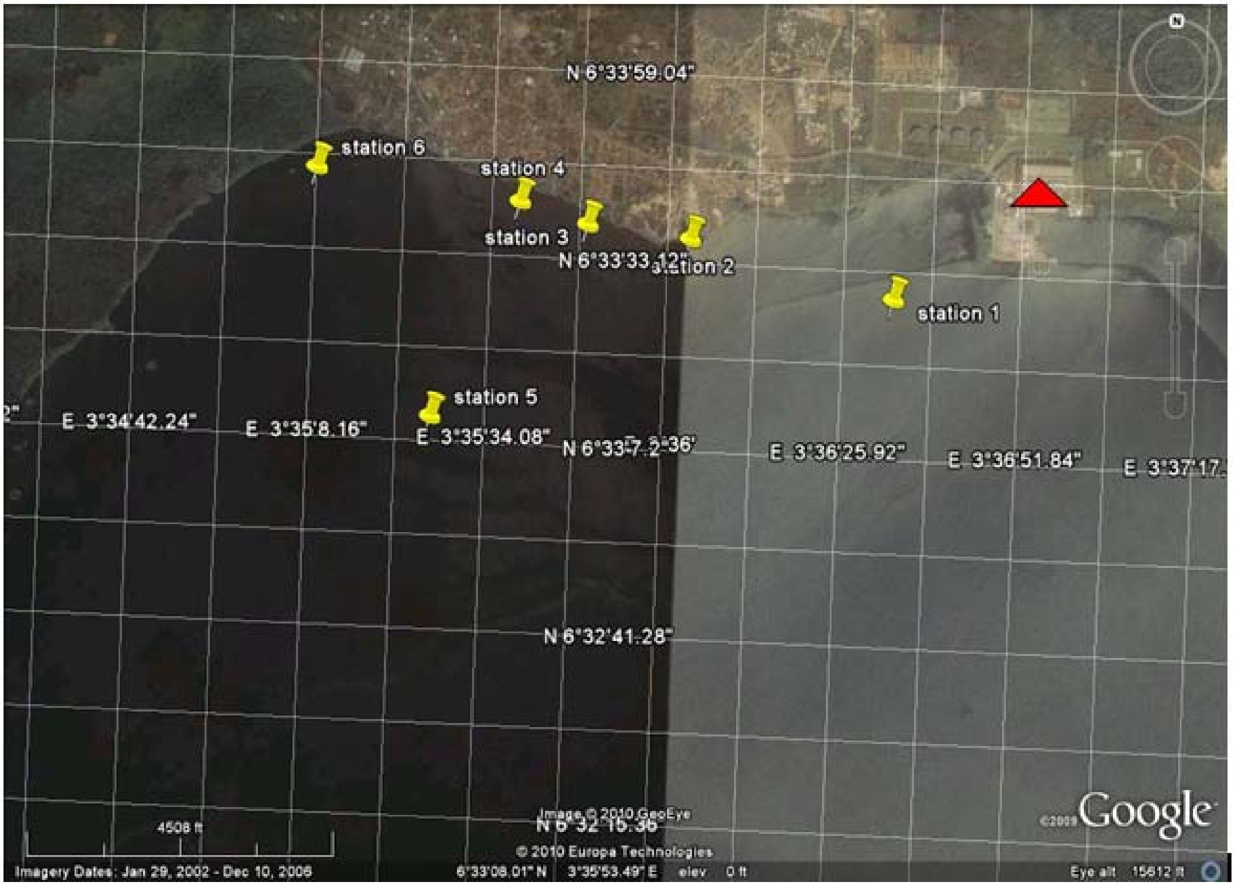

Figure1. Satellite Imagery of the stations

▲ Egbin Power Plant

Table 1: Sampling Stations and coordinates

Stations	**Time**	**Speed for towing net (m/s)**	**Depth(m)**	**Coordinates**
1	10.40am	1.26W	22.8	06^{o} 33'26".7N, 03^{o} 36' 32.6" E
2	10.59am	1.20W	7.7	06^{o} 33'33".9N, 03^{o} 36' 02.6" E
3	11.20am	1.26W	18.2	06^{o} 33'35".3N, 03^{o} 35' 47.5" E
4	11.30am	1.5W	14.4	06^{o} 33'38".1N, 03^{o} 35' 37.5" E
5	11.45am	1.5W	16.8	06^{o} 33'38".0N, 03^{o} 35' 25.4" E
6	12.05pm	1.4E	12.1	06^{o} 33'41".7N, 03^{o} 35' 07.6" E

Materials and Methodology

Collection and Analysis of Samples

Surface water samples were collected with a $1dm^3$ water sampler and stored in 1litre water bottles and analysed in the laboratory for pH, conductivity, salinity and turbidity using a multi-meter water checker (Horiba U-10). Separate water samples were collected in 250ml dissolved oxygen bottles at each station for dissolved oxygen estimation using iodometric Winkler's method. Air and surface water temperature were measured *in situ* using mercury-in-glass thermometers.

Benthic samples were collected with the use of Van-veen grab. The sediment samples collected were sieved through 0.5mm aperture size sieve. The materials retained in the 0.5mm sieve were then preserved in 5% formalin. Sorting was done to get the clean samples of the benthic organisms. The sorted macro benthic fauna were identified to species level where possible. They were counted and numbers recorded. Identification was done after Edmund (1978), Yankson and Kendall (2001), Olaniyan, (1968), and Schneider (1990).

Results

Water chemistry

The analysis of the water chemistry of the sampling area is recorded in Table 2. The highest water temperature (38.83^0C) was recorded in Station 2 and it corresponds with the lowest dissolved oxygen level (5.20g/ml). The lowest water temperature (33.23^0C) was located in Station 6 and corresponded with the highest dissolved oxygen (8.00 g/ml).

Table 2: Result of water chemistry of the study area

PARAMETERS	1	2	3	4	5	6	MEAN
pH	7.80	7.87	7.82	7.93	7.93	7.99	7.89
CONDUCTIVITY (μScm^2)	14.30	14.00	14.30	15.50	15.60	15.10	14.80
TURBIDITY (NTU)	8.00	5.00	203	213	6.0	3.0	68.3
SALINITY ($^0/_{00}$)	8.30	8.10	8.20	9.00	9.10	8.70	8.57
ALKALINITY	8.00	16.00	6.00	20.00	10.00	8.00	11.33
DISSOLVE OXYGEN (g/ml)	6.40	5.20	6.40	6.80	6.00	8.00	6.47
WATER TEMP. (ºC)	37.20	38.83	37.58	34.50	34.34	33.23	35.41
AIR TEMP. (ºC)	31.03	35.12	32.32	31.12	30.51	30.31	31.61
DEPTH (M)	2.28	0.72	1.82	1.44	1.68	1.21	1.52

Benthic Macroinvertebrates

A total of 946 individuals comprising of 3 phyla, 4 classes, 14 genera and 15 species were sampled during the period of study. The class gastropoda recorded the highest number of individuals sampled (642) constituting about 68.2% of the total number of individuals sampled for the period of study while the polychaetes was the least sampled (2) constituting only about 0.2% of individuals sampled. The genus *Protomella* was sampled in all the stations except Station 5. Station 3 had the highest biodiversity with 8 species constituting about 53.3% of the total number of species sampled during the period of study. The names of the species sampled in each of the sampling station, the classes they belong and the numbers are shown in Table 3. Table 4 shows the summary of community structure of benthic macroinvertebrates at the study stations.

Table 3: Benthic organisms sampled, classes and numbers

LABEL	SPECIES	CLASS	NUMBER
STATION 1	*Terebralia palustris*	Gastropoda	19
	Protomella capensis	Gastropoda	3
	Mractra glabrata	Bivalve mollusc	15
	Arcuatula capensis	Bivalve mollusc	5
	Censisrithidae decollate	Gastropoda	16
STATION 2	*Serpulorbis natalensis*	Gastropoda	27
	Protomella capensis	Gastropoda	40
	Turritella sanguine	Gastropoda	112
	Cerithidae decollate	Gastropoda	23
STATION 3	*Pseudoneresis variegate*	Polychaete	1
	Protomella capensis	Gastropoda	7
	Cerithidae decollate	Gastropoda	20
	Mactra glabrata	Bivalve mollusc	82
	Arcuatula capensis	Bivalve mollusc	2
	Terebralia palustris	Bivalve mollusc	7
	Nephty spp (Bristle worm)	Polychaeta	1
	Helmith crab		3
STATION 4	*Mactra glabrata*	Bivalve mollusc	77
	Arcuatula capensis	Bivalve mollusc	9
	Tricolla neritina	Gastropoda	23
	Protomella capensis	Gastropoda	6
	Planaxis sulcatus	Gastropoda	29
STATION 5	*Turritella carinifera*	Gastropoda	13
	Rhinoclavis sinensis	Gastropoda	57
	Cerithidae decollate	Gastropoda	32
	Arcuatula capensis	Bivalve mollusc	4
	Mactra glabrata	Bivalve mollusc	54
	Clionella sinuate	Bivalve mollusc	12

STATION 6	*Rhinoclavis sinensis*	Gastropoda	125
	Protomella capensis	Gastropoda	23
	Mactra glabrata	Gastropoda	34
	Arcuatula capensis	Bivalve mollusc	3
	Cerithidae decollata	Gastropoda	76

Table 4: Summary of the community structure of benthic organisms at the study stations

Phyla	Class	Genera	Species	Individuals
Mollusca	Gastropoda	8	9	642
Mollusca	Bivalvia	3	3	299
Annelida	Polychaeta	2	2	2
Arthropoda	Crustacea	1	1	3
Total	4	4	15	946

Discussions

The main objective was to identify the impacts of the thermal water power plant on the physic-chemistry of the water as well as the benthic assemblages. Station 2 is the outlet of the effluents from the thermal power station with the highest temperature. The high temperature corresponded with low dissolved oxygen. This agrees with Nkwoji *et al*, 2010 on the relationship between water temperature and dissolved oxygen of the water. Conversely, Station 6 which recorded the lowest water temperature had the highest dissolved oxygen level. The pH of the water was slightly alkaline for all the sampling stations and throughout the period of study. This finding was in consonance with Edokpayi and Nkwoji, 2007 which recorded slightly alkaline water for most part of the Lagos lagoon.

Conductivity and salinity have been previously reported as associated factors (Onyema and Nwankwo 2009, Onyema 2009b). These two parameters showed a similar relationship for this study (Table 2). The highest salinity (9.10 $^{0}/_{00}$) recorded in Station 5 corresponded with the Highest conductivity (15.60 µScm^2) in the same station during the period of study. Nwankwo (1996) is of the view that the dynamic interplay between freshwater inflow and tidal seawater incursion determines the Lagos lagoon environment. Salinity over the years has been singled out as a key factor in coastal waters of Nigeria in determining the absence / presence or density of endemic species (Sandison and Hill 1966, Oyenekan 1988, Brown and Oyenekan, 1998; Nwankwo 2009b, Onyema 2008).

Bivalve mollusc; ***Mactra glabata*** is the most abundant, ranking first in total number 262. Individuals were encountered in almost all samples (stations). Followed by the Gastropod; ***Rhinoclavis sinensis*** with 182 individuals in only 2 stations and 167 ***Cerithidae decollate*** (gastropods) widely distributed in all the stations. Only 2 polychaete worm were encountered. This may be attributed to the sandy nature of the sampled stations

Conclusion

The elevated temperature typically decreases the level of dissolved oxygen (DO) in water. The decrease in level of DO can harm aquatic organisms. The thermal pollution may also increase the metabolic rate of the aquatic organism as enzymes activity, resulting in these organisms consuming more food in a shorter time than usual. An increase in metabolic rate may result in food shortage, causing a sharp decrease in population. Change in the environment may also result in a migration of organisms to a more suitable environment.

With the high temperature, the dissolved oxygen values recorded from the studied stations are still within the permissible level for aquatic organism to dwell favorably. However, the thermal pollution by the power plant might be responsible for the general low biodiversity of living organisms in the study area. The scanty population recorded for some macro invertebrate species could be attributed to the effluent from the Egbin thermal power station that has a severe effect on fish (particularly eggs and larvae), macro invertebrate and river productivity. Also, possible migration of some of these organisms, as some fishes, macro invertebrate and other organisms migrates to a more suitable environment. While only those that are tolerant of warmer environment remains.

This actually explain the reason why most of the inhabitants of Egbin community have abandoned fishing which historically was their means of livelihood for an alternative job – sand mining- (dredging).

References

Adjeroud, M. (1997). Long-term changes of epibenthic macrofauna communities in a closed lagoon (Tairo Atoll, French Polymesia): 1972 – 1994. *Hydrobiologia*. **356**: 11 – 19.

Akinsoji, A., Adedoyin, J. and Adekanye, M. (2002). Aquatic macrophytes of three selected

Akpata, T.V.I.; Oyenekan, J.A. and Nwankwo, D.I. (1993). Impact of organic pollution on the Bacterial, Plankton and Benthic Population of Lagos Lagoon, Nigeria. *International Journal of Ecology and Environmental Science.* **19**: 73-82.

Benthic invertebrate characteristics of the Lagos lagoon sewage dump site at Iddo, Southern Nigeria. Ecology, Environment and Conservation. 13(1): 13 – 18.

Biodiversity sustainability. University of Lagos Press. Inaugural lecture seris. 44pp.

Brown, C.A. and Oyenekan, J.A. (1998). Temporal variability in the structure of benthic macrofauna communities of the Lagos lagoon and harbour, Nigeria. Pol. Arch. Hydrobiol. 45(1): 45 – 54

.

Chukwu, L. O. and Nwankwo, D. I. (2004). The impact of land based pollution on the hydro-chemistry and macrobenthic community of a tropical West African Creek. *The Ekologia*. **2** (1-2): 1 – 9.

Chukwu, L.O. (2002). Ecological effects of human induced stressors on coastal ecosystems in southwestern Nigeria. PIM 2002 Conference: The ocean in the New economy. Held in Cape Town, South Africa between 8 – 14, December, 2002. 61 – 70.

Dublin-Green, C.O. and Tobor, J.G. (1992). Marine Resources and activities in Nigeria. NIOMR Tech Paper No. 84. 25pp.

Edokayi, C.A., Lawal, M.O., Okwok, N.A. and Ogunwemo, C.A. (2004). Physico-chemical and macrobenthic faunal characteristics of the Kuramo water, Lagos, southern Nigeria. *African Journal of Aquatic Sciences*. **29** (2). 235-241.

Edokpayi, C.A. and Nkwoji, J.A. (2007). Annual changes in the physico-chemistry and macro-

F.A.O. (1969). Fisheries Survey in the Western and Mid-Western Regions of Nigeria. FAO/Sf: 74/NIR 6. 142pp.

Hill, M.B. and Webb, J.E. (1958). The ecology of Lagos lagoon II. The topography and physical features of the Lagos harbour and Lagos lagoon. *Philosophical Transaction of Royal Society, London.* **241**: 307-417.

Hynes, H.B.N. (1960). *The biology of polluted waters*. Liverpool University Press, Liverpool.202pp.

Ibe, A. C. (1988). *Coastline erosion in Nigeria*. University Press, Ibadan. 217pp.
Journal of Sciences. 21: 45-51.

Kirk, R.M. and Lauder, G.A. (2000). Significant coastal lagoon systems in the South Island, New Zealand. Coastal processes and lagoon mouth closure. *Science for conservation*.**146:** 47 p. Kjerfve, B. (Ed.) 1994: *Coastal lagoon processes*. Elsevier Oceanography Series 60. Elsevier, Amsterdam. 577pp.

Kjerfve, B. (Ed.) 1994: *Coastal lagoon processes*. Elsevier Oceanography Series 60. Elsevier, Amsterdam. 577pp.

Kusemiju, K. (1988). Strategies for effective management of water hyacinth in the creeks and lagoons of south-westrn Nigeria. Proceedings of the international on water Hyayacinth, Lagos 7 – 12 August, 1988. 39 – 45.

Nkwoji, J.A., A.Yakub, G.E. Ajani, K.J. Balogun, J.K Igbo, K. O. Renner , A. A. Ariyo, and B. O. Bello (2010). Seasonal variations in the water chemistry and benthic macroinvertebrates of a South Western Lagoon, Lagos, Nigeria. *J. Am. Sci*., 6: 85-92.

Nwankwo, D.I. (1990). Distribution and seasonal variation of dinoflagellates in Lagos lagoon, Nigeria. *Nigerian Journal of Botany*. **3**: 197-207.

Nwankwo, D.I. (2004). The Microalgae: Our indispensable allies in aquatic monitoring and

Nwankwo, D.I. and Akinsoji, A. (1989). The Benthic Algal Community of a Sawdust Deposition Site in Lagos Lagoon. Marsland

Press Journal of American Science 2009;5(4):151-156

Onyema, I.C. (2008). A checklist of phytoplankton species of the Iyagbe lagoon, Lagos. Journal of Fisheries and Aquatic Sciences. 3(3): 167 – 175.

Oyenekan, J.A. (1988). Benthic macrofaunal communities of Lagos Lagoon, Nigeria. Nigerian sites in Lagos, Southwest Nigeria. *Journal of Science*, *Technology & Environment*. **2**(1): 9 – 15.