Caspian J. Env. Sci. 2005, Vol. 3 No.1 pp. 49~54

CJES
Caspian Journal of Environmental Sciences

[Research]

Pollution Studies of Some Water Bodies in Lagos, Nigeria

V.O. Ajibola[1]*, I.I. Funtua[2] and A.E. Unuaworho[1]
*[1]Department of Chemistry, Ahmadu Bello University, Zaria 810005, Nigeria; [2]Centre for Energy Research and Training, Ahmadu Bello University, Zaria 810005, Nigeria *Corresponding Author's E-mail: tunjiajibola2003@yahoo.com*

ABSTRACT

Over the years, there has been an obvious pollution problem in Lagos area, Nigeria with high population of over eleven million and the near absence of waste management infrastructures. Concentrations of some pollution parameters and trace elements (temperature, pH, salinity, SO_4^{2-}, NO_3^-, PO_4^{3-}, F^-, DO, BOD, COD and coliform, Cr, Co, Ni, Ag, Cd and Pb) were determined from water bodies of Isolo Canal, Lagos lagoon and the Seaport in Lagos area, during the rainy season (July, August, September and October) of 2002. Temperature was fairly constant with a range of 26 – 31^{o}C while salinity, SO_4^{2-}, NO_3^-, BOD, COD decreased in the three water bodies as the rains increased. DO and coliform counts increased, while F^- was almost constant during the same period. Phosphate was below detection limit in all the water bodies. The concentrations of dissolved metals varied between the water bodies. The concentration of Pb was found to be highest in the Sea and Cd was not detected in all the water bodies. The concentrations of the Cr, Co, Ni and Ag varied differently with salinity in all the water bodies. Pb concentrations did not show any significant variation with salinity in all the water bodies.

Keywords: pollution, water bodies, Lagos, Nigeria

Introduction

Pollution has negative effects on the planet's ecosystem including the oceans. In many countries, the ocean is considered a dump, that is a place that makes waste disposal easy. Largely, this mentality is due to the incomprehensible vastness of the world's ocean. The waste materials when disposed into seas diffuse through a large volume of water, which makes them less concentrated and more dispersed. However, marine animals concentrate toxins in their tissues and over time the toxins can accumulate and eventually kill the animals (Bhattacharya, 1994). Metal concentrations in the coastal waters are controlled by physical, chemical and biological processes (Kraepiel *et al*., 1997).

Marine pollution takes a variety of forms, from raw sewage, oil spills, garbage dump to industrial effluents. Storm water is one of the major ways of transporting wastes into lagoons, canals and rivers and this eventually causes significant environmental damage to the ecology of the water bodies. The change in salinity, temperature, oxygen level, siltation and nutrient enrichment of lagoon water can particularly affect coral communities (Lee and Lee, 1983). Sewage adds to the amount of small particles suspended in the water column and contributes large amount of nutrients. Sewage generally contains large amounts of nitrates and phosphates, which can lead to phytoplankton blooms. As the plankton dies and decays, oxygen is taken up from the water. The loss of oxygen as a result of increased nutrient leads to eutrophication. Once the nutrient levels are high, the result is massive algae blooms and infestation of aquatic plants on the surface of the water body (Davis, 1983).

The determination of metal concentration in water is important in understanding their role in biogeochemical processes occurring in the coastal environment (Morris, 1990; Boughriet *et al*., 1992). In recent times, the pollution hazards of coastal waters have increased due to indiscriminate use of petroleum products, detergents and heavy metals. Generally, these pollutants get mixed together in the receiving waters and produce unpredictable hazards (Konar and Mullick, 1993).

One of the prime reasons for analysis of samples and collecting data on pollutant level is to assess what effect certain activities are likely to have upon the waters that receive the pollutants and its environmental impact (Goulden, 1978). Physical, chemical and biological parameters are examined to assess the status of these receiving water bodies with respect to pollution. These parameters are affected by temperature, which in turn is influenced by latitude, altitude, season, time of the day, air circulation, cloud cover, flow and depth of the water body (Chapman, 1992).

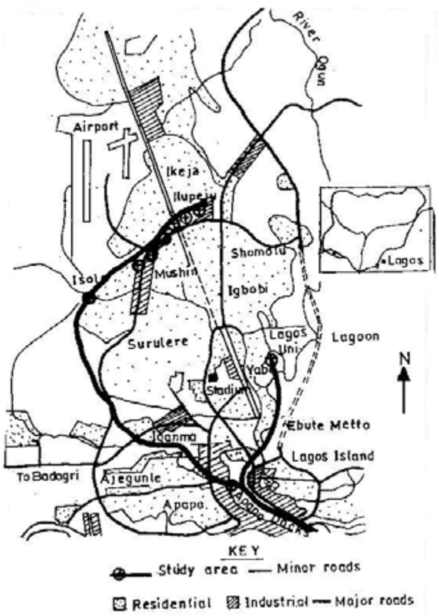

Fig 1. Map of Lagos, Nigeria showing study areas

In this study three water bodies in the Lagos area, Isolo canal, Lagos lagoon and Apapa seaport were sampled and analyzed in order to determine the pollution levels.

MATERIALS AND METHODS

Sample Collection

Water samples were collected from Isolo Canal, the lagoon and the Atlantic Ocean in Lagos, Nigeria (Fig. 1). Isolo Canal is slow flowing, largely populated by algae and water hyacinth thus imparting a green color on the water. The canal is seldom used as a means of transportation but subsistence fishing takes place at some locations by local fishermen. The canal is about 20 km long and it empties into the lagoon. The lagoon is used as a route to transport goods and people around some parts of the city. The water is colored and has a low population of water hyacinth and opens into the Atlantic Ocean. The water in the Ocean is light brown in color with very few water hyacinths at some locations.

Composite samples were collected monthly from ten different locations along the canal, lagoon and the sea from July to October 2000 (representing the second peak of the rainy season). Samples were collected from the surface and stored in sterile screw-capped plastic containers and stored in a refrigerator at 4^{o}C ±1^{o}C. Temperature and pH of the samples were measured *in situ*. The time lapse between sample collection, preparation and analysis was about a week for each set of samples. The samples were preserved as recommended in APHA (1992) for the different parameters measured.

Chemical Analysis

The parameters measured include, pH, temperature, nitrates, sulphates, phosphates, fluorides, salinity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), bacteria colony count (i.e. coliform count) and some heavy metals (Cr, Co, Ni, Ag, Cd and Pb). All reagents used for the analyses were of analytical grade and double distilled water was used in the preparation of all the solutions.

Standard methods recommended by the American Public Health Association for the examination and analysis of water and wastewater were used in this study (APHA, 1992).

Results and Discussion

The values of the physical and chemical parameters measured in the Isolo Canal, Lagoon and the ocean during the period July to October are presented in Table 1. The variations in some of these parameters in the three water bodies are compared in Fig. 1. Temperature ranged between 28 and 29 ^{o}C and was fairly constant throughout the period. At this temperature physical, chemical and biological processes in the waters are usually affected. The pH of the three water bodies ranged between 6.01 to 6.80 during the study period. These pH values are lower than values reported by Vanzquez *et al.*, (1998) for typical marine environments. The salinity of samples from the ocean was found to be highest each month followed by the lagoon and the least been the canal. Salinity decreased steadily in the water bodies as rainfall increased (Fig. 2A). The sulphate concentration was found to fluctuate throughout the period, showing an

Table1.The Result of chemical analysis of different water samples in studies area

Parameter	Isolo canal water samples			Lagoon water samples			Sea water samples		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Temperature (^oC)	28 – 29	28.50	0.01	27 – 29	28	0.01	26 – 28	27	0.01
PH	6.18 – 6.80	6.48	0.00	6.01 – 6.71	6.47	0.00	2.31 – 6.67	4.55	0.02
Salinity (mg/dm^3)	27.3 – 63.8	47.9	15.6	45.7 – 54.8	48.6	4.3	54.8 – 76.8	67.2	9.8
Sulphates (mg/dm^3)	230 – 490	307.50	1.23	160 – 430	260.30	1.26	250 – 472	388	0.98
Nitrates (mg/dm^3)	40 – 70	51	0.14	60 – 68	63.25	0.04	45 – 62	53.75	0.08
Phosphates (mg/dm^3)	-	-	-	-	-	-	-	-	-
Fluoride (mg/dm^3)	1.00 – 2.00	1.25	0.01	1.00	1.00	0.00	1.00 – 3.00	2.00	0.01
DO (mg/dm^3)	2.10 – 4.00	3.40	0.01	2.90 – 4.40	3.55	0.01	5.20 – 6.00	5.62	0.00
BOD (mg/dm^3)	20 – 200	110	0.88	120 – 300	195	0.86	20 – 60	40	0.16
COD (mg/dm^3)	140 – 420	315	1.24	100 – 610	362.50	2.08	120 – 320	190	0.89
HPC 10^{-2} (cfu/cm^3)	120 – 325	238.80	0.98	98 – 327	235.30	1.09	192 – 328	257.80	0.71
Pb (mg/dm^3)	1.08 – 9.45	4.70	0.03	0.36 – 4.79	1.97	0.02	2.02 – 5.87	4.24	0.02
Cd (mg/dm^3)	-	-	-	-	-	-	-	-	-
Ni (mg/dm^3)	0.00 – 0.09	0.04	0.00	0.00 – 0.17	0.05	0.00	0.00 – 0.19	0.08	0.00
Co (mg/dm^3)	0.09 – 0.67	0.33	0.00	0.00 – 0.65	0.21	0.00	0.00 – 0.61	0.24	0.00
Cr (mg/dm^3)	0.30 – 0.60	0.47	0.00	0.12 – 0.88	0.42	0.00	0.25 – 0.81	0.48	0.00
Ag (mg/dm^3)	0.05 – 0.08	0.07	0.00	0.05 – 0.67	0.16	0.00	0.01 – 0.09	0.05	0.00

(-) = Below detection level

initial increase in the month of August and then a drop in the month of October as the rains increased (Fig. 2B). The lowest values of sulphate were recorded in the lagoon in September and October (Table 1).

Nitrate can be of natural origin and the levels in water can give a general indication of nutrient status and level of organic pollution. The high nitrate concentrations in the three water bodies are a major factor supporting the growth of phytoplanktons. This together with the favorable temperature explains why the water bodies especially the canal and the lagoon have high population of water hyacinth and algae thus resulting in the relatively low DO recorded. The concentration of nitrates decreased as the rainfall increased (Fig. 2C). Phosphates are generally the limiting nutrient for plant growth, and excesses can lead to eutrophication. Phosphate was not detected in all the water bodies, probably because phosphates are usually insoluble at the pH recorded for the water. The concentration of fluoride was found to be low and almost constant throughout the period of study. The highest concentrations were obtained in the sea samples.

Oxygen is essential to all forms of aquatic life, including those organisms responsible for the self-purification process in natural waters. The oxygen content of natural waters varies with temperature, salinity, turbulence, and photosynthetic activity of algae, plants and atmospheric pressure. The solubility of oxygen decreases as temperature and salinity increases (Chapman, 1992). In this study DO was found to increase as salinity decreased (Fig. 2D). The sea samples contained the highest concentration of dissolved oxygen (DO) and the canal contained the least. The sea and the lagoon samples contained higher DO than the canal samples and this increased steadily as rainfall increased. The trend observed for the canal was probably as a result of constant reception of trade effluents, which contain oxygen-demanding sub-stances. Biochemical Oxygen Demand (BOD) decreased in all the water bodies as the rains progressed. The lagoon showed the highest BOD and COD values (Fig 2E & F). These high values may be attributed to wastewater from the canal, runoffs and domestic sewage from various parts of the city. The increase in the BOD and COD in the month of August may be as a result of the short break in the rains during this month. During this period also the values of DO decreased slightly.

The coliform bacteria increased as the rains increased in all the water bodies and this correlated with the DO of the water bodies. The favourable temperature and water conditions may be responsible for this increase (Fig. 2G).

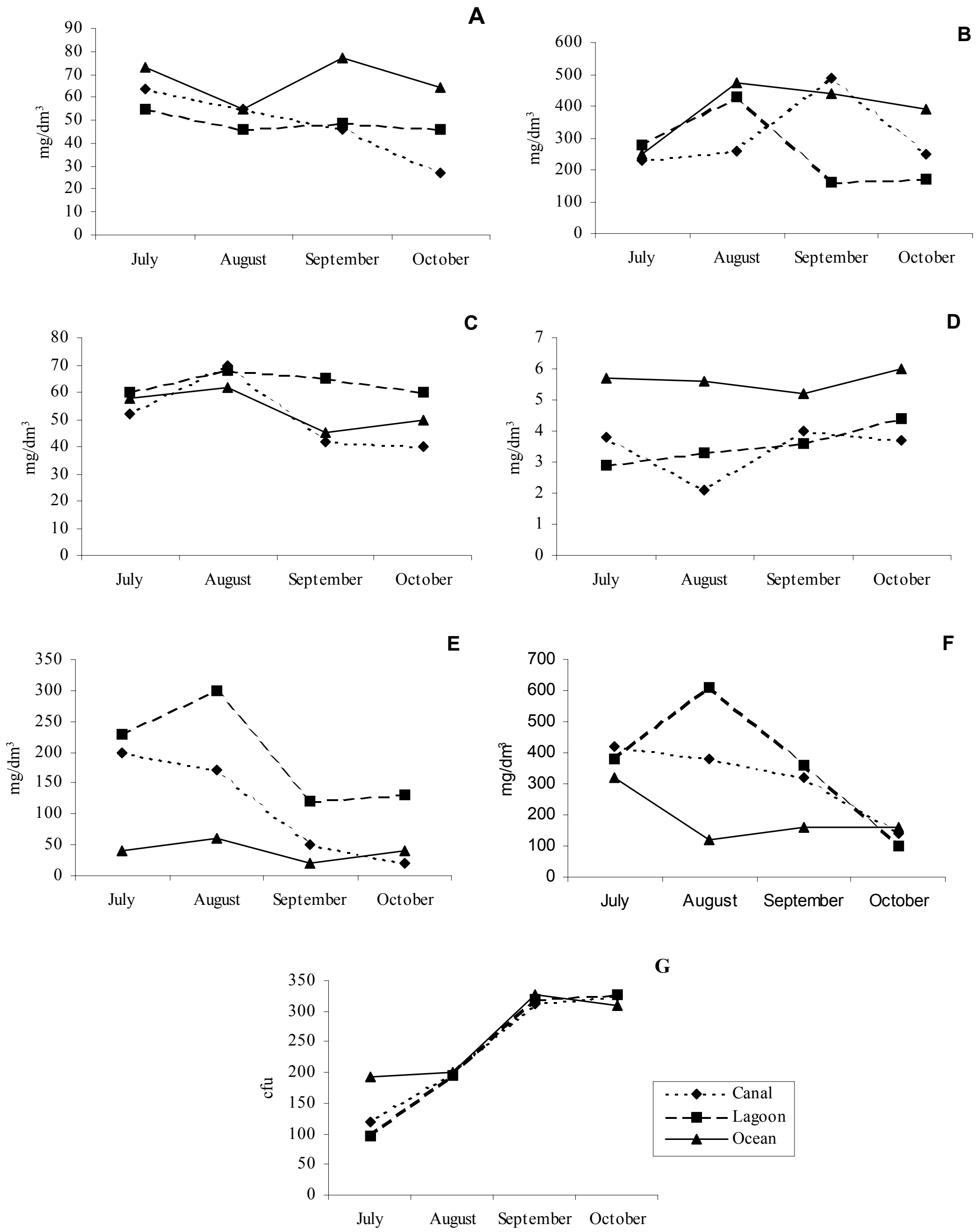

Fig 2. Variation of salinity (A), sulphate (B), nitrate (C), dissolved oxygen (D), biochemical oxygen demand (E), chemical oxygen demand (F) and coliform count (G) with increasing rainfall.

Metal levels can be high and can be varied in concentration ranges depending on the type of waste discharged into such water bodies. In general, results showed that the distributions of dissolved metals are different in the three water bodies. The total mean concentrations of trace metals were found to be in the magnitude of Pb > Co > Cr > Ag > Ni in the Isolo Canal samples, Pb > Cr > Co > Ag > Ni in the lagoon samples and Pb > Cr > Ag > Co > Ni in the sea samples. As expected the level of dissolved Pb is high in all the water bodies, since inorganics and formation of strong chloro-complexes control the speciation of Pb. This result in more dissolved Pb in a solution phase at high salinity (Kraepiel, *et al.*, 1997).

Analysis revealed little variation in the concentrations of Cr, Co, Ni and Ag in the water bodies. A fluctuating mean con-

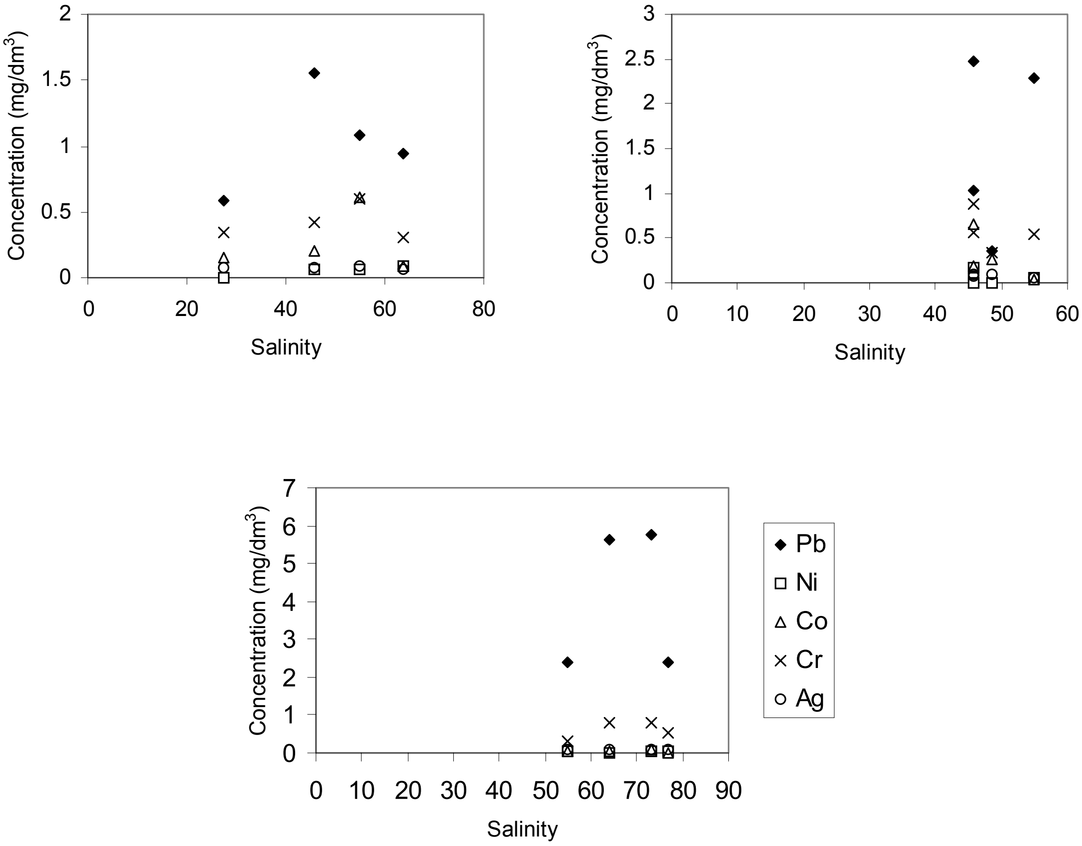

Fig 3. Correlation of dissolved metals with salinity in Isolo Canal (A), Lagoon (B) and the Sea (C)

centration of Pb was observed in the three water bodies, which could be attributed to different anthropogenic inputs such as industrial and sewage effluents. Further, the data were subjected to simple regression analysis (Fig. 3) to determine the probable correlation between the metals and salinity. Results revealed that Pb did not show significant correlation with salinity in all the water bodies. Cr, Co, Ni and Ag showed significant correlation only in the Isolo Canal samples (i.e. 0.90, 0.83, 0.89 and 0.76 respectively). These metals did not show any significant correlation in the lagoon and sea samples.

Conclusion

Pollution in the water bodies of the Lagos area is highly varied. The canal appears to be the most polluted of the water bodies considering the values recorded for the pollution indicators. Reduction in some of these parameters could be attributed to increased dilution during the rainy season. The concentration of Cr, Co, Ni and Ag did not show significant correlation with salinity except in canal samples, while the concentration of dissolved Pb did not correlate with salinity in all the water bodies.

References

APHA (1992) Standard Methods for the Examination of Water and Wastewater (18th ed.). Published jointly by American Public Health Association, American Water Works Association and, Water Pollution Control and Environment Federation, U. S. A.

Bhattacharya, B., Sarkar, S. K. and Maji, P. K (1994) Bioaccumulation of heavy metals in flora and fauna of Hooglily Estuary, East Coast of India. *Toxicol. Environ. Chem.*, **42,** 123-130.

Boughriet, A., Ouddane, B., Fischer, J. C., Wastel, M. and Leman, G. (1992) Variability of dissolved Mn and Zn in the Seine Estuary and chemical speciation of these metals in suspended matter. *Water Res.*, **26,** 1359-1378.

Chapman, D. (1992) Water quality assessment. A guide to the use of biota, sediments and water in environmental monitoring. Published on behalf of UNESCO, WHO and UNEP. Chapman Hall, London.

Davis, A. G. (1983) The effects of heavy metals upon natural marine phyto-plankton population. Prog. Phycol. *Res.,* **2,**113-145.

Goulden, P. D. (1978) Environmental pollution analysis. Heyden and Sons Ltd. Norfolk.

Konar, S.K. and Mullick, S. (1993) Pollutional hazards of coastal waters by petrol, detergents and heavy metals. *Environ. Ecol.* **11,** 688-690.

Kraepiel, A. M. L., Chiffoleau, J.F., Martin, J.M., Morel, F.M.M. (1997) Geochemistry of trace metals in the Gironde Estuary. Geochim. *Cosmochin Acta.*, **61,** 1421-1436.

Lee, S.H. and Lee, K.W. (1983) Heavy metals in sediments from Juhae Bay, Korea. *Haeyang Haklwechi*, **18,** 49-54.

Morris, A.W. (1990). Kinetic and equilibrium approaches to estuarine chemistry. *Sci. Tot. Environ*, **97,** 253-266.

Vanzquez, G. F., Diaz, R. A., Salvador, L. G. and Virender, K.S. (1998) Dissolve metals in Alvarado Lagoon, Mexico. *Environ. Inter.* **24,** 721-727.

(Received: May 6, Accepted June 7, 2005)