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Heavy Metal Analysis of Industrial Discharges in Lagos, Nigeria

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ABSTRACT

An atomic absorption spectrometric analysis of the heavy metal components of waste water samples from three different industrial areas in Lagos state (Ikeja, Apapa and Victoria Island) spanning the dry and wet seasons was carried out. The heavy metals analyzed were Pb, Cu, Cd, Mn and Fe. The mean values of Fe were within the FMEnV and WHO limits used as standard while the mean values of Cd, Cu, Pb and Mn exceeded these limits indicating that these industries constitute source of pollution to the human lives and ecosystem in the areas involved. Utilization of improved method of treatment and frequent awareness to the compliance of the industries were recommended.

Keywords: ecosystem, environmental pollution, industrial waste water, spectrometric analysis

INTRODUCTION

Increase in the world population has resulted in the pollution of the environment. Air and water pollution have been the most common forms of environmental pollution over the decades; water pollution being largely due to industrial waste water. Industrial wastewater contains pollutants that are freely discharged into the environment leading to physical and chemical changes of the environment. Contaminated air, soil and water by effluents from the industries are associated with heavy disease burden (WHO 2002; Yusuff *et al.* 2004). Apart from heavy metal ions, these effluents also contain poisonous chemicals which are not only poisonous to humans but also found toxicity adversely disrupts plant growth and other physiological processes, significantly leading to great economic and ecological trauma (Eckenfelder and Wesley 1989; Aiyesanmi 2006; Khan and Chaudhry 2006).

Continuous, gradual degradation of the environment causing threat to human lives has been a major source of concern in Nigeria, especially Lagos State because of her population. Almost no industrialization process takes place without a side effect of environmental deterioration which can undermine future productivity (Ejereonu 2003; Soldan 2003; Chukwu 2005). Industries such as food and beverages, soap and detergents, breweries, chemicals and allied, textiles and rubber produce various effluents that are discharged into the environment. No doubt, these industrial discharges cause environmental hazards so the need to avert or at least, reduce, these calls for urgent attention (Ghoreishi and Haghighi 2003; Dawodu and Ajanaku 2008).

The aim of the present study was to evaluate the environmental impact of waste water obtained from the specified industrial areas by analyzing the heavy metal components of these effluents and make possible recommendations. This work also studied the effect of climatic variations on the values of the heavy metals analyzed.

MATERIALS AND METHODS

Study site

The study areas cover three popular areas in Lagos: Ikeja (Oba Akran Avenue), Apapa (Unilever Plc) and Victoria Island (Bar Beach, Ozumba Mbadikwe stream and Ahmadu Bello Way). These locations were chosen due to the industrial activities in operation, especially the discharge of effluents into surrounding water bodies. The areas covered by these industries are within different ecosystems and are as indicated in the study area map (**Fig. 1**).

Sample collection and analysis

Samples were collected in different trips spanning both dry and rainy seasons, with the aim of variations on the results obtained. The point of collection was chosen using global positioning system, GPS, such that the samples were representative of the total quantity of effluents produced in each of the industries. In case of Apapa, Ikeja and Ahmadu Bello way, the effluents were collected at point of discharge from the treatment plants to the sewers, while the Bar Beach and Ozumba Mbadikwe Stream samples were collected at point of reception of effluents discharged into them.

The samples were collected in white labeled plastic 50 cm^3 bottles which had been previously soaked in 10% nitric acid for two days and thoroughly rinsed with distilled water. They were properly preserved and refrigerated before analysis in the laboratory using the method of Horsfall, 1998. Each sample bottle was acidified with 3-4 drops of concentrated trioxnitrate IV acid to mobilize metal ions and minimize adsorption to container walls. They were then properly digested with aqua regia mixture of concentrated trioxonitrate (IV) acid and hydrochloric acid (1: 3) before being analyzed for the trace metals using Perkin Elmer Atomic Absorption Spectrophotometer.

All chemicals used were of analytical grade and deionised water was used throughout the experiment to ensure acceptable data quality. The methods of analysis employed are as specified in Standard Methods for Examination of Water and Wastewater (APHA 1995).

RESULTS AND DISCUSSION

The result for the atomic absorption spectroscopic analysis of the heavy metals for the dry season is shown in **Table 1** while the result for the wet season is presented in **Table 2**. Generally, the mean values of all the metals exceeded the allowable limits of the standards except Iron (Fe) with values ranging from 0.04–0.25 mg/l for the dry season and 0.02–0.18 mg/l for the wet season. It was below detection level (BDL) for Ikeja location. Mn content ranged from

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Research Note

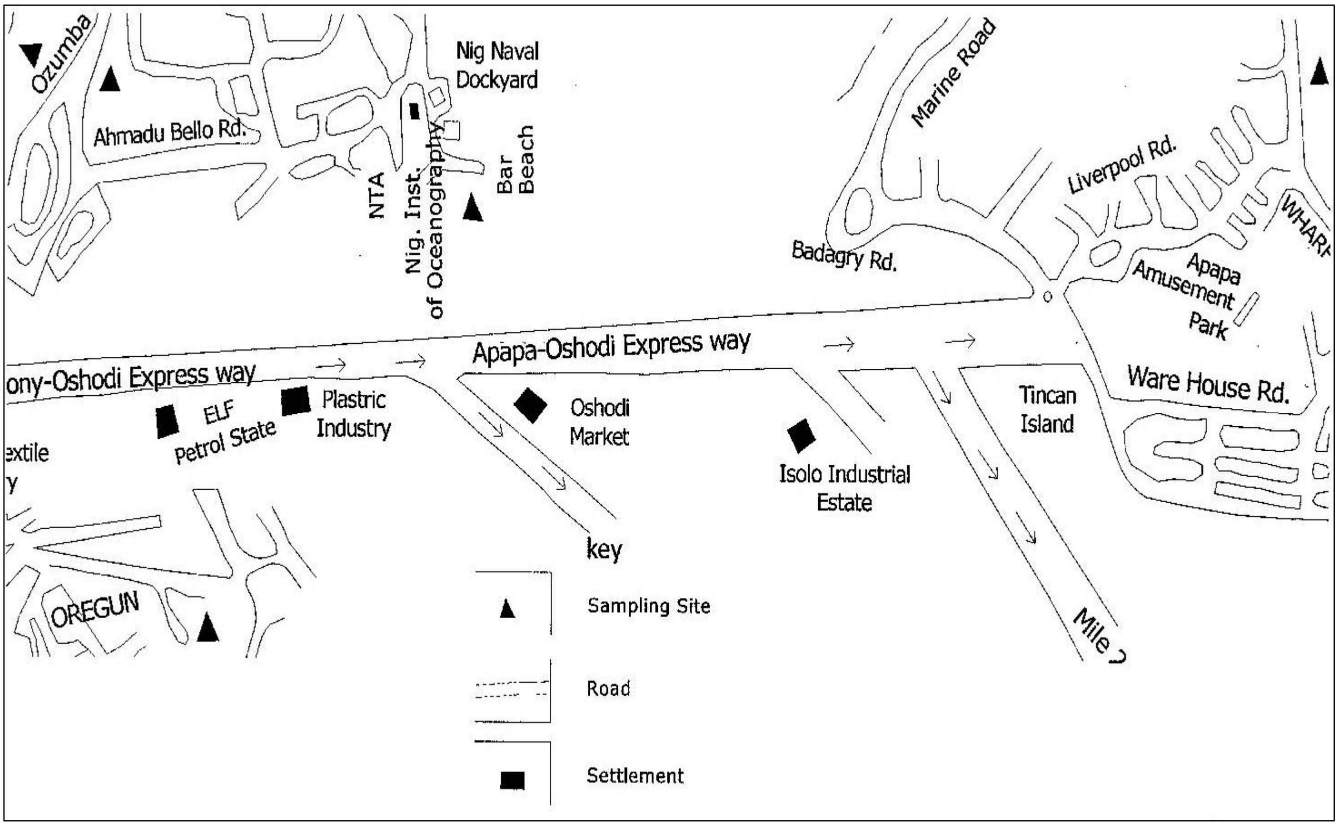

Fig. 1 Map showing the sampling sites.

Table 1 Heavy metals analysis for the dry season. Values in mg/l. n = 4

Location	Pb		Cu		Mn		Fe		Cd	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Ahmadu Bello way	1.990 ± 0.01	0.09	1.030 ± 0.02	1.7	BDL	BDL	0.070 ± 0.01	0.06	0.440 ± 0.01	0.36
Bar Beach	1.030 ± 0.02	0.1	1.100 ± 0.01	2.16	10.360 ± 1.250	3.06	0.040 ± 0.002	0.04	0.265 ± 0.02	0.47
Ozumba Mbadikwe Stream	1.060 ± 0.01	2.0	1.050 ± 0.04	1.58	7.120 ± 1.050	0.82	0.160 ± 0.004	0.08	0.140 ± 0.04	0.20
Apapa Dockyard	1.400 ± 0.03	0.8	1.730 ± 0.05	1.06	6.410 ± 0.45	5.38	0.240 ± 0.001	0.08	0.610 ± 0.01	0.54
Ikeja	1.090 ± 0.01	2.02	1.360 ± 0.05	1.26	19.885 ± 3.50	36.7	BDL	BDL	0.845 ± 0.05	0.99

Table 2 Heavy metals analysis for the wet season. Values in mg/l. n = 4

Location	Pb		Cu		Mn		Fe		Cd	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Ahmadu Bello way	1.060 ± 0.02	0.6	1.760 ± 0.02	0.72	7.840 ± 0.5	2.08	0.070 ± 0.01	0.04	0.900 ± 0.01	0.20
Bar Beach	2.030 ± 0.02	0.14	2.280 ± 0.4	1.44	6.280 ± 1.20	0.96	0.090 ± 0.001	0.06	0.430 ± 0.01	0.06
Ozumba Mbadikwe Stream	1.920 ± 0.05	0.64	1.200 ± 0.03	1.40	5.920 ± 1.00	4.20	0.130 ± 0.004	0.40	0.700 ± 0.02	0.80
Apapa Dockyard	2.120 ± 0.04	0.76	1.760 ± 0.05	0.48	8.020 ± 0.35	3.64	0.180 ± 0.001	0.22	0.510 ± 0.01	0.26
Ikeja	1.860 ± 0.01	0.72	1.020 ± 0.03	0.76	9.100 ± 1.40	8.40	0.020 ± 0.001	0.02	0.630 ± 0.02	0.10

1.05–19.88 mg/l for the dry season and 5.92–9.10 mg/l for the wet season and was below detection level (BDL) at Ahmadu Bello location. Its mean values were exceptionally high for all the locations among the metals analyzed. The mean values of Cd were relatively low compared to the other metals analyzed even though its values exceeded the allowable limits of WHO and FMEnv standards (**Table 3**). It ranged from 0.140-0.845 mg/l for the dry season and 0.43–0.90 mg/l for the wet season, its value of 0.63 mg/l (Ikeja location) could be attributed to the consequence of mining and smelting operations carried out by different various chemical and textile industries located at this industrial area. Cu had a range of 1.030-1.730 mg/l for the dry season and 1.02-2.28 mg/l for the wet season. Pb ranged from 1.03-1.99 mg/l for the dry season and 1.06-2.03 mg/l for the wet season. Its lowest mean value, 1.06 mg/l (Ahmadu Bello way) is much higher than the WHO standard limit of 0.01 indicating a high concentration of Pb in these effluents. This originates from high concentrations of lead resulting from use of lead-containing chemical compounds and corrosion of leaded paints; leading to environmental pollution.

Table 3 Standards.

Metal	WHO	FMEnV
Pb	0.01	<1.0
Cu	1.0	<1.0
Mn	0.5	5.0
Fe	0.3	
Cd	0.003	

From the results, it is evident that the heavy metals analyzed were detected at all the locations during the wet season but were not detected in two locations during the dry season; Fe at Ikeja location and Mn at Ahmadu Bello way.

Furthermore, the mean values of Cu was higher during the wet season than in the dry season, while the mean value of Fe in Apapa dockyard and Ikeja was higher during the wet season compared to the dry season. Also, the highest mean value of Fe, obtained at Apapa dockyard location during the wet season could be attributed to the higher deposition of particles carried by rain floods into receiving water bodies.

The Mn level was hiher during the dry season than in the wet season in Bar beach, Ozurmba Mbadikwe and in Ikeja. This implies that manganese-containing compounds occur in higher concentrations during this period compared to the wet season when this concentration could be "diluted" by rain floods. The highest mean value of Cu, 2.28 mg/l at Bar Beach location during the wet season is affiliated to the facts that industries around that area which deposit their effluents into this water body utilize a lot of materials that produce copper containing compounds either as by-products or through decomposition reactions and the rate of deposition of these effluents was enhanced by rain floods which was also in accordance with the findings of Ismail *et al*. (2007).

CONCLUSION

The results show that the mean values of all the metals analyzed, (except iron) exceeded the allowable limits of the WHO and FMEnV standards. The high values of the metal concentrations in these effluents indicate their untreated states before discharge into surrounding water bodies. Therefore, this study reveals that the effluents analyzed pose an environmental threat to human lives and ecosystem in the industrial areas investigated. Improved method of treatment and measures to maintain compliancy with standard by these industries is recommended.

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