Water quality monitoring in Nigeria; Case Study of Nigeria's industrial cities

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Abstract: The aim of this study was to analyze the state of water quality management in Nigeria's industrial cities. In a developing country such as Nigeria, there is immense demand for advancement in various facets of living and economic development is a priority of the government. This has led to increase in industries resulting in an increased quantity of discharge and a wide range of pollutants reaching water bodies. This study indicates that both urbanization and industrialization have contributed to the large scale of pollution currently observed in most Nigerian cities notably those swarming with industries namely; Lagos, Rivers, Kano and Kaduna states. There are no incentives for implementing pollution reduction measures. Wastes are disposed indiscriminately especially for small and medium scale industries. Data for this paper were obtained by observation, investigation and from related studies on the subject matter. Finally, this paper proposes constant river water monitoring as a step towards pollution abatement. [Journal of American Science 2010;6(4):22-28]. (ISSN: 1545-1003).

Key words: Water, Quality, Monitoring, Nigeria, Industrial Cities

1. Introduction

Nigeria is the most populous country in Africa. With a population of over 140 million, the country is endowed with generous resources of water bodies. The span of water bodies within the country is estimated at 900 km^2. This water provides resources for fishery, transportation, irrigation, recreation and domestic uses. Different regulations put in place to protect the marine environment in Nigeria have not been effective in controlling the indiscriminate dumping of effluent into open water bodies. These effluents range from chlorides, phosphates, oil and grease, nitrates, heavy metals to name a few. The heavy metals present in most Nigerian rivers and found in concentrations well above acceptable and permissible levels are lead, copper, zinc, nickel, chromium, Cadmium and Iron (Olayinka and Alo 2004; Esoka and Umaru 2006, Eniola et al, 2010). Degradation of water quality is most severe in the four states that contain 80 percent of the nations industries; Lagos, Rivers, Kano and Kaduna States. This has continued to pose a threat on health and economic development in Nigeria (Ajibade 2004; Olayinka and Alo 2004; Adekunle et al., 2007; Adeyemi et al., 2008; Mustapha, 2008; Adewolu et al., 2009).

Enforcement of emission standards have not been done strictly and the Federal Ministry of Environment still faces some challenges in helping industries adopt cleaner technologies (Adelegan, 2004). Although findings related to industrial pollution of water resources have been disturbing, the category of pollution that has received much attention in Nigeria is sewage pollution of portable drinking water. This has been managed with the weight of such bodies as UNICEF established in Nigeria in 1952 and WaterAid which began work in Nigeria in 1995 to assist with the vast water and sanitation needs found and has since been assisting the water and sanitation units (WASU)

of local government councils to deliver water and sanitation services to the poor. However, about 60 percent of the Nigerian populace both rural and some urban dwellers still source for domestic water and sometimes drinking water from ponds, streams and shallow wells justifying the concern for increases in the level of pollutants in surface and groundwater thus making water monitoring even more vital. (Adelegan 2004; WaterAid 2007; Morenikeji 2010).

Presently, very little if any has been done on an integrated level concerning industrial pollution abatement in Nigerian waters (Egbu, 2004; Olayinka and Alo; 2004, Essoka and Umaru, 2006). The Federal Government of Nigeria only gave attention to environmental abuse after the discovery of an Italian ship dumping toxic wastes in Nigeria in May 1998, giving rise to the establishment of the "Federal Environmental Protection Agency" FEPA later that year. The establishment of FEPA was also followed by the publication of "National Guidelines and Standards for Environmental Pollution" which focused mainly on industrial pollution. This body was renamed in September 1999 and is presently the 'ministry of environment'.

2. Materials and Methods:

Study Area:

Figure 1 shows the map of Nigeria, illustrating the four key industrial cities and the Federal capital Territory Abuja.

Data collection:

Data for this paper was obtained by observation, investigation and by review of several literatures on industrial pollution especially in the specified areas.

The information needed for this study was collected between August and December 2009. Information on water quality and supply within Nigerian cities was obtained at the Federal ministry of Agriculture and water resources, Abuja. A review of the water quality status for the major industrial cities in Nigeria and physio-chemical characteristics of effluent discharge in these cities is given below:

Lagos State:

Lagos is the largest city in Nigeria and the second largest in Africa. It contains over 40% of Nigeria's manufacturing activities with the highest level of emission of 8000 tons of hazardous waste per year, most of which is discharged directly into the Lagos lagoon.

Lagos Lagoon lies between longitudes 3° 22' E and 3° 40' E and Latitude 6° 17'N and 6° 28' N. The lagoon is generally shallow with a depth of between 0.3 and 3.2 m in most parts with the exception of some dredged parts, notably in the Lagos Harbor, where depth is greater than 10 m. The tidal range is 0.3-1.3 m.

Waters in the lagoon and ocean surrounding

Lagos do not meet required standards and thus are not fit for human consumption. Experts have reported that pollution of the lagoon is responsible for the fast depleting of its coastal terrain. Studies have also shown that urban and industrial wastes discharged into the Lagos Lagoon have had a significant impact on the ecosystem (Okoye, 1991; Sangodoyin 1995; Adebayo et al, 2007).

Hence, public authorities in Lagos have had to source for water from neighboring states. In 1910, Lagos installed its first water treatment plant in Iju village, Ogun state with subsequent expansions almost every decade due to consequent rise in population. In a 1985 study, it was discovered that only 47% of the people living in the metropolis were served with portable water at reduced level of service. This figure has since reduced.

Lagos is the only state that charges pollution levies and although the measure is expected to serve as some disincentive to pollution generation and also for the alleviation of pollution problems in the state, it is better seen as a revenue generation effort on the part of the government.

Kaduna State:

Kaduna city is the capital of Kaduna State in north-central Nigeria. The Kaduna River is a tributary of the Niger River which flows for 550 km through Nigeria. It runs along the town from the north to the south of the city covering extensive areas and with low current during the dry season.

The river has a storage reservoir (Kangimi Dam) in the upper region. It is diverted at two points, the north and south water serves as a source of drinking water with a capacity of 240 and 35 million liters per day respectively. The major drains carrying effluents are sited at points beyond the south water works.

The river has a strong seasonal pattern with a flow of 2,000 m^3/s in the rainy season and 1 m^3/s in the dry season and is the major sink of most industrial effluents in the city (Essoka and Umaru, 2006). The concern for pollution is within the six months of the dry season (November to May) and particularly in march, which is the peak of the dry season. The river achieves a 200:1 dilution in the rainy season. However, during the dry season, the river becomes an open sewer for waste pollutants.

The only extensive study on this river was the 'Kaduna River Pollution Study' carried out in 1987 (KRPS, 1987).

Kano State:

The main water body in Kano state is the Kano River basin. It serves as the major source of water supply to the city and is also the major sink for wastes from industrial estates within the state. The river has numerous tributaries but the main rivers that make up the Kano river basin are the Salanta, Challawa and Bompai rivers.

In a study of the effects of industrial effluent in this river basin, the river was found to be contaminated. It was found to contain the following pollutants in significant concentration; high Chemical Oxygen Demand, total solids, hardness, Calcium Carbonate, and ammonia nitrogen. These rivers are used extensively for domestic water supply, irrigation, fishing and recreation but the quality of the water has been found to be unsuitable for these purposes. (Bichi and Anyata, 1999; Mashi and Alhassan 2007).

Rivers State:

Rivers state, as the name suggests is bound by many rivers, notably, the Atlantic Ocean to the North of the state. The state has twenty four administrative divisions with the city of Port Harcourt as its capital.

The major source of pollution in the state is the Petroleum industry. The city of Port Harcourt serves as the nerve center to most transnational petroleum processing companies in the region. Other major contributors to this pollution include iron and steel, fertilizer and petrochemical plants. Another issue

of concern is the mixed disposal of municipal and industrial solid wastes in water bodies (Solomon, 2009) and poor sewerage systems. Effluents from households are discharged into open drains, gutters and water bodies. (Ajao and Anurigwo, 2002).

3. Results and discussion:

Lagos State:

The study through Table 1 shows composition of waste water discharge from two manufacturing industries; a textile and an alcoholic beverage company within Lagos state.

It shows effluents characteristics from both companies (Afprint [textile] and Nigeria Breweries Plc) that discharge into the lagoon.

Table 1. Physio-chemical parameters of effluents from two Lagos industries

Industries	Afprint	NBPlc	**Total (Rounded Figure)**
Temp (^oC)	27.6	30.3	**50.0**
pH	7.6	4.8	**-**
Conductivity	761.0	1156.6	**1,900.0**
Turbidity	11.6	573.6	**580.0**
Salinity	0.1	0.5	**-**
Alkalinity	766.6	445.0	**1,200.0**
Total Hardness	1233.3	4083.3	**5,300.0**
TSS	320.0	833.3	**1,100.0**
Oil/Grease	20.0	0.0	**20.0**
BOD_5	534.0	1352.3	**1,800.0**
COD	850.6	2253.3	**3,100.0**
H_2S	17.2	130.0	**140.0**

Source: Adebayo et al., 2007

All values in mg/ L [except those indicated]

Kaduna State:

The concentration of select pollutants (Cl^-, No_3, NH_3, Po_4, S^{2-}) and other physico-chemical indexes associated with textile processing are shown in Table 2. It shows average values of effluent from five different textile companies that discharge into the Kaduna River.

Table 2. Physio-chemical parameters of effluents from Kaduna industries

Industries	**Total (Rounded Figure)**
Temp. (^oC)	**30.0**
Color	**2,400.0**
TDS	**1,100.0**
Free Chlorine	**0.5**
Nitrate	**4.0**
Ammonia	**1.0**
Phosphate	**1.0**
TSS	**400.0**
Oil/Grease	**7.0**
BOD_5	**300**
COD	**1,800.0**
Sulphide	**0.6**

Source: Yusuf and Sonibare, 2004

All values in mg/ L [except temperature]

Kano State:

Dominant pollutants discovered in Kano river basin from an extensive study of the basin are listed in Table 3. This table shows significantly high concentrations of COD, TSS, hardness, $CaCo_3$, NH_3-N in the three rivers that make up the Kano river basin.

Table 3. Concentration of pollutants in Kano river basin

Rivers	Salanta	Bompai	Challawa	**(Total Rounded Figure)**
COD	8557.4	1166.9	598.7	**2,600.0**
TSS	16934.6	1458.0	1609.0	**20,000.0**
Hardness	1349.6	2506.8	1332.0	**5,100.0**
$CaCo_3$	5150.0	530.0	400.0	**6,000.0**
NH_3-N	5150.0	530.0	400.0	**6,000.0**

Source: Bichi and Anyata, 1999.

[All values in mg/ L]

Rivers state:

Table 4 shows Total effluents from industry and households (in tones/ yr) in Port Harcourt. Pollutants of concern as listed in the table include Oil and grease, Nitrogen, Phosphorus and Biological oxygen demand.

Table 4. Total effluents from industry and households (in tones/ yr) in Port Harcourt.

	Industries	Septic/Oil	**Total (Rounded Figure)**
BOD_5	4374.0	8808.0	**13,000.0**
TSS	3533.0	6178.0	**19,500.0**
OIL	2343.0	2343.0	**4,700.0**
N	362.0	2966.0	**3,300.0**
P	836.0	360.0	**1,200.0**

Source: Ajao and Anuriguo, 2002.
[All values in mg/ L]

Recent efforts, such as rehabilitation of water pumping stations and replacement of outdated pipe networks are in place to improve water quality and supply within Rivers state and although these efforts are commendable, the issue of industrial pollution is still ignored.

Water quality monitoring in Nigeria

The basis of water quality monitoring is to obtain information which will be useful in management of water resources in the country. It would prove useful in management, control and investigation of pollution cases, Classification of water resources, Collection of baseline data, Water quality surveillance and Forecasting water quality.

In Nigeria most of the portable water used for both domestic and industrial purposes is channeled from rivers and groundwater. The present water quality monitoring status in Nigeria involves monitoring only groundwater once every year by each states' water board using FEPA standards. There is no integrated river water quality monitoring scheme in Nigeria.

FEPA and EPA:

The United States Environmental Protection Agency (EPA) sets standards that, when combined with protecting ground water and surface water, are critical to ensuring safe drinking water. The EPA also regulates about 90 contaminants and so does FEPA but the EPA works with its regional offices, states, tribes and its many partners to protect public health through implementing the Safe Drinking Water Act.

Amongst unfavorable legislative, technical and operational constraints, the existing water quality monitoring status in Nigeria is affected principally by institutional barriers: which are constraints or difficulties encountered by the various institutions as a result of the defective organizational framework, these include; inadequate and untimely funding, shortage of requisite personnel, lack of central coordination body of the agencies activities, poor maintenance culture of infrastructures and obsoleteness of the legislations that established some of the institutions with the resultant effect of mild or no penalties for culprits (Egbu, 2004).

Conclusion and Recommendations:

The issue of water in Nigeria may marvel a lot of people considering its abundance in the area. However, the question is whether what is available is good enough for consumption. The desire and determination to provide good quality water that is affordable to the citizenry therefore should influence constant monitoring. The lack of information on pollution is a serious hindrance to pollution management directly or remotely. Thus, in addition to treatment of waste water before disposal, appraisal of water resources would offer proficient information able to indicate areas of main concern. This would prove useful in detection of threats to human and environmental health. Data from monitoring would also fine-tune the control strategies and approaches

already identified thereby helping to develop practical guidelines for pollution reduction. In Nigeria where environmental regulatory measures are relatively frail, and most of the populace still obtain water from rivers and shallow wells, constant water quality monitoring would serve as a means of checking and averting pollution and also upgrading outdated standards. This would be most practical in cities with high incidence of industries resulting in discharge of a great deal of industrial waste into water bodies. It should be noted that the establishment of FEPA signifies a landmark in environmental management efforts in Nigeria but the laws and guidelines published by FEPA need a strict follow up to achieve a pollution free environment.

Faced with this condition, it is suggested that water quality monitoring be contracted to private environmental monitoring companies who will liaise with the government for a healthier environment, this is to ensure that regularity of monitoring activities is not affected by change in government. There is also, little or no institutional memory in Nigeria on the influence of industrial waste on human health, thus, a detailed campaign should be put in place, elucidating the mechanism of water pollution especially with regard to toxic substances. Also, because of the seasonal nature of most Nigerian rivers, for river water monitoring to be very effective, it is proposed that monitoring frequency be upgraded from once to twice a year. This would help ensure that water decline and reduced dilution point due to seasonal changes do not affect the consistency of monitoring results. Better sewerage systems should also be constructed for wastewater from households.

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