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Ecotoxicological Study of the Niger-Delta Area of the River Niger

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Nigeria being an oil producing country is faced with the problem of environmental degradation caused by oil pollution of the environment through accident blow-outs, oil pipe line leaks, failure of storage tanks and effluents from refinery operations. Since streams and rivers have been considered a convenient means of clearing and carrying wastes as well as transporting various forms of petroleum and crude oil from the discharge points, most rivers in urban areas are highly loaded with urban and industrial wastes (Smith et al. 1987 and Garrick et al 1993). According to the Pan American Health Organisation, (PAHO), less than 10% of the municipalities in developing countries treat sewage adequately before emptying it into natural water course, and waste treatment and sewers for industrial effluent are often not working or non-existent (Black, 1994).

The present study investigated the impact of chemicals arising from industries particularly crude oil industry with a view of compiling the ecotoxicological data of Niger River. The sample station were sited at Onitsha in Anambra State (source), Ishukwa in Ndokwa-East Local government Area (L.G.A.) of Delta State (Middle point) and Adai in Ndoni Local Government Area (L.G.A.) of Rivers State (Tail point). Water samples were collected from the River Niger along its path in these areas, and analysis for heavy metals carried out.

MATERIALS AND METHODS

The sampling stations were selected for analysis from the course of River Niger at Onitsha in Anambra State Nigeria (Source), Ishukwa in Ndokwa-East L.G.A. of Delta State (middle point) and Adai in Ndoni L.G.A. in Rivers State (Tail point). Surface water samples were collected from four sports at each sampling stations.

Manual pump was used to collect 10 liters of water at depth of 0.5m. At each sampling station the presence of macro organism was recorded by capturing them in a net (diameter of hole 0.2mm) and by direct observation. Concentration of lead, calcium, cadmium, were determined in each sample using Atomic Absorption Spectroscopy (Piper, 1994). Concentration of Ammonium and Nitrite were determined using UV-visible spectrophotometer.

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The salinity was measured using the digital meter for salinity, and pH using the digital pH meter and electrical conductivity using the digital conductometer (Postgate, 1969). Complexiometric titration method was employed in the determination of total hardness of water samples. Other pollutant parameters that were measured included suspended solids, volatile and non-volatile solids.

RESULTS AND DISCUSSION

The amount of lead, cadmium, zinc and calcium detected in the water samples from the three sampling stations, Onitsha (source), Ishukwa (middle) and Adai (tail) are shown in fig. 1. Lead content ranged from 1.0 to 1.5ppm. Onitsha (source) showed the highest level of 1.5ppm, while the Ishukwa (middle point) and Adai (tail point) gave level of 1.00ppm respectively. It can be seen that the values of cadmium obtained from the samples were constant for all the three sample stations. Zinc content obtained from the samples ranged from 0.0063 to 0.0125ppm. The source (Onitsha) showed the lowest value of 0.0063ppm and the other two sample stations, (middle and tail points) gave the same value of 0.0125ppm of zinc. For calcium, the highest level of 2.64ppm was noted at Onitsha (source) and least level of 1.108ppm at Adai (tail point).

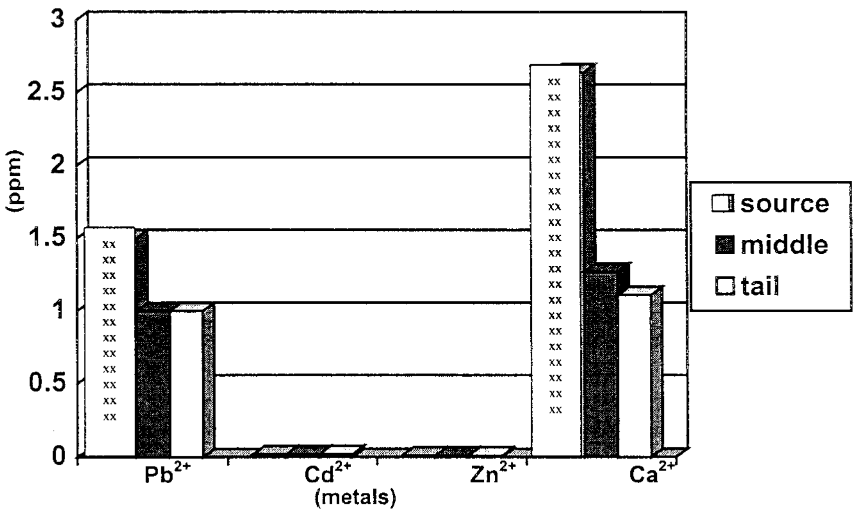

Figure 1. Metal levels (ppm) at different sample stations.

Table 1 shows the level of different pollutant parameters namely ammonium, nitrate, salinity, pH, electrical conductivity, suspended solids, volatile solids, non-volatile solids and total hardness. For ammonium, the highest level of 1.17mg/l was noted at Adai (tail point) and the least level of 0.92mg/l at Onitsha (source). The highest level of nitrate (0.597mg/1) was at Ishukwa

Table 1. Pollutant parameters in water samples.

Sample Station	NH^+_4 (mg/1)	No^-_3 (mg/1)	Sal.	pH	EC (Ms)	SS (%)	VS (%)	NVS (%)	TH (mg/1)
Source	0.92	0.12	0.02	7.5	94	0.17	3.67	3.81	27
Middle	1.02	0.60	0.03	7.4	82	0.22	3.59	3.75	22
Tail	1.17	0.25	0.03	7.1	60	0.30	3.38	3.50	42

Sal. = Salinity, EC = Electrical Conductivity, SS = Suspended Solids, VS = Volatile Solids, NVS = Non-volatile Solids, TH = Total Hardness.

(middle point) and least of 0.121mg/1 at Onitsha (source). The range of the salinity, pH and electrical conductivity were 0.02-0.03mg/1, 7.1-7.5 and 60-94Ms respectively. The water sample was found to contain suspended solids (0.17-0.30), volatile solids (3.38-3.67) and non-volatile solids (3.50-3.81). Total hardness of water sample ranged from 22-42mg/1.

River Niger take rises from the Fouta Djallon highlands in Guinea running through Mali, Niger and finally coming into Nigeria. In Guinea, sited all around it are mining activities for gold, in Mali there is also mining activities for metals and in Nigeria Iron ore, oil and natural gas are just a few of the known industrial activities around the river Niger. The study investigated the impact of chemicals arising from industries, particularly crude oil with view of compiling ecotoxicological data of the delta area of the river Niger.

The data on salinity, hardness and electrical conductivity have been presented by this study. The acceptable range for total dissolved solids in any water samples 500 – 1500 (WHO, 1947). The water samples from Onitsha, Ishukwa and Adai all showed low level of dissolved solid indicating low debris content. This may not be surprising, as there are forces of degradation and weathering of the crude oil on water surface. Apart from the degradation of the crude, the river is fast flowing towards the Delta hence an increase in total hardness, which was found to be highest at the tail point. Leaching of pollutants may increase pH. The pH range of 7.1-7.5 found in this study nontheless connotes the low presence of Agro based industries on the flood flow of River Niger.

The major human health risk associated with exposure to nitrate is considered to be conversion of nitrite to nitrate. Nitrite derived from nitrate may react in vivo with amides to form N-nitroso compound, which may have carcinogenic properties. A high nitrate intake had been associated with stomach cancer (Boeing, 1991). Our study revealed low levels of nitrate. The low level of Nitrate (NO^-_3) and ammonium (NH^+_4) can also be an indication of low level of Agro-based industries along the course of the river since fertilizers and pesticides have been known to fix nitrogen to the environment.

The presence of cadmium (Cd^{2+}) and lead (Pb^{2+}) along the river Niger is noteworthy. There was even distribution of cadmium of about 0.019ppm all around which may rise to significant level in future. As previously stated cadmium is highly toxic, accumulating in the body and eventually causing effects such as tubular dysfunction, disturbances in calcium homeostatis and metabolism (WHO, 1992).

Lead content (Pb^{2+}) along the River was found ranging from 1-1.5ppm. This is relatively high comparing it with the acceptable value in the body which is 0.2ppm (Hicks; 1992). Lead poisoning though rare arise from cumulative inhalation of dust and consumption of organolead compounds, resulting in headaches, dizziness and insomnia. Man's intake of lead from food and drink normally amounts to 200-400mg, of which only about 10% is absorbed.

Zinc levels as determined from the sample was between 0.0063 – 0.0125ppm. Zinc is generally considered a relatively non-toxic metal (NAS; 1980), but some zinc salts such as zinc chlorides, in sufficient concentration can injure tissues. Inhalation, exposure of skin, or ingestion can produce local pathological effects. The recommended daily allowances of zinc in the human body are 8 to 15mg.

The pH of an aquatic environment can be upset by added acid or alkali from waste water. To maintain a good fish population in a marine environment it is necessary to keep the pH of the water in the range between 6.7 to 8.6. Only a few fishes can survive outside this range (Tarzwell; 1957) and a medium with extremely high pH (>10) or low pH (<4.0) cannot support fishes at all. In addition to this; pH is known to influence the toxicity of inorganic pollutants such as ammonia, cyanide and hydrogen sulphide to fishes. The toxicity of ammonia is enhanced by high pH, while the toxicity of cyanide and sulphide is enhanced at low pH.

The presence of volatile contaminants, suspended solids in the delta area of River Niger calls for a systematic follow up on the water quality. The control of illegal industrial discharges to the municipal sewage system should be considered a high priority. Short-term structural actions to improve enforcement must be taken by Federal Environmental Protection Agency (FEPA). One of these actions could be to map and designate certain location as industrial estate and to require such area to collect and recycle waste water and finally the adoption and implementation of more effective laws of monitoring and penalizing pollution in the nation's water ways.

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