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Pollution Studies on the Qua-Iboe River Estuary Ibeno, Akwa-Ibom, Nigeria

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Abstract

It was speculated that the tidal backwash of the effluent discharge from Exxon-Mobil Waste Treatment Plant located near the Qua-Iboe River estuary may constitute a source of pollution to the estuary. This study was carried out to investigate this possibility. Water samples were randomly collected from five different points along the bank of the estuary. The physicochemical parameters of the estuary were analyzed and the mean concentrations of some of the metals determined using Atomic Absorption Spectrophotometer (AAS). When compared with WHO permissible limits for marine water, the mean concentration (x) (n=125) showed that the estuary was significantly polluted with respect to Ni (0.22 mg / L), Cr (0.21mg / L), Cd (0.02mg / L), Fe (0.73 mg/L) and Pb(0.18 mg /L) ($p < 0.01$). The levels of Cu (0.02 mg / L), Zn (0.08mg / L), and Mn (0.03mg / L) were within WHO acceptable limits. This study revealed that the Qua-Iboe River estuary was polluted with some metals. This puts the human population who depend on the water at health risk.

Keywords: Qua- Iboe River Estuary, Effluent Discharge, Pollution, and Health Hazard.

1.0 Introduction

Water is vital to life and makes up about 70% of the total body weight of an average adult. It is also essential for industrial and agricultural purposes. The quality of water varies according to the source, economic or industrial activities of its course, and the status of pollution emanating from anthropogenic and euthrophication processes surrounding the water (Chapman, 1992).

Water quality may be affected by natural geological content of the water course, sewage disposal, industrial effluent and pollution arising from surface run-off and agricultural activities.(Nemerow,1986.)In Nigeria many studies have been done on water pollution, especially in the Niger Delta region, because of the impact of crude oil exploration and exploitation activities in this area. The extent of damage to ecological and marine life, as well as degradation of the economic and social life of the people have been previously reported by Ajayi and Osibanjo (1981), Kakulu (1985), Osibanjo (1992), Offiong and Edet (1998), Egeronu and Ibe (1999), Nathaniel el. al. (2000), Edet el.al (2001), and Maduka (2006). In Olomoro, a village in Isoko LGA of Delta State, many young men have been reported to grow expansive grey hair which is attributed to the effect of crude oil pollution on the human environment (Olaifa et. al. 2001). Obodo (2002) specifically reported on the heavy metal pollution of the lower reaches of the River Niger and the degree of bioaccumulation of heavy metal contaminants by Synodontis membranaceus (catfish) and Tilapia zilli. He pointed out the potentials health hazards for the consumers of such polluted aquatic life.

Based on the Foregoing, the importance of the quality of water of Qua-Iboe estuary should attract the attention of researchers and government because of its close proximity to the Exxon – Mobil Effluent Treatment/Discharge Plant, and the possible risk to the human settlements along the bankof the river. The understanding so far has been that the pollution of the river estuary was not possible because the tidal waves carry particulate matters back to the open sea. This study was carried out to investigate the validity

of this assumption in order to prevent any possible health hazards that may affect the inhabitants of the bank of the river estuary.

Qua-Iboe River rises from Umuahia in Abia State, and empties in the Atlantic Ocean in Ibeno LGA (Via Eket), Akwa Ibom State of Nigeria.

The assessment of water quality was carried out in 5 communal settlements that border the Qua-Iboe estuary. These were Qua-Iboe Terminal (Mouth of the river), Itak-Abasi, Ukpenekang, Iwuo-achang and Ikoro-itub. The point of water sample at the terminal was about 1.2 km from the effluent discharge plant. It is the nearest to the point of discharge. Ikoro-Itub is the farthest from the point of discharge at a distance of about 12km along the course of the river. There were two reports in which the inhabitants observed that the river was covered with crude oil in recent years (Isuale, 2005). The oil eventually receded to the ocean leaving the estuary polluted and unsafe for domestic activities. Part of the objective of this study is to assess the water quality and the possible extent of residual pollution. From available information at our disposal, there appears to be no published work on the pollution status of the Que-Iboe River Estuary. This Study therefore serves to bridge this information gap.

2.0 Methods of Analysis

A field survey was carried out to trace some major communities along the course of the estuary. Water was randomly collected from each of the five selected communities: Qua-Iboe Terminal, Itak-Abasi, Ukpenekang, Iwuo-achang and Ikoro-Itub.

The hydrochemical analysis of the water samples were carried out in the laboratory of the Federal University of Technology, Owerri, using Jenway, model 3501 pH meter; Jenway conductivity meter 4070 (Jenway Gransmore Green, Essex, England); Spectronic 20D(330-1000NM); Metler Balance Model LP203, (B. Braun Scientific & Instruments Company, England); Cecil CE 2011spectrophotometer, 2000 series (Cecil Instruments, Cambridge, England), Atomic Absorption Spectrophotometer, (AAS), Hitachi; Dissolved Oxygen meter, Horiba model 10

2.1 Hydrochemical Analysis

Metalic elements

Water samples were collected from five locations along the course of the estuary. These were designated with the names of the respective communal settlements at the point of sampling (Table 1). The samples were stored in clean 250 ml polythene bottles. Two sets of samples were obtained from each location. One set was later acidified with nitric acid for heavy metal analysis. The bottles were packed in plastic coolers with ice-flakes and conveyed to the laboratory where they were stored in refrigerator at 4^0C prior to the analysis. The concentrations of Ni, Cr, Cd, Fe, Cu, Zn, Mn and Pb were estimated in the water sample using the Atomic Absorption Spectrophotometer (AAS). (HITACHI). Stock solutions from which working standards were prepared by serial dilution were done by the method of Franson (1975). Calibration graph for each element was prepared following the procedure in Technical Bulletin 27 (HM S0, 1973) and standard method for the examination of water and waste water (Franson, 1975).

Alkalinity, Ammonia and Chloride Content

These were determined by the titrimetric method. (Vogel, 1961, and Franson, 1975).

Determination of total hardness

Calcium and magnesium hardness were determined by EDTA titrimetric method (Vogel, 1961).

pH and electrical conductivity

The pH meter (Jenway 3510 pH meter) was used to determine the pH; while a conductivity meter (Jenway, 4070) was used for the Electrical conductivity.

Temperature

The temperature of the water was determined using mercury in glass thermometer. (C66-460B)

Nitrate

This was estimated from KNO_3 standard using a spectrophotometer (Cecil CE 2011, 2000 series) at 401nm wavelength (Vogel, 1961).

Sulphate

Was estimated from K_2S0_4 standard using spectrophotometer at 420 nm wavelength.

Chloride

This was estimated by titrimetric method using $AgNO_3$.

Dissolved Oxygen (DO)

Estimated using Dissolved Oxygen meter (Horiba 10 model).

Biochemical Oxygen Demand (BOD)

It was estimated using the DO meter from the formula

$BOD_5 = (DO\ day_i - DO\ day_f)$ mg/l

Where

BOD_5 = Biochemical Oxygen demand after 5 days.

DOi = Dissolved oxygen initial day.

DOf = Dissolved oxygen final day.

3.0 Results and Discussions

The concentration of various chemical pollutants varied as one moved away from the source of effluent discharge. Table 1 illustrates that the Qua-Iboe terminal was highly polluted with the metals relative to other stations. Ikoro-Itub, the farthest station has the least pollution level. There is a decreasing order of metal pollution as you move away from the effluent discharge terminal.

The data presented indicated that the quality of the water was not affected with respect to Cr, Cd, Fe, Cu, Zn, Mn and Pb in Itak-Abasi, Ukpenekang, Iwuo-achang and Ikoro-Itub respectively based on WHO Standard. But the Qua-Iboe terminal was significantly ($P<0.01$) polluted with respect to all the metals except N: which polluted Ikoro-Itub-significantly (Table 3). The reason for the high Ni concentration in Ikoro-Itub cannot be explained precisely. However, it is assumed that the Ni may be associated with geological seepage along the natural course of the estuary at Ikoro –Itub; Nemerow (1986) said that the natural geological content of a watercourse might constitute a source of its pollution. Generally, the pollution burden decreased as the distance from the point of effluent discharge increased. Relative to the mean concentrations of the metals for the five communities sampled, the estuary was polluted with Ni, Cr, Cd, Fe and Pb. The mean concentration of Zn, Mn and Cu were within WHO safe limits (Table 2).

Kidney and Liver damage are common with Cr and Cd. (Dudley el. al. 1985). Psychiatric syndrome associated with Mn and Pb poisoning are known to occur (Harvey, 1975; Sandra, 1984 ;Kosneth, 2001). Iron overdose predisposes to haematochromatosis,(Harvey, 1975), while Cu and Zn toxicity have been reported to cause tissue damage (Chen and Liao, 2003).The implication of the foregoing puts the health of the community at the Qua-Iboe terminal at risk of these metals except Ni. This is so because the food chain of the inhabitants are linked to the fishes and the crustaceans consumed by the inhabitants of the estuary. The possibility of the marine lives concentrating these metals cannot be ruled out.We are currently working based on this speculation.

Table 1. Mean concentrations of physicochemical parameters of water in the five communities

parameter	Qua-iboeTerminal	Itak abasi	Upenekang	Iwuo-achang	Ikoro-itub	Mean	WHO Std.
PH	7.89 ± 0.33	7.81 ± 0.04	7.37 ± 0.23	7.15 ± 0.10	8.44 ± 0.15	7.73	8.5
Temperature(°C)	26.4 ± 0.37	26.4 ± 0.39	26.5 ± 0.22	26.5 ± 0.18	26.6 ± 0.49	26.48	...
Conductivity(us/cm)	24.03 ± 2.6	23.06 ± 2.0	24.01 ± 2.20	22.1 ± 1.99	20.08 ± 2.7	22.66	...
Nitrate(mg / L)	2,63 ± 0.23	2.25 ± 0.21	1.63 ± 0.12	1.82 ± 0.18	1.50 ± 0.16	1.97	50
Sulphate(mg / L)	7.89 ± 0.80	7.78 ± 0.85	9.20 ± 0.88	8.40±0.29	40.46 ± 2.42	14.75	250
Total hardness (mg/ L)	128.14 ± 49.2	79.71 ± 15.40	64.29 ± 6.15	52.14 ± 8.26	51. 29 ± 13.2	75.11	500
Alkalinity	9.88 ± 3.84	13.42 ± 2.27	10.54 ± 3.74	12.01 ± 1.12	12.05 ± 2.06	11.60	50
Chloride(mg / L)	280.50 ± 15.5	227.50 ± 13.33	176.72 ± 9.7	168.0 ± 6.35	244.30 ± 3.0	229.40	250
Dissolved oxygen(mg/ L)	4.22 ± 0.16	3.80 ± 0.28	4.12 ± 0.70	3.97 ± 0.41	3.97 ± 0.32	4.02	...
BOD(mg/ L)	1.2 ± 0.04	1.4 ± 0.08	1.4 ± 0.10	1.4 ± 0.11	1.6 ± 0.06	1.40	...

Table 2. Mean concentrations of trace metals in water from the five communities. (mg/L)

Parameter	Qua-iboeTerminal	Itak abasi	Upenekang	Iwuo-achang	Ikoro-etub	Mean	WHO Std.	Comment
Ni	0.21 ± 0.012	0.17 ± 0.022	0.18 ± 0.013	0.18 ± 0.02	0.38 ± 0.096	0.22	0.1	SD
Cr	0.533 ± 0.01	0.364 ± 0.19	0.133 ± 0.08	N.D	N.D	0.21	0.05	SD
Cd	0.033 ± 0.01	N.D	N.D	0.025 ±	0.017 ± 0.01	0.02	0.005	SD
Fe	2.125 ± 1.02	0.50 ± 0.20	0.50 ± 0.20	0.25 ± 0.14	0.25 ± 0.02	0.73	0.3	SD
Cu	0.1 ± 0.078	N.D	N.D	0.1 ± Nil	0.05 ± Nil	0.02	2.0	Safe
Zn	0.14 ± 0.02	0.08 ± 0.003	0.08 ± 0.02	0.06 ± Nil	0.05 ± 0.01	0.08	30.	Safe
Mn	0.135 ± 0.09	0.017 ± 0.005	N.D	N.D	N.D	0.03	0.5	Safe
Pb	0.3 ± 0.12	0.25 ± 0.13	0.15 ± 0.01	0.1 ± 0.01	0.1 ± 0.01	0.18	0.01	SD

Table 3. Comparative analysis of the water pollution levels in the five communities.

Metal	*Qua-iboe terminal*	*Itak-Abasi*	*ukpenekang*	*Iwuo-chang*	*Ikoro-Itub*
Ni	—	*	*	*	+++
Cr	+++	*	*	—	—
Cd	+++	*	*	*	—
Fe	+ ++	*	*	*	—
Cu	+	—	—	+	*
Zn	+	*	*	*	—
Mn	+++	*	—	—	—
Pb	+++	*	*	—	—

Legend

+++ Highly Polluted: Exceeds WHO permissible limit (P<0.01)

--- Not Polluted: Not detected

* Not Polluted: Within WHO limit (P> 0.01)

\+ Polluted but within WHO limit (P> 0.01)

The physicochemical parameters remained relatively constant along the watercourse, except for total hardness which was elevated in the Qua-Iboe terminal. The water hardness in the terminal was 128.14 ± 49.2 as against the lowest values of 51.29 ± 13.2, which was recorded at Ikoro-Itub. The Qua-Iboe terminal value was not above the WHO permissible limit (500mg/L) This concentration may be a direct reflection of the concentration of Mg and Ca in the pollutants discharged from the effluent plant into the estuary.

4.0 Conclusion

The result showed that the concentrations of some metals in the estuary were higher than the WHO permissible ranges, especially at the Qua-Iboe terminal. The analysis on table 2 tends to suggest that the source of contamination may be the Exxon Mobil Effluent discharge plant. Boat building activities at Ukpenekang may also contribute to the pollutant levels of Fe and Pb.

It is suggested that evaluation of the quality of water in the estuary be done on regular basis to forestall acute toxicity that may arise from sudden discharge of these effluent into the estuary. A regular medical check on the inhabitants is recommended to avoid chronic toxicity arising from residual metal contaminants. Preventive environmental measures should be put in place to ensure that the river is constantly safe for domestic and economic activities. Further studies should be done to determine the extent of pollution on the marine life and possibly the soil.

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