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Preliminary Investigation of Some Physicochemical Parameters and Water Quality of Imo River Nigeria

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Abstract
Research on water quality of Imo River Nigeria was conducted between the months of June and September, 2011 to investigate the impact of some human and industrial activities on some physicochemical and bacteriological characteristics of the system. Industrial activities such as local sand dredging, cottage industries producing papers and cosmetics, construction of a jetty for marine activities and municipal waste discharge all take place at the bank of the river. Water and sediment samples were collected and analysed in the laboratory to ascertain the level of the concentration of the parameters being monitored. Standard methods were adopted for both field and laboratory analyses. For purpose of comparison the study was conducted in three stations (upstream, station A. midstream, station B and downstream, station, C). Water sample was also collected from tap water to act as a control for the potability fitness of the study area. The result of the mean concentrations of the parameters for water sample include: pH (6.25), conductivity (217.30µS/cm), temperature (26.13^{0}c), TDS (123.67mg/l), TSS (67.67mg/l), Nitrate (3.93mg/l), Sulphate (5.67mg/l), Turbidity (105.65mg/l), phosphate (0.33mg/l), BOD (12.13mg/l), Lead (0.98mg/l), Aluminum (0.47mg/l), Cadmium (0.02mg/l) and Chromium (0.0003mg/l). The mean concentration for sediments include pH (5.95), temperature (26.200c), Nitrate (10.3mg/l), Sulphate (1.105mg/l), phosphate (2.43mg/l), Iron (0.73mg/l), Copper (1.42mg/l), Manganese (0.34mg/l), Lead (1.56mg/l), Cadmium (0.04mg/l) and Chromium (0.005mg/l).
Key words: Imo River, water, sediments, parameters.

Introduction
Water is an essential natural resource, a primary need of man in his environment and essential for his sustenance (Ajayi and Osibanjo,1981). Water quality describes the physicochemical and biological characteristics of water and its suitability for a particular purpose (Corke and Doornkamp, 1974). Majority of surface waters in Nigeria are negatively affected by human activities such as human excrement on the surface water and disposal of domestic waste untreated (Udosen, 2004). Imo River is used by the rural dwellers as source of drinking water, bathing and other domestic uses. However the steady growth in population and industrial activities has impacted negatively on the water quality (Obunwo et al, 2004). The water need of Owerri, Imo state capital is expected to rise to about 11.4millons m^3/per day in coming years (Egejuru, 1987). The indiscriminate discharge of effluent by cottage industries in the state untreated and failure of enforcement by government agencies poses a challenge to demand for safe and good water (Ibe and Njemanze, 1998). The continuous growth in population and impact of these industries will continue to exert pressure on water resources of the area, change the physicochemical variables and pose a threat to the health of the communities (Harrison, 1990). This results in the deterioration of the water quality which in turn affects aquatic ecosystem, recreational values and pollute the groundwater deposits (Benka-Coke and Ojior, 1995). It is essential natural resources are exploited rationally and conserved at regional and local levels (Ademoroti, 1996).

Methods
Study Area
Imo river is located in Ngor Okpala local Government Area of Imo state, Nigeria (Fig 1), with an area of 561km^2 and a population of 159,932 (National Population Commission, 2006 census). The inhabitants are mostly farmers and Fishermen. The Imo River is being investigated to know the concentrations of the physicochemical parameters of the river as a result of human activities like farming, quarrying, industrializations etc and the effects on the use of this water.
Fig.1 and Fig. 2 show location of the river in the lower southern-eastern region of Nigeria. The basin is moderately high plain with the land suitable for agriculture and industrial activities. Land ownership system, farming system, poor planning and relatively small land mass with high population density and growth are probably responsible for location of pockets of farmland at close vicinity to residential and industrialization areas. This situation and poor waste disposal system enhance pollution risks in the basin (Sikoki and Zabbey,2006)

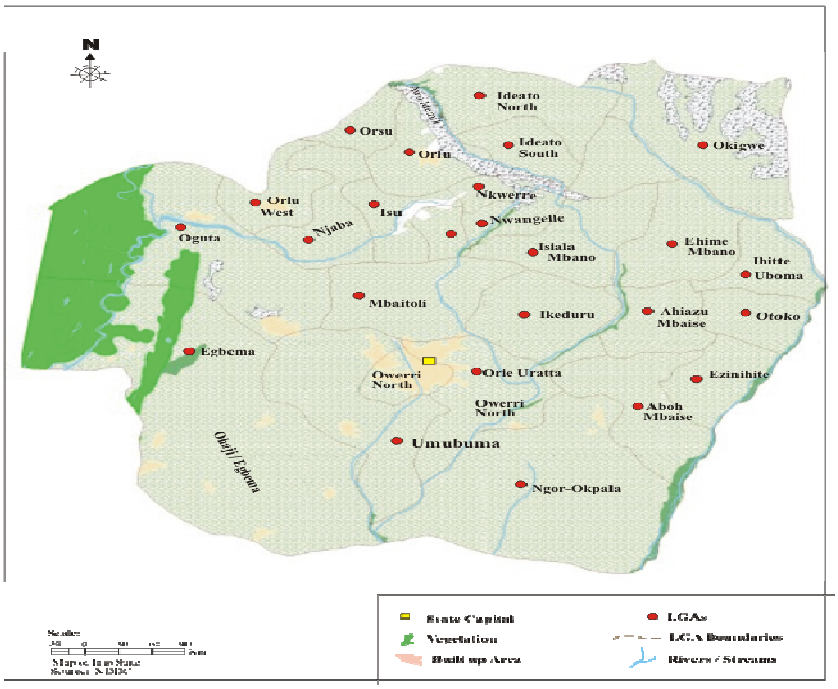

Fig. 1. Map of Imo State Showing the study area

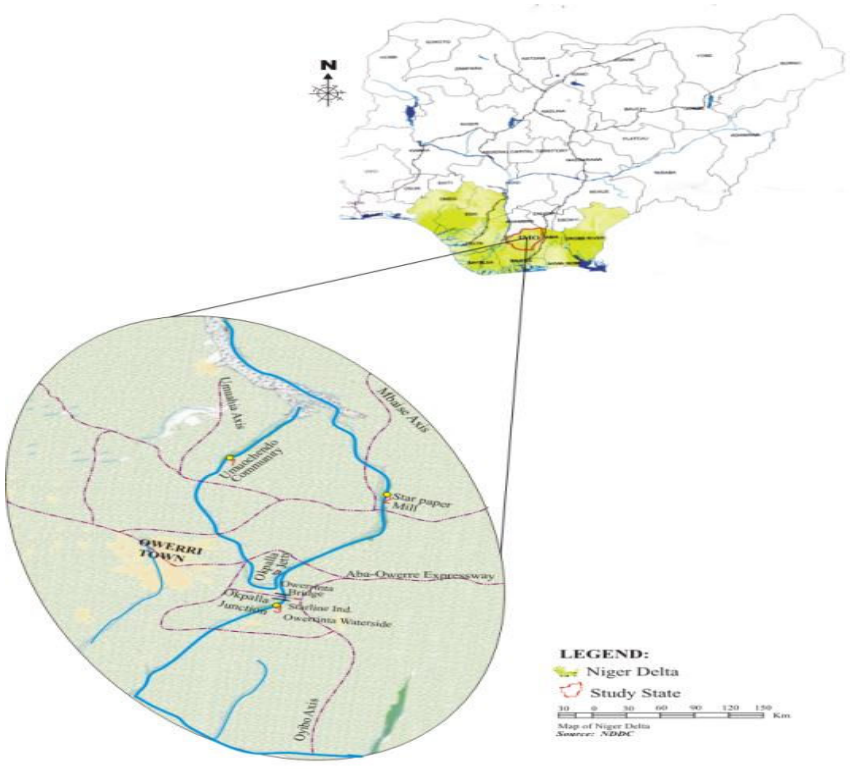

Fig. 2. Map of Nigeria, Imo State showing the Study Locations

Sampling procedure.

Surface water samples were collected in the rainy season month of June, 2011. Three sampling stations were selected on a section of the river (station A, B, and C). Station A was the upstream where the human activities were minimal. Station B was the discharge point where effluents from a cottage industry are discharged, station C is the downstream. The choice of the stations was to compare the impact of the identified physicochemical variables on the sections of the river. The parameters studied include; temperature, pH, Total Dissolved Solids,

Total Suspended Solids, Turbidity, Nitrates, Phosphates, Iron, Copper, Manganese, lead, Aluminum, Chromium, Cadmium, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) for both water and sediment samples. After collection the samples were taken to the laboratory for analysis.

Analysis of Samples

Temperature was measured in situ using thermometer. pH was determined for both sediment and surface water using suntex pH meter by inserting the probe inside the container for some minutes until the reading became stable. Electrical conductivity concentration was determined by the use of conductivity meter while multi probe meter was dipped into the beaker containing the samples to take TDS readings. The data logging spectrophotometer model DR 2010 was used to determine the concentration of the following parameters by entering their respective program and wavelength numbers: Total suspended solids, Turbidity, Nitrates, Phosphates, Iron, Copper, Manganese, lead, Aluminium, Chromium, and Cadmium. The Dissolved Oxygen, DO was determined by measuring the sample with Jenway model 9071 water proof meter by inserting the probe into the container and the value displayed digitally.

The Biochemical Oxygen Demand, BOD was determined using the dilution method after 5-day incubation period. The value of the Dissolved Oxygen before incubation subtracts the value after the five days to determine the BOD values in mg/liter(APHA, 1992).

Statistical analysis

The data obtained for the various parameters were subjected to statistical tools of mean, standard deviation, ANOVA, correlation matrix at significant difference of $P \leq 0.05$ and $P \leq 0.05$.

Results

The data of the results of the water and sediment samples analyzed were shown on tables 1 and 2; while the statistical description are on tables 3 and 4.

Temperature varied from 26.00 – 26.30[26.13±0.09]^{0}c. the pH varied from 5.84 – 6.48[6.2467±0.20], while conductivity of the sample varied from 195.00 – 232.00[217.33±11.34] µS/cm. Total Dissolved Solids varied from 92.50 – 166.00[123.67±21.94]mg/L. Colour varied from 173.00 – 514.00[287.67±11.17]Ptco. Also turbidity varied from 6.00 – 305.00[105.67±99.67]mg/L, Total suspended solid varied from 15.00 – 172.00[67.67±52.17]mg/L.

The table also shows some variation of the nutrients present in the water like Nitrate which varied from 2.30 – 5.70[3.93±0.98]mg/L, Sulphate varied from 5.00 – 7.00[5.67±0.67]mg/L, and Phosphate varied from 0.06 – 0.86[0.34±0.26]mg/L. Aluminum varied from 0.24 – 0.61[0.48±0.12]. Heavy metals such as Cadmium varied from 0.001 – 0.006[0.003±0.002] and Chromium varied from 0.00 – 0.001[0.0003±0.0033]. Iron varied from 0.35 – 0.66[0.49±0.09] mg/L; copper varied from 0.92 – 1.16[1.06±0.07]mg/L; Manganese varied from 0.06 – 0.12[0.08±0.02], Lead varied from 0.63 – 1.18[0.99±0.18].

DO varied from 3.6 – 5.80[4.5±0.67]mg/L; BOD varied from 9.30 – 16.70[12.13±2.3] and Lead varied from 0.63 – 1.18[0.99±0.18]

Table.2 shows the variations in the physicochemical parameters of the sediment samples at the upstream, the midstream and downstream stations of Imo River.

Temperature varied form 26.10 – 26.40[26.20±0.10]^{0}c; pH of the stream varied from 5.00 – 6.45[5.9467±0.47]. Nitrate varied from 8.20 – 13.60[10.3067±1.67]mg/L while sulphate varied from 7.00 – 10.70[8.5667±1.11]mg/L as well as phosphate which varied from 1.13 – 3.12[2.433±0.65]mg/L. The variations in the range of concentrations of heavy metals were as follows; Iron varied from 0.61 – 0.85[0.7333±0.69]mg/L, Copper varied from 1.32 – 1.58[1.42±0.008]mg/L; Manganese varied from 0.15 – 0.48[0.3433±0.99]mg/L, also Lead varied from 1.24 – 1.98[1.56±0.16]mg/L. Cadmium varied from 0.01 – 0.07[0.4±0.02]mg/L and Chromium varied from 0.001 – 0.008[0.005±0.002]mg/L.

TABLE 1. The analytical results of water samples at different stations and the WHO/FMENV (2003) standards

S/NO	PARAMETERS	WHO/FMEVN STD (2003)	UPSTREAM	MIDSTREAM	DOWNSTREAM	PORTABLE
1.	Temperature	20-30	26.1	26.3	26.00	26.5
2.	pH	6.5-8.5	6.24	5.84	6.48	6.7
3.	Conductivity [μS/cm]	100	195	225	232	38
4.	TDS [mg/l]	250	92.5	112.5	166	19
5.	Colour [Ptco]	18	176	514	173	2
6.	Odour	Odourless	odourless	unpleasant	Unpleasant	odourless
7.	Appearance	Clear	Clear	Clear	Brownish	Clear
8.	Turbidity [NTU]	50	6	305	6	1.0
9.	TSS [mg/l]	50	16	172	15	3
10.	Nitrate [mg/l]	40	2.3	5.7	3.8	3
11.	Sulphate [mg/l]	240	5	7	5	1.0
12.	Phosphate [mg/l]	5	0.06	0.86	0.09	0.11
13.	Iron [mg/l]	1.0	0.47	0.66	0.35	0.12
14.	Copper [mg/l]	0.3	0.92	1.16	1.11	0.16
15.	Manganese [mg/l]	0.4	0.06	0.12	0.07	0.21
16.	DO [mg/l]	>4.0	5.8	3.6	4.1	4.6
17.	BOD [mg/l]	40	9.3	16.7	10.4	1
18.	Lead [mg/l]	0.05	0.63	1.18	1.15	0.01
19.	Aluminum [mg/l]	5	0.58	0.24	0.61	-
20	Cadmium [mg/l]	0.05	<0.001	0.006	0.001	0.0
21.	Chromium[mg/l]	-	BDL	<0.001	BDL	BDL

TABLE 2 The analytical results of sediments at different location points and WHO/FMENV (2003)

S/NO	PARAMETERS	WHO/FMENV (2003)	UPSTREAM	MIDSTREAM	DOWNSTREAM
1.	Temperature	20 – 30	26.1	26.4	26.1
2.	pH	6.5 – 8.5	6.39	5.00	6.45
3.	Conductivity [us/cm]	100	215	264	270
4.	TDS [mg/l]	250	107.5	132	135
5.	Colour [Ptco]	15	487	1243	325
6.	Nitrate [mg/l]	40	8.2	13.6	9.12
7.	Sulphate [mg/l]	240	10.7	17	8
8.	Phosphate [mg/l]	5	1.13	3.12	3.05
9.	Iron [mg/l]	1.0	0.61	0.85	0.74
10.	Copper [mg/l]	0.3	1.32	1.58	1.38
11.	Manganese [mg/l]	0.4	0.15	0.48	0.40
12.	Lead [mg/l]	0.05	1.24	1.66	1.78
13.	Cadmium [mg/l]	0.05	0.01	0.07	0.04
14.	Chromium [mg/l]	-	<0.001	0.008	0.006

TABLE 3. Descriptive statistics of physicochemical parameters of water sample across sampling location of Imo River.

PARAMETERS	MIN. VALUE	MAX. VALUE	RANGE	MEAN	SE
Temp (0c)	26	26.3	0.3	26.1333	0.8819
pH	5.84	6.48	0.64	6.2467	0.20407
Conductivity µs/cm)	195	232	37	217.3333	11.34803
TDS (mg/L)	92.5	166	73.5	123.667	21.93994
Colour (Ptco)	173	514	341	287.6667	113.17
Turbidity (mg/L)	6	305	299	105.6667	99.6667
TSS (mg/L)	15	172	157	67.6667	52.16747
Nitrate (mg/L)	2.3	5.7	3.4	3.9333	0.98376
sulphate (mg/L)	5	7	2	5.6667	0.6667
Phosphate (mg/L)	0.06	0.86	0.8	0.3367	0.2681
Iron (mg/L)	0.35	0.66	0.31	0.4933	0.09025
Copper (mg/L)	0.92	1.16	0.24	1.0633	0.07311
Manganese (mg/L)	0.06	0.12	0.06	0.0833	0.01856
DO (mg/L)	3.6	5.8	2.2	4.5	0.66583
BOD (mg/L)	9.3	16.7	7.4	12.1333	2.30531
Lead (mg/L)	0.63	1.18	0.55	0.9867	0.17854
Aluminium (mg/L)	0.24	0.61	0.37	0.4767	0.11865
Cadmium (mg/L)	0.001	0.006	0.005	0.00267	0.001667
Chromium (mg/L)	0	0.001	0.001	0.00033	0.0033

SE = Standard Error

TABLE 4. Descriptive statistics of physiochemical parameters of sediment samples across sampling location of Imo River

PARAMETER	MIN. VALUE	MAX. VALUE	RANGE	MEAN	SE
Temp (^{0}c)	26.1	26.4	0.3	26.2	0.1
pH	5	6.45	1.45	5.9467	0.47365
Nitrate (mg/L)	8.2	13.6	5.4	10.3067	1.66795
Sulphate (mg/L)	7	10.7	3.72	8.5667	1.10504
phosphate (mg/L)	1.13	3.12	1.99	2.4333	0.65198
Iron (mg/L)	0.61	0.85	0.24	0.7333	0.6963
Copper (mg/L)	1.32	1.58	0.26	1.42	0.08083
Manganese (mg/L)	0.15	0.48	0.33	0.3433	0.09939
Lead (mg/L)	1.24	1.78	0.54	1.56	0.16371
Cadmium (mg/L)	0.01	0.07	0.06	0.04	0.1732
Chromium (mg/L)	0.001	0.008	0.007	0.005	0.002082

SE = Standard Error

Discussion

Variations in the water temperature and pH Of Imo River across the sampling location.

Temperature recorded the highest value at midstream (26.30^{0}c). The pH had the lowest value of 5.84 at the midstream (discharge point) indicating acidity. This shows that the effluents discharged into the river from the industrial activities around the watershed are organic in nature (Phiri et al, 2005). This pH value in comparison with the potable water indicates that the water from Imo River in this original form is not safe for drinking (FEPA, 1991).

The conductivity values at the three sampling stations exceeded the WHO/FMENV standard which shows that the activities taking place at the bank of Imo River elevated the quantity of dissolved salts present in the water body. The concentrations of the conductivity and TDS were lowest at the upstream and highest at the downstream; hence conductivity is approximately proportional to the TDS content. The levels of turbidity, colour and Total Dissolved Solids, TDS were highest at the midstream and exceeded the WHO/FMENV acceptable limits. Turbidity is a measure of the dispersion of light in a column of water due to suspended matter. The higher the turbidity, the cloudier the water appears (Akeredolu,1991).If water becomes too turbid, it looses the ability to support a wide variety of plants and other aquatic organisms. The activities in Imo River give rise to high concentrations of suspended solids leading to high turbidity and colour at the midstream (discharge point). The concentrations of Nitrate, Sulphate and Phosphate were within WHO/FMENV acceptable limits though highest at the midstream. The metals and heavy metals concentrations lie within acceptable limits of WHO/FMENV safe limits except lead which exceeded the limits at all the stations.

The Dissolved Oxygen, DO level was lowest at the midstream and below safe limits of WHO/FMENV; while Biochemical Oxygen Demand, BOD was highest at the midstream. DO is indirectly proportional to BOD (Braide et al 2004). The large amounts of degradable organic materials at the midstream resulted to low level of Dissolved Oxygen, DO (McNeely et al;1979).

Conclusion

Effluents of the industrial and human activities on the banks of Imo River altered the quality of the river negatively at the midstream station close to the discharge point. The effluents are acidic at this point. The concentrations of turbidity, TSS, and DO show that the river is not fit for drinking without treatment; and the river cannot support aquatic life sufficiently. These results show that the river is polluted by activities taking place at the paper mills ,cosmetic company and other companies along the bank as well as urban run-off .If these activities go on unregulated the water quality of Imo River will further be deteriorated.

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