



Physicochemical and Heavy Metal Assessment of the Udu River, Delta State, Nigeria

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ABSTRACT: The Udu River is a major source of commerce and provides water for agricultural and domestic use to the Udu people, hence we studied the physicochemical parameters (pH, electrical conductivity, TSS, TDS, turbidity, Salinity, DO, COD, BOD, chlorides, sodium, potassium, total hardness, alkalinity, nitrates, ammonium, sulphates) as well as the evaluation of the degree of metal contamination (iron, zinc, cadmium, nickel, copper and lead) present in the samples. The analyses carried out revealed water samples were acidic, pH below 7, temperature ranged from 29.5 °C - 32.7 °C which was above WHO permissible limit 25°C, low levels of Dissolve oxygen DO (DO: max = 6.5 mg/L below WHO limit of 7.5 mg/L) and BOD ranges did not exceed the suggested 4.5mg/L (WHO max. limit). Concerning the heavy metals, the examined results showed lead, nickel, copper and zinc all below the WHO max limit. A significant increase in the concentration of Iron was noticed in Ovwian sampling site, also there was also build of cadmium above WHO limit 0.003mg/L at Igbogidi.

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Water constitutes an integral part of man's life as well as the earth surface; hence continuous research is imperative to ascertain its quality due to one form of human activity or the other. In many locations the contamination of surface and sub- surface waters by domestic and industrial waste causes great environmental challenges Prescott *et al.*, (2000).

Water (saline water) makes up approximately 97% of the water in the earth, while the other 3% of the earth's water is fresh water contained in rivers, lakes and ground water from which human and animals get their water supply Al-Ghamdi *et al.*, (2014) Only about 0.25% of the earth fresh water is surface water contained in rivers, ponds, dams, streams and lakes (El-Dessouki and Ettouney, 2002; Kalogirou, 2005; Eltawil *et al.*, (2009).

The Udu River is of great importance to the people of Udu whose main occupation is fishing and agriculture. The River is a source of sea food, water for farmers of channel fish ponds and domestic purposes. Recent trends like the loss of commercial fishes, contaminated sea foods, species extinction and the alteration in the water quality has increased anxiety of the rural inhabitant, as such the study to know the physicochemical and heavy metal characteristics of

the river is a prerequisite to the people of Udu local government Area.

MATERIALS AND METHODS

Description of study area: The Udu River which is a large tributary of the Warri River is located at Udu local government area of Delta state and spans over 48km². The river has its source from Aboh in Delta North between longitude 6.20°N and latitude 5.45°E and flows southwest where it is joined by a large number of creeks from where it empties into the very brackish Forcados River and finally into the Atlantic Ocean (Udo, 1975).

Sample collection and preparation: Samples for both physicochemical and heavy metal analysis were collected directly from the different River locations (Aladja, Oleri, Opete, Ovwian, Udu Bridge, Eket, Igbogidi and Ogbe- Ijaw) into 750ml water cans that were washed clean and rinsed with sample water. The pH and temperature were taken on site with a pH meter Model Testr-1 and the electrical hand thermometer respectively. Samples for heavy metal analyses were pre- concentrated and made acidic by adding 0.75ml of 0.1M HNO₃ solution and covered immediately.

Physicochemical/heavy metal analysis: All field meters and equipment were checked and appropriately

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calibrated according to the manufacturers' instructions. The physicochemical parameters of water quality comprising of temperature, pH, turbidity, total suspended solid, total dissolve solid, hardness, magnesium hardness, salinity, conductivity, sulfate (SO₂-) phosphate (PO₄), nitrate (NO₃-), nitrite(NO₂-)

ammonia (NH₃), biological oxygen demand (BOD) and chemical oxygen demand (COD), Heavy metal concentrations, including cadmium (Cd); copper (Cu); aluminium (Al); lead (Pb); Zinc (Zn); mercury (Hg); Iron (Fe) and Manganese (Mn) were analysed using the APHA, 2006 methodology.

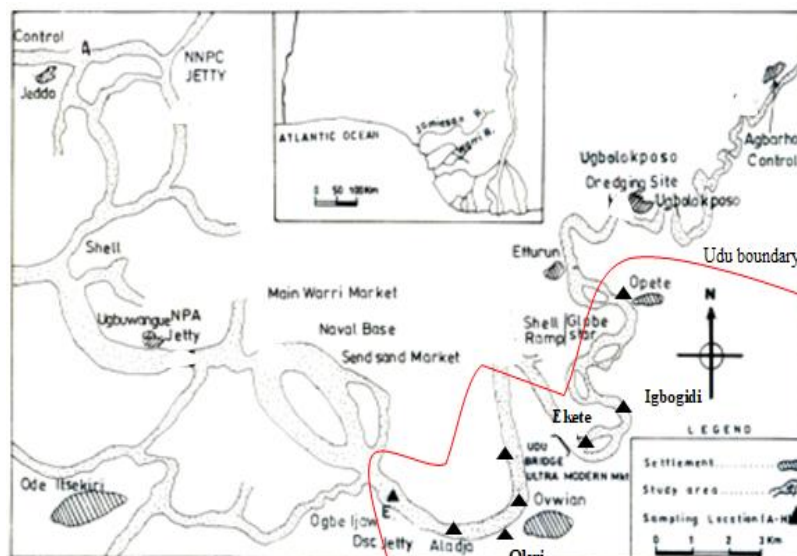


Fig. 1: Map of study area indicating sampling points (modified from the N. P.A., 2005)

RESULTS AND DISCUSSION

Hydrogen potential: The pH value in this study ranged from 5.87 to 6.32 at all locations, which is low, slightly acidic and all fell below the (World Health Organisation) WHO, 2011 pH value lower permissible limit of 6.5. This is similarly to Aghoghovwia, 2014 findings and corroborates the claim of Enujiugha and Nwanna (2004) that a high organic content will tend to decrease the pH because of the Carbonate chemistry. The results are similar to those of the Udu River because of the close proximity of the water bodies.

Temperature: Table 1 showed a temperature range from 29.50 °C -32.70°C that is higher than the WHO (2011) permissible limit of 25°C. Ovwian had the highest temperature this could be because of the proximity of the sampling point to the Ovwian market and the effluent discharge point from Premium Steel Company, which usually has higher temperature than recipient water. Increased temperature increases the rate of chemical reactions and decreases solubility of gases (especially oxygen) in water. Respiration value of aquatic organisms increases leading to increased oxygen consumption and increased decomposition of organic matter Enujiugha and Nwanna (2004). This is evident in this study as the study area samples are low in dissolved oxygen, with attendant high temperature.

Total Dissolve Solid: TDS levels in study area ranged from 23.80 - 49.70 mg/L, which are within maximum permissible limits WHO, 2011 of 500mg/L. Seiyaboh *et al.* (2013) reported a similar average TDS value.

Conductivity: Conductivity readings from the 8 samples site ranged from 40.11-73.84(µs/cm) and an average value of 52.56 µs/cm which were below the WHO max. limit of 250 µs/cm.

Total suspended solid: TSS had an average value of 24.75 mg/L and ranged from 15 mg/L- 45mg/L. Three sampling points Aladja, Oleri and Ogbe-Ijaw were above the WHO maximum permissible limit of 20mg/L.

Turbidity: Turbidity measurement had similar trends with the TSS with locations Aladja, Oleri and Ogbe-Ijaw all higher than the WHO maximum permissible limit of 25 NTU. Ovwian had the lowest Turbidity of 11.91 indicating that the river water at Ovwian is clearer and less cloudy than the others.

Sulphate: From Table 1, the sulphate concentration ranged from 0.30- 0.92mg/L and shows that the WHO maximum permissible limit of 250 mg/L was not breached by any of the samples collected from the eight locations.

Phosphate: concentration ranged from 0.11- 0.57 mg/L and well below the WHO permissible limit of 1.0 mg/L.

Nitrate: nitrates concentration in the sampling points ranged from 0.11-0.31mg/L well below the permissible limit of 50mg/L. These low concentrations may be due to utilization by the species in absence of sufficient oxygen, which proves Clinton and Kathy work of 2003 that phosphate concentration is directly proportional to nitrate concentration.

Alkalinity: From the table shows that Aladja has the highest concentration of 9.26 mg/L, followed by Eketé with 8.41 mg/L and Oleri with 8.32 mg/L and lowest at Udu Bridge with a concentration of 3.19 mg/L.

Total hardness (TH): TH is very important in the physicochemical analysis of any water analysis. It is an indication of the ability of the water to form lather when soap is applied. The total hardness value comprises on the calcium and magnesium content of the water. Table 1 show that TH ranged from 15-

35mg/L which are all below the WHO permissible limit of 75 mg/L.

Dissolved Oxygen: Dissolved oxygen (DO) recorded in the study area ranged from 3.10 mg/L- 6.50mg/L and below the WHO minimum recommended standard of 7.50mg/L. this is similar to studies carried by Tesi *et al.*, (2019). The low DO values obtained in this study may be attributable to high organic matter content which high microbial oxidation Prasanna and Ranjan, 2010; Mandal *et al.*, (2011).

Biological oxygen Demand: this is a very important with a WHO maximum permissible limit of 4.00 mg/L. The values recorded in the study area ranges from 0.79 mg/L -1.50 mg/L.

These were all below the WHO maximum limit which according to Vowels and Connel (1980) and Mara,1983 classification of aquatic pollution with respect to BOD puts the Udu river between non-polluted and moderately polluted in some sample points.

Table 1- Result of River Water analysis (Study Area)

S/N	Parameters	Eketé	Ogbe- ijaw	Ovwian	Opete	Udu Bridge	Aladja	Oleri	Igbogidi	WHO Standard (2011)
1	pH	6.15	6.19	5.98	6.02	5.87	6.32	6.09	5.96	6.5- 8.5
2	Temp. (°C)	30.80	29.50	32.70	30.10	32.60	29.70	30.80	31.90	25.00
3	TDS (mg/L)	43.40	49.70	27.30	23.80	28.30	37.70	26.81	28.70	500
4	COND (µs/cm)	70.21	73.84	49.82	40.11	47.29	55.28	42.31	41.62	250
5	DO (mg/L)	4.60	3.10	5.30	4.20	6.20	6.50	4.90	6.10	7.50
6	BOD ₅ (mg/L)	1.20	1.50	0.97	1.10	0.83	0.79	1.20	0.97	4.00
7	TSS (mg/L)	15.00	45.00	15.00	20.00	18.00	40.00	30.00	15.00	20.00
8	Turbidity (N.T.U)	14.09	39.77	11.91	17.44	16.14	38.21	27.85	14.78	5 – 25
9	Salinity (mg/L)	11.26	12.35	6.45	5.28	6.61	7.43	5.98	6.06	
10	Sulphate (mg/L)	0.90	0.92	0.71	0.55	0.59	0.51	0.39	0.43	2.50
11	Phosphate (mg/L)	0.43	0.57	0.22	0.19	0.12	0.27	0.11	0.25	1.00
12	Nitrate (mg/L)	0.29	0.31	0.16	0.21	0.15	0.19	0.11	0.15	50.00
13	Alkalinity(mg/L, as CaCO ₃)	8.41	7.71	3.45	3.97	3.19	9.26	8.32	3.33	
14	Total hardness (mg/L)	32.0	29.0	17.0	15.0	19.0	35.0	20.0	18.0	75.00
15	Calcium (mg/L)	7.56	6.64	3.29	2.85	4.41	6.67	4.98	3.75	5.00
16	Magnesium (mg/L)	3.27	2.81	1.43	1.27	2.02	2.54	1.85	1.21	50.0
17	COD (mg/L)	2.54	3.42	2.33	2.74	2.08	1.76	2.64	2.39	10.0
Heavy Metals										
18	Lead (mg/L)	0.004	<BDL	<BDL	0.001	<BDL	<BDL	<BDL	<BDL	0.01
19	Cadmium (mg/L)	<BDL	<BDL	<BDL	<BDL	<BDL	0.001	<BDL	0.003	0.003
20	Iron (mg/L)	0.026	0.005	0.011	0.009	0.045	0.002	<BDL	0.008	0.03
21	Copper (mg/L)	0.019	0.008	<BDL	0.005	0.013	0.007	0.004	0.001	0.05
22	Zinc (mg/L)	0.307	0.514	0.227	0.083	0.065	0.027	0.109	0.221	3.00
23	Nickel (mg/L)	<BDL	0.001	<BDL	<BDL	<BDL	<BDL	<BDL	<BDL	0.006

BDL - Below Detection Limit, i.e. <0.001

Chemical Oxygen Demand: COD of the water samples presented in the Table 1 ranged from 1.79 –

3.42 mg/L and the entire sampling site concentration were all below the maximum permissible limit of 100 mg/L. COD values were higher than their

corresponding BOD values in the sampling sites. This may be attributable to the ratio of all oxygen oxidizable organic to all oxidizable organics as COD measures all the oxidizable organics while BOD measures the oxygen available for biological activities Okorafor *et al.*, (2013).

Heavy metal: The heavy metal tested (Iron, lead, Nickel, copper, zinc and cadmium) were below detectable limit and therefore below the maximum permissible limit of the WHO, except for iron and cadmium. Iron had significant build-up of 0.045 mg/L in Udu Bridge which could be caused by the production of barges along the shore line by Petroleum Training 1 Construction Company. Cadmium also had a build at the Igbogidi sampling point this might be as a result of the dumpsite up river in the Igbogidi town.

According to Damaskos and Papadopoulos (1983), the generally accepted indicators of water quality are dissolved oxygen and the biological oxygen demand; High oxygen depletion can be so severe as to affect fish life. If DO values fall below the minimum oxygen requirement for the particular species of fish, they are subjected to stress, which can result in mortality. The oxygen content of natural waters varies with temperature, salinity, turbulence, the photosynthetic activity of algae and plants, and atmospheric pressure Enjiugha and Nwanna (2004).

Conclusion: This study was to assess the physicochemical and heavy metal properties of the Udu River. The water samples analysed were within the permissible limit for potable water as recommended by WHO apart from instances such as pH and temperature, TSS, Iron and Cadmium concentrations at some sampling points which did not conform to standard. As such the water is not suitable for drinking without appropriate treatment and waste water disposal from industrial sites should be monitored as this may be the cause of high water temperature.

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