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The Analysis of Selected Physico-Chemical Parameters of Water (A Case Study of ISU and Calabar Rivers in Ebonyi State, Nigeria)

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Abstract: *Physicochemical parameters of Isu and Calabar rivers of Ebonyi State, Nigeria were evaluated and compared with known standard (WHO standard for drinking water). The result obtained showed; pH (6.5-6.8), turbidity (2.8-3.2 NTU), conductivity (120-160µs/cm), alkalinity (5.93-7.32 mg/l), TS (0.23-0.30mg/l), TDS (0.10-0.19 mg/l), TSS (0.09-0.13 mg/l), CI(0.14-0.18mg/l), SO4 (0.25-0.32 mg/l), Nitrate (0.288-0.440 mg/l), phosphate (0.033-0.227 mg/l), Pb (0-0. 40 mg/l), Cd (0-0.6mg/l), Cr(0-0.06 mg/l), Cu (0.10-1.60 mg/l) and As (0-0.04 mg/l) . Most of these measured parameters conforms to the WHO drinking standard while parameters like Pb with the value of 0.12mg/l, Cd at the upstream and downstream of Calabar river, As with value of 0.04mg/l for Isu river and 0.03mg/l for Calabar river, Turbidity of Isu river with values from 5.98 to 5.93mg/l, Cr with value 0.06mg/ at the downstream of Isu river, where all relatively above/higher that the WHO standard for drinking water.*

Keywords: *Isu, Calabar, rivers and physicochemical parameters.*

I. Introduction

A river is any natural stream of water that flows in a channel with defined banks. Modern usage includes rivers that are multi-channelled surface flow, however, remains central to the definition. The word stream emphasizes the fact of flow; as a noun, it is synonymous with river andis often preferred in technical writing (Lawson, 2011: Adeyemo et al., 2008). Rivers are nourished by precipitation, by direct overland runoff, through springs and seepages, or from melt-water at the edges of snowfield and glaciers. The contribution of direct precipitation on the water surface is usually minute, except where much of a catchment area is occupied by lakes. River water losses result from seepage and percolation into shallow or deep aquifers (permeable rock layers that readily transmit water) and particularly from evaporation. The difference between the water input and loss sustains surface discharge or stream flow. The amount of water in river systems at any time is but a tiny fraction of the Earth’s total water; 97 percent of all water is contained in the oceans and about three-quarters of fresh water is stored as land ice; nearly all the remainder occurs as groundwater. Lakes hold less than 0.5 percent of all fresh water, soil moisture accounts for about 0.05 percent, and water in river channels for roughly half as much, 0.025 percent, which represents one four-thousandth of the Earth’s total fresh water (Arain et al., 2008; Adefemi and Awokunmi, 2010; Nduka, 2008; Bellingham, 2012).

Rivers have been of fundamental importance throughout the human history. Water from the rivers is a basic natural resource, essential for various human activities. Therefore, the river banks have attracted settlers from ancient times. These settlements have now become big cities. Using rivers for irrigation, navigation, hydro-power generations of special significance for country like India, where agriculture is the major source of livelihood of the majority of its population (Lawson, 2011).

Natural resources are one of the important wealth of our country, water is one of them. Water is a wander of the nature. “No life without water” is a common saying depending upon the fact that water is the one of the naturally occurring essential requirement of all life supporting activities (Basavaraja, 2011). Since it is a dynamic system, containing living as well as nonliving, inorganic, soluble as well as insoluble substances. So its quality is likely to change day by day and from source to source. Any change in the natural quality may disturb the equilibrium system and would become unfit for designated uses. The availability of water through surface and groundwater resources has become critical day to day. Only 1% part is available on land for drinking, agriculture, domestic power generation, industrial consummation, transportation and waste disposal (Adefemi and Awokunmi, 2010).

Rivers have always played a prominent role in human civilization. When people first began settling in one place and growing crops for sustenance, it was invariably near water sources like rivers, lakes, or groundwater springs. Water was needed for drinking, preparing food, bathing cleaning, irrigating crops, and a variety of other tasks, so it was important to have ready access to this resource. Rivers of good drinking quality is of basic importance to human physiology and man's continued existence depends on its availability (Lamikaran, 1999). The provision of potable water to the rural and urban population is necessary to prevent health hazards (Nikoladze and Akastal,1989).

In the recent years, the availability and access to fresh water has become the most critical issue in the world. Freshwater is essential to human health, agriculture, industry and natural ecosystems, but is now running scarce in many regions of the world (WWF, 1998). The desirable properties of water quality should include adequate amount of dissolved oxygen, relatively low organic content, pH value near neutrality, moderate temperature, and free from excessive amount of infectious agents, toxic substances and mineral matter (Oluyemi et al., 2010). Potable water should be free from disease producing microorganisms and chemical substance that are dangerous to health (Lamikaran, 1999, shittu, 2008). Majority of the rural people do not have access to potable water and therefore, depend on well, stream and river waters for domestic use. Excessive use of limited water resources, disposal of various industrial effluents, human wastes into water may release heavy metals, which harm both human and animals health (Singh, and Mosley, 2003). Heavy metals are released into water bodies such as streams, lakes, rivers and ground water by either natural processes or anthropogenic sources (Kanu et al., 2006; Sattler, 2004). Ibe and Duruike, (2001) noted that soil is depleted of essential nutrients by erosion. Thus, as the soil becomes depleted of minerals, the water bodies becomes enriched. Continuous exposure of heavy metals to animals and humans cause hepatotoxicity and nephrotoxicity. So, periodical estimation of level of heavy metals in water is necessary.

There is a close relationship between heavy metal, ions and sediments, such as suspended particles, bed loads and bottom sediments, in natural water bodies such as lakes and rivers. Elevated salt concentration create increased competition between cations and metals for binding sites. Often metals will be driven off into the overlaying water. Many factors affect the adsorption of metals to soils and particles. The factors include pH and temperature. A lower pH increases competition between metals and hydrogen ion biding site. A decrease in pH may also dissolve metal carbonate complexes releasing free metal ions into water column (Lawson, 2011).

Agriculture is the major occupation of the people of Ebonyi state. The crops produced are yam, cassava, plantain, banana, maize, cocoyam. Others are palm produce, cocoa and rubber. It is a leading producer of rice, yam, potatoes, maize, beans and cassava. Rice and yams are predominantly cultivated in EDDA. This makes the needs for surface waters (rivers) used for irrigation purposes a must in the state (Omaka, 2007).

Rivers have remained important through the ages. Generally, the economical roles of rivers are as follows (Lawson, 2011):

a) The areas along the banks of rivers have witnessed great cultural and economic progress since ancient times.
b) Rivers are integral parts of our folklore and folk-songs
c) Rivers water is a basic natural resource
d) It is essential for human, agricultural and industrial activities.
e) Rivers deposits alluvial soils.
f) They provide the most productive agricultural lands to the country.
g) Farmers get irrigation water from rivers. Hence rivers are the backbone of the development of the nation's agriculture.
h) Rivers valleys have dense cities are located on the banks of rivers.
i) Most of the large cities are located on the banks of rivers.
j) Rivers provide us with essential water supplies.
k) They also receive, dilute and transport wastes from settlements. Hence they prove to be biggest cleaners to towns and cities.
l) Industrial development has flourished along rivers because numerous industrial processes depend on water.
m) Water is used as raw material.
n) It is used in generation of electricity.
o) Rivers provide primary channels of inland waterways in the form of navigable waterways.
p) Rivers are also being used for recreation; tourist promotion and fishing activities in a big way.

The main objective of this study was to determine selected water quality parameters viz., Total solids, Total dissolved solids, Total suspended solids, pH, sulphate, nitrate, phosphate, electrical conductivity, and heavy metal (Pb, Cu, Fe, Cr, and Cd) of Isu and Calabar rivers in Ebonyi state, Nigeria as recommended by world Health Organization.

II. Material And Methods

Study Area

Both Isu and Calabar rivers are located in Ebonyi state, with Isu situated in Isu village and Calabar river situated along the boundary between Ebonyi and Rivers state. The activities around and in both rivers are mainly farming fishing, swimming, washing of laundry, bathing, etc. The rivers is also use as a source of drinking water for the people of the state. The Calabar river is characterized with the presence of human settlement along the bank of the river, boats used by fishermen for fishing and a slaughter house. These occupants are mainly fishermen, farmers and labourers. The labourers convey the sand and sediments from the sea bed to the shores/bank of the river and are paid for their work by the tipper drivers who buy these sand from them. These various activities points out the economic importance of both rivers to the people of Ebonyi state.

III. Sample Collection And Preparation

Water from both Isu and Calabar rivers were collected in litre sample containers and preserved with 2M HNO3 to prevent it against bacteria attack. The sample while taken from five different spots in the study area one composite sample. 100ml of the sample was measured into a 250ml beaker. 5ml of 1:1 HCI was added and the beaker was placed on a steam bath and allowed to stand for 30minutes. The solution was filtered through a whatman No 1 filter paper into 100ml volumetric flask and the solution made up to mark with distilled water and then analysed.

IV. Methods

Determination Of Total Solids (Ts)

TS was determined by evaporated 100ml of the sample in a beaker on a hot plate. The beaker and residue were dried in a laboratory oven and allowed to cool in a dessicator. TS was calculated thus; TS = Weight of beaker and residue – weight of beaker

Determination Of Total Dissolved Solid (Tds)

TDS was determined by filtering 100ml of the sample through whatman filter paper. The filtrate was allowed to dry on a hot plate. The beaker and residue were allowed to dry in a labouratory oven and subsequently placed in a dessicator to cool. TDS was calculated thus; TDS = weight of beaker and residue – weight of beaker

Determination Of Total Suspended Solids (Tss)

TSS was determined thus; TSS = TS – TDS

Ph, Conductivity, Alkalinity, Temperature, Turbidity And Chloride

The pH was determined using a standard Techmel pH meter. 50ml of the sample was measured into a 100ml beaker and the pH electrode was dipped into the solution. The measurement was recorded. The conductivity was determined using a Hanna conductivity meter. As stated in pH determination. 100ml of the sample was titrated with 0.10M sulphuric acid, with two drops of phenolphthalein indicator to successive end point. Temperature was measured in situ using a digital temperature meter. Turbidity was measured using a Luton turbidimeter. Chloride was measured using a Luton chloride meter.

Sulphate Determination

100ml of the sample was measured into a 500ml volumetric flask and 5ml of 2M HCI was added. The solution was boiled down to 50ml on a hot plate and Barium chloride was added to it until no more precipitates were formed. The solution was filtered through a whatman filter and dried in an oven. The difference in the weight of filter paper was noted.

Nitrate And Phosphate Determination

Nitrate and phosphate were determined using the methods described by APHA, 1998. PD303 UV Spectrophotometer was the use in the determination of nitrate level.

Determination Of Metals

100ml of the sample was measured into a 250ml beaker. 5ml of 1:1 HCI was added and the beaker was placed on a steam bath and allowed to stand for 30minutes. The solution was filtered through a whatman No 1 filter paper into 100ml volumetric flask and the solution made up to mark with distilled water. The sample was analyzed for Pb, Cd, Cr, Cu and As, using a Unican Atomic Absorption Spectrophotometer at Project Development Institute, (PRODA).

V. Results And Discussion

Results For Physico-Chemical Parameters Of Isu River

Table 1 shows the physical parameters determined in Isu River.

Parameters	TS (mg/1)	TDS (mg/1)	TSS (mg/1)	Turbidity NTU
WHO standard	500	500		5.0
A1	0.30	0.18	0.12	2.8

A2	0.30	0.19	0.11	2.8
Mean	0.30	0.185	0.115	2.8
M.D	0	0.005	0.005	0
R.M.D (%)	0	2.7027	4.3478	0
S.D	0	0.0071	0.0071	0.

Note: A1 = Upstream
A2 = Downstream
M.D = Mean Deviation
R.M.D= Relative Mean Deviation
S.D = Standard Deviation
N.D = Not Detected

Table 2: shows the chemical parameters determined in Isu River

Parameters	pH	Conductivity (μs/cm)	Alkalinity (mg/1)	CI^- (mg/l)	SO_4^{2-} (mg/l)	NO^{3-} (mg/l)	PO^{3-}_4 (mg/l)	Pb (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	As (mg/l)
WHO Standard	6.5-8 .5			250	200	10	2	0.01	0.003	0.05	2.0	0.01
A1	6.5	130	5.98	0.15	0.36	0.440	0.068	ND	ND	0.04	0.50	ND
A2	6.7	130	5.93	0.14	0.25	0.406	0.033	0.12	ND	0.06	0.6	0.04
Mean	6.6	0	5.955	0.145	0.305	0.423	0.0505	0.06	0	0.05	0.55	0.02
MD	0.1	0	0.025	0.005	0.055	0.017	0.0175	0.06	0	0.10	0.05	0.02
R.M.D (%)	1.5152	0	0.4198	3.4483	18.0328	0.0240	34.6535	100	0	20	9.091	100
S.D	0.1414	0	0.0354	0.0071	0.0778	4.0189	0.0247	0.0849	0	0.0141	0.0707	0.283

Result For Pysico-Chemical Parameters Of Calabar River

Table 3: Shows the physical parameters of Calabar River

Parameters	TS (mg/l)	TSD (mg/l)	TSS (mg/l)	Turbidity NTU
WHO Standard	500	500	-	5.0
B1	0.27	0.18	0.09	3.0
B2	0.23	0.10	0.13	3.2
B3	0.30	0.19	0.11	3.3
Mean	0.267	0.157	0.11	3.167
M.D	0.0243	0.0377	0.0133	0.025
R.M.D(%)	9.1011	24.0127	12.0909	3.5049
S.D	0.0351	0.0493	0.02	0.1528

Note: **B1 = Upstream**
B2 = Midstream
B3 = Downstream

Table 4 shows the Chemical parameters determined in Calabar River

Parameters	pH	Conductivity (μs/cm)	Alkalinity	CI^- (mg/l)	SO_4^{2-} (mg/l)	NO^{3-} (mg/l)	PO^{3-}_4 (mg/l)	Pb (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	As (mg/l)
WHO Standard	6.5-8 .5			250	200	10	2	0.01	0.003	0.05	2.0	0.01
B1	6.5	160	6.98	0.14	0.32	0.324	0.227	ND	0.04	ND	1.20	ND
B2	6.5	160	7.32	0.18	0.32	0.288	0.018	0.40	ND	0.05	1.60	0.03
B3	68	120	5.96	0.16	0.34	0.425	0.083	ND	0.03	0.05	0.10	ND
Mean	6.6	146.667	6.753	0.16	0.327	0.3457	0.1093	0.133	0.023	0.033	0.967	0.01
M.D	0.1333	17.7777	0.529	0.0133	0.009	0.0529	0.0784	0.1777	0.01567	0.0223	0.5777	0.0133
R.M.D (%)	2.0197	12.1211	7.836	8.3125	2.7523	15.3023	71.729	7.0889	68.1304	70.6061	59.7415	133
S.D	0.1732	23.0940	0.7078	0.02	0.0116	0.07103	0.1070	0.3646	0.0131	0.0289	0.7768	0.0173

VI. Discussion

From the result it can be seen that most of the parameters of both river are within the WHO standard for drinking water (WHO, 2004; WHO, 2006) like; pH, CI, sulphate, Nitrate, phosphate, Cd of Isu river, Cu, TDS and TS. While Cr of the Calabar river is at the exact value with that of WHO standard for drinking water, which is 0.05mg/l and parameters like pb with the value of 0.12mg/l, Cd of Calabar river , As with value of 0.04mg/l for Isu river and 0.03mg/l for Calabar river, Turbidity of Isu river with values from 5.98 to 5.93mg/l, Cr with value 0.06mg/l at the downstream of Isu river.

VII. Conclusion And Recommendation

Conclusion

I thereby conclude that although some of the parameters of the parameters of both rivers conforms to the WHO standard for drinking water, it still needs to be treated since parameters like Pb, Cd, As and Cr all have values that are above the WHO standard for drinking water.

VIII. Recommendation

I then recommend that the government and various water agencies of Ebonyi state to set up a treatment plant where water from these rivers will be treated before made available to the people for drinking.

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