

Limnological Assessment of Abadaba Lake in Imo State, Nigeria

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Abstract

This work assessed the quality of the Adabada Lake in Ihitte Uboma Local Government Area of Imo State; Nigeria. Water samples were collected from sampling point A where residents draw water for domestic use and sampling point B close to shoreline where the Lake has initial contact with runoff. Samples were tested for temperature, turbidity, pH, conductivity, colour, TSS, TDS, DO, BOD, COD, sulphate, phosphate, nitrate, total hardness, total microbial load, total coliform count and Escherichia coli count, using standard methods. Laboratory analysis results obtained for sampling point A and B respectively were :Temperature (28,30),Turbidity (60,69), Colour, (25,29), TSS (54,58), Electrical conductivity (107,112), TDS (125,132), Total Hardness (265,266), Ph (5.8,5.6), Do (8,5), BOD (15,18), COD (3,4) Nitrate (47,60), Phosphate (6,6.9), Sulphahte (260, 265) Total Microbial Load(14,14.5), Total Coliform Count (3.6,4), Escherichia Coli Count (2.8,3). Correlation analysis between results of the samples A and B show strong positive relationship for variations in A and B ($R^2=0.9$). Water Quality Index analysis show that the Lake has poor water quality (WQI=37) using the Canadian Council of Ministers of the Environment Method. It is recommended that the Lake be environmentally renewed and beautified for aesthetics, recreation, irrigation and uses other than drinking.

Keywords: assessment, quality, lake, pollution.

1. Introduction

Water pollution is the addition of any agent whether chemical, physical and or biological that renders the body of water unfit for a specific use or re use (Galloway, 2003) ^[2]. According to Meybeck (1989), pollution occurs when waste matter is introduced in sufficient amount to alter the water quality and make it unsuitable for domestic or industrial supply or adequate support and growth for marine life. Sustainable water resources management have become an imperative as these vital resources become sink for waste generated in the increasing synthetic world (Fraser 1990) ^[6].

Cunningham (2004) ^[8]. Pointed out that physico-chemical parameters in aquatic ecosystem respond to nutrient enrichment, acidification and particulate Contamination. Lakes are inland depressions that held standing freshwater resulting from runoff or bound water or both all year round. They take depth range from a few materials to over 1600 meters (Cunningham and Sagio, 2001) ^[7]. Thomas, Meybeck and Besin (2007) defined lake as an enclosed body of water totally surrounded by land and with no direct access to the sea. Lakes may be isolated, with no observable direct water input and on occasions no direct input, it may occur in series, Inter connected by river or as an expansion in water width along the course of a river.

Lake waters with good qualities are essential in maintaining recreation, fishing and provision of municipal drinking and donate water supply (Curtis and Barnes, 1989) ^[9]. Lakes are characterized in terms of production of organic matter and rich in nutrients. They are relatively shallow and rich in organic matter and nutrients with profound decline in Dissolved

Oxygen which can lead to conversion of Nitrates and sulphates to sulphide and ammonia (Raven and Johnson, 1989).

Generally lakes are characterized by a low, average current velocity of 0.001 to 0.01m/s surface values (maybeck and Helmer, 2001)

Pollution in lakes has remarkable difference with that of rivers and streams. Light and temperature have significant influence on a lake than rivers (Fraser, 1990) ^[6]. The supply of carbon, phosphorus and nitrogen coming into unpolluted lake is small enough to limit algae production and productivity of the entire ecological system (Arms and Camp, 1982) ^[10]. The source of toxic pollutants to lakes is usually materials derived from human activities. Presence of large organic matter in lakes induces anaerobism which produces turbidity, decreasing light penetration and limiting photosynthetic algae activity in the surface layers.

Lake pollution can be reversed by dredging the lake beds, oxygenation of the hypotemion (Simpkins and Williams, 1986). Effects of lake pollution have been found in chlorinated hydrocarbon, toxic heavy metal contamination and accumulation (Arms and camp, 1982) ^[10].

The green Abadaba Lake is one of the largest lakes in Imo State and is presumed to have originated from a natural depression (Ita and Balosm, 1983). The lake is classified as shallow, eutrophic with relative mixing (Raven and Johnson, 1983). Organic materials in the lake encourage the proliferation of oxygen – consuming decomposers such as bacteria and fungi (Moran and Morgan, 1982) ^[11]. Biological growth requires the presence of elements at least in trace quantities prominent among these nutrients are phosphorus and nitrogen (Botkin and keller, 1998) ^[12].

2. Materials and Methods

2.1 Description of Study Area

The green lake is situated at Elugwu-Nkwumeato in Ihitte Uboma L.G.A. It lies on geographical coordinates of latitude 5.41°N – 5.45°N and longitude 6.45°E and 6.50°E.

Ihite Uboma is bounded on the North by Okigwe LGA, South by Obowo and Ahiazu Mbaise LGAs, East by Imo River and West by Ehime Mbano LGA.

Ihite Uboma has a land area of 109km² and a population of 270,767 (NPC, 1991). The land mass is indented with hills, valleys and swamp with an average elevation of 65m above sea level. The lake has average surface area of 1.9km², and 2.4km² for dry

and wet seasons respectively. The maximum depth is 9m while minimum depth is 5.7m.

The area is a lowland rainforest zone; it has high rainfall of 1800-2500mm annually. It is characterized by dry and wet seasons from November to February and March to October respectively.

Social economic activities in the area involve mainly subsistence agriculture (pig, sheep, goat & poultry farming) as well as food and cash crop cultivation. Civil service, petty trading and technical trades (artisans) are other economic activities in the area. The Mbom Uzo festival is a major cultural attraction in the area.

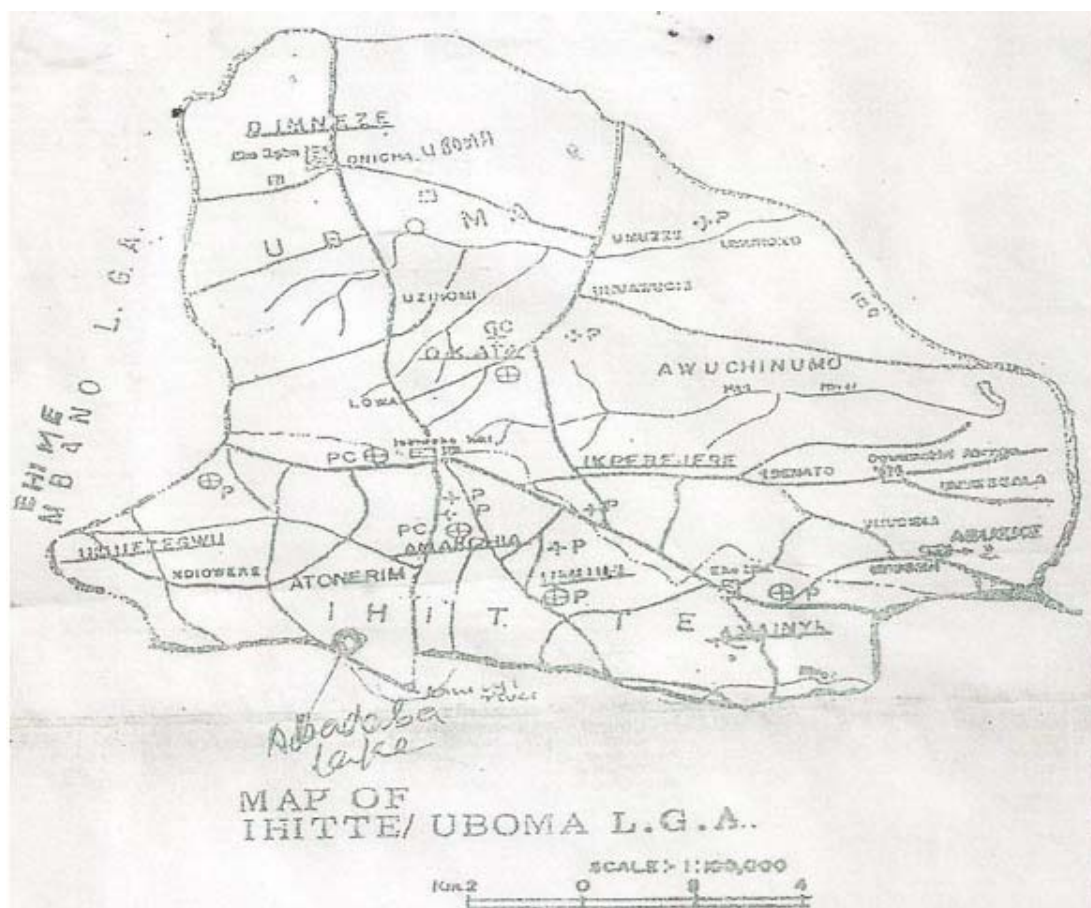


Fig 1: Map of Ihitte Uboma L.G.A showing Abadaba Lake

2.2 Sampling

Samples were collected on November 17, 2014 from two points A and B. point A is where residents draw drinking water while B was close to shore line where products of anthropogenic activities have initial contact with the lake. Samples for physico-chemical analysis were collected with a 2L plastic container; the sample for dissolved oxygen and biochemical oxygen demand were collected with a 250ml BOD container and protected from light. Samples for microbial analysis were collected with sterilized 500ml plastic container.

The ice chest at 4°C was used to preserve the samples which were analyzed in the laboratory within 24 hours.

All were collected at sub-surface with the container filled almost to the neck and covered while still beneath the water surface.

2.3 Laboratory Analysis

Parameters analyzed for include: Temperature, pH, Turbidity, Conductivity, Colour, TSS, TDS, DO, BOD, COD, Sulphate, Phosphate, Nitrate, Total Hardness, Total Microbial Load, Total Coliform Count and Escherichia Coli Count.

Standard methods as outlined by APHA (2012) were used to carry out the laboratory analysis.

2.4 Data Analysis

Table and bar charts were used to present the findings while correlation and water quantity index analysis was used to analyze the data.

According to CCME (2001),

$$\text{Water quality index (WQI)} = 100 - \frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732}$$

$$\text{Where } F_1 = \left(\frac{\text{No of variables that failed}}{\text{total no of variables}} \right) \times 100$$

$$F_2 = \left(\frac{\text{No of failed Tests}}{\text{total no of Tests}} \right) \times 100$$

$$F_3 = \left(\frac{nse}{0.01 nse + 0.01} \right)$$

$$\text{Excursion I} = \left[\frac{\text{Failed Test Value } i}{\text{Objective } i} \right] - 1$$

$$nse = \frac{\sum_{i=1}^n \text{excursion } i}{\text{No of tests}}$$

CCME (2001) ranged the WQI into five categories as excellent (95-100), very good (89-94), good (80-88), fair (65-79), marginal (45-64) and poor (0-44). Poor indicates that water quality is almost always impaired; conditions usually depart from desirable levels (CCME, 2001).

3. Results and discussion

Table 1: Results of physico-chemical and biological properties of Abadaba Lake.

S/N	Parameter	UNIT	Mean Values Sample A	Mean Values Sample B	WHO/SON
1	Temperature	^o c	28	30	20-30
2	Turbidity	NTU	60	69	50
3	Colour	Pt/Co unit	25	29	15
4	Total suspended solids (TSS)	mg/l	54	58	50
5	Electrical conductivity (EC)	μ s/cm	107	112	100
6	Total dissolved solids (TDS)	mg/l	125	132	250
7	Total hardness (TH)	mg/l	265	266	250
8	pH	-	5.8	5.6	6.5-8.5
9	Dissolved oxygen (DO)	mg/l	8	5	6-10
10	Biochemical oxygen demand (BOD)	mg/l	15	18	10
11	Chemical oxygen demand (COD)	mg/l	3	4	40
12	Nitrate	mg/l	47	60	40
13	Phosphate	mg/l	6.0	6.9	5
14	Sulphate	mg/l	260	265	250
15	Total microbial load	MPN/100ml	14	14.5	10
16	Total coliform count	mpn/100ml	3.6	4	2
17	Escherichia coli count	mpn/100ml	2.8	3	2

The results were presented in figures 1-6

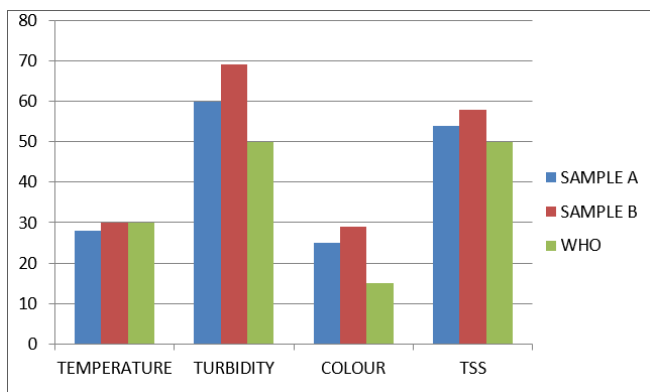


Fig 1: Variation of Physical Properties of Abadaba Lake.

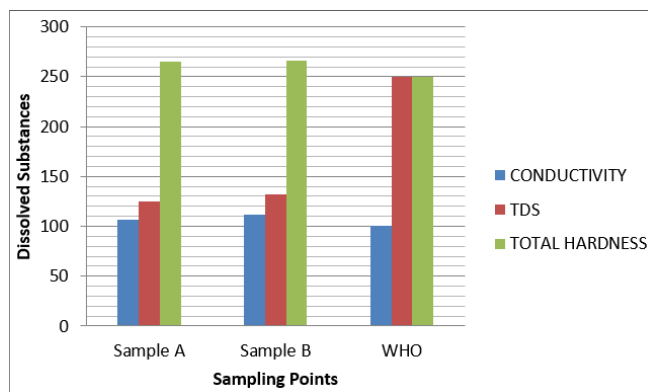


Fig 3: Level of Dissolved Substances in Abadaba Lake.

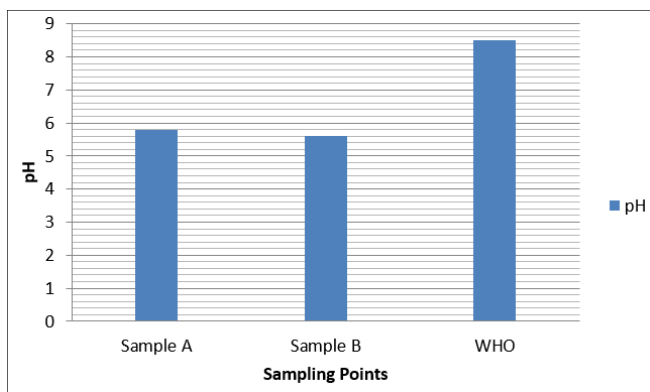


Fig 2: pH Variation of Abadaba Lake

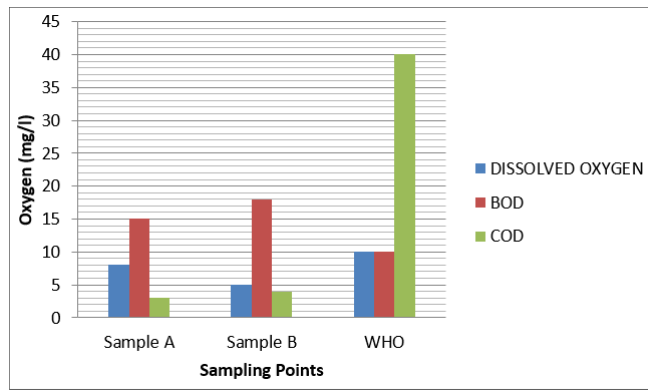


Fig 4: level of Dissolved Oxygen and Oxygen Demands of Abadaba Lake.

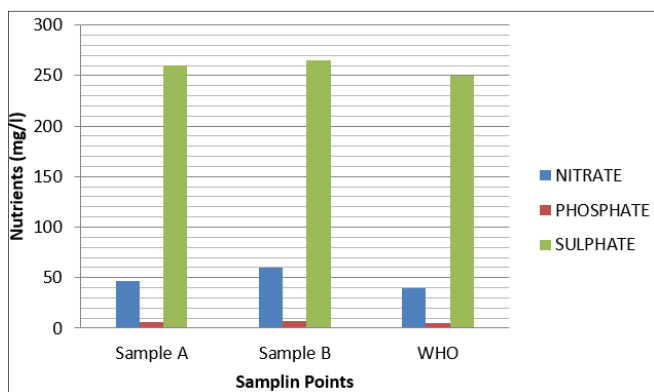


Fig 5: Nutrient Level of Abadaba Lake.

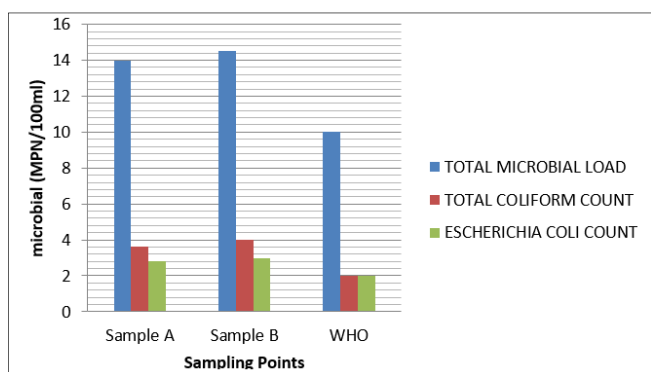


Fig 6: Biological properties of Abadaba Lake.

4. Discussion

4.1 Variation of physico-chemical and bacteriological properties of Abadaba Lake

The turbidity, colour and TSS exceeded the WHO Permissible limit for drinking water; Michaud (1991)^[3] and Moore (1989)^[4]. found that lakes have high turbidity, colour and TSS. The turbidity could arise from high TSS deposited in the lake which makes the lake murkier giving rise to high turbidity. Phytoplanktons and particulates such as sand & clay from shore line erosion are the major sources of turbidity.

The major source of turbidity in the open water zone of most lakes is typically phytoplankton but closer to shore, particulates such as clay, silts and other depositions from runoff and shoreline erosion. Re suspended bottom sediments contributed to turbidity as well.

The electrical conductivity is a measure of dissolved salts (TDS) in the lake (Moore and Malms (1989)^[4]). The high TDS total Hardness and Electrical conductivity could be due to carbonate minerals contained in the area, sedimentary basin characterizing the geology, lake basin ratio to lake area, the Abadaba lake has a bigger watershed to lake surface area which means more contact with soil and more run off draining into the lake. The lake pH was in the acidic region. Fraiser (1990) found similar result, this could be as a result of bacterial metabolism of organic matter which produces CO₂ after liberating the energy, the CO₂ rapidly dissolves in water to form carbonic acid (H₂CO₃), bicarbonate ions (HCO₃⁻) and carbonate ions (CO₃⁻) while the acid lowers the pH, the bicarbonate and carbonate ions increase TDS and Electrical Conductivity and Total Hardness. The pH affects the Dissolved Oxygen; The lake DO is within permissible limit, though the level (5-8mg/l) calls for closer monitoring. The temperature of the lake during the

sampling period in November was relatively high and could reduce the rate of atmospheric oxygen and plant oxygen dissolution coupled with microbial action on biomaterials in the lake, runoff depositions and products of anthropogenic activities around the lake which raises the Biochemical oxygen demand thereby depleting the dissolved oxygen. (Baldwin and Swanson, 1965)^[15]. found that Lake BOD's in tropic areas are usually high. The Abadaba lake BOD could result from leaves and woody debris, dead plants and animals, animal dungs, storm water runoff from farms and adjacent water shed, garbage and laundry activities.

Nutrients in lakes are essential for growth of aquatic life. Although growth and productivity can be termed beneficial but the additional algae and other plant growth allowed by the nutrients may easily become nuisance. The main nutrients are phosphorus and Nitrogen. The levels of phosphorus and Nitrate in the study are quite much. It could be contributed by runoff passing through farms, laundry activities with soaps and detergents, organic matter transport and depositions, USEPA (2006) found out that lakes have slow flow which makes nutrients, sediment and particles accumulate thereby increasing algal growth and environmental pollution.

The seasonal market about 15m from the lake is a major contributor of organic waste in the lake as during rainy season the lake extends over 17m washing off all depositions and structures of the market. Defecation by inhabitants around the lake bank will also contribute to Nitrogen enrichment of the lake. Phosphate is the limiting variable and is responsible for eutrophication of the lake.

Total microbial load is relatively high in lakes. It could result from solid waste and faecal matter. The total coliform counts of the lake were high; this is an indication of bacterial contamination, even though it is not harmful to health. USEPA (2006) found out that high coliform count was due to human and animal waste. The Abadaba lake coliform may be due to runoff from farms, bush and watershed. The high Escheria coli bacteria could be from the animal faecal matter that littered the watershed. The E-coli could cause diarrhea, vomiting, typhoid fever, dysentery, salmonellosis, hepatitis, cholera and jaundice (RMB environmental lab Inc, Detroit 2013).

5. Conclusion

The study concludes that the Abadaba Lake is of poor quality and poses an environmental challenge especially as inhabitants continue to make use of the resource for most recreational and domestic activities including drinking. Efforts should therefore be made by government, corporate bodies, good spirited individuals, nongovernmental organizations, community based organizations and other stakeholders to invest in the environmental renewal, beautification, treatment and protection of the green lake.

6. Acknowledgment

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7. References

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Appendix I: Correlation analysis of parameters in sample A and B

	Correlation coef R²
Physical properties Temperature Turbidity Colour TSS	0.9950
Dissolved substances	
Electrical; conductivity TDS Total Hardness pH	0.999
Oxygen Dissolved oxygen DO BOD COD	0.9346
Nutrients; Nitrate Phosphate Sulphate	0.9989
Biological organisms Total microbial load Total coliform count E-Coli	0.999

Appendix II: Water Quality Index (WQI) Analysis

S/N	Turbidity	FT	Failed Test Mean Value (i)	WHO (Objective) Value (i)	FTi /Obj	i/i-1
1	Turbidity	129	64.5	50	1.29	0.29
2	Colour	54	27	15	1.80	0.80
3	TSS	112	56	50	1.12	0.12
4	Conductivity	219	109.5	100	1.095	0.095
5	Total Hardness	531	265.5	250	1.062	0.062
6	pH	11.5	5.7	8.5	-1.329	-2.329
7	BOD	33	16.5	10	1.65	0.65
8	Nitrate	107	53.5	40	1.34	0.34
9	Phosphate	12.9	6.45	5	1.29	0.29
10	Sulphate	525	262.5	250	1.05	0.05
11	Total Microbial load	285	14.25	10	1.43	0.43
12	Total Coliformcount	7.6	3.8	2	1.90	0.90
13	E.Coli	5.8	2.9	2	1.45	0.45
		1,776.2			1,118.5	2.148

WQI Calculation (CCME)

$$F_1 = \frac{13}{17} \times 100 = 76.47$$

$$F_2 = \frac{26}{34} \times 100 = 76.47$$

$$nse = \frac{\sum excursion}{Total\ no\ of\ Tests} = \frac{2.148}{34} = 0.0632$$

$$F_3 = \frac{0.0632}{0.01(0.0632)+0.01} = 5.96$$

$$WQI = 100 - \left[\frac{\sqrt{F_1^2 + F_2^2 + F_3^2}}{1.732} \right] = 100 -$$

$$\left[\frac{\sqrt{76.47^2 + 76.47^2 + 5.96^2}}{1.732} \right]$$

$$WQI = 100 - 62 = \underline{37}$$