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An Assessment of the Pollution Levels of Rivers in Enugu Urban Nigeria and their Environmental Implication

Dr Obinna Ubani[1*] Arc Emeka Mba[2] & Ozougwu Moses[3]
1. Department of Urban & Regional Planning, University of Nigeria, Enugu Campus, Enugu
2. Department of Architecture, University of Nigeria, Enugu Campus, Enugu
* E-mail of the corresponding author: obisally2004@ yahoo.com

Abstract

The increased scarcity of pipe-borne water supply in Enugu Urban, Nigeria has led to residents seeking alternative sources of water supply. This has resulted in households depending on surface for their consumption. It is believed that various human activities have contaminated this surface water thus making them unsafe for human consumption. The purpose of the study is to examine the pollution levels of rivers in Enugu urban in relation to the safe limits described by the National Agency for Food and Drug Administration and Control standard. Water samples were collected from the ten major rivers in the study area. The result of the study shows that apart from New Haven River, the level of pollutants in rivers in Enugu is not significantly different from the NAFDAC standard. However, most rivers in Enugu, though with some traces of pollutants, can be easily treated for domestic consumptions and usages

Keywords: Pollution, Standards, Rivers

1. Introduction

Life on earth began in water and humans are made up of nearly 80% of water. In the same vain, the increasingly dynamic growth and concentration of population in the urban areas of Nigeria and other developing countries has led to the multiplication of urban utility demand. This urbanization and industrialization trend has led to increased contamination of surface water and worse still, man has regarded it as a prerogative to pollute the environment whether aquatic, aerial or terrestrial. It is no news that most of the surface waters which have been used for laundry, bathing, swimming, washing food, irrigation and sometimes drinking have been heavily polluted. Contaminated surface water supplies are the causes of variety of water related diseases, including typhoid, hepatitis, cholera, schistosomaiasis and guinea worm. (UNESCO, 1994). In Enugu metropolis, access to adequate urban water supply from the State Water Cooperation is a serious problem facing the populace, coupled with the geometric increase of urban population, which has exacerbated the problem of the scarcity. In a bid to meet the demand for water supply, most people have resorted to utilizing surface water. Regrettably, Ude, (2001) on highlighting the sources of pollution of these streams posited that most streams in Enugu urban drain some heavily – fertilized agricultural land as well as some uncultivated land. Some of these rivers receive effluents from abattoir as well as kitchen wastes and septic tanks overflow from homes. In some places, streams are used as a "natural lavatory" so that there are concentrations of human excrement. Livestock are regularly watered in streams; therefore animal faeces are common features.Since certain foods are washed in the water and people washing in the stream sometimes accidentally swallow some of water, there is need for a comparative relationship to be made between the rivers' and the National Agency for Food and Drug Administrative Control (NAFDAC) river safety acceptable limits.

The thrust of this study however is to examine the pollution levels of rivers (physical, chemical and biological) in Enugu urban in relation to the safe limits prescribed by the NAFDAC standard and their environmental implication. The study hypothesized that the level of pollution in the rivers in Enugu urban is not significantly different from the NAFDAC acceptable standards. This hypothesis will be tested with the student T test statistical tool. This study would serve as an eye opener to the lots of urban inhabitants that dump wastes in rivers for most people are ignorant of the health and environmental implication of such activity. Information derived from the assessment of the water quality of the rivers would help create awareness of the need for a considerable improvement on waste and water management and treatment practices in Enugu municipality in particular and Nigeria in general. Furthermore, it will stimulate an improved attitude by the authorities concerned.

2. Study Area

Enugu urban lies approximately on latitude $06^{o}\,21^{o}$ N and $06^{o}\,30^{o}$ and longitude $07^{o}\,26^{o}$ E and $07^{o}\,37E^{o}$. It has an estimated land area of about 72.8 square kilometers. Enugu has a total land area of about 12,831 kilometer

and is the state capital of Enugu State of Nigeria. Residential land- use account for the highest land use comprising about 54.3% of total urban area in Enugu. Enugu has about twenty (20) distinct neighborhoods that may be broadly categorize as low, medium and high-density areas. However, due to the influences of spread effects, mixed densities exist. Planned and unplanned areas sprang alongside Enugu metropolis as a result of a high demand in residential accommodations. The 1991 census figure puts the population at about 482,977. The population figure for Enugu urban in 2006 stands as 722, 664 (NPC, 2006).

The Enugu water distribution system is complex due to the city's expansive area and the varied topography. Presently more than nine booster stations are in operation within the system. Major storage reservoirs include the 4 million gallon reservoir on Onitsha Road, the 4.05 million liter storage at the Ekulu works and the 2.5 million litre reservoir on Mission Avenue. Other significant storage tanks include the 216,000 liters ground level storage in Independence Layout and elevated storage along the Women Training College, Queens School, University of Nigeria Teaching Hospital, Parliament Building, the Airport, and the tank on Park Lane. There are additional small reservoirs in various parts of the town. The distribution system had been constructed over the years since the 1920's and consists of pipes ranging from 75mm to 600mm in diameter.

Directly under Enugu, there is little or no ground water potential. Enugu is situated near the western edge of the Cross River plain on Asata-Nporo shale. To the west of Enugu on the Udi Plateau, ground water potential is much better. As previously mentioned a small portion of Enugu water supply currently comes from boreholes of the 9th Mile Corner water scheme. Borehole specific capacity of 410 liters/hour/meter of draw down can be expected. Borehole depths are generally about 110 meters.

It is important to know that rivers in the study area are somewhat linked to one another across some neighbourhoods. In other words, some of them are tributaries of others as they move along neighbourhoods. From the geological map of Enugu, Ekulu river is the largest river that cuts across the study area, and Asata river empties itself into it at the Emene layout (a neighbourhood at the eastern part of the study area). This Asata river has other tributaries like New Haven river (found in New Haven), Agangwu (around Coal Camp area) and Okwuosa river (at Ogui layout). Ekulu river has Abakpa river (Ava) as one of its tributaries. Idaw River is a tributary of a large river outside the study area called Nyaba river. Mbanugo and Ogbete rivers which flow across "Coal camp" area have sources outside the study area.

3. Literature Review

Water pollution is a rapid growing menace in the society and environment. Achi (1991) defined pollution as a term applied to any environmental state or manifestation which is harmful and unpleasant to life and resulting from failure to achieve or maintain control over the biological, chemical and physical side effects or consequences of human scientific, industrial or social habits. A similar description was given by Adenyinka and Rim-Rukeh(1999), they indicated that at concentrations where wastes or contaminants become dangerous to human health and ecological balance and are culturally offensive, it is labeled pollution. Pollution ultimately makes good quality water increasingly scarce by leaving less volume of flow suitable for use. Pollution may be accidental and sometimes with grave consequences, but most often it is caused by uncontrolled disposal of sewage and other liquid wastes from domestic sources. Industrial wastes containing a variety of pollutants, agricultural effluents from animal husbandry, drainage of navigation water and urban run off are other sources of water pollution. Domestic and municipal sewage contains decomposable organic matter that exerts a demand on oxygen resources of the receiving water.

Current levels of water pollution in cities of developing countries are critical and have led to significant losses in terms of human health, productivity, and damage to ecological resources (Piteous, 1991). Cart (1990) indicated that the sources of pollutants threatening water quality are wide ranging but can be grouped into three, namely; industrial, agricultural and domestic. He noted that water pollution can be by accident or design, and is often exacerbated by industrialization, urbanization and market economy. Specifically on urban growth as a source of wastes and water pollution, Hickeh et al (1969) stated that the process of urbanization has a considerable hydrological impact in terms of delivery of pollutant to rivers and influencing the nature of runoffs. According to them, storm run off from an urban area may contain large amounts of contaminants derived from industry, construction, animal droppings, litter, garbage and wastes from households and agriculture.

4. Research Methodology

Primary and secondary data were used for this study. Data used for this work were sourced from: score card; This study is experimental and as such much of the data required were sourced from the study environment. Secondary data were collected, and these include the safety standard limits from NAFDAC/WHO. There are

many rivers in Enugu State, however only the ten in the urban area were considered and these include Mbanugo River (Coal Camp), Asata River (Asata), Agangwu River (Coal Camp), Okwuosa River(Ogui), Ogbete River (Ogbete) Thinkers Corner River (Emene), New Haven River (New Haven), Idaw River (Idaw River), Ekulu River (GRA) and Abakpa River (Abakpa Nike). These rivers are the ten major surface water bodies in the study area, Enugu urban Water samples were randomly collected from various points in each of the rivers. In order to make them as representative as possible, the samples were taken from different points at each of the ten stations (rivers). New clean polypropylene containers of one litre capacity were used in collecting the samples. For ease of identification, the containers were labeled with details of source and dates of collection. Samples to be analyzed for Dissolved Oxygen and BOD were collected in special air tight 60ml BOD (biological oxygen demand) glass bottle to prevent loss or gain of oxygen. In other to prevent natural interference such as organic growth and unnecessary reactions, analyses of PH and Dissolved Oxygen are done immediately while the rest were determined within 48 hours. The water quality analysis was carried out at the water laboratory of Projects Development Authority (PRODA), Enugu. The NAFDAC safety limit standards were used as control water quality standards.

The major fifteen physical, chemical and biological parameters used for the river water quality assessments in the study include P.H value, electrical conductivity, temperature, turbidity, specific gravity, total solid, dissolved solid, suspended solid, chemical oxygen demand (COD), oxygen demand, dissolved oxygen, nitrogen, phosphorus, biological oxygen demand and total coliform.

5. Results and Findings

Water samples were collected and tested from the selected rivers in Enugu urban using the above named fifteen (15) parameters. Standardized units of the various parameters got manually. To determine whether the pollutants introduced into the rivers are still within the acceptable limits, the range of each parameter's value was compared with the NAFDAC acceptable standards. Table 1 below compares the values of range of results from the rivers to the NAFDAC standard.

Colour*:* Most of the rivers studied have very unpleasant coloration and this shows the presence of lots of suspended and dissolved solids, which were introduced by the surrounding industrial establishments and wastes. Ogbete river, Mbanugo, Okwuosa and Ekulu rivers stand out as having very bad colour among the sampled rivers. Coloured water usually discourages users from making attempt to collect it for domestic or drinking purposes

Turbidity*:* Turbidity is a measure of water clarity and an indicator of its optical properties. Turbidity in water is usually caused by suspended materials such as mineral particles, soluble organic compounds, micro organisms and other microscopic organism. From the comparison table, it becomes obviously clear that the range of values of the samples were from 15.7 to 77.4 NTU, which is far above the NAFDAC 5.O NTU desired standard. In other words, the rivers turbidity values are far much above the acceptable standard. This result is dangerous and very harmful to humanity. Turbid water is less acceptable to consumers from aesthetic viewpoints. River Hew Haven and that of Okwusa have the highest turbidity value and this could be attributed to the closeness of heaps of refuse to the rivers.

Temperature: It has been established (WHO, 1994) that high temperature makes water bodies very unattractive for recreational activities and unsafe for domestic uses. Equally, vegetation on the edges of rivers that have high temperature dies off and such conditions do not support aquatic life and are not good for recreational purposes. Rivers like New Haven,

Thinkers, Ogbete and Abakpa have temperatures that are relatively lower than the NAFDAC standard. However, they are still good and fall within acceptable range.

Nitrogen: Nitrogen in water can cause methemoglobiuema in bottle-fed infants when in excess (Klein, 1996). Furthermore, cancer can result from high nitrate concentration (WHO Ibid). However, nitrogen encourages the growth of algae and phytoplankton, though when in excess, causes them to die and decompose and this ultimately reduces the dissolved oxygen in the water, thus leading to the death of animals. From the result, the experimental samples from Mbanugo, Asata, Agangwu, Okwuosa, Idaw River, Ekulu and Abakpa

rivers have values below the NAFDAC 20mg/l value (standard). It is better to have relatively low nitrogen content in a stream than to have it in excess. The impacts of excess nitrogen have been enumerated above. Ogbete, Thinkers and

New Haven rivers have nitrogen values slightly above the recommended NAFDAC standard. However, the variance is infinitesimal / negligible.

pH Value: pH is a measure of acidicity and alkalinity of a liquid. This is a very important parameter in water chemistry, because the effectiveness of most water treatment projects depends on PH. The recommended permissible value for drinking water is 6.3 – 8.5. This recommendation is not directly related to health hazard but rather to minimize technical problems in water distribution system or to avoid inefficient chlorine disinfections.

Furthermore, another pronounced effect of acidification in river is the gradual removal of fish species until only the most tolerant ones are left, eliminating the molluscs, and crustaceans. Again, floral compositions are altered and macrophytes disappear. From the analysis result, all the rivers fall within the acceptable standard of NAFDAC.

Suspended Solids: These involve settleable solids. The turbidity introduced by these solids prohibits photosynthesis, and does decompose leaves of aquatic macrophytes and algae. From the result, Okwuosa and Mbanugo rivers have the highest values of suspended solids.

***Total Solid And Dissolved Solids*:** Total solid refers to the totality of suspended solids, settleable and dissolved solids. The total solid in a river or stream might influence the general polluting potentials. The dissolved and suspended solid usually increase the turbidity and colouration of water. Thinkers river and Ogbete river have the highest total solid values and this explains their poor colouration. Rivers like Asata and Idaw rivers seem relatively transparent due to the little quantity of solids in them. However, the value of total solid recorded from the study sample ranges from 2.91 – 11. 6mg/l while the dissolved solid ranges from 0.80 – 4.60 mg/l.

Biological Oxygen Demand: (BOD): BOD refers to the rate of oxygen use. It measures the amount of oxygen required by bacteria and other micro-organism to stabilize degradable matter (Umeh and Uchegbu, 1997). The B.O.D in some of the rivers is lower than the NAFDAC value of 5.0mg/l. Such rivers include, Mbanugo, Asata, Okwuosa and Idaw Rivers. Recall that B.O.D increases as pollution increases. Thus the above-mentioned rivers are to this extent, not polluted. However, other samples out of which Ogbete River stand top most have high B.O.D. The environmental implication is that aquatic life in these rivers that have high B.O.D is threatened and this accounts for the rivers being turned into putrid, turbid and decaying mess, which produces foul smelling, bubbles of gases at their surfaces and very offensive and odourous.

***Dissolved Oxygen* (DO)**: Dissolved oxygen is an important factor in the chemistry and microbiology of water. This is because fish and other aquatic animals depend on oxygen for life. In the same vain, the traditional organic waste contributed by domestic sewage and industrial wastes or of plant and animal origin are destroyed (oxidized) by bacteria and microorganisms with the help of dissolved oxygen. From the comparism table, the range of values in the sampled rivers has dissolved oxygen as 11.1 –30.1mg/l, which is higher than the value needed for water to get saturated with oxygen at 9mg/l under normal temperature. This then means that the dissolved oxygen in most of the rivers in the study area is commendable.

Faecal Total Coliform: These refer to those microorganisms that reside in the intestines of man and other animals which are usually discharged with the solid body waste through the anus. The presence of them in water indicates the contamination of the water by excreta. From the table, Ogbete river, Thinkers, New Haven and Abakpa rivers have high coliform value. The worst river is Ogbete River.

The above result is not surprising as the neighbourhood where these rivers run through are highly populated. Faecal coliform count is a common and standard measure of the bacteriological quality of water. The presence of feacal coliform in water suggests a possible outbreak of such water-borne diseases as dysentery, cholera, and typhoid fever if the water is consumed untreated as observed in Abakpa River. However, Idaw River

and Asata river with a value of 2.20 have the least score, implying a little coliform and safe concentration of coliform.

Chemical Oxygen Demand: This includes a test on the different samples of water or river to have a much quicker oxidation of organics in the samples. The NAFDAC standard of 75mg/l happens to be the acceptable limit. However, Thinkers river has the highest value of 180.97mg/l of all the samples. Six rivers have values less than this NAFDAC standard.

Summarily, the following inference can be drawn, first, considering the NAFDAC standard (bench mark) for the parameters, and the results from the sampled rivers, the rivers failed in the following parameters / variables.

(i) Electrical conductivity.

(ii) Turbidity

(iii) Phosphorus

(iv) Dissolved Solid.

Secondly, there exist some levels of pollution in virtually all the rivers sampled, though there was no much variance from the NAFDAC acceptable standard. The result of the test shows that apart from New Haven River, which has a significant value of 0.008, the level of pollutants in rivers in Enugu is not significantly different from the NAFDAC standard. The t-test value of the rivers was less than the t-critical value of 2.964 at 0.01 significant levels. Thus the null hypothesis was accepted. In other words, most rivers in Enugu, though with some traces of pollutants, can be easily treated for domestic consumptions and usages

6. Recommendations and Conclusion

6.1 Proper Enlightenment

If the surface waters would be utilized for domestic purposes, following the erratic nature of public piped borne water supply from the State Water Corporation , then there is need to educate the inhabitants on the dangers of drinking microbial contaminated water. The water should be treated before use, either by boiling and filtration or by chemical sterilization.

*6.2 Improvement Of Water Corporation***:**

Since it has been ascertained from the study that the use of these rivers for domestic purposes was streamlined sequel to the gross inadequacy of public water supply, the state government should provide adequate financial assistance to the Enugu State Water Corporation to improve the quantity, quality and regularity of water they supply to the public. The assistance should also be in form of providing skilled manpower and modern equipment.

6.3 Research and Documentation

The monitoring of water quality which at present is inadequate and haphazard needs to be more organized and regular, covering municipal water reservoirs and their catchment areas, streams and rivers, irrigation schemes and domestic water wells. Standards for good quality water need to be set and used as yardstick for monitoring. In this way, it should be possible to detect outbreaks of diseases, for example, typhoid, cholera, bilharzias, or guinea worm and to take appropriate preventive measures.

It is gratifying to note that the Federal Environmental Protection Agency (FEPA) which was established by decree in 1988 has environmental monitoring as one of its priorities. It is good planning to establish Federal water quality standards and effluent limitations and to monitor the pollution of both our surface water and groundwater resources.

6.4 Administrative Framework

At present, there are very many bodies concerned with the management of different aspects of our water resources and their development. They include the Hydrological Technical Committee, the Water Resources Institute in Kaduna, the River Basin Development Authorities, DFRRI, State Water Boards, the National Electric

Power Authority, Federal and State Ministries of Agriculture and Water Resources, Agricultural Development Projects and Chad Basin Commission and so on. Between them, there is much overlap of interest, jurisdiction, and functions and very little coordination, cooperation or control. A workable and efficient organizational structure for the management of our water resources is required. This does not necessarily mean a new body. Rather, part of what is needed is for the RBDAs to be streamlined and made more professional and less political so that they can become effective clearing houses for all water-related projects. Water Ordinance, enacted in 1913, among other things, prohibits the pollution of any waterworks, or water which may be carried into the waterworks by any foul poisons or injurious matter or any earth deposit or excavated material". The Public Health Ordinance, 1958, contains general provisions prohibiting nuisances, including any pool drain, well collection of silage water" or other things in such a state or condition as to be injurious to health". It also prohibits the fouling of any water used as a supply to man or beast.

The River Basin Development Authorities Decree of 1976 and the Niger Delta Basin Development Authority Decree of 1976 both give the respective authorities the powers to control pollution in their own rivers and lakes" in accordance with nationally – laid down standards. Since 1969, petroleum exploration, exploitation and refining activities have come under a comprehensive set of anti-pollution laws.

We also need laws, which define and allocate water rights and this raises complex issues of jurisdiction between relevant authorities, such as between the state governments and federal government or between the River Basin Development Authorities and other government agencies.

6.5 Enforcement Of Legislation

Having water laws is one thing. Enforcing them is quite a different matter. The situation of anti-pollution laws referred to above is very instructive in this area. With the possible exception of the anti-pollution laws in the petroleum industry, most legislation relating to water pollution in Nigeria is virtually not enforced. How else would one explain the common sight of people doing their laundry or watering livestock around water-supply reservoirs and disposing their liquid and solid wastes so indiscriminately.

6.6 Grants And Subsidies; And Imposition Of Fines And Levies

The award of grants or subsidies and the imposition of fines and levies are also measures to help curb water pollution. Subsidies may be given to industries to enable them treat their effluent before discharging them into water courses. The subsidies may be in form of tax credits, loans with low interest rate or outright grants, especially in areas that are economically depressed. Water pollution may also be controlled through the imposition of fines and levies. Firms and households are assessed and charged fees on the basis of the quantity and quality of effluents they discharge into water courses and lagoons. This approach again requires effective monitoring, inspection and policing to ensure that all culprits are brought to book and that appropriate fees are charged and paid.

7. **Conclusion**

Environmentally, sustainable development depends on the protection of a country's natural resource base and on ensuring that assimilative capacity of the environment is not exceeded. The water quality of rivers in Enugu urban has been found to be slightly below the acceptable safe limit set by NAFDAC. This calls for attention because if neglected, many harms would be done to both human and aquatic life. Surface water must not be allowed to deteriorate since animals as well as human beings drink most times directly from this source. Thus, the belief by the society that rivers that flow through urban areas are suitable for the disposal of waste is grossly unacceptable.

However, it is very unfortunate that the authorities responsible for water pollution control in Nigeria lack comprehensive control database on the sources, quantity and types of pollutants released into the environment. Incidentally, without such information, water pollution, monitoring, control and prevention will be a mere mirage

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Table 1: Pollution value range from the rivers and NAFDAC standard

S /N	Parameters	NAFDAC Standard *	Value Range of Samples
1.	P.H	7.8	6.50-7.50
2.	Electricity Conductivity	4.0	18-80
3.	Temperature	29.0	26.5-29
4.	Turbidity	5.0	15.7-77.4
5.	Specific Gravity	1.05	1.02-1.05
6.	Total Solid	10.0	2.9-11.6
7.	Dissolved Solid	20.0	1.70-9.90
8.	Suspended Solid	10.0	0.80-4.60
9.	Chemical oxygen Demand	75.0	21.37-180.9
10.	Oxygen Consumed	15.0	5.40-83.6
11.	Dissolved Oxygen	9.0	11.1-30.1
12.	Nitrogen	20.0	2.67-26.6
13.	Phosphorus	5.0	7.5-21
14.	Biological Oxygen (BOD)	5.0	2.16-6.98
15.	Total Coliform	10.0	2.2-240

Source: Researcher's Field Work, 2011