Analytical Evaluation of Ava River Quality for Domestic Purposes

Chime A.C, Asogwa E.A, Iloabaichie, I.C, Amujiogu J.O

***Abstract:** Since declining water quality has the potential to significantly alter the hydrological cycle, it has become a worldwide concern. In the last ten years, human activity has had a remarkable impact on the environment due to an unprecedented rise in population, a rapid rate of urbanization, intensification and expansion of agricultural practices and other factors. These factors have resulted in the progressive and ongoing degradation of resources, particularly surface water. In this research study, Ava River Quality was analyzed due to the continuous application of inorganic fertilizers, herbicides and pesticides for crop production and management at the Green Land Vegetable Farm Cluster of Ugboezeji, Abakpa Nike Enugu East LGA stream segment. The continuous application has been found to impact positively on crop quality and yield, but negatively on the quality of water at the downstream segment of the irrigation areas. Biological oxygen demand, nitrate,phosphate, copper and cadmium levels in the water samples analyzed at the downstream segment exceeded the maximum acceptable limit of World Health Organization (2011). It was observed that the amount of inorganic fertilizers, herbicides and pesticides applied by the farmers are quite higher than the quantity required for optimum yields, but inappropriate techniques and timing of application resulted in the occurrence of excess chemicals being flushed into the Ava River. Therefore, it is important to apply strict regulatory strategies and measures in order to safeguard the water body from pollution caused by unfavorable anthropogenic activities, as climate change poses a threat to the preservation of the water bodies' quality for agricultural and residential purposes.*

***Keywords:** Ava River Quality, Physicochemical Properties, Selected Toxic Metal Concentration*

I. INTRODUCTION

Unsafe drinking water is inaccessible to around 20% of the world's population (UNEP, 2000). Surface water quality fluctuates daily, seasonally, and in response to climatic patterns because it is dependent on the balance between the physical, chemical, and biological aspects of the surrounding environment. The amount of available but contaminated water that is constantly rising due to shifting patterns of industrial and agricultural output, as well as growing urbanization (Pestle, 2000).

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In addition, a host of other factors, including ignorance and antiquated methods, have contributed to water contamination. Water pollution is the result of undesirable elements—typically chemicals or microorganisms—entering a stream, river, lake, ocean, aquifer, or other body of water, lowering its quality and making it hazardous for people or the environment. Nigeria is endowed with an abundance of natural resources, including water. The water sector is in charge of ensuring that homes, businesses, enterprises, institutions, and agricultural production have access to clean water. According to Nwankwoala (2011), the primary water sources for homes are hand-dug wells, shallow boreholes, ponds, springs, streams, lakes, and rivers; these sources also include piped supplies from treated water sources.

Surface water is utilized for a variety of purposes, including drinking, business, farming, and industry (Akan, et al., 2009). Despite surface water's significance to human existence; it is the world's most mismanaged resource (Fakayode, 2005).

However, pollution from both point and non-point sources has negatively impacted surface water. According to Uchegbu (2002), surface water pollution happens when artificial or natural sources discharge hazardous materials into bodies of water. Surface waters pollution, according to Akaninwor et al. (2007) and Singh, (2012), is primarily caused by surface runoff, industrial effluent discharge, and domestic waste water.

Manufacturing, commercial businesses, mining, agricultural production processing and effluent from clean-up of petroleum and chemical contaminated sites are the major sources of surface waters pollution (NPDES, 2008). The aim of this research work is analytically evaluate the Ava River quality for domestic purpose with specific objective of determining the physicochemical and selected toxic metals concentration.

II. REVIEW OF RELATED LITERATURE

Water pollution refers to the contamination of water bodies, such as rivers, lakes, oceans, and groundwater, with harmful substances. This contamination can have serious effects on aquatic ecosystems, human health, and the environment as a whole. According to Nwangwu (2011), Water is said to be polluted if they introduced into it substances of such character and in such quality that its natural qualities are so altered as to impair its usefulness or renders it offensive to the sense of taste, sight or smell.

Water pollution can take various forms and the sources of pollutants are diverse. Industrial chemicals, heavy metals, fertilizers, and pesticides are examples of chemical pollution. In addition to potentially endangering human health if ingested, these compounds have the potential to be hazardous to aquatic life.

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The overabundance of nutrients from wastewater discharges and agricultural runoff, primarily nitrogen and phosphorus, can cause nutrient contamination. Aquatic life may be harmed, algae blooms may occur, and oxygen levels may drop. Waterborne illnesses in humans can result from the presence of microbiological contaminants, such as viruses, bacteria, and other microbes from untreated wastewater and sewage.

Contaminants that are linked to a particular source, location, and perpetrator and find their way into a body of water are referred to as point source pollution. Handling it is simpler. Industrial waste disposal, wastewater treatment plant effluent disposal, illicit disposal, and so on.

When pollutants reach a body of water and cannot be linked to a particular source, location, or perpetrator, they are considered non-point source pollution. Pollution may become concentrated in rivers and other freshwater resources, even though it originates from a variety of scattered sources and often arrives in little amounts. For instance, nitrate deposition, acid rain, septic tank leaching, and agricultural runoff (such as pesticides, fertilizer, etc.). Most contamination in water systems is caused by non-point sources of pollution (Rusell, 1973).

III. RESEARCH METHODOLOGY

Study Area

The Ava River`segment under study passed through Abakpa Nike, Enugu East Local Government Area,which is one of the 17 local government areas in Enugu State with its headquarters at Nkwo Nike. Enugu East LGA has total land area of 383km^2 and a population of 277,119 (2006 census). It lies between Latitude 6.30850 0 North of Equator and Longitude 7.30141 0 East of Greenwich Meridian with mean elevation of 450m above sea level. It has an annual rainfall range of 1700mm- 2010mm with minimum and maximum temperatures of 26^{0}C and 35^{0}C respectively.

The River is about 4-6ft deep and it is one of the major sources of water to the Abakpa community and neighborhood which is mostly used for domestic and agricultural purposes.

Sample Collection

Samples for the water analysis were collected from four (4) designated points each at the Upstream (less effluents) and Downstream (more effluents) segments of Green Land Vegetable Farm Cluster, Ugboezeji, Abakpa Nike Enugu East LGA stream line in July, 2023. New clean screw cap polypropylene containers of one litre capacity were used in collecting the samples. 60ml air tight glass bottles were used to collect samples for Dissolved oxygen and Biological oxygen demand in order to prevent loss or gain of oxygen. The containers were labeled with details of source and date of collection.

Sample Analysis

The physicochemical parameters analyzed were Temperature, pH, turbidity, electrical conductivity,dissolved oxygen, biological oxygen demand, chemical oxygen demand and total alkalinity using standard methods (APHA, 1992; APHA, 1998;Skoog et.al., 1998; USEPA, 1998)

In other to prevent natural interference such as organic growth and unnecessary reactions, analyses of pH, Temperature and Dissolved Oxygen were done immediately while the rest were determined within 48 hours.

IV. RESULTS

The mean values of all variables investigated in the four sampling points each for Upstream and Downstream segments were presented in Table 1 & 2 with comparative chart in Figures 1 & 2.

Table 1: Mean Values of Selected Physicochemical Parameters for Upstream and Downstream Segments of Ava River (July, 2023)

Parameters	Ava River	WHO (2011)
Temperature (0^{o}C)	US 24.99 DS 26.03	10 -25
pH	US 7.06 DS 6.38	6.5 – 8.5
Turbidity (NTU)	US 8.14 DS 11.64	5 < 10
Electrical Conductivity (µs/Cm)	US 254.18 DS 460.19	500
DO(mg/l)	US 9.381 DS 2.811	14
BOD (mg/l)	US 4.49 DS 8.64	6
COD (mg/l)	US 7.98 DS 6.54	10
Total Alkalinity (mg/l)	US 6.726 DS 1.515	10
Nitrate (mg l-1)	US 46.1 DS 74.8	50
Phosphate (µg)	US 36.3 DS 64.5	10 - 50
Sulphate Mg/L	US 6.726 DS 1.515	250

Table 2: Mean Values of Selected Toxic Metals Concentration for Upstream and Downstream Segments of Ava River (July, 2023) US =Upstream, DS=Downstream

Location	Ava River	WHO (2011)
Cd (mg/L)	US 0.60 DS 0.05	0.003
Cu (mg/L)	US 0.03 DS 0.09	1
Pb (mg/L)	US 0.07 DS 0.01	0.001

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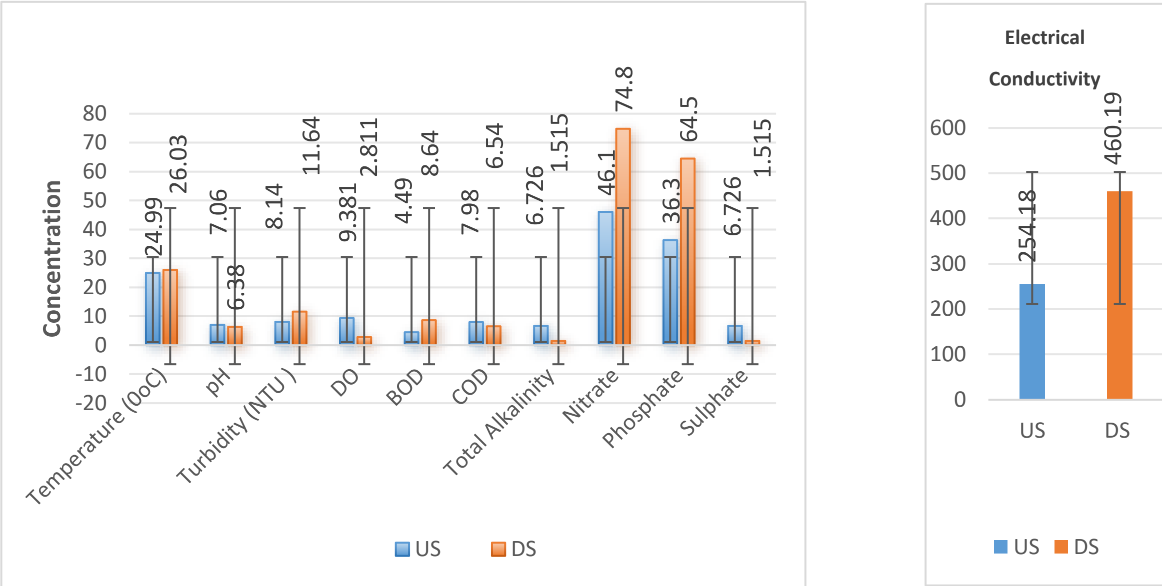

Figure 1: Comparative Chart for Selected Physicochemical Parameters Between Upstream and Downstream Segments of Ava River

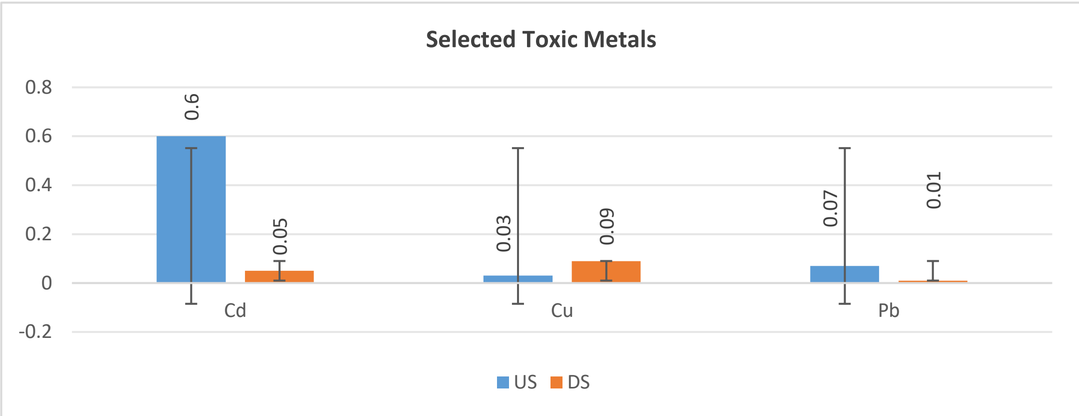

Figure 2: Comparative chart for Selected Toxic Metals Concentration Between Upstream and Downstream segments of Ava River

Temperature

The extent to which light penetrates water strata affects the temperature of surface water and it can affect other physicochemical parameters like electrical conductivity, dissolved oxygen as well as biological process in water (Ekubo and Abowei, 2011).

The mean value for temperature of water samples obtained from Upstream and Downstream segments indicated 24.99 and 26.03 0C respectively.The downstream segment temperature fall above the acceptable range of World Health Organization (2011) permissible level which may have resulted from the frequent irrigation that usually facilitate surface runoffs into water bodies which stimulate high turbidity. Higher temperatures reduce ability to hold dissolve oxygen which could be detrimental to aquatic life.

The variation trends in temperature values between the upstream and downstream segments of the Ava River can also be observed from the comparative charts.

pH Value

The pH of water affects concentration of ions in water as the solubility of chemicals is affected; therefore, the availability of these substances to aquatic organisms is affected. It was observed from the results that pH value fall within the range of WHO (2011) permissible level (6.5 – 8.5) as water sample collected from upstream and downstream segments indicated 7.06 and 6.83 respectively. pH of an aquatic system is an important indicator of the water quality and the extent of pollution in the watershed areas (Kumar et al., 2000).

Turbidity

Turbidity has an indirect effect on aquatic life. This is so because turbidity is affected by amount of suspended solids which restricts light penetration through the water.

In this research study, turbidity mean values of 8.14 and 11.64 NTU were revealed for upstream and downstream segments respectively. The downstream showed higher turbidity above 5 < 10 maximum acceptable limits of WHO. This might have resulted from the frequent irrigation surface runoffs into water bodies which causes re-suspension of dissolved materials.This can also be seen from the comparative chart in Figure 1

Electrical Conductivity (EC)

High conductivity reflects the pollution load as well as tropic levels of aquatic body. EC mean values in the upstream and downstream segments indicated 254.18 and 460.19 µS/cm respectively which are significantly moderate to the WHO (2011) permissible level of 500 µS/cm.

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Conductivity values below 50 (µScm-1) are regarded as low, while those between 50 – 600 (µScm-1) are said to be medium and values above 600 (µScm-1) are considered to be high (Abida and Harikrishna, 2008). The downstream segment of the Ava River analyzed are purely agricultural cluster and the slightly high conductivity value could be due to inorganic fertilizer and herbicide applications in the farmlands.

Dissolved Oxygen (DO)

The irregular pattern of DO along the river may be attributed to seasonal fluctuation affecting temperature and input of organic load into the river whose decomposition depletes oxygen (Izonfuo and Bariweni, (2001). It was observed from the results that DO value falls below WHO (2011) permissible level of 14 as water sample collected from upstream and downstream segments indicated 9.38 and 2.81 (mg/l) respectively.

Nwinyimagu et al., (2016), asserted that low values of DO is harmful to aquatic life and shows the extent of anthropogenic interference at the fringes of the water body.

Biological Oxygen Demand (BOD)

Biological oxygen demand, BOD, is a measure of the amount of oxygen required by microorganisms during decomposition of organic matter. Usually BOD increases with decrease in DO (Narayanan, 2007). BOD exceeding 5.00mg/L generally indicates pollution (Akaahan and Azua, 2016). The mean values of BOD in this study at the upstream and downstream segments were 4.49 and 8.64 mg/L. The downstream revealed higher BOD above 6 mg/L maximum acceptable limits of WHO (2011). This could be attributed to the presence of decaying organic matter from possible use of herbicides

Chemical Oxygen Demand (COD)

Chemical oxygen demand, COD, shows presence of bio- and non- biodegradable organic matter in water (Ioryue et al., 2018). It measures oxidized organic matter.

In this research study, COD values at the upstream and downstream segments indicated 7.98 and 6.54 mg/L respectively which are significantly lower than the WHO (2011) permissible level of 10 mg/L**.** The decreased COD values in this study could be attributed to reduced water volumes (Eneji *et al*., 2012).

Total Alkalinity (TA)

Total alkalinity in water is a measure of the water's ability to neutralize acids. It indicates the water's capacity to resist significant changes in pH when acids are added.

TA values at the upstream and downstream segments indicated 6.72 and 1.51 mg/L respectively which are significantly lower than the WHO (2011) permissible level of 10 mg/L**.** Higher alkalinity levels buffer acid waste and prevent pH changes that are harmful to aquatic life (Feely *et al*., 2010).

Nitrates

Nitrate (NO_3-) is a chemical compound consisting of one nitrogen atom (N) bonded to three oxygen atoms (O) and carrying a negative charges. In this research study, Nitrates values at the upstream and downstream indicated segments 46.1 and 74.8 (mg l-1) respectively. The downstream revealed higher nitrates value above 50 (mg l-1) maximum acceptable limits of WHO (2011). This could be attributed to the application of nitrogenous fertilizer used to enrich soils and may have been carried by rain, irrigation and other surface waters through the soil into the water bodies. Human and animal wastes within the study area can also contribute to nitrate contamination of the Ava river. Nitrates can be harmful to humans if they exceed acceptable limits because our intestines cannot break them down into nitrites which affect the ability of red blood cells to carry nitrogen. Nitrates can also cause serious illness in fish and death, these decreases fish population. This agreed with the finding of Eziashi (2015) and Waite (2011).

Phosphate

In this research study, phosphate values at the upstream and downstream segments indicated 36.3 and 64.5 (µg) respectively. The downstream revealed higher phosphate value above the range of 10 - 50 (µg) maximum acceptable limits of WHO (2011). This could have been attributed to excessive phosphate runoff from agricultural fields and other sources which can lead to eutrophication in bodies of water. This causes harmful algal blooms and depletes oxygen, negatively impacting aquatic ecosystems.

Sulphate

The sulphate in the water sample of the study area varies from 6.726– 1.515 mg/L which falls below WHO (2011) recommendation for domestic water.This highlights the great interest of sulphates as indicators of pollution caused by leachates (Lerner and Tellam 1992; Khattabi and al. 2002).

Cadmium (Cd)

Cadmium can enter agricultural wastewater through the use of cadmium-containing fertilizers, sewage sludge, or the application of phosphate fertilizers contaminated with cadmium. Other probable sources include leachates from nickel-cadmium based batteries which are so carelessly discarded by battery chargers, and cadmium plated items that are disposed at the refuse dumps both in urban and rural communities. The mean concentrations of cadmium (Cd) in all the analyzed water samples are above 0.003 mg/L maximum acceptable limit. Cd, even at very low concentration, when ingested through consumption of polluted water, fish or vegetables, induces renal damages because it has a long biological half-life of 10- 33years in human body (Ehi-Eromosele and Okiei,2012).

Copper (Cu)

Copper is a toxic metal that can be introduced into agricultural wastewater from the use of copper-based fungicides or other agricultural chemicals. It was observed from the results that samples collected at upstream and downstream revealed 0.030 and 0.19 mg/L. The down stream revealed higher copper value above 1.0 mg/L maximum acceptable limits of WHO (2011). This could be attributed to run off of agricultural wastewaters from the study area.

Lead (Pb)

Lead can be present in agricultural wastewater from sources like lead-based pesticides or contaminated soil and dust. Water sample collected at upstream and downstream segments indicated 0.07 and 0.01mg/L which falls within the acceptable limit set by WHO (2011). The occurrence of Pb above its threshold level in these rivers portends danger to human health, especially the children. Pb can affect the foetus, results in convulsion, major neurological damage (Ezennubia et al., 2019; and Igwenyi and Okorie, 2014)

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V. CONCLUSION

The assessment of water quality is very pertinent to both public health and aquatic life. Toxic contaminants and pollutants can be identified using water quality analysis, which can ascertain their sources and destinations from the local ecosystem, geology, and anthropogenic activities. The continuous application of inorganic fertilizers, herbicides and pesticides for crop production and management, has been found to impact positively on crop quality and yield, but negatively on the quality of water at the downstream segment of the irrigation areas. Biological oxygen demand, nitrate,phosphate, copper and cadmium levels in the water samples analyzed at the downstream segment exceeded the maximum acceptable limit of WHO (2011). It was observed that the amount of inorganic fertilizers, herbicides and pesticides applied by the farmers are quite higher than the quantity required for optimum yields, but inappropriate techniques and timing of application resulted in the occurrence of excess chemicals being flushed into the Ava River.

RECOMMENDATION

Sustainably managing water resources necessitates a trifecta of technology advancements, legislative initiatives and public awareness campaigns to combat water contamination.

These contaminants can be eliminated from water by employing reverse osmosis (RO) and granular carbon filtering (GCF), but these methods are quite expensive. Therefore, limiting the adverse effects of these agrochemicals is best achieved by source management. In order to curtail the amount of agrochemicals that can leak into water bodies,applications of organic farming practices and cultivation must be adopted.

It is also important to apply strict regulatory strategies and measures to safeguard the water body from pollution caused by unfavorable anthropogenic activities, as climate change poses a threat to the preservation of the water bodies' quality for agricultural and residential purposes.

Furthermore, the excessive lack of public water supply led to the streamlining of the use of these rivers for domestic purposes. Therefore, the state government ought to give the Enugu State Water Corporation sufficient funding to enhance the volume, caliber, and consistency of water that the corporation provides to the public. Moreover, modern equipment and skilled labor should be provided as part of the help.

DECLARATION STATEMENT

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Ethical Approval and Consent to Participate	No, the article does not require ethical approval and consent to participate with evidence.
Availability of Data and Material	Not relevant.
Authors Contribution	All the authors have equal participation in this article.

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