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# Effects of Anthropogenic Activities on Water Quality Parameters of Iju Stream, Ota, Ogun State, Nigeria

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## ABSTRACT

When solid and liquid wastes enter into water sources unchecked, the water becomes unfit for consumption. When human beings consume such water, they are at risk of waterborne diseases such as dysentery, typhoid and cholera. Therefore, this study investigated the effects that the anthropogenic activities happening around Iju Stream Ota, Ogun State, Nigeria have on the water quality collected from the stream. Three water samples each were collected across the stream (upstream, midstream and downstream) in three different months of 2024 (January, April and August), making a total of nine samples. Samples were collected during both rainy and dry seasons for data to be representative enough. Physico-chemical and microbial parameters were analysed in compliance with American Public Health Association (APHA) (2018) guidelines. Results obtained were compared with World Health Organization (WHO) (2022) standards for drinking water quality. Physico-chemical and microbial results obtained for upstream, midstream and downstream sections in January, April and August respectively were; pH (7.4, 7.6, 8.8); Turbidity (6.7, 6.7, 7.9); Electrical conductivity (122, 131, 131), Nitrate (39, 36, 43), Phosphate (24, 27, 46), Calcium (14.8, 18.6, 20.8), Magnesium (22.6, 25.7, 24), Chloride (10, 13.8, 14.2), Temperature (28 $^0$C, 29 $^0$C, 31 $^0$C), Total dissolved solids (61, 68, 65.9), Dissolved oxygen (8.1, 9.2, 9.9), Hardness (37.4, 39.5, 44.6), Colour (2.80, 3., 3.25), Salinity (7.81, 8.2, 9.04), Manganese (0.01, 0.10, 0.09), Zinc (0.14, 0.14, 0.21), Copper (0.13, 0.19, 0.21), Iron (0.05, 0.09, 0.16), Biochemical oxygen demand (1.09, 1.14, 1.38) and Coliform count (130, 133, 151 cfu) in mg/l. Analysed water samples substantially failed to meet the minimum WHO requirements for drinking water quality. This work is applicable in the protection of surface water for public use and consumption, to preserve public health and prevent waterborne diseases.

**Keywords:** Anthropogenic activities, Physico-chemical parameters, Coliform count, Surface water, Water quality

## INTRODUCTION

Water is among the critical natural resources available for man's use (APEC, 2016; Zacchaeus *et al.*, 2020). It is often obtained from two major natural sources; groundwater (hand-dug wells, motorized boreholes and manually operated boreholes), and surface water (streams, rivers, lakes, oceans and seas). Also, there are other sources such as precipitation, wastewater recycling and desalination (Temilola *et al.*, 2011; Boateng *et al.*, 2016). Similarly,

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the two broad categories of water are saltwater (oceans and seas) and freshwater (rivers, lakes, dams and reservoirs). Furthermore, the Earth has been described as the water planet because more than 70% of the planet is covered with water, while the remaining 30% is made up of the lithosphere (Vivekanand, 2017). However, a significant percentage (97%) of water on the earth is saltwater (seas and oceans), while a tiny fraction (< 3%) is the fresh water. More challenging is the fact that over 70% of freshwater sources in the earth cannot be readily accessed for domestic uses because they are tied up in ice and glaciers (Żeber-Dzikowska *et al*., 2022).

Water is an essential requirement for the body to carry out functions such as movement of blood and nutrients to body organs, digestion, excretion, homeostasis and metabolism (Oladejo, 2014). When the body is deprived of water for up to 72hours, organs begin to shut down and if the situation is not remedied, death will inevitably result (Adilov *et al*., 2021). Similarly, the National Academy of Sciences (2016) reported that an adult human being requires between 20 - 50 liters of potable water daily for normal functioning of organs and systems. Furthermore, water is also required for specific domestic needs such as (bathing, cleaning, washing and cooking), agricultural purposes (irrigation and photosynthesis) and industrial activities (production, mining, exploration and manufacturing). It is therefore clear that the important role water plays in the general wellbeing of human beings cannot be overemphasized (WHO, 2022).

According to Cosgrove and Loucks (2015), nearly 30% of the world freshwater is provided by groundwater, thereby meeting the clean water needs of about 25 – 40% of the world's increasing population. This implies that only a small population of about 0.5 - 1% of the water resources in the world can be useful for man's industrial, agricultural and domestic activities. Consequently, the rapid rate of industrialization, increased urbanization and rising world population have increased the demand for potable water (Richey *et al*., 2015; Ugbaja & Ephraim, 2018). However, Olatunji *et al.* (2015) reported that freshwater sources are becoming scarce at a frightening rate because of global warming and climate change, thereby making it impossible to meet the daily potable water needs of many people. This unfortunate situation of water scarcity even though a global challenge, is more prevalent in developing countries like Nigeria.

According to a WHO (2020) report, more than 1 billion people in developing countries do not have potable water (Bangalore & Latha, 2018). Since Nigeria has the largest population in Africa with more than 200 million people, this makes the country one of the most affected in terms of water-related problems. Some of these problems include poor water treatment and distribution infrastructures, inadequate maintenance, improper refuse disposal and poor waste management generated from anthropogenic activities (Oladejo & Olanipekun, 2018). Thus, developing countries like Nigeria are regularly faced with the problem of handling the huge toxic effluents, harmful substances and wastes produced from domestic and commercial activities. These wastes are often dumped indiscriminately into streams and other water bodies by houses, farms, factories and allied industries (Osibanjo *et al.*, 2011).

Worse still, leachates from chemicals, metals, fertilizer application to crops and dead organic matter also pollute water sources, thereby water obtained from such sources become unsafe for domestic use (Makinde *et al.*, 2016). These contaminants do not just compromise the biological and physical parameters of water; they also impact their chemical composition through the deposition of heavy metals which are harmful to human health (Klos, 2016; Longe *et al.*, 2020; Chmielewski *et al*., 2021). According to Kanu and Achi (2011), if these indiscriminate dumping practices are not curtailed, water sources will become hazardous for drinking and other domestic purposes. This is even more critical for a country like Nigeria where an estimated 66.3 million of the population rely on questionable water sources, due to failure of government to provide pipe-borne water (Temilola *et al.*, 2011).

Consequently, Omole and Isiorho (2021) reported that communities where provision of pipe-borne water is inadequate and consumption of questionable water sources is common often suffer from waterborne and communicable diseases such as typhoid, cholera, dysentery, diarrhea and hepatitis. It is therefore expedient to regularly carry out the assessment of water quality of surface water sources, especially in communities with a lot of industrial and anthropogenic activities, since many residents of poor and developing countries depend on them for their daily water needs. To this end, the objectives of this study included the collection of three water samples each across Iju stream (upstream, midstream and downstream sections) for three different months (January, April and August) and their laboratory analyses (physical, chemical and microbial), to determine the impacts of anthropogenic activities on the water samples.

## MATERIALS AND METHODS

The equipment used for this study were; extraction cup, laboratory beaker, volumetric flask, agar plates, test tubes, laboratory incubator, laboratory thermometer, evaporating dish, autoclave, conical flask, laboratory oven, weighing scale and atomic absorption spectrophotometer (AAS).

The materials used for this study were; ten numbers of ten liter sterilized kegs and ninety liters of stream water samples obtained at the upstream (Latitude 6.684081 and Longitude 3.143267), midstream (Latitude 6.693496 and Longitude 3.146280) and downstream (Latitude 6.683614 and Longitude 3.143738) sections of Iju Stream, Ota, Ogun State, Nigeria, as shown in Figures 1, 2 and 3. The stream samples were obtained in three different months (January, April and August) covering the two major seasons (dry and rainy) of the year, to ensure that the results will be a true representation of the water quality all year round. Furthermore, the water samples were obtained in the evening (6pm every day) to ensure that all daily anthropogenic activities would have been completed before collecting the samples. After collection, water samples were stored in sterilized ten liter kegs and taken to Central Research Laboratory, Bells University of Technology, Ota, Ogun State, Nigeria for analyses of their physical, chemical and microbial parameters according to APHA (2018) standards. The results obtained were compared with WHO (2022) for drinking water quality.

### Analyses of Physico-Chemical Parameters

pH: pH values were determined by using a well calibrated pH meter. Surface water samples were measured into an extraction cup. Also, the probe of the pH meter was rinsed with distilled water and was thereafter standardized with a buffer solution of known concentration.


**Figure 1: Upstream section of the river with abattoir wastes polluting the stream**


**Figure 2: Midstream section of the stream showing onset of plants growth and eutrophication**

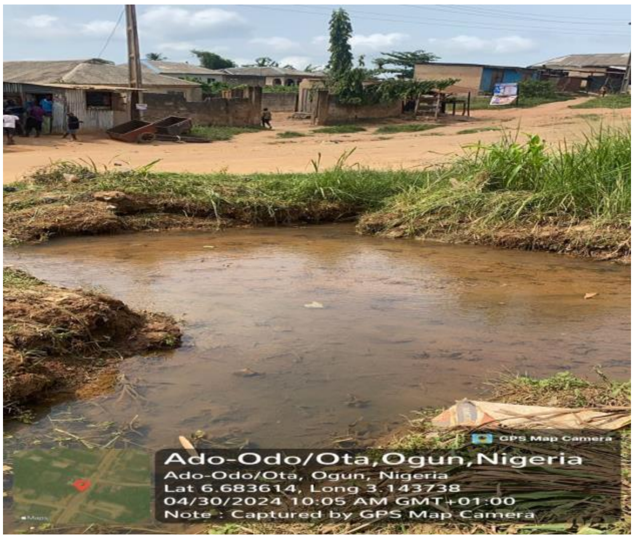


**Figure 3: Downstream section of the stream with proximity to residents for water collection**

Furthermore, enough amount of the aliquot sample was measured into a beaker to allow full immersion of the pH probe, while also ensuring the pH meter was turned on. The values were read to determine the degree of alkalinity and acidity.

Temperature: The thermometer was immersed well in the water samples to reach the right depth for accurate readings to be obtained. The temperature values were read to the nearest fraction of degree Celsius before the thermometer was removed.

Phosphate: Surface water samples were measured into an extraction cup, while 5 mls of Murphy and Riley solution (colour reagent) was also added. 10 mls of distilled water was added to the mixture and the solution was left to cool for few minutes. A bluish colour developed and the blue colour solution was analysed for phosphate using the AAS at 882nm wavelength.

Turbidity: This was measured with turbidity meter which uses optical scattering detection techniques for quick and reliable measurements. Surface water samples were measured into a small glass basin connected electronically to the turbidity meter for measurement. The turbidity meter was switched on and allowed to measure accurately.

Colour: The photo electric method was used. The standard colour solutions were measured into 100ml volumetric flasks which gave a range from 10 to 200 Hazen units. Each of the standard measured quantities was diluted to the required level with distilled water that was already filtered to remove any turbidity. A calibration graph relating optical density to Hazen units was used and the samples were filtered through a glass fiber filter paper to remove any turbidity. Thereafter, optical density was measured with AAS at a wavelength between 385 and 470nm. From the calibration graph, the colour of the samples was recorded to the nearest 5 Hazen units.

Nitrate: 25g of phenol was diluted in concentrated $H_2SO_4$ measuring 150mL, with another 5mL of $H_2SO_4$ concentration added before stirring. The solution was thereafter heated on a hot water bath and left to cool for a while. Surface water sample measuring 100mL was mixed with another 100mL $Ag_2SO4$ solution for treatment and prevention of chloride interference. 4.4g $AgSO_4$ was diluted in 1L of distilled water to prepared silver sulphate solution. 100mg/L of nitrogen was used to dissolve 0.722g anhydrous $KNO_3$ in 1L distilled water to prepare the nitrate stock solution. Neutralization of surface water sample to pH 7 was carried out with dilute NaOH before filtration. Surface water samples were poured inside a beaker and allowed to evaporate to dry state and the residue was mixed with phenoldisulfonic acid reagent of 2.0mL measurement through the use of glass rod for dissolving the solids. The mixture was dissolved with concentrated ammonia of 6mL and distilled water of 20mL, till a deep yellow colour developed. The solution was dissolved in distilled water and poured into a volumetric flask of 50mL. The solution was left to cool and thereafter, $NO_3^-$ results were read from the graph.

Calcium, Magnesium, Potassium, Manganese and Iron: Surface water samples were collected into extraction cup and analysed for the presence of Calcium, Magnesium, Potassium, Manganese and Iron using AAS.

Total dissolved solids (TDS): TDS meter was immersed dipped in a plastic container having measured surface water samples and the TDS measurements were taken immediately. Replicate measurements were carried out to ensure accuracy. Calibration of TDS meter was done using 0.02M KCl and 0.20M KCl.

Biochemical oxygen demand: Incubation in the dark was done for surface water samples through laboratory bottles of analytical grade. Reduction in the concentration of dissolved oxygen while incubating confirmed the value of biochemical oxygen demand as presented in Equation 1

Biochemical oxygen demand:

$$D1 - D5 \tag{1}$$

D1 = Initial dissolved oxygen of surface water sample

D5 = Final dissolved oxygen of surface water sample after five days of incubation

Dissolved oxygen: Surface water samples were measured with pipette into a conical flask. Manganous sulphate measuring 2mL and potassium fluoride measuring 1mL were also added. Concentrated 2 mL of $H_2S0_4$ and alkaline iodide acid of 2mL of were equally added. Sodium thiosulphate ($NaS_20_3$) was used to carry out titration was done with sodium thiosulphate ($NaS_20_3$) to obtain a clear solution, while 5 mL indicator that was newly prepared was also added. A colour change to blue-black was noticeable and titration was conducted again using sodium thiosulphate for a colourless solution to develop.

## Heavy Metals Analyses

Nitric acid of 5mL concentration nitric acid was poured into surface water sample of 250mL in a beaker and then stirred. The solution was heated using hot plate until the volume reduced to 20mL. De-ionized water was used to dilute to 50mL and then poured into a tagged sample bottle. Preparation of stock solutions in 1L flask was carried out through dissolution of specific amount of salts and made up to 1000mL. Serial dilution was done from the stock solution for analysis, while final concentrations of Copper, Iron and Zinc were then determined in ppm using AAS.

**Microbial Analyses**

The most probable number (MPN) of coliform counting was used. Distilled water measuring 9mL was poured into 6 test tubes. Eosine Methylene Blue (EMB) agar of 3.8g was measured and added to distilled water of 100mL. EMB solution and test tubes were placed inside autoclave for 45minutes of sterilization. After sterilization, 1mL of surface water sample was poured inside the first test tube containing sterilized distilled water of 9mL to make $10^{-1}$ dilution, which was shaken well. Properly mixed $10^{-1}$ dilution of 1mL was poured into the second test tube ($10^{-2}$ dilution). This was repeated for the other test tubes that remained by taking 1mL of previous test tube and adding it to the 9mL diluents that are next. The final dilution of bacteria cells were taken as the $10^{-6}$ dilution. Thereafter, surface water sample of 1mL was measured from each test tube and poured into plates having EMB agar and covered. These were left in the incubator for 72 hours, while the developed Escherichia Coli colonies were determined using colony counter.

## RESULTS AND DISCUSSION

The results obtained from the physico-chemical and microbial analyses of the surface water samples are presented in Tables 1, 2 and 3 respectively. The results showed that the surface water samples did not all meet the minimum requirements of WHO (2022) for drinking water quality as shown in Table 4. The values of pH, Nitrate, Phosphate, Total Dissolved Solids, Dissolved Solids and Turbidity did not just fail to meet the minimum requirements, but also displayed a tendency to continually rise across each stream section. This trend was observed across the three months of analyses as well. This may have been caused by the proximity of the stream to residential areas where artisans wash themselves after the day’s work and more importantly, an abattoir dumpster. Children in the community are also known to often defecate and urinate close to the stream.

Furthermore, the data obtained agrees with the findings of Oladejo and Olanipekun (2018) that dead organic matter often contribute to the prevalence of Nitrate, Phosphate and Calcium in analysed water samples. According to the WHO (2022), surface water samples that are intended for domestic uses such as bathing, washing and cooking should be located away from dumpsites, landfills and solid waste collection points where the water could be at risk of contamination with leachate. Iju stream currently fails to meet these requirements. Similarly, Ogunba (2011) reported that sustained and intense precipitation with heavy surface runoff enable contamination of surface water such as streams, rivers and lakes.

**Table 1: Water quality parameters in mg/l for January**

| S/N | Parameters | Upstream | Midstream | Downstream |
|---|---|---|---|---|
| 1 | pH | 7.4 | 7.4 | 7.4 |
| 2 | Turbidity (NTU) | 6.7 | 6.6 | 6.7 |
| 3 | Electrical Conductivity | 122 | 124 | 129 |
| 4 | Nitrate | 39 | 38 | 40 |
| 5 | Phosphate | 24 | 23 | 24 |
| 6 | Calcium | 14.8 | 13.9 | 14.6 |
| 7 | Magnesium | 22.6 | 21.7 | 21.3 |
| 8 | Chloride | 10 | 10.5 | 11.4 |

| | | | | |
|---|---|---|---|---|
| 9 | Temperature ($^0$C) | 28 | 28 | 28 |
| 10 | Total dissolved solids | 61 | 59.8 | 60.7 |
| 11 | Dissolved oxygen | 8.1 | 8.0 | 8.8 |
| 12 | Hardness | 37.4 | 38 | 37.9 |
| 13 | Colour | 2.8 | 2.8 | 3.1 |
| 14 | Salinity | 7.81 | 7.11 | 7.7 |
| 15 | Manganese | 0.01 | 0.04 | 0.03 |
| 16 | Zinc | 0.14 | 0.16 | 0.16 |
| 17 | Copper | 0.13 | 0.11 | 0.10 |
| 18 | Iron | 0.05 | 0.04 | 0.05 |
| 19 | Biochemical oxygen demand | 1.09 | 1.00 | 1.13 |
| 20 | Coliform count (cfu) | 130 | 132 | 134 |

**Table 2: Water quality parameters in mg/l for April**

| S/N | Parameters | Upstream | Midstream | Downstream |
|---|---|---|---|---|
| 1 | pH | 7.2 | 7.6 | 8.1 |
| 2 | Turbidity (NTU) | 6.8 | 6.7 | 6.9 |
| 3 | Electrical Conductivity | 129 | 131 | 131 |
| 4 | Nitrate | 33 | 36 | 35 |
| 5 | Phosphate | 26 | 27 | 25 |
| 6 | Calcium | 17.9 | 18.6 | 20 |
| 7 | Magnesium | 26.2 | 25.7 | 25.1 |
| 8 | Chloride | 12.3 | 13.8 | 14.7 |
| 9 | Temperature ($^0$C) | 28 | 29 | 27 |
| 10 | Total dissolved solids | 66 | 68 | 68 |
| 11 | Dissolved oxygen | 8 | 9.2 | 9.7 |
| 12 | Hardness | 38.7 | 39.5 | 39.9 |
| 13 | Colour | 3.12 | 3 | 3.88 |
| 14 | Salinity | 7.66 | 8.2 | 8.9 |
| 15 | Manganese | 0.08 | 0.10 | 0.10 |
| 16 | Zinc | 0.11 | 0.14 | 0.13 |
| 17 | Copper | 0.16 | 0.19 | 0.19 |
| 18 | Iron | 0.08 | 0.09 | 0.08 |
| 19 | Biochemical oxygen demand | 1.11 | 1.14 | 1.12 |
| 20 | Coliform count (cfu) | 135 | 133 | 133 |

**Table 3: Water quality parameters in mg/l for August**

| S/N | Parameters | Upstream | Midstream | Downstream |
|---|---|---|---|---|
| 1 | pH | 8.0 | 8.6 | 8.8 |
| 2 | Turbidity (NTU) | 7.6 | 7.7 | 7.9 |
| 3 | Electrical Conductivity | 130 | 130 | 131 |
| 4 | Nitrate | 41 | 40 | 43 |
| 5 | Phosphate | 23 | 25 | 26 |
| 6 | Calcium | 19.2 | 21.1 | 20.8 |
| 7 | Magnesium | 23 | 24.2 | 24 |
| 8 | Chloride | 12.8 | 13.9 | 14.2 |
| 9 | Temperature ($^0$C) | 31 | 30 | 31 |
| 10 | Total dissolved solids | 64 | 63.3 | 65.9 |
| 11 | Dissolved oxygen | 9.6 | 9.9 | 9.9 |
| 12 | Hardness | 42.4 | 41.8 | 44.6 |

| | | | | |
|---|---|---|---|---|
| 13 | Colour | 3.02 | 3.09 | 3.25 |
| 14 | Salinity | 8.87 | 8.81 | 9.04 |
| 15 | Manganese | 0.07 | 0.07 | 0.09 |
| 16 | Zinc | 0.18 | 0.22 | 0.21 |
| 17 | Copper | 0.18 | 0.17 | 0.21 |
| 18 | Iron | 0.17 | 0.14 | 0.16 |
| 19 | Biochemical oxygen demand | 1.28 | 1.33 | 1.38 |
| 20 | Coliform count (cfu) | 149 | 151 | 151 |

**Table 4: WHO (2022) parameters for drinking water quality**

| S/N | Parameters | Permissible limits (mg/l) |
|---|---|---|
| 1 | pH | 6.5 – 8.0 |
| 2 | Turbidity (NTU) | 5 |
| 3 | Electrical Conductivity | <1000 |
| 4 | Nitrate | 10 |
| 5 | Phosphate | 5 |
| 6 | Calcium | 20 |
| 7 | Magnesium | 10 |
| 8 | Chloride | 250 |
| 9 | Temperature ($^0$C) | 25 |
| 10 | Total dissolved solids | <300 |
| 11 | Dissolved oxygen | 4 – 6 |
| 12 | Hardness | 60 – 120 |
| 13 | Colour | 5 |
| 14 | Salinity | <200 |
| 15 | Manganese | 0.1 |
| 16 | Zinc | 5 |
| 17 | Copper | 0.05 |
| 18 | Iron | 0.3 |
| 19 | Biochemical oxygen demand | <5 |
| 20 | Coliform count (cfu) | <10 |

The effects of this runoff can be seen in the high values of Turbidity, Total Dissolved Solids and Electrical Conductivity.

Even more worrisome are the heavy metals and microbial results obtained across the three sections of the stream as shown in Tables 1, 2 and 3. These values were mostly beyond the permissible limits in Table 4; especially the values obtained for January and August. These values also displayed a tendency to keep rising like the physico-chemical values as well. Therefore, Iju stream urgently requires treatment before consumption or for any domestic use. According to Okoro *et al.* (2012), sustained pollution of surface water in an area will eventually affect groundwater of the same area also. If this contamination continues unchecked, the WHO warned that consumers of such water sources are at risk of contracting communicable and life threatening waterborne diseases such as typhoid fever, dysentery and cholera. This will consequently take a huge toll on the economy of affected people because they have to expend their scarce resources to seek medical attention, while also putting avoidable strain on limited public health facilities. It is therefore imperative for communities that rely on surface water sources for domestic purposes to ensure that their sources are adequately protected from all forms of contamination.

## CONCLUSION AND RECOMMENDATION

This study assessed the impacts that anthropogenic activities around Iju stream, Ota, Ogun State, Nigeria have on the quality of the water. This was done through collection of water samples at three different times spanning eight months at the upstream, midstream and downstream sections for laboratory analyses. Based on the findings, it is concluded that;

i) The values of the physico-chemical and microbial parameters substantially failed to meet the minimum requirements of the WHO for drinking water quality
ii) The water in Iju stream is not fit for drinking or any domestic purpose to avoid the incidence of waterborne and communicable diseases in the community
iii) Iju stream should be adequately treated to ensure the water collected from it meets the minimum requirements for consumption and measures should be put in place to protect the stream from contamination.

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