**Determination of Physico-chemical** **Characteristics of Urasi River for Sustainable Quality Water and Health Management in Urasi, Ihiala Local Government, Anambra State, Nigeria**

**ABSTRACT**

Assessing water quality for different water purposes, such as domestic use, irrigation, conservation and industrial usage, are an important strategy for food safety and human health. Suitability of water for various uses depends on type and concentration of dissolved minerals present. The alarming state of environmental management and improper waste management pose a threat to lives, invariably the topography and geological formation of the study area is prone to erosion, therefore, contaminants can easily get to the groundwater or the surface water. This study aimed to analyze and appraise the Physico-chemical properties or characteristics of Urasi river to ensure sustainable quality water and health management. Due to the predominant sandstone formation in the study area, the vulnerability of the study area to erosion and environmental hazard which has been unfair to resources. The abiotic parameters such as Temperature, Hydrogen Ion concentration, Dissolved oxygen, Conductivity and Biochemical Oxygen Demand was estimated by adopting standard protocol. The variation in water parameters helps to denote the quality of the water for sustainable health management scenario. The results revealed that the Physico-chemical data depict an overall air temperature of 29.0±1.3oC, highest mean value of 29.4±1.2 (range 27.0-31.0) oC occurring in station B followed by station C 29.1±1.8 (range 25.5±31.0) oC. Water Temperature varied across the months as mean value of 30.17±1.17oC (range 28.0-31.0oC), was record in March. 26.17±1.330C range (24.0-28.0) and 26.03±2.170C (21.0-28.0) record in July and September, respectively as the June value of 26.33±1.030C. Biochemical oxygen raised across the months in value of 11.27±0.1 range (11.2-11.3) mg/L obtained in April, it decreased gradually from July 10.3±0.1 range (10.3-10.6) mg/L. it then increased from October 11.07±0.1 range (11.2-11.3) mg/L. And decreased from January 9.67±0.1 range (9.6-9.7) mg/L to March 10.47±0.1 range (10.4-10.5) mg/L and peaked in June 15.27±1.0 range (14.2-16.5). Alkalinity mean values vary from station A to station B, 9.0±0.9 (range 8.3-10.6) mg/l station A 8.6±1.7mg/l (range 5.3-11.0) mg/l station B and decrease in station C on the range of 7.7±1.9 mg/l (range 4.0-10.0) mg/l. Water quality parameters were significantly (P<0.05) deteriorated and water temperature increased while alkalinity and hardness decreased in the study. The higher wet season variability in conductivity, pH, dissolved, and Oxygen, was due to extrinsic factors such as rainfall and wind. The higher dry season variability in most of the water quality characteristics of Urasi river may be attributed to the influence of intrinsic factors such as depth and current.

**Key Words:** Water Quality, Intrinsic Factors, Alkalinity Mean Values, Physico-chemical Data and Water Temperature

1. **INTRODUCTION**

“Water is a vital commodity, both to sustain life and for the global economy. However, the quality of global water has rapidly Water quality assessment refers to the methods/techniques used to determine the suitability of water for different uses according to its physical, chemical and organoleptic (e.g., taste) properties”, (Onyenweife, Omezi, and Nnnaemena (2024)). “In recent years, with increasing population and resource consumption, groundwater resources have faced growing pressures, with anthropogenic substances present in many aquifers, which may pose significant risks to the chemical integrity of groundwater. Additionally, recurrent extreme climate events and escalating human activities have led to significant changes in groundwater chemical composition and water quality. Therefore, revealing the hydrochemical characteristics of groundwater and its water quality evolution mechanisms is crucial for the sustainable development and utilization of water resources and the protection of ecological environments. Moreover, ecological conditions can influence organisms’ biochemical responses” (Du et al., 2025; Debels et al., 2025). “Assessing water quality for different water purposes, such as domestic use, irrigation, conservation and industrial usage, is an important strategy for food safety and human health. Suitability of water for various uses depends on type and concentration of dissolved minerals present”. (Onyenweife, Omezi, and Nnnaemena (2024). “Surface water quality indexes have been developed and introduced worldwide by researchers with various applications of the Nation Sanitation Foundation Water Quality Index (NSFWQI)” ([Carroll *et al.,* 2006](javascript:;)), the Water Quality Index (WQI), the Comprehensive Pollution Index (CPI), the Organic Pollution Index (OPI), the Trace Metal Pollution Index (TPI) the Eutrophication Index (EI) based on the database of water monitoring parameters. In Nigeria, research on water quality assessment mostly focuses on comparing the concentration of pollutants to the national surface water quality standard. The WQI has been used for 10 years; however, a combination of WQI with other water pollution indices has not been applied widely for water quality assessment research. According (Ifesinachi and Chikwado 2023), “there is a very low risk of infection to those who usually use boiled water for drinking. Poor water management practices exacerbate the challenges of water management, leading to severe consequences for both human and environmental well-being. Poor water management can lead to water scarcity, water pollution, and environmental degradation. Water scarcity can cause economic and social instability, while water pollution can cause health problems and environmental damage. Environmental degradation, such as the loss of wetlands and degradation of rivers and lakes, can lead to the loss of biodiversity and ecosystem services” (Mourad, 2020).

**1.1 Classification of water**

“Based on its source, water can be divided into ground water and surface water” (Nwosu and Ibemenuga, 2016). “Both types of water can be exposed to contamination risks from agricultural, industrial, and domestic activities, which may include many types of pollutants such as heavy metals, pesticides, fertilizers, hazardous chemicals, and oils” (Ibemenuga, 2016). According to (Onyenweife, Omezi, and Nnnaemena, 2024) “the degree and type of mineralisation of ground and surface water determines its suitability for municipal, industrial, irrigation and other uses”.

Water quality can be classified into four types—potable water, palatable water, contaminated (polluted) water, and infected water (Chatterjee, 2010). The most common scientific definitions of these types of water quality are as follows:

1. Potable water:It is safe to drink, pleasant to taste, and usable for domestic purposes
2. *Palatable water:* It is aesthetically pleasing; it considers the presence of chemicals that do not cause a threat to human health.
3. *Contaminated* (*polluted*) *water:* It is water containing unwanted physical, chemical, biological, or radiological substances, and according to Ibemenuga (2016) it is unfit for drinking or domestic use.
4. *Infected water:* It is contaminated with pathogenic organisms.

**1.2 Physical Parameters of Water Quality**

It is essential to monitor the physical aspects of water quality to determine if the water is polluted or not. Physical characteristics can be determined by:

1. Colour – pure water is colourless; coloured water can indicate pollution. Colour can also show organic substances. The maximum acceptable level for the color of drinking water is 15 TCU (True colour unit).
2. Turbidity – pure water is clear and does not absorb light. If turbidity appears in the water, it may indicate water pollution.
3. Taste and odour – pure water is always tasteless and odourless. If any type of taste and smell is present, it may indicate water pollution (Ibemenuga and Nwosu, 2017).
4. Temperature – The temperature is not directly used to evaluate whether water is drinkable or not. However, in natural water systems like lakes and rivers, the temperature is a significant physical factor that determines water quality
5. Solids – If water is filtered to remove suspended solids, the remaining solids in the water indicates the total dissolved solids. If the dissolved solids in the water exceed 300 mg/l, it adversely affects living organisms as well as industrial products (Monre, 2015).

**1.3 Chemical properties of water**

Chemical properties of water involve assessing parameters such as pH and dissolved oxygen:

1. pH – pH of water is measured between 0 and 14 to determine how acidic or alkaline it is. Measurement is conducted using a logarithmic scale.
2. Dissolved oxygen – is the level of free, non-compound oxygen present in water or other liquids. It is an essential parameter in assessing water quality because of its influence on the organisms living within a body of water (Shah, 2017).

Temperature

“Temperature is an important physical and essential parameter of aquatic habitats because almost all the physical, chemical, and biological properties are controlled by temperature”, (Pawar, 2012). “The basis of all life functions is complicated set of biochemical reactions that are influenced by physical factors such as temperature. The temperature was basically important for its. Effects on the chemical and biological activities of organisms in water” (Ogueji, 2016). “The water temperature varies throughout the year with seasonal changes in air temperature, day length, and solar radiations,” (Pawelek, 2015). “Bright sunlight and temperature help in production of green algae. Temperature influences determination of other factors like pH, conductivity, dissolved gases and various forms of alkalinity” (Bojarazu, 2016). “Temperatures of water were generally higher than air temperature in the afternoon hours except for few months (January to March), air and surface water temperatures were almost uniform in the month of October/November but most peculiarly in the morning hours and monthly variations of water temperatures of surface and bottom” (Ibrahim, 2016). The water temperature varied from winter to monsoon (June-August), higher water temperatures were recorded in lentic part of Bhagirathi and Bhilangana respectively, compared to lotic portion. Water temperature of the lacustrine portion was significantly different from that of lotic and changes in physico-chemical features and Plankton. Ibrahim et al. (2016) reported that “the low water temperature of Kontagora reservoir during the dry season could be a result of seasonal changes in air temperature, which could be associated with the cool, dry Northeast trend winds. The air and water temperature readings indicated an increase from January to March in Makwaye Reservoir” (Yemi et al., 2016).

### 1.4 Electrical conductivity

Conductivity of natural water is a measure of its ability to conduct an electric current. According to Olusanya (2002), waters with very high conductivity are potable. The conductivity of most fresh water is generally lower during the rainy seasons than dry season (Adaka et al., 2014). It is due to a dilution by rain and less evaporation during the rainy season, especially in lakes with short retention time (Agbugui, 2019). This also conforms with the reports of Yemi and Bankole (2016), which stated that “an increase in water conductivity could result from low precipitation, higher atmospheric temperatures resulting in higher evapotranspiration rates and higher total ionic concentration, and saline intrusions from underground sources. Specific conductivity can be utilised as a rapid measurement of dissolved solids and it is useful in monitoring waste in Rviers and conducting field in water quality. The level of conductivity in water gives a good indication of the amount of substances dissolved in it, such as phosphate, nitrate and nitrites. Different ions vary in their ability to conduct electricity” (Kwem et al., 2016). Conductivity can influence the composition, abundance and distribution of biotic organisms (Ayinla, 2003). Generally conductivity of the natural water is directly proportional to the concentration of ions. Distilled water has a conductivity of about l Pmhos/cm, while natural water normally has a conductivity of 20-1500 Pmhos/cm The conductivity of solutions depends upon the quantity of dissolved salts present (Jamu, 2003). Fazio October and Dry season from November to March. It has annual rainfall of 200 mm and average temperature of 27 °C approximately.

**1.5 Alkalinity**

“The alkalinity of water is its acid-neutralizing capacity comprised of the total of all titratable bases . The measurement of alkalinity of water is necessary to determine the amount of lime and soda needed for water softening (e.g., for corrosion control in conditioning the boiler feed water)” ([WHO](https://www.intechopen.com/#B22) 2016). “Alkalinity of water is mainly caused by the presence of hydroxide ions (OH−), bicarbonate ions (HCO3−), and carbonate ions (CO32−), or a mixture of two of these ions in water. As stated in the following equation, the possibility of OH− and HCO3− ions together is not possible because they react together to produce CO32− ions:” (Tomar, 2019).

“Alkalinity is determined by titration with a standard acid solution (H2SO4 of 0.02 N) using selective indicators (methyl orange or phenolphthalein)” (Alley, 2017).

“The high levels of either acidity or alkalinity in water may be an indication of industrial or chemical pollution” (Monre, 2015). “Alkalinity or acidity can also occur from natural sources such as volcanoes. The acidity and alkalinity in natural waters provide a buffering action that protects fish and other aquatic organisms from sudden changes in pH”(Vadde, 2018). “For instance, if an acidic chemical has somehow contaminated a lake that had natural alkalinity, a neutralization reaction occurs between the acid and alkaline substances; the pH of the lake water remains unchanged. For the protection of aquatic life, the buffering capacity should be at least 20 mg/l as calcium carbonate” (Carroll *et al.,* 2006).

**1.6 Dissolved oxygen**

“Dissolved oxygen is an essential chemical ion needed for energy metabolism of aquatic organisms. It also provides information about the biological and biochemical processes in water. Dissolved oxygen (DO) is of primary importance in natural water because most organisms other than anaerobic microbes- diminish rapidly when oxygen levels in water decreases, of all dissolved gases; oxygen plays the most important role in determining the potential biological quality of water. Dissolved oxygen level of 5 mg/l or greater will support healthy growth of most fishes” (Morhit, 2014). Absence of oxygen in water permits anaerobic decay of organic matter and production of toxic materials and gases such as hydrogen sulphide. Natural eutrophication of the lake is strongly influenced by anaerobic conditions at the bottom (Mouhir et al., 2014). Dissolved oxygen supply in water mainly comes from atmospheric diffusion and photosynthetic activity of plants. The quantity of dissolved salts and temperature greatly affects the ability of water to hold oxygen (Shemkar, 2012). Photosynthetic activity and reduced turbidity enhanced dissolved oxygen concentrations, (Udoh et al., (2014).

**1.7 Biochemical oxygen demand (BOD)**

“Biological Oxygen Demand (BOD) is the amount of oxygen required to biologically breakdown a contaminant,” (Carpenter et al., 2006). “It is often used as a measurement of pollutants in natural and waste waters and to assess the strength of waste, such as sewage and industrial effluent” (Carroll et al., 2006). “BOD therefore is an important parameter of water, indicating the health scenario of freshwater bodies” (Cole, 2019). Codling et al. (2010) reported that “the coefficient of biological oxygen demand variation was higher in the rainy season than dry season in Mbo River, Alcwa Ibom State. The trend of seasonality in BOD followed that of DO concentration with higher values and variability during the rainy season than in the dry season. The wet season increase in BOD values was probably due to the increased input of decomposable organic matter into the river through surface runoff. These organic matters require oxygen for their biodegradation”.

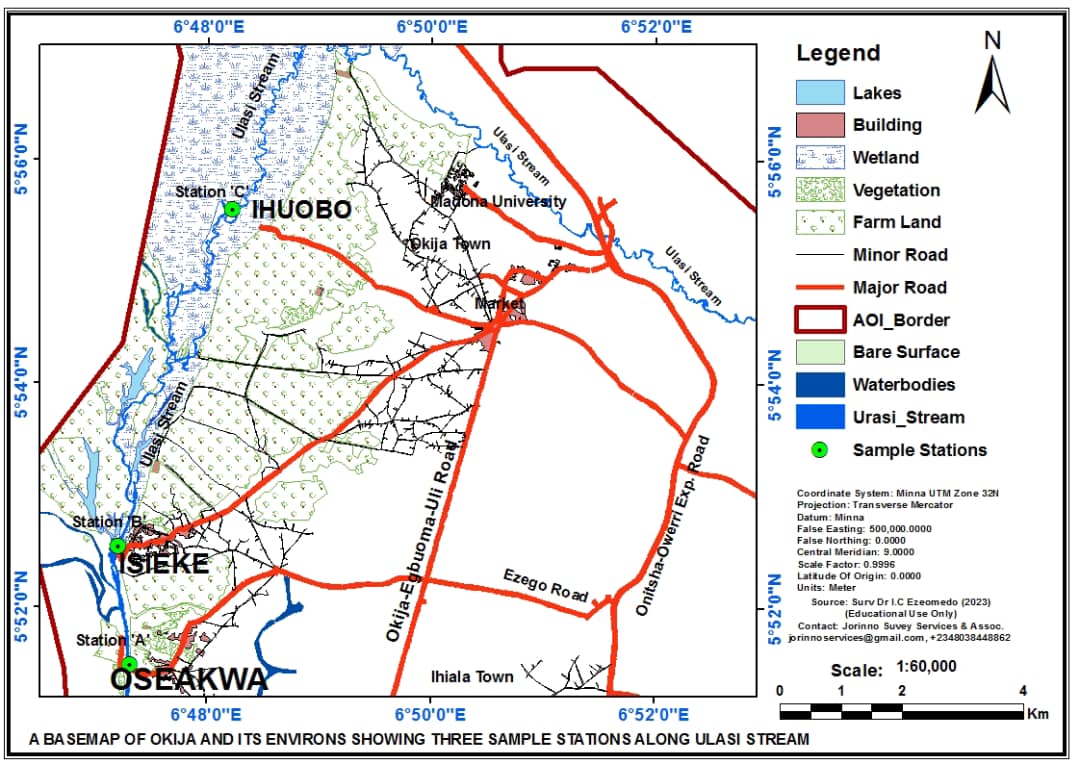
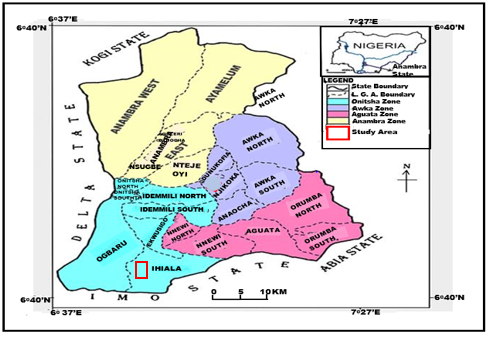
**1.8** **pH**

“Water pH is considered as an important chemical parameter that determines the suitability of water for various purposes. The pH expresses the acidity or alkalinity of water, which is determined by means of hydrogen ion (H+) and the hydroxyl ion (0H-) concentration in water, respectively. Water of around pH 7 is considered neutral, it is of great importance to biotic communities because most of the aquatic organisms are adapted to an average pH” (Surajit and Tapas, 2014). “During the daylight, aquatic plants usually remove the CO2 from the water for photosynthesis quickly and so pH increases. At night, CO2 from respiration accumulates and pH declines” (Cole, 2019). “The high amount of organic matter brought in by rain as a result of runoff tends to reduce dissolved oxygen through the utilization of organic dehydration, giving rise to a fall in pH” (Dawes et al., 2006). Stanley (2011) reported that “the slight acidity increase in the dry season may be due to high carbon dioxide concentration from organic decomposition. The high pH values promote the growth of phytoplankton, which most often results in algal blooms. Decomposition reduced the amount of oxygen, while increasing the amount of carbon dioxide in the affected environment” (Dawes, 2006).

**MATERIALS AND METHODS**

**STUDY AREA**

Ihiala local government area is located in Anambra state southeastern parts of Nigeria. It lies within the geographical coordinate of approximately between latitude 5º47ʹ60ʺN and 5ºʹ55ʺ12N and between longitude 6º47ʹ60ʺE and 6º5ʹ80ʺE (Fig. 1). Geologically, the study area is overlaid by Agulu Nanka formation, made up of highly sediments sandstones, shales and limestone. Due to the predominant sandstone formation in the study area, the vulnerability of the study area to erosion and environmental hazard which has been unfair to resources, (Onyenweife, Omezi, and Nnnaemena, 2024). The data location is Urasi River.



**Fig. 1: Map of Anambra State highlighting the Study Locations, Source: State Survey Anambra State (Ezeonedu, 2022).**

**3. STUDY PROTOCOL**

**Determination of** **Abiotic Parameter**

1. **Temperature**

The water temperature and pH was measured in-site using “suntex temperature meter” (model JPB-607A PORTABLE).

The temperature of the water was determining with the probe of the meter inserted in the Rvier 10-15 cm below the water surface and the reading recorded in 0C (degree Celsius).

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1. **Hydrogen Ion concentration (pH)**

The pH meter (suntex pH meter model H1-98107) was used. The pH meter was switched on 30 minutes before the test and was calibrated with buffer solution of 7.00 pH for alkalinity, 9.00 and 4.00 pH for acidity. The probe of the meter was inserted at each sample collected from the different station. The reading was taken from the display at the end of the exercise the probe of the meter was rinsed in the distilled water.

1. **Dissolved oxygen (DO)**

Dissolved oxygen (DO) was measured with DO meter (JPB-607A PORTABLE DO ANALYZER). The DO meter was put ON and allowed to stabilize for 15 minutes and calibration was done following manufacturers procedure by inserting the probe in 5% sodium sulphate solution. The probe was inserted at each samples collected from different stations of Urasi Rvier 10-15cm below the water surface.

1. **Conductivity**

The conductivity of water sample, which is inverse or resistivity (R) was determined from the voltage and current values according to ohm’s law, that is; R = . With 0.1 potassium chloride prepared, the conductivity metre was calibrated to 14.12 mhos using the standard 0.1m potassium chloride by adjusting the calibration krob. The probe of the metre was inserted in the water at each water sample from each station of the river and the reading were recorded on micro Siemens (ms/sm).

1. **Biochemical Oxygen Demand (BOD)**

The biochemical oxygen demand (BOD) of the water was determined using DO meter calibrated in 5% sodium sulphate solution. The probe was inserted into the water samples from each stations of the Rvier and the reading were taken and recorded in mg/l. the water sample was then incubated in a 250ml winkle’s bottle for 5 days at 20%. On the fifth day, the probe of the DO meter was inserted agan and the value was recorded as DOs.

1. **RESULTS & DISCUSSION**

**4.1 Physico-chemical** **Characteristics of Urasi River**

**i. Air Temperature**

The highest mean value of 30.83 ± 0.4 oC occurred in December followed by March 30.35 ± 1.1oC (range 29.0 - 31.0) and followed by January 30.33 ± 0.5oC range (30.0 - 31.0), the 1east mean value of 27.08±1.24oC obtained in July which was significantly different (P>0.05) from the values of November, December, January, March and May which was not significantly different (P>0.05) from the value of all other months.

**ii. Water Temperature**

Water Temperature varied across the months. The maximum mean value of 30.17±1.17oC (range 28.0-31.0oC), was record in March. This value significantly differed (P<0.05) from the mean of 26.17±1.330C range (24.0-28.0) and 26.03±2.170C (21.0-28.0) record in July and September respectively as the June value of 26.33±1.030C. however these values did not differ significantly (P>0.05) from each other and the value of all other month

**iii. Hydrogen - ion concentration (pH)**

pH raised across the months (Table 1). The men value of August (5.87±0.34) ranged (5.6-6.3) to October (5.50±.78) range (20.0-28.0) it then increased from November (5.67±0.21) range (26.0-31.0) to January (6.10±0.36). However, it decreased again from February 5.83±0.36 to April 5.97±0.90 however, it increases in May (6.33±0.67) and peaked in June (6.50±0.05) these values were not significantly different (P>0.05) from each other.

**iv. Dissolve oxygen**

Dissolve oxygen varied across the months. The highest mean value of 8.25±1.63 (range 6.1-9.4) was recorded in June. This value significantly differed P<0.05 from the mean value 4.62±0.4 (range 4.0-5.0) and 4.57±0.9 (range 3.4-5.0) recorded in February and March responsibility. However, the value does not differ significantly (P>0.05) from each other and the value of other months.

1. **Alkalinity (mg/l)**

The highest mean value of 10.00±0.8 (range 8.0-11.0) occurred in January followed by November 9.40±1.0 range (8.0-10.0) and followed by June 9.27±1.7 range (7.0-10.7). The least mean value of 5.88±1.9 range (40.53) obtained in July which was significantly different P<0.05 from the value of November, December, January, February, April, May and June which was not significantly different (P>0.05) from each other value of all other months.

1. **Electrical conductivity (μs/cm)**

Electrical conductivity varied across the months. The highest means value occurred in August 18.33±0.1 range (18.2-18.4) ms/cm followed by June, range 18.08±2.1 (15.0-20-0) ms/cm. This values were not significantly different (P>0.05) from the value obtained from all the months except the least value occurred in October 13.40±2.9 range (11.0-17.2) which varied significantly from all other months (P<0.05).

1. **Biochemical oxygen (mg/l)**

Biochemical oxygen raised across the months. The means value of 11.27±0.1 range (11.2-11.3) mg/L obtained in April, it decreased gradually from July 10.3±0.1 range (10.3-10.6) mg/L. it then increased from October 11.07±0.1 range (11.2-11.3) mg/L. However, it decreased again from January 9.67±0.1 range (9.6-9.7) mg/L to March 10.47±0.1 range (10.4-10.5) mg/L and peaked in June 15.27±1.0 range (14.2-16.5) these value was not significantly different (P>0.05).

The results of physico-chemical Characteristics of Urasi River in relation to months is presented in Table 1.

Table 1: Comparative Analysis of Physico-chemical Parameters in Relation to Months

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Months** |  | **Parameters** | | | | | | | |
| **Air Temperature (°C)** | | **Water Temperature (°C)** | **PH** | **Dissolved Oxygen (mg/L)** | **Alkalinity (mg/L)** | **Conductivity (μS/cm)** | **Biochemical Oxygen (mg/L)** |
| July | 27.08±1.242e  (25.5-28.5) | | 26.17±1.329b  (24.0-280) | 6.48±0.337a  (6.1-6.8) | 6.05±2.5dcba  (3.0-9.1) | 5.88±1.9c  (4.0-5.3) | 15.90±2.4a  (13.0-18.4) | 10.43±0.1fe  (10.3-10.6) |
| August | 27.68±1.206edc  (27.0-29.0) | | 27.18±0.776ab  (26.0-28.0) | 5.87±0.339a  (5.6-6.3) | 4.80±1.0dc  (4.0-6.2) | 7.10±1.6cb  (5.0-8.3) | 18.33±0.1a  (18.2-18.4) | 10.53±0.1fed  (10.5-10.6) |
| September | 27.33±0.516ed  (27.0-28.0) | | 26.03±2.616b  (21.0-28.0) | 5.83±0.981a  (5.2-7.1) | 4.80±1.0dc  (4.0-6.2) | 7.47±0.9cb  (6.4-84) | 17.20±1.5a  (16.2-19.2) | 10.60±0.1fedc  (10.5-10.7) |
| October | 28.48±0.752edcb  (27.0-29.0) | | 27.00±3.464ab  (20.0-28.0) | 5.50±0.775a  (5.0-6.5) | 5.07±0.8cb  (4.5-6.2) | 8.10±0.9cba  (7.2-9.2) | 13.40±2.9a  (11.0-17.2) | 11.07±0.1dbc  (11.0-11.1) |
| November | 29.17±1.169dcba  (28.0-310) | | 27.83±2.317ab  (26.0-31.0) | 5.67±0.683a  (5.0-6.5) | 7.43±1.4cba  (6.0-9.2) | 9.40±1.0ba  (8.0-10.0) | 16.03±3.0a  (12.1-21.0) | 10.77±0.1edcb  (10.7-10.8) |
| December | 30.83±0.408a  (30.0-31.0) | | 27.50±1.049ab  (26.0-29.0) | 5.97±0.207a  (5.7-6.1) | 7.58±2.3ba  (4.5-9.2) | 9.18±1.6ba  (7.1-10.6) | 17.17±3.6a  (12.5-20.0) | 11.27±0.1b  (11.2-11.3) |
| January | 30.33±0.516ba  (30.0-31.0) | | 28.17±1.329ab  (26.0-29.0) | 6.10±0.358a  (5.7-6.1) | 5.52±0.8dcb  (4.0-6.2) | 10.0±0.8a  (9.0-11.0) | 17.50±4.2a  (12.0-21.0) | 9.67±0.1g  (9.6-9.7) |
| February | 28.17±0.753edc  (27.0-29.0) | | 29.00±1.265ab  (27.0-30.0) | 5.83±0.516a  (5.5-6.5) | 4.62±0.4d  (4.0-5.0) | 8.57±0.4ba  (8.2-9.0) | 17.90±3.6a  (13.2-21.0) | 10.10±0.1gf  (10.0-10.2) |
| March | 30.35±1.007ba  (29.0-31.0) | | 30.17±1.169a  (28.0-31.0) | 5.50±0.775a  (5.0-6.5) | 4.57±0.9d  (3.4-5.2) | 8.05±0.9cba  (7.0-9.2) | 17.03±2.8a  (14.2-21.0) | 10.47±0.1fed  (10.4-10.5) |
| April | 29.00±1.673edcba  (27.0-31.0) | | 28.00±0.894ab  (27.0-29.0) | 5.97±0.896a  (5.2-7.1) | 5.80±0.5dcba  (5.0-6.2) | 8.62±0.4ba  (8.3-9.2) | 16.10±3.2a  (12.0-19.2) | 11.27±0.1b  (11.2-11.3) |
| May | 29.52±1.372cba  (28.0-31.0) | | 27.33±1.633ab  (25.0-29.0) | 6.33±0.671a  (5.6-7.1) | 5.60±0.4dcba  (5.1-6.2) | 9.17±0.6ba  (8.5-10.0) | 16.80±2.1a  (14.0-18.2) | 11.17±0.1bc  (11.1-11.2) |
| June | 28.00±0.894edc  (27.0-29.0) | | 26.33±1.033b  (25.0-27.0) | 6.50±0.245a  (6.3-6.5) | 8.25±1.629a  (6.1-9.4) | 9.27±1.7ba  (7.0-10.7) | 18.08±2.3a  (15.0-20.0) | 15.27±1.0  (14.2-16.5) |

*Results are in mean±standard deviation of sextuplicate determination.*

*Means in columns with different superscripts are significantly (p<0.05) different*

**The results of physico-chemical Characteristics of Urasi River in relation to station is presented in Table 2.**

**i. Air Temperature**

The overall mean air temperature of 29.0±1.3oC °C was recorded during the study. The highest mean value of 29.4±1.2 (range 27.0-31.0) oC occurred in station B followed by station C 29.1±1.8 (range 25.5±31.0) oC. Therefore, the mean value air temperature for station B and C was not significantly different from each other (p > 0.05).

**ii. Water temperature**

The mean water temperature increases from 28.6±1.3oC with a (range 26.0-31.0) in station C to 27.6±1.6 with a (range 25.0-30.0) oC in station B, it decreases in station A with the means value 27.0±1.7oC (range 24.0-30.5), therefore station A, B, C are significantly different from each other (p > 0.05).

**iii. (pH) Hydrogen ion concentration**

The overall means pH 5.9±0.3 was recorded during the study. The highest means value of 6.0±0.6 (range 5.0-7.1) occurred in station C, but station A and B maintain the same means value 5.9±0.7 (range 5.0-7.1). Therefore, stations A, B and C was not significantly different from each other (p > 0.05).

**iv. Dissolved oxygen (mg/l)**

The mean values of dissolved the oxygen were highest in station B 6.2±1.9 mg/l (range 4.0-9.4) mg/l but station A and C maintain the same value 5.7±1.9mg/l (range 4.0-9.4). Therefore, the means value for station A, B and C was not significantly different from each station (p > 0.05).

**v. Alkalinity (mg/l)**

Alkalinity means values of Urasi River varies in stations, there is a study increase from station A to station B, 9.0±0.9 (range 8.3-10.6) mg/l station A 8.6±1.7mg/l (range 5.3-11.0) mg/l station B, it decreases in station C 7.7±1.9 mg/l (range 4.0-10.0) mg/l, therefore the mean values in station A and B was not significantly different from each other (p > 0.05) but station C was significantly different from station A and B (p < 0.05).

**vi. Electrical conductivity (us/cm)**

The means values of conductivity in Urasi River was highest in station B 18.3±2.6μs/cm (range 16.2-21.0) followed by station A 18.1±1.5us/cm (range 16.3-21.0) and was lowest in station C 13.9±2.4 (range 22.0-29.2) us/cm, therefore means value in station A and B were not significantly different from each other (p > 0.05) but station C was significantly different from station A and C (p < 0.05).

**vii. Biological oxygen (mg/l)**

The mean value of biological oxygen maintains a stable increase in station A and B 11.2±1.5 mg/l (range 10.0-10.5) station A, 11.0±1.4 mg/l (range 9.7-15.1) station B and C 10.9±2.1 mg/l (range 10.1-14.2). Therefore, the means value of biological oxygen in station A, B and C was not significantly different (p > 0.05) from each other.

**Table 2 Results of physico-chemical Characteristics of Urasi River in relation to station**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | A | SATTION  B | C |  |
| Air temperature | 28.3±1.4 (27.0-31.0) a | 29±1.2 (27.0-31.0) a | 29.1±1.8 (25.5- 31.0) a | 29.0±1.3 (25.5-3.10) |
| Water temperature | 27.0±1.7 (24.0-30.5) a | 27.6a±1.6 (25.0-30.0) a | 28.0±0.8 (20.0-31.0) a | 28.0±0.8 (20.0-31.0) |
| PH | 5.9±0.9 (5.0-7.1) a | 5.9±0.7 (5.0-7.1) a | 5.9±0.3 (5.0-7.1) a | 5.9±0.3 (5.0-7.1) |
| Dissolved oxygen | 5.7±1.9 (4.0-9.4) a | 6.2±1.9 (4.0-9.4) a | 5.9±0.3 (3.0-9.4) a | 5.9±0.3(3.0-9.4) |
| Alkalinity(mg/L) | 9.0±1.5 (8.3-10.6) a | 8.6±1.7 (5.3-11.0) a | 8.4± 0.7 (4.0-10.7) a | 8.4± 0.7(4.0-10.7) |
| Conductivity | 18.1±1.5 (16.2-21.0) a | 18.3±2.6 (16.2-21.0) a | 16.8±2.5 (12.0-21.0) a | 16.8±2.5(12.0-21.0) |
| Biochemical oxygen | 11.1±1.5 (10.0-16.5) a | 11.0±1.4 (9.7-15.1) a | 11.1± 1.4(9.6-16.5) a | 11.1±1.4(9.6-16.5) |

*Results are in mean±standard deviation of sextuplicate determination.*

*Means in columns with different superscripts are significantly (p<0.05) different*

**4.2 Variation of physico-chemical characteristics of Urasi River in relation to seasons**

The wet seasons (May-October) was characterized by higher water temperature (27.0±0.850C) range (24.5-29.0) increased dissolved oxygen level (6.0±0.6mg/L) range (3.0-9.4) mg/L and elevated conductivity 17.1±1.6 µ/cm range (13.0-19.2) µ/cm in contrast, the dry season (November - April) showed lower pH level 5.7±0.2 Range (5.0-6.5), reduced alkalinity 8.9±0.5 range (8.0-11.2) mg/L and decreased Biochemical Oxygen (BO) value 10.6±0.62 range (mg/L)

Table 3: Comparative Analysis of the Physiochemical parameters across the Wet and Dry Seasons for Station A in Urasi River.

|  |  |  |
| --- | --- | --- |
| Parameters | WET | DRY |
| Air temperature | 28.0±0.85 (25.0-3.10) b | 29.5±0.330 (27.0-31.0)a |
| Water temperature | 27.0±0.85 (24.5-29.0) b | 28.3±1.05 (20.0-31.0)a |
| PH | 6.5± 0.25 (5.2-7.1)a | 5.7±0.2 (5.0-6.5) b |
| Dissolved oxygen | 6.0 ±0.6 (3.0-9.4)a | 5.81±0.3(4.0-9.2) b |
| Alkalinity(mg/L) | 7.92±0.92 (4.0-10.7)b | 8.9±0.5(8.0-11.2)a |
| Conductivity | 17.1± 1.6 (13.0-19.11)a | 16.5±3.4(11.0-21.0) b |
| Biochemical oxygen | 11.5±0.25 (10.3-16.5)a | 10.6±0.62 (9.7-11.3) b |

*Results are in mean±standard deviation of sextuplicate determination.*

*Means in rows with different superscripts are significantly (p<0.05) different*

1. **CONCLUSIONS**

In this study, the results showed that there was variation in the physico-chemical parameters of Urasi Rvier. The variation could be a difference in the physical and geological features of Urasi Rvier. This observation is in accordance with the work by Nwosu *et al.,* (2017), who stated that the water chemistry of an aquatic ecosystem is dependent on the physical and geological features of it drainage basin. The result of this study showed that the water temperature mean value was highest in December 2022, 31.0±0.30C range (30.0-31.00C) and lowest in June 2023, 28.0±1.00C (range 25.0-31.00C) The result of this study showed the range of 25.83 to 28.330C. This finding conforms to the study by Ibemenuga *et al.,* (2017) who also reported water temperature range between 250C-290C. The pH means values were highest 6.5±2.8 (range 6.1 - 6.8) in July 2022 while the lowest in October 2022, and March 5.5±0.9 (5.7-6.00).

Declaration

The authors hereby declare that there is no conflict of interest.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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