



## APPLICATION OF WATER QUALITY INDEX (WQI) FOR THE ASSESSMENT OF EGBE RESERVOIR

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### ABSTRACT

The African continent continues to face challenges in improving water accessibility, exacerbated by significant water quality issues that pose serious risks to public health, particularly through the transmission of waterborne diseases. This study aimed to evaluate the Water Quality Index (WQI) of Egbe Reservoir, a crucial source of potable water and irrigation for several local governments in Ekiti and Ondo states in Southwestern Nigeria. The assessment utilized selected physicochemical criteria, analyzed through conventional laboratory techniques. Data collected were subjected to statistical analysis using SPSS (Version 25), and the WQI was calculated based on the average of nine chosen variables, following the drinking water standards established by the World Health Organization. The physicochemical analysis of Egbe Dam revealed a generally healthy aquatic environment; however, some sampling stations exhibited signs of pollution, particularly concerning *E. coli* levels, phosphate (PO<sub>4</sub>) concentrations (8.33 ± 1.50 mg/L), and nitrate (NO<sub>3</sub>) concentrations (2.18 ± 1.05 mg/L), which exceeded both national and international standards. The WQI showed a weak positive correlation with temperature (0.452) and strong negative correlations with total phosphate (-0.925) and *E. coli* (-0.706), indicating that improved water quality is linked to lower levels of these contaminants. The overall WQI for Egbe Reservoir was 83.05, with the Ode station scoring the highest at 91.25, indicating good water quality, while the lowest score of 57.58 at Downstream still categorized as good. These findings suggest that, despite variations in specific parameters, the overall health of the reservoir remains satisfactory, highlighting the need for continuous monitoring and management of water quality parameters.

**Keywords:** Water Quality Index (WQI); Egbe Reservoir; Physicochemical Parameters; *E. coli*; Nitrate; Phosphate; Water Quality Assessment; Southwestern Nigeria.

### INTRODUCTION

Reservoirs serve as natural indicators of the overall well-being of a community and exert a substantial influence on the lives of adjacent residents. The ecological condition of reservoirs and rivers is determined by the characteristics of water resources and their susceptibility to a range of environmental factors, including natural phenomena like precipitation, erosion, and weathering, as well as human activities such as urbanization, industrialization, and agriculture (Adedeji et al., 2019). The reservoirs have seen substantial eutrophication due to elevated nitrogen levels coming from agricultural activity, sewage runoff, and population growth. For instance, environmental studies conducted in Lake Changhu, in Jingzhou City, Hubei province, China before 2013 and 2015 as well as after 2017 and 2018, have documented higher concentrations of total nitrogen and chlorophylla, in the districts of Lake Haizihu, Ahongtai Channel and Lake Dahu during the year 2017 compared to other years (Akinnowo, 2023). The deterioration of water quality in reservoirs designated for drinking water supply is frequently attributed to the discharge of pollutants from both specific sites and diffuse sources, such as agricultural runoff and wastewater (Wojtkowska and Bojanowski, 2018). In recent years, Akinnowo 2023, stated that the rise in nutrient levels due to agricultural operations, sewage runoff, and population growth has been identified as a significant factor in the progression of eutrophication as described in lake Haizihu above. The discharge of pollutants from stationary or dispersed origins, such as agricultural runoff and human wastewater, has been recognized as a significant factor in the deterioration of water quality in lakes that serve as drinking water sources, (Romero et al., 2016). In addition to the above, the African continent continues to face

challenges in enhancing water accessibility, while simultaneously dealing with the problem of water quality, which presents substantial hazards to public health, mostly due to the spread of waterborne illnesses (UNICEF & WHO, 2005). Several governments have enacted initiatives to tackle these issues by prioritizing the preservation and monitoring of water quality (Behmel et al., 2016; Romero et al., 2016). Therefore, continuous monitoring and assessment of water quality are crucial for formulating effective management approaches to mitigate surface water contamination. This is particularly vital given the escalating urbanization and the pressure on water supplies resulting from human activities. Moreover, it is essential to analyze the quality of water by identifying the primary causes that contribute to spatial and temporal variations.

Several studies have been conducted by scientist to communicate the water quality data (Adedeji et al., 2019; Ayoade and Izah, 2019). These methods utilize multivariate statistical techniques (Oketola et. al., 2013, Obayemi and komolafe , 2023) and modeling methods (Huang et al., 2016; Wang et al., 2017), together with the application of multi-metric index approaches (Wu et al., 2017). The water quality index (WQI), originally developed by Horton et al. (1965) has undergone significant enhancements by several researchers (Wojtkowska & Bojanowski, 2018; Akoteyon et al., 2011). It serves as a very effective means of conveying information regarding trends in water quality. The index in question employs a range of physicochemical and biological characteristics of water samples to calculate a singular measurement that reflects the overall state of water quality (Qin et al., 2020; Wojtkowska & Bojanowski, 2018). The Water Quality Index (WQI) enables the collection of data on water quality attributes over different time periods and

geographical areas, providing a succinct depiction of the temporal and spatial dimensions involved (Qin et al., 2020). Alobaity et al. (2010) and Qin et al. (2020) have created a Water Quality Index (WQI) by leveraging the expertise and viewpoints of water quality specialists to communicate the condition of the water in a clear, simple and unambiguous way to all stakeholders.

Egbe reservoir is not immune to the influence of human activities on its water quality and scientist such as Edward and Ugwumba, 2010 and others if any, has assessed the water quality in the past but none of this scientist has communicated in such a way that nonscientific stakeholders such as politician and immediate host community can understood easily. Therefore, the aim of this study is to employ the Water Quality Index (WQI) method to evaluate the water quality of Egbe Reservoir, which provides drinking water and irrigation

for multiple local governments in Ekiti and Ondo states, located in Southern Nigeria.

## MATERIALS AND METHODS

The present study was carried out at Egbe Ekiti, a community situated in Ekiti State, Nigeria that hosted the Egbe Reservoir. The reservoir was built on the Osse River, specifically at Egbe Ekiti, situated in the Ekiti East Local Government area. The local indigenous community actively participates in fishing and agriculture, employing irrigation systems for their agricultural endeavors. Individuals residing in various regions of the state frequently journey to Egbe Ekiti to procure freshly caught and smoked fish for domestic consumption. Furthermore, the reservoir serves as a reliable source of piped water for local authorities and the surrounding areas.

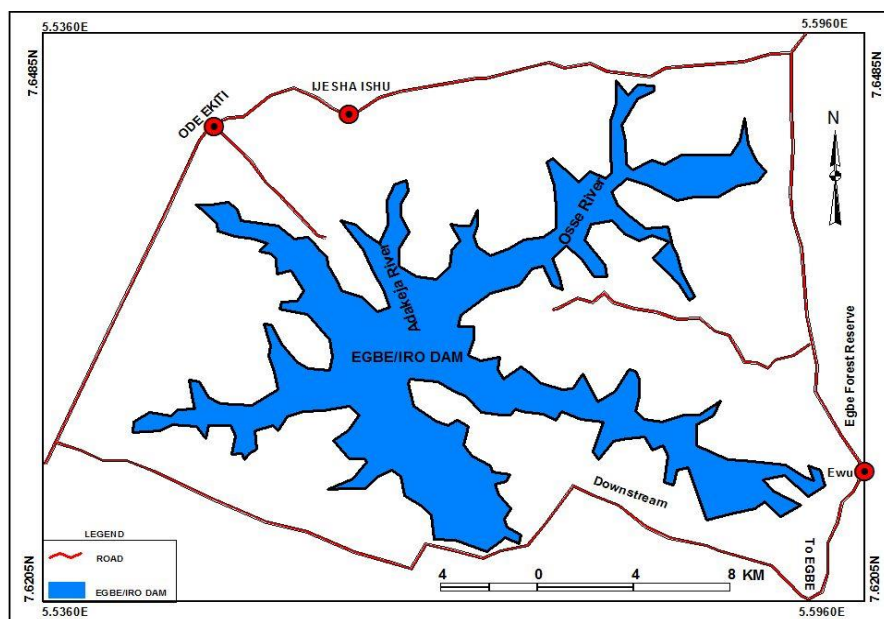


Figure 1: Geographical Map of the Sampling Locations

### Water Sampling

Water quality indicators were regularly and systematically assessed monthly for a period of 12 months at a fixed location in each of the six selected sample sites (Ode, Adakeja, Osse, Ewu, Main Reservoir, and downstream) (Fig 1). A multi-parameter sensor was used at the designated sample sites to assess some physical and chemical parameters of water quality insitu. These parameters include water temperature, dissolved oxygen concentrations, pH levels, and conductivity. Thereafter 2-L plastic containers were used to collect surface water samples from all six sampling sites. Prior to sample collection, the container was sanitized by washing with distilled water and subsequently, the containers were filled, sealed, and dispatched to the laboratory for physicochemical analysis, adhering to the standardized protocols outlined by APHA (2005).

The quantification of dissolved organic carbon (DOC) was conducted by spectrophotometry following acidification and combustion protocols, with a detection threshold established at 0.5 mg/L. The determination of Total Suspended Solids (TSS) was conducted by a gravimetric method, involving filtration and subsequent drying for 2 hours at a temperature range of 103-105 °C. The spectrophotometer was used to measure the concentrations of total nitrogen (TN) and total phosphorus (TP). The Biological Oxygen Demand (BOD),

Chemical Oxygen Demand (COD), and Dissolved Oxygen (DO) levels were quantified using an oxygen membrane probe following a 5-day incubation period at a temperature of 20 °C. Spectrophotometry was used to evaluate the chlorophyll a (Chl-a), in accordance with the APHA Standards (1992).

### Computation of the Water Quality Index (WQI)

The parameter values utilized are the mean values derived from the analysis of six sites in this study. The importance of several parameters in determining the Water Quality Index (WQI) is contingent upon the particular intended purpose of the water. The aim of this study was to assess the appropriateness of water quality indicators for human consumption. This study utilized the drinking water standards advocated by the World Health Organization (WHO) [WHO, 2004]. In the absence of the World Health Organization (WHO) requirements, the Nigerian drinking water standards established by the National Environmental requirements and Regulations Enforcement Agency (NESREA) in 2011 were utilized.

### The Water Quality Index (WQI) was Calculated and Constructed Using the Following Steps:

- i. During the initial stage, a weight (AW<sub>i</sub>) ranging from 1 to 4 was assigned to each of the nine parameters assessed

during the study, using expert assessments information gathered from previous research projects. Table 1 presents the average weights assigned to each parameter, along

with the consulted references utilized to establish these values. The weight of 1 was seen the least consequential, whereas a weight of 4 was regarded as the most crucial.

**Table 1: Assigned Weight Values Adopted from the Literature**

Parameter	Alobaidy et al, (2010)	Puri et al, 2015	Hector et al 2012	Peace and Wunderlin 2000	Ravikumar et al , 2013	Average
Ph	2.1	3	4	1	3	2.62
DO (mg/l)	4	4	4	4	-	4
Turbidity(cm)	2.4	-	3	2	-	2.5
BOD (mg/l)	3	-	-	3	-	3
Alkalinity(mg/l)	1.6	-	-	-	-	1.6
Conductivity(μS/cm)	2.7	-	4	-	3	3.2
TN (mg/l)	2.2	-	2	2	-	2.1
TP (mg/l)						1.5
E coli count (c fu /m L)						3
TDS (mg/l)	-	1	1	2	5	2.7

ii. During the second phase, the relative weight (RW) was determined by applying the equation:  $RW = 1/(AW_i \div \sum AW_i)$  The equation incorporates the variables RW,  $AW_i$ , and  $\sum AW_i$ , representing relative weight, weight allotted to each parameter, and the total sum of weights, respectively. Table 2 presents the estimated relative weight (RW) values for each parameter.

iii. The third phase, a quality rating scale ( $Q_i$ ) was allocated to all parameters, excluding pH and DO, through the division of their concentration in each water sample by their corresponding standards as outlined in the WHO drinking water guideline [WHO, 2004] or Nigerian drinking water standards [NESREA, 2011]. The resulting quotient was then multiplied by 100.

**Table 2: Relative Weight of the Water Quality Parameters**

Parameter	Water Quality Standard	Assigned Weigh (AW)	Relative Weigh $RW = 1/(AW_i \div \sum AW_i)$
Ph	6.5 -8.5 (7.5)	2.62	0.1000
DO mg/l	6	4	0.1526
Temperature	29.25	2.5	0.0954
Biological oxygen demand mg/l	3	3	0.1144
Alkalinity mg/l	100	1.6	0.0610
Conductivity μS/cm	250	3.2	0.1220
TN mg/l	45	2.1	0.0800
TP mg/l	3.5	1.5	0.0572
TDS mg/l	500	2.7	0.1030
Ecoli count (c fu /m L)	50	3	0.1144
Total		26.22	1.0000

The equation (2) can be expressed using the formula  $Q_i = (C_i/S_i) * 100$ . The quality rating for pH or dissolved oxygen (QpH, DO) was determined using the formula  $100: DO = (C_i - V_i)/(S_i - V_i) * 100$  (3).

The pH value, denoted as QpH, can be determined by applying the formula  $QPH = (C_i - V_i)/(S_i - V_i) * 100$  (3). Where, the variable  $Q_i$  denotes the numerical value attributed to the evaluation of water quality. The variable  $C_i$  indicates the quantitative measurement of a certain water quality characteristic, which is determined through laboratory examination. The variable  $S_i$  represents the value of a water quality parameter recommended by either the World Health Organization (WHO) or the Nigerian standard, depending on the specific criterion being evaluated. The variable  $V_i$  denotes the optimal value for the parameter, specifically 7.0 for pH and 14.6 for dissolved oxygen (DO). Equations (2) and (3) guarantee that  $Q_i$  is zero when there is no pollutant in a water sample, and  $Q_i$  is 100 when the parameter value exceeds the permissible threshold by a small amount. According to John et al. (2014), a high  $Q_i$  value indicates an increase in water pollution.

The Water Quality Index (WQI) was calculated by initially calculating sub-indices ( $S_{i_i}$ ) for each parameter. The sub-indices were subsequently employed in the computation of the

Water Quality Index (WQI) utilizing the subsequent equations:

The equation (4) can be expressed as  $S_{(i)} = R_w \times Q_i$

Here,  $S_{\{i\}}$  represents the specific index,  $R_{\{W\}}$  is the weight or rate, and  $Q_{\{i\}}$  is the quantity associated with the index  $i$ . The Water Quality Index (WQI) is calculated by summing the individual sub-indices ( $S_{i_i}$ ) and subsequently multiplying the sum by 5.

The WQI values were classified as follows: values below 50 were categorized as excellent, values between 50 and 100 were categorized as good, values between 100 and 200 were classified as poor, values between 200 and 300 were classified as very poor, and values over 300 were classified as unsuitable (Ramakrishnaiah et al., 2009).

## RESULTS AND DISCUSSION

The table 3 presents the mean and standard deviation of various water quality parameters measured at six different stations in the Egbe Dam, compared against established guidelines from the World Health Organization (WHO) and the National Environmental Standards and Regulations Enforcement Agency (NESREA). The spatial distribution of the water quality measurement was shown in fig 2.

The mean temperature across the stations ranges from 26.20 to 29.35°C, with an overall average of 28.68°C. This falls within the acceptable range of 25-30°C, indicating suitable thermal conditions for aquatic Conductivity values vary significantly, with a mean of 179.68 to 305.58 µS/cm. The average conductivity at the main reservoir is 184.84 µS/cm, which is within the acceptable range of 180-1000 µS/cm, suggesting that the water is not overly saline.

The mean dissolved oxygen levels range from 4.69 to 8.30 mg/l. While the values at Ode, Adakeja, and Osse stations are above the minimum requirement of 6 mg/l, the downstream station shows lower levels (4.85 mg/l), which may indicate potential pollution or reduced water quality.

The pH values range from 6.56 to 7.35, with an average of 7.03. This is slightly below the recommended range of 7.0-8.5, suggesting that some stations may be experiencing slightly acidic conditions, which could affect aquatic organisms. Turbidity levels are generally low, with means ranging from 0.15 to 1.49 cm. The values indicate relatively clear water, although the higher turbidity at some stations may suggest localized disturbances.

The mean values for total dissolved solids range from 60.19 to 102.37 mg/l, which is below the maximum acceptable level of 1000 mg/l, indicating good water quality. BOD values

range from 2.48 to 4.46 mg/l, with the downstream station showing the lowest value. All values are below the threshold of 6 mg/l, indicating low organic pollution levels.

Alkalinity levels range from 37.05 to 50.21 mg/l, which is within the acceptable range of 100 mg/l, suggesting that the water has a good buffering capacity. The mean total nitrogen levels are low, ranging from 2.16 to 3.63 mg/l, which is below the guideline of 45 mg/l, indicating minimal nutrient pollution.

Total phosphorus levels vary from 2.17 to 13.65 µg/l, with the highest value at Ode station. All values are below the threshold of 3.5 µg/l, suggesting low levels of nutrient enrichment. E. coli counts range from 4.65 to 24.02, with the highest levels at the main reservoir. While some stations are below the acceptable limit of 50 CFU/100ml, the presence of E. coli indicates potential fecal contamination, particularly at the downstream station.

Overall, the water quality parameters at Egbe Dam indicate a generally healthy aquatic environment, although some stations show signs of pollution, particularly in terms of dissolved oxygen and E. coli levels. Continuous monitoring and management efforts are recommended to maintain and improve water quality.

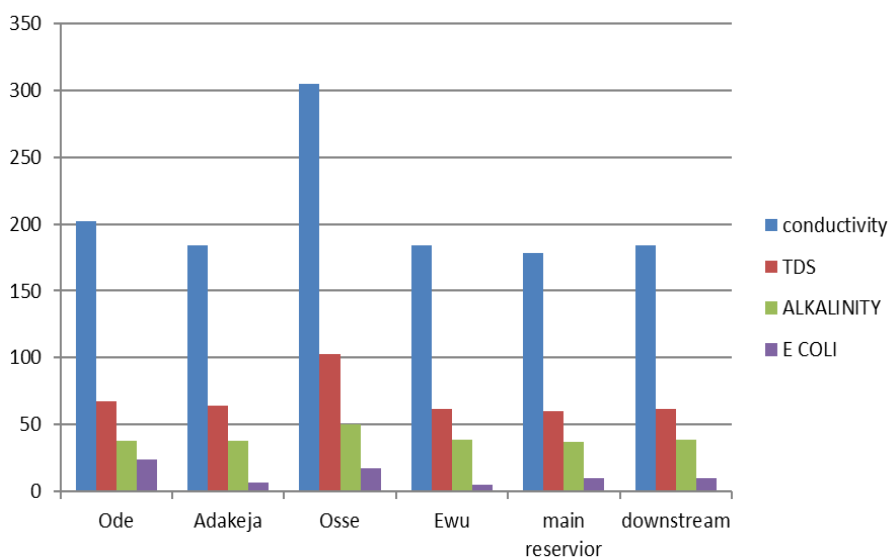


Figure 2: Spatial Distribution of Some Important Physical and Chemical Parameters in Egbe Reservoir

Table 3: Mean and Standard Deviation of Water Quality Parameters in Six Stations of Egbe Dam

Parameter	WHO	NESR EA	Ode	Adakeja	Ossre	Ewu	main Reservoir	downstre am
Temperature (T (°C))	25-30		28.32±1.45	28.16±2.12	26.20±1.29	29.35±2.26	29.18±1.84	28.68±1.71
Conductivity (EC (µS/cm)	180-1000		202.32±4.81	184.68±3.25	305.58±9.43	184.42±1.73	179.68±17.30	184.84±2.94
dissolved oxygen(mg/l)		6	7.25±0.8	7.11±1.4	8.30±1.3	8.12±0.9	4.69±1.26	4.85±1.0
Ph (PH)	7.0- 8.5		6.56±0.6	6.66±0.7	6.88±0.7	6.87±0.7	7.35±0.40	7.03±0.4
Turbidity(cm)		10	1.49±0.1	1.06±0.1	0.39±0.1	0.82±0.1	1.00±0.16	0.15±0.0
total dissolved solids (mg/l)	1000	500	67.65±14.87	63.86±9.15	102.37±3.16	61.78±5.80	60.19±5.80	61.93±7.69
biological oxygen demand (mg/l)	6		4.26±0.8	4.04±1.0	3.20±0.3	3.62±0.8	4.46±0.60	2.48±0.1
Alkalinity(mg/l)		100	37.48±1.51	37.58±9.47	50.21±13.39	38.37±5.50	37.05±11.7	38.21±6.60

Parameter	WHO	NESR EA	Ode	Adakeja	Ossre	Ewu	main Reservoir	downstream
total nitrogen(mg/l)		45	3.63±0.50	2.66±0.43	2.32±0.23	2.28±0.52	2.16±0.45	2.32±0.23
total phosphorous(µg/l)		3.5	13.65±2.31	10.26±2.29	10.93±1.64	2.17±0.56	5.83±1.92	7.13±0.81
E coli		50	24.02±1.03	6.37±0.43	17.29±0.98	4.65±0.03	9.42±1.20	9.56±1.34

Table 4: Correlations Between Water Quality Parameters in Egbe Reservoir

Parameter	temperature (0°c)	Conductivity (µS/cm)	Dissolved oxygen(mg/l)	pH	turbidity (Cm)	Total Dissolved Oxygen(mg/L)	Biological oxygen demand(mg/l)	Alkalinity (mg/l)	Total nitrogen(mg/l)	Total phosphate(mg/l)	e coli (c fu /m L)	Water Quality Index
Temperature	1											
Conductivity	-.935	1										
dissolved oxygen	-.487	.542	1									
Ph	.294	-.131	-.676	1								
TURBIDITY	.287	-.346	.168	-.442	1							
TOTAL DISSOLVED OXYGEN	-.948	.999	.553	-.331	-.339	1						
biological oxygen demand	.275	-.287	.041	-.706	-.906	-.279	1					
Alkalinity	-.899	.982	.517	-.485	-.981	-.388	1					
total nitrogen	-.072	-.062	.255	-.707	-.061	.375	-.237	1				
total phosphate	-.632	.420	.196	-.335	.433	.156	.266	.732	1			
e coli	-.501	.489	.207	-.316	.473	.138	.325	.726	.803	1		
water Quality Index	.452	-.221	.154	-.351	-.234	-.278	-.073	-.621	-.925	-.707	1	

The table 4 provides correlation coefficients for various water quality parameters in the Egbe Reservoir, indicating relationships between them. A strong negative correlation of -0.935 between temperature and conductivity suggests that as temperature rises, conductivity significantly decreases. Dissolved oxygen exhibits a moderate negative correlation with temperature (-0.487), implying that higher temperatures may lead to lower dissolved oxygen levels. Conversely, dissolved oxygen has a moderate positive correlation with conductivity (0.542), indicating that increased conductivity may be associated with higher dissolved oxygen levels.

The pH shows a weak positive correlation with temperature (0.294) and a weak negative correlation with dissolved oxygen (-0.676), suggesting that as pH increases, dissolved oxygen tends to decrease. Turbidity has a weak positive correlation with temperature (0.287) and a weak negative correlation with pH (-0.424), indicating that higher turbidity may correlate with lower pH levels.

Total dissolved oxygen has a strong negative correlation with temperature (-0.948) and a strong positive correlation with conductivity (0.999), highlighting that increased temperature leads to a significant decrease in total dissolved oxygen, while higher conductivity is linked to increased total dissolved oxygen. Biological oxygen demand (BOD) shows a weak positive correlation with temperature (0.275) and a strong positive correlation with turbidity (0.906), suggesting that higher turbidity is associated with increased BOD levels, potentially indicating higher organic pollution.

Alkalinity has a strong negative correlation with temperature (-0.899) and a strong positive correlation with conductivity (0.982), meaning that as temperature increases, alkalinity tends to decrease, while higher conductivity correlates with increased alkalinity. Total nitrogen shows a weak negative correlation with temperature (-0.072) and a strong negative correlation with pH (-0.768), suggesting that higher pH levels may be linked to lower total nitrogen levels.

Total phosphate has a moderate negative correlation with temperature (-0.632) and a weak positive correlation with total nitrogen (0.732), indicating that higher temperatures may be associated with lower phosphate levels, while higher nitrogen levels may correlate with increased phosphate levels. E. coli shows a moderate negative correlation with temperature (-0.501) and a weak positive correlation with total nitrogen (0.726), suggesting that higher temperatures

may lead to lower E. coli levels, while higher nitrogen levels may be associated with increased E. coli counts.

The water quality index has a weak positive correlation with temperature (0.452) and strong negative correlations with total phosphate (-0.925) and E. coli (-0.706), indicating that better water quality is associated with lower levels of phosphate and E. coli. Overall, these correlations reveal complex interactions among water quality parameters, with temperature, conductivity, and dissolved oxygen being critical factors affecting the overall water quality in the Egbe Reservoir. Continuous monitoring and management of these parameters are vital for maintaining water quality.

The table 5 presents the water quality index for the Egbe Reservoir, detailing various parameters measured at different locations: Ode, Alakeja, Osse, Ewu, Main Reservoir, and Downstream. Each parameter is assigned a relative weight, indicating its importance in the overall water quality assessment.

Dissolved oxygen, with a relative weight of 0.16, shows the highest values across the locations, particularly at Osse (22.13) and Ewu (21.65), while the lowest is observed downstream (12.33). Fecal coliform levels are notably low, especially at Alakeja (1.91) and Ewu (1.40), with the highest value at Ode (7.68). The pH values are relatively consistent, ranging from 8.47 at Ode to 9.48 at Downstream, indicating generally good water quality.

Biological oxygen demand (BOD) values vary, with the highest recorded at Ewu (8.17) and the lowest at Downstream (4.54). Temperature change is fairly stable across locations, with values around 9.23 to 9.60. Total phosphorus shows significant variation, peaking at Ode (31.2) and dropping to 4.96 at Osse, while total nitrogen remains low across all sites, with the highest value at Ode (0.81).

Conductivity values are relatively uniform, with a slight increase at Osse (6.7) compared to others. Alkalinity is the least variable parameter, with values ranging from 2.22 to 3.01. The overall water quality index reflects these measurements, with Ode scoring the highest at 91.25, indicating good water quality, while the lowest score is at Downstream (57.58), still categorized as good. All locations are classified as having good water quality, suggesting that despite some variations in specific parameters, the overall health of the reservoir remains satisfactory.

**Table 5: Water Quality Index of Egbe Reservoir**

Parameter	Relative weight	Ode	Alakeja	Osse	Ewu	Main Reservoir	Downstream
Dissolved oxygen	0.16	19.33	18.96	22.13	21.65	12.50	12.33
Fecal coliform	0.15	7.68	1.91	5.19	1.40	2.83	2.84
Ph	0.10	8.47	8.52	8.88	8.88	9.48	9.07
Biological oxygen demand	0.12	7.81	7.33	5.87	6.60	8.17	4.54
Temperature change	0.10	9.23	9.22	8.57	9.60	9.55	9.34
Total phosphorous	0.08	31.2	23.45	4.96	7.77	12.56	12.75
Total nitrogen	0.10	0.81	0.59	0.52	0.52	0.52	0.38
Conductivity	0.13	4.45	4.1	6.7	4.1	4.05	4.1
Alkalinity	0.06	2.27	2.27	3.01	2.30	2.22	2.23
Water quality index		91.25	76.35	65.83	62.82	61.88	57.58
		Good	Good	Good	Good	Good	Good

The pH values of water samples ranged from 6.5 to 7.35, indicating that the water was mostly neutral to slightly alkaline. The pH level of water is a crucial factor that affects its appropriateness for various uses. The pH values reported are within the acceptable range of 6.5 to 8.5 for surface water used on a national level (Adedeji et al., 2019; Ayoade and Izah, 2019).

Accurate assessment of water quality relies on the measurement of dissolved oxygen (DO), which has a direct impact on the survival and distribution of aquatic species (Qin et al., 2020). In our study, an average concentration of dissolved oxygen was recorded at 6.30 mg/L, with values ranging from 4.69 to 8.30 mg/L. This concentration exceeds the permissible limit of 5.0 mg/L recommended by the World Health Organization (WHO) for drinking water. Study on Dandaru lake in Ibadan have shown that high levels of dissolved oxygen are crucial for maintaining healthy aquatic ecosystems, as they support the respiration of fish and other aquatic organisms (Ayoade and Izah, 2019).

However, it has been observed that as water flows downstream, the concentration of dissolved oxygen tends to decline, which can be attributed to factors such as increased organic matter decomposition and reduced photosynthetic activity (Adedeji et al., 2019). Elevated dissolved oxygen concentrations in the Egbe Reservoir indicate enhanced productivity and a thriving aquatic ecosystem, which is essential for sustaining biodiversity and supporting local fisheries (Qin et al., 2020). These findings underscore the importance of continuous monitoring of dissolved oxygen levels to ensure the health of aquatic environments and the species that inhabit them.

The quantification of biochemical oxygen demand (BOD) involves assessing the amount of oxygen consumed by microorganisms during the degradation of organic compounds in a laboratory setting over a five-day period (Wojtkowska and Bojanowski, 2018). In this study, the recorded BOD concentrations in the Egbe Reservoir ranged from 2.28 to 4.46 mg/L, all of which fall below the World Health Organization (WHO) drinking water limit of 6 mg/L. These findings align with the quality criteria established by the National Environmental Standards and Regulations Enforcement Agency (NESREA, 2011), which sets benchmarks for water quality at regional, national, and global levels. Local research has similarly indicated that BOD levels below 5 mg/L are indicative of good water quality, supporting the health of aquatic ecosystems and the safety of water for human consumption (Obayemi, and Komolafe, (2023)). Consequently, it can be inferred that the water in the Egbe Reservoir meets the necessary criteria to be classified as clean, thereby supporting both biodiversity and the well-being of local communities that rely on this vital resource for drinking and agricultural purposes (Edward and Ugwumba, 2010).

Measuring total dissolved solids (TDS) is a reliable method for assessing the presence of dissolved salts in water, which can indicate potential contamination from sewage or excessive plankton growth. In the Egbe Reservoir, TDS values exhibited a range from 60.19 mg/L to 102.37 mg/L, with an average concentration of 68 mg/L throughout the study. This variability in TDS levels across different seasons reflects the dynamic nature of the reservoir's ecosystem, although no statistically significant differences were observed among the various sampling stations. According to the United States Geological Survey (USGS, 2015), it is recommended that TDS concentrations in drinking water remain below 1000 mg/L to ensure safety and palatability. Given that the TDS levels in the Egbe Reservoir are well below this threshold, the

water can be classified as suitable for drinking purposes. Local studies have also highlighted the importance of monitoring TDS as an indicator of water quality, particularly in regions where agricultural runoff and urban development may contribute to increased salinity levels (Oketola et al., 2013). Furthermore, maintaining low TDS levels is crucial for preserving aquatic biodiversity and ensuring the health of local communities that depend on this water source for their daily needs (Adedeji et al., 2019).

The assessment of electrical conductivity (EC), which measures the amount of positively charged ions, has been discovered to significantly affect the taste and appropriateness of water for consumption (Adedeji et al., 2019; Ayoade and Izah, 2019). Electrical conductivity (EC) is an accurate assessment of the total concentration of dissolved ions in water. The electric conductivity values in this study fell below the acceptable limit for drinking water, as defined by the World Health Organization (WHO). The phosphorus values observed in this study ranged from 2.17 to 13.65 mg/L is above the prescribed NESREA limit for both drinking water and aquatic species. The buildup of phosphate in reservoirs can be ascribed to diverse origins, such as home sewage, detergents, and agricultural runoff, including fertilizers (Wojtkowska and Bojanowski, 2018).

The nitrate ion concentration ( $\text{NO}_3^-$ ) in water varies across the sampling sites, ranging from 2.16 to 3.64 milligrams per liter (mg/L). The water samples collected from the Egbe Reservoir had nitrate levels that were below the threshold established by the National Environmental Standards and Regulations Enforcement Agency (NESREA) for sustaining the viability of aquatic life. Since the values of nitrate in the reservoir are low, it potential to promote the growth of aquatic plants and tiny algae, leading to the occurrence of eutrophication could not be guaranteed. This implies that sources of nitrates in the reservoir such as human activities: food production, agricultural practices, and wastewater discharge were not in the right concentration that can initiate eutrophication. Nevertheless, the concentration of nitrate at Ode site was marginally above the necessary threshold due to proximity of the site to the Ode town, surface runoff, sewage discharges, agricultural fertilizers, and organic wastes are the main factors responsible for the presence of nitrate in the surface water of the reservoir (Qin et al., 2020).

The assessment of the Water Quality Index (WQI) for Egbe Reservoir reveals a medium classification, with a specific numerical value of 52.33. This WQI indicates variability among different sampling stations, reflecting the influence of diverse land use activities, particularly agriculture and forestry. These activities often lead to increased physical and chemical parameters in the water, primarily due to the application of fertilizers and pesticides, which have been linked to a decline in water quality (Adedeji et al., 2019). The correlation between the WQI and various water quality indicators further substantiates these findings. For instance, the Ode Town Station, situated in a residential area, recorded a WQI of 47, suggesting that human activities, including sewage disposal and other anthropogenic influences, have adversely affected water quality (Wojtkowska and Bojanowski, 2018). International studies have similarly highlighted the impact of agricultural runoff on water quality. For example, research conducted in the Iraq demonstrated that agricultural practices significantly contribute to nutrient loading in water bodies, leading to eutrophication and deteriorating water quality (Alobaidy et al., 2010). Additionally, a study in India found that urbanization and agricultural expansion resulted in increased levels of contaminants in nearby water sources, necessitating rigorous

water treatment processes to ensure safety for consumption (Kachroud et al., 2019). To safeguard the water quality in Egbe Reservoir for drinking and household use, it is imperative to implement comprehensive treatment processes for untreated water. This approach is essential not only for protecting public health but also for maintaining the ecological balance within the reservoir, as highlighted by global best practices in water management (WHO, 2017). Implementing the Water Quality Index (WQI) as a strategic tool in local government management plans has the capacity to improve water quality and increase public knowledge about the condition of water resources. The evaluation methodology utilized ensures a comprehensive analysis of water quality by taking into account multiple indications, rather than just assessing single parameters, hence improving the accuracy of the results. The application of the Water Quality Index (WQI) methodology has demonstrated its efficacy in assessing the overall state of aquatic ecosystems and the overall excellence of water, hence providing valuable insights for water resource management. It is crucial to recognize that the Water Quality Index (WQI) depends on a substantial volume of data for its computations and may be susceptible to data loss (Kachroud et al., 2019).

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