Determination of Water Quality Index and Suitability of Three Major Dams in Ekiti State, Nigeria

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Abstract

Water Quality of Egbe, Ureje and Ero dams in Ekiti State was studied for a period of one year from November 2017 to October 2018. Twenty-four physicochemical parameters (temperature, conductivity, turbidity, pH, DO₂, BOD, COD, alkalinity, turbidity, total dissolved solids, hardness, colour, phosphates, nitrates, nitrite, Cu, Pb, Mg, K, Mn, Fe, Na, Ca and Zn) were considered in the computation of Water Quality Index (WQI) based on Weighted Arithmetic Water Quality Index Method. ANOVA was used to evaluate the significant differences between water quality variables at the dams. *T*-test was used to show the variations of physico-chemical parameters and WQI between the two seasons. WQI in Egbe dam ranges from 118.00 - 164.67 (dry season) with a seasonal value of 145.69 and from 89.39 - 161.86 (rainy season) with a seasonal value of 120.59. In Ureje dam, WQI ranges from 101.88 - 164.76 (dry season) with seasonal value of 134.08 and from 96.61 - 138.36 (rainy season) with a seasonal value of 123.39 while in Ero, WQI ranges from 32.28 - 45.13 (dry season) with a seasonal value of 39.43 and from 52.12 - 106.22 (rainy season) with a seasonal value of 81.84. WQI of Egbe dam and Ureje dam during the dry and rainy seasons indicated poor water quality that is unfit for drinking while in Ero dam, the WQI during the dry season indicated good quality water while during the rainy season, the water in the dam was polluted. Our findings highlighted the deterioration of the dams due to anthropogenic activities and urbanization. There is an urgent need for proper management measures and suitable tools to restore the water quality of these dams. The formulas used to calculate the WQIs are easy to use thus providing a valuable tool for the accurate monitoring of water pollution in water bodies.

Subject Areas

Environmental Sciences

Keywords

Water Quality Index, Physico-Chemical Parameters, Anthropogenic Activities, Dams

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1. Introduction

Water is the most critical resource for life and as a prime natural resource and precious national asset, it forms the chief constituent of ecosystem. In addition to the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. However, the aquatic environment is perceived to be at risk of several thousands of toxic chemicals, of both anthropogenic and natural origin. Environmental pollution especially in aquatic ecosystems is a current global environmental problem of the 21st century due to limited supply of fresh water and the role of anthropogenic activities in deteriorating the water quality [1] [2]. Deterioration of the aquatic environment is associated with urbanization by human populations commencing with the industrial revolution in the eighteen century [3].

Dams in Ekiti State are surrounded by farmlands. A large amount of chemicals (fertilizers and pesticides) are used by farmers which can enter the dams through runoff, atmospheric deposition and leaching. Also, garbage and wastewaters are poured in the dams by inhabitants around the dams areas. All of these factors may lead to the contamination of Ekiti State waters. Reference [4] reported that surface water quality in a given location is largely influenced by both natural processes and by anthropogenic inputs. The deteriorating of water quality affects man, other animals and plant life with far-reaching consequences. It is therefore essential to prevent and control pollution of aquatic resources. Information on water quality and pollution sources is important for the implementation of sustainable water-use management strategies and to manage the environmental degradation, it is mandatory to assess the quality of the water sources from time to time [5] [6]. Thus, the evaluation of water quality is a critical element in the assessment of water resources.

Water quality of any specific area can be assessed using physical, chemical and biological parameters and these parameters are harmful for man when they occurred more than defined standard limits [7] [8]. This is because water quality characteristics of aquatic environment arise from a multitude of physical, chemical and biological interactions [9]. Some of these compounds are toxic to the ecosystem, some provide nutrients to aquatic organisms and others are responsible for the aesthetics of the water body [10]. One of the simplest methods to

assess water quality conditions is by using water quality indices. Water Quality Index (WQI) provides a single number that expresses overall water quality at a particular location and time based on several water quality parameters. WQI incorporates data from multiple water quality parameters into a mathematical equation that rates the health status of a water body with number. Thus, WQI depicts the composite influence of different water quality parameters and communicates water quality information to the public and legislative decision makers [11]. The WQI was first formulated by Horton [12] in the United State and subsequently used by several workers for the quality assessment of different water resources in several places. Although WQI is not a new concept and is widely used in Nigeria, however its application as a method for water quality assessment is fairly undeveloped in Ekiti State and to the best of our knowledge, WQI of any of the Ekiti State water bodies has not been reported in the published literatures. Hence, the aim of this investigation was to determine the WQI for the three major water bodies in Ekiti State and provide baseline information on WQI on Ekiti State waters. This shall be helpful for the efficiency improvement in water quality management and policymaking on water resources in Ekiti State.

2. Material and Methods

2.1. Study Area

Ekiti state is located in the tropical climate with distinct wet and dry season [13]. Geographically, it is located between longitude 4°45' to 5°45' East of Greenwich Meridian and on latitude 7°15' to 8°5' North of the equator. It shares boundaries with Kwara State in the north (Figure 1), Kogi State in the north-east Osun State in the south and south-east. Ekiti state dams lie within the South western Basement Complex of Nigeria [14]. Human activities including defecation, washing, recreation (boating, swimming/bathing and fishing), agricultural activities and

Figure 1. Map of Ekiti state dams showing the sampling sites.

waste disposal are prevalent especially where human settlements exist around the dams. This study involves the three major dams in the state. They are: **Ureje Dam**, located at Longitude 5°14'E and Latitude 7°38.2'N; **Egbe Dam**, situated at Longitude 5°36.9'E and Latitude 7°37.1'N and **Ero Dam**, situated at Ikun-Ekiti, Moba Local Government Area of Ekiti State, Nigeria between latitudes 7°15' and 8°5'N and longitude 4°45' and 5°31'E.

2.2. Sample Collection

Samples of surface water were collected monthly from Ureje, Ero and Egbe dams from November, 2017 to October, 2018. Ten sampling sites were chosen in each dam to make pooled water sample monthly according to [15] [16] [17]. The sites were selected to represent the open water bodies and different variations within each dam so as to obtain a realistic overall representation. The GPS of sampling sites were taken using Garmin hand-held GPS. The geographical location of each selected sampling site within the reservoir is shown in **Table 1**.

Water samples from all ten sampling sites were collected during morning hours between 8.00 to 10.00 a.m. at a depth of about 0.3 m below water surface into 2 Litre polyethylene plastic containers. Prior to sampling, the containers were cleaned with 10% nitric acid and rinsed with distilled water. The containers were rinsed three times with the dam water at the time of sampling. Samples were then collected by direct immersion of the sampling containers into the dam. All sample containers were properly labeled to indicate date of sampling and the sampling location. Immediately after sample collection, 2 ml of concentrated nitric acid was added to the water samples for metal analysis to reduce adsorption of metals onto the walls of the plastic containers and to prevent microbial growth in the water sample. Winkler's bottles were used to collect water samples for COD and BOD. Samples were transported to the laboratory at about 4°C (ice/cold packs) to retard reactions and stored at 4°C awaiting analysis. *In*

Table 1. The sampling sites and GPS co-ordinates.

EGBE DAM			UREJE DAM			ERO DAM		
S/N	Lat.	Long.	S/N	Lat.	Long.	S/N	Lat.	Long.
1	7°38'0.15"N	5°34'6.15"E	11	7°36'0.30"N	5°12'52.98"E	21	7°59'14.68"N	5°12'11.57"E
2	7°37'49.93"N	5°33'44.19"E	12	7°35'58.97"N	5°12'44.77"E	22	7°59'1.24"N	5°11'49.96"E
3	7°37'39.96"N	5°33'42.62"E	13	7°36'8.46"N	5°12'36.96"E	23	7°59'19.58"N	5°11'38.59"E
4	7°37'12.77"N	5°34'12.02"E	14	7°36'10.41"N	5°12'33.99"E	24	7°59'15.42"N	5°11'29.52"E
5	7°37'16.20"N	5°34'3.00"E	15	7°36'9.36"N	5°12'33.60"E	25	7°59'0.51"N	5°11'35.96"E
6	7°37'35.25"N	5°34'23.55"E	16	7°36'6.48"N	5°12'37.62"E	26	7°58'46.31"N	5°11'22.93"E
7	7°37'4.02"N	5°34'23.93"E	17	7°36'1.61"N	5°12'47.92"E	27	7°58'14.84"N	5°11'32.92"E
8	7°37'28.09"N	5°33'53.02"E	18	7°36'0.54"N	5°12'38.81"E	28	7°58'32.51"N	5°11'44.57"E
9	7°37'1.91"N	5°34'12.11"E	19	7°36'1.45"N	5°12'49.42"E	29	7°58'50.92"N	5°11'42.88"E
10	7°37'49.16"N	5°33'55.76"E	20	7°36'0.55"N	5°12'48.51"E	30	7°57'45.39"N	5°11'39.13"E

situ water quality variable were recorded using Jenway portable 970 DO₂ Meter and Jenway 430 pH/Conductivity Meter. The *in situ* water quality parameters taken were temperature (°C), pH and electrical conductivity (µS/cm) and dissolved oxygen (mg/L).

2.3. Water Sample Analysis

The samples were analyzed in the laboratory as per standard methods [18], for different Physico-Chemical parameters namely, conductivity (EC), turbidity (Tur), Total solids (TS), pH, DO₂, BOD, COD, Total alkalinity (Totalk), total dissolved solids (TDS), Total hardness (TH), colour (Col), PO₄, NO₃ and NO₂. Metals (Cu, Pb, Mg, K, Mn, Fe, Na, Ca, Zn and Cd) in the water samples were determined by atomic absorption spectrophotometric method using Atomic absorption spectrophotometer (Bulk Scientific Model 211 VGP) [19].

2.4. Data Analysis

Statistical analysis was performed using SPSS software version 23 and Excel spreadsheet. The means of the physico-chemical variables, evaluation of significant differences between different samples were determined using descriptive statistics and analysis of variance (ANOVA) respectively. Results of the test were considered significant if the calculated P values were ≤0.05 or ≤0.01. *T*-test was used to show the variations of physico-chemical parameters between the two seasons.

Twenty-four physico-chemical parameters were used for calculation of Water Quality index for each of the dams using weighted arithmetic index method [20] according to the following equations:

$$k = \frac{1}{\sum_{i=1}^n 1/S_i} \quad (1)$$

in which k = constant of proportionality

S_i = permissible limit for the i th parameter

n = number of parameters.

$$\text{Relative Weight } (W_i) = \frac{k}{S_i} \quad (2)$$

$$\text{Quality Rating Scale } (Q_i) = 100 \left[(V_i - V_o) / S_i - V_o \right] \quad (3)$$

where, V_i is estimated concentration of i th parameter in the analyzed water

V_o is the ideal value of this parameter in pure water

$V_o = 0$ (except pH = 7.0 and DO = 14.6 mg/l)

S_i is recommended standard value of i th parameter.

Water Quality Index (WQI) is then calculated from the following equation

$$\text{WQI} = \frac{\sum_{i=1}^n Q_i W_i}{\sum_{i=1}^n W_i} \quad (4)$$

The standards for the drinking water recommended by the Indian Council of

Medical Research (ICMR), World Health Organization (WHO), Nigerian Industrial Standard (NIS), National Environmental Standards and Regulations Enforcement Agency (NESREA) and Bureau of Indian standards (BIS) were considered for the computation of quality rating (Q_i) and unit weights (W_i). The water quality was classified as excellent (if the WQI value is 0 to 25), good (26 to 50), moderately polluted (51 to 75), severely polluted (76 to 100), and unfit for drinking (above 100) according to [21] and [22].

3. Results and Discussion

Average values for each water quality parameter per season in the three dams used in the computation of water quality index are presented in **Table 2**. The

Table 2. Seasonal variations of the physicochemical parameters of the dams.

PARAMETERS	YEAR 2017-2018						STANDARD VALUE	AGENCIES
	EGBE DAM		UREJE DAM		ERO DAM			
	DRY SEASON	RAINY SEASON	DRY SEASON	RAINY SEASON	DRY SEASON	RAINY SEASON		
T (°C)	27.93 ± 3.35 ^a	26.61 ± 0.50 ^a	27.44 ± 3.01 ^a	25.66 ± 0.87 ^a	26.75 ± 2.35 ^a	26.14 ± 0.97 ^a	<40	WHO
pH	8.30 ± 1.55 ^a	8.83 ± 1.30 ^a	8.11 ± 0.96 ^a	8.72 ± 1.39 ^a	9.05 ± 0.54 ^a	9.07 ± 1.33 ^a	8.5	ICMB/BIS
DO ₂ (mg/l)	7.77 ± 2.85 ^a	9.06 ± 3.90 ^a	6.86 ± 1.85 ^a	7.65 ± 2.14 ^a	8.85 ± 3.13 ^a	10.07 ± 1.22 ^a	5	ICMB/BIS
TUR (NTU)	2.37 ± 1.31 ^a	2.91 ± 0.39 ^a	2.78 ± 0.89 ^a	3.43 ± 1.01 ^a	2.76 ± 1.75 ^a	2.39 ± 1.00 ^a	5	WHO
COL (Hazen)	5.00 ± 0.00 ^a	5.00 ± 0.00 ^a	5.42 ± 1.02 ^a	7.29 ± 2.55 ^a	5.00 ± 0.00 ^a	5.00 ± 0.00 ^a	5	BIS
EC (µS/cm)	126.08 ± 29.08 ^a	134.22 ± 18.91 ^a	202.56 ± 74.04 ^a	212.65 ± 57.09 ^a	124.93 ± 10.67 ^a	129.67 ± 36.08 ^a	300	ICMB
TS (mg/l)	50.43 ± 11.98 ^a	72.09 ± 11.80 ^b	94.97 ± 36.37 ^a	99.53 ± 22.20 ^a	58.34 ± 9.56 ^a	63.77 ± 20.74 ^a	-	-
TDS (mg/l)	47.40 ± 10.63 ^a	67.43 ± 10.08 ^b	87.26 ± 34.78 ^a	92.62 ± 19.15 ^a	52.17 ± 9.66 ^a	57.42 ± 20.12 ^a	500	ICMB/BIS
TSS (mg/l)	3.26 ± 1.20 ^a	4.67 ± 1.04 ^a	7.72 ± 2.46 ^a	6.98 ± 3.12 ^a	6.15 ± 1.31 ^a	6.35 ± 0.82 ^a	25	NESREA
TH (mg/l)	63.88 ± 4.69 ^a	66.31 ± 8.90 ^a	97.05 ± 17.08 ^a	86.32 ± 19.26 ^a	76.07 ± 6.92 ^a	75.34 ± 7.54 ^a	300	ICMB/BIS
Totalk (mg/l)	33.82 ± 8.02 ^a	33.40 ± 6.47 ^a	53.60 ± 16.70 ^a	47.41 ± 8.83 ^a	46.10 ± 7.63 ^a	36.61 ± 11.49 ^a	120	ICMB
BOD (mg/l)	5.68 ± 1.01 ^a	5.21 ± 0.59 ^a	7.46 ± 1.67 ^a	6.32 ± 0.70 ^a	5.21 ± 0.53 ^a	5.54 ± 0.84 ^a	5	ICMB/BIS
COD (mg/l)	10.36 ± 2.53 ^a	6.99 ± 0.73 ^b	11.80 ± 1.88 ^a	9.53 ± 1.11 ^b	8.62 ± 0.94 ^a	9.13 ± 1.32 ^a	10	WHO
NO ₃ (mg/l)	0.041 ± 0.04 ^a	ND ^a	0.143 ± 0.22 ^a	0.20 ± 0.27 ^a	0.187 ± 0.27 ^a	0.56 ± 0.56 ^a	45	1CMB/BIS
NO ₂ (mg/l)	0.006 ± 0.01 ^a	ND ^a	0.033 ± 0.07 ^a	ND ^a	0.002 ±0.002 ^a	ND ^a	0.2	NIS
PO ₄ (mg/l)	0.015 ± 0.02 ^a	ND ^a	0.024 ± 0.02 ^a	ND ^a	0.002 ± 0.003 ^a	ND ^a	0.1	USEPA
Na (ppm)	22.62 ± 7.39 ^a	22.94 ± 5.99 ^a	10.74 ± 2.09 ^a	22.39 ± 6.09 ^b	40.22 ± 1.29 ^a	53.90 ± 3.66 ^b	200	NIS
Ca (ppm)	40.30 ± 10.35 ^a	54.92 ± 17.56 ^a	23.18 ± 3.34 ^a	29.47 ± 2.63 ^b	53.12 ± 3.61 ^a	52.54 ± 1.50 ^a	75	WHO
K (ppm)	11.11 ± 1.61 ^a	13.16 ± 3.44 ^b	11.60 ± 2.00 ^a	17.50 ± 3.12 ^b	31.57 ± 1.09 ^a	26.11 ± 2.22 ^a	10	WHO
Fe (ppm)	0.18 ± 0.02 ^a	0.10 ± 0.03 ^b	0.31 ± 0.04 ^a	0.20 ± 0.04 ^b	0.06 ± 0.005 ^a	0.081 ± 0.03 ^b	0.1	WHO
Mn (ppm)	0.21 ± 0.05 ^a	0.17 ± 0.04 ^b	0.19 ± 0.08 ^a	0.12 ± 0.04 ^a	0.096 ± 0.005 ^a	0.24 ± 0.02 ^a	0.1	BIS
Zn (ppm)	0.24 ± 0.07 ^a	0.27 ± 0.10 ^a	0.12 ± 0.005 ^a	0.30 ± 0.09 ^b	0.101 ± 0.002 ^a	0.39 ± 0.034 ^b	3.0	NIS
Mg (ppm)	4.82 ± 0.44 ^a	4.87 ± 0.69 ^a	4.21 ± 0.34 ^a	4.96 ± 0.53 ^b	2.25 ± 0.05 ^a	5.57 ± 0.31 ^b	30	BIS
Cu (ppm)	0.17 ± 0.04 ^a	0.16 ± 0.05 ^a	0.12 ± 0.03 ^a	0.16 ± 0.03 ^b	0.030 ± 0.004 ^a	0.069 ± 0.012 ^b	0.05	BIS
Pb (ppm)	0.005 ± 0.003 ^a	0.0013 ± 0.0010 ^b	0.001 ± 0.0004 ^a	0.001 ± 0.0005 ^a	0.0031 ± 0.0006 ^a	0.0048 ± 0.0014 ^a	0.05	WHO

Physico-chemical parameter values of dry season and wet season with similar superscription are not significant^a. ND—Not detected^b.

average values of TS, TDS, COD, K, Fe and Mn were significantly different ($P \geq 0.05$) between dry and rainy seasons in Egbe dam. However, average pH, turbidity, DO_2 , EC, TS, TDS, TSS, TH, Na, K, Zn and Mg were higher in the wet season compared to the dry season in Egbe dam. In Ureje dam, the differences between dry season and rainy season values of COD, Na, Ca, K, Fe, Zn and Cu were significant ($P \geq 0.05$). But in the dam, the average values of pH, turbidity, DO_2 , colour, EC, TS, TDS, NO_3 , Na, Ca, K, Zn, Mg and Cu were higher during the rainy season than the dry season. In Ero dam, only Na, Fe, Zn, Mg and Cu showed significant difference ($P \geq 0.05$) between the dry season and rainy season. However, pH, DO_2 , EC, TS, TDS, TSS, BOD, COD, NO_3 , Fe, Zn, Mg, Cu and Pb showed higher values during the rainy season than dry season. The water sample analysis reveals that dams' water is not fit for drinking with respect to pH, DO_2 , K, BOD, COD (except in Ero dam), Fe (except in Ero dam), Zn (except in Egbe dam), Cu and colour (only Ureje dam), the concentrations of these parameters exceed the permissible limits of WHO and other international organizations. **Table 3** and **Table 4** show the seasonal WQI for Egbe dam during the dry and rainy seasons respectively. **Table 5** and **Table 6** show the seasonal WQI for Ureje dam for dry and rainy seasons respectively while **Table 7** and **Table 8**

Table 3. Water quality index in Egbe dam during the dry season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	W_i	Q_i	$Q_i W_i$
1	Temp	40	WHO	27.93	0.0130537	0.000326343	69.825	0.022786865
2	pH	8.5	ICMB/BIS	8.3	0.0130537	0.001535729	8.294117647	0.01273752
3	DO_2	5	ICMB/BIS	7.77	0.0130537	0.00261074	71.14583333	0.185743273
4	BOD	5	ICMB/BIS	5.68	0.0130537	0.00261074	113.6	0.296580064
5	COD	10	WHO	10.36	0.0130537	0.00130537	103.6	0.135236332
6	TOT. ALK.	120	ICMB	33.82	0.0130537	0.000108781	28.18333333	0.003065806
7	TURBIDITY	5	WHO	2.37	0.0130537	0.00261074	47.4	0.123749076
8	TOT. HAR.	300	ICMB/BIS	63.88	0.0130537	4.35123E-05	21.29333333	0.000926523
9	TSS	25	NESREA	3.26	0.0130537	0.000522148	13.04	0.00680881
10	TDS	500	ICMB/BIS	47.4	0.0130537	2.61074E-05	9.48	0.000247498
11	TS			50.43	0.0130537			
12	COLOUR	5	BIS	5	0.0130537	0.00261074	100	0.261074
13	CONDUCT.	300	ICMB	126.08	0.0130537	4.35123E-05	42.02666667	0.001828678
14	NO_3	45	ICMB/BIS	0.041	0.0130537	0.000290082	0.091111111	2.64297E-05
15	NO_2	0.2	NIS	0.006	0.0130537	0.0652685	3	0.1958055
16	PO_4	0.1	USEPA	0.015	0.0130537	0.130537	15	1.958055
17	Na	200	NIS	22.62	0.0130537	6.52685E-05	11.31	0.000738187
18	Ca	75	WHO	40.3	0.0130537	0.000174049	53.73333333	0.009352251
19	K	10	WHO	11.11	0.0130537	0.00130537	111.1	0.145026607
20	Fe	0.1	WHO	0.18	0.0130537	0.130537	180	23.49666

Continued

21	Mn	0.1	BIS	0.21	0.0130537	0.130537	210	27.41277
22	Zn	3	NIS	0.24	0.0130537	0.004351233	8	0.034809867
23	Mg	30	BIS	4.82	0.0130537	0.000435123	16.06666667	0.006990982
24	Cu	0.05	BIS	0.17	0.0130537	0.261074	340	88.76516
25	Pb	0.05	WHO	0.005	0.0130537	0.261074	10	2.61074
					$\Sigma W_i =$	1.00000309	$\Sigma Q_i W_i =$	145.6869193
					$\Sigma Q_i W_i / \Sigma W_i$		= 145.69	

Table 4. Water quality index in Egbe dam during rainy season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	W_i	Q_i	$Q_i W_i$
1	Temp	40	WHO	26.61	0.0130537	0.000326343	66.525	0.021709935
2	pH	8.5	ICMB/BIS	8.83	0.0130537	0.001535729	14.52941176	0.022313245
3	DO ₂	5	ICMB/BIS	9.06	0.0130537	0.00261074	57.70833333	0.150661454
4	BOD	5	ICMB/BIS	5.21	0.0130537	0.00261074	104.2	0.272039108
5	COD	10	WHO	6.99	0.0130537	0.00130537	69.9	0.091245363
6	TOT. ALK.	120	ICMB	33.4	0.0130537	0.000108781	27.83333333	0.003027733
7	TURBIDITY	5	WHO	2.91	0.0130537	0.00261074	58.2	0.151945068
8	TOT. HAR.	300	ICMB/BIS	66.31	0.0130537	4.35123E-05	22.10333333	0.000961768
9	TSS	25	NESREA	4.67	0.0130537	0.000522148	18.68	0.009753725
10	TDS	500	ICMB/BIS	67.43	0.0130537	2.61074E-05	13.486	0.000352084
11	TS			72.09	0.0130537			
12	COLOUR	5	BIS	5	0.0130537	0.00261074	100	0.261074
13	CONDUCT.	300	ICMB	134.22	0.0130537	4.35123E-05	44.74	0.001946742
14	NO ₃	45	ICMB/BIS	0	0.0130537	0.000290082	0	0
15	NO ₂	0.2	NIS	0	0.0130537	0.0652685	0	0
16	PO ₄	0.1	USEPA	0	0.0130537	0.130537	0	0
17	Na	200	NIS	22.94	0.0130537	6.52685E-05	11.47	0.00074863
18	Ca	75	WHO	54.92	0.0130537	0.000174049	73.22666667	0.012745053
19	K	10	WHO	13.16	0.0130537	0.00130537	131.6	0.171786692
20	Fe	0.1	WHO	0.1	0.0130537	0.130537	100	13.0537
21	Mn	0.1	BIS	0.17	0.0130537	0.130537	170	22.19129
22	Zn	3	NIS	0.27	0.0130537	0.004351233	9	0.0391611
23	Mg	30	BIS	4.87	0.0130537	0.000435123	16.23333333	0.007063502
24	Cu	0.05	BIS	0.16	0.0130537	0.261074	320	83.54368
25	Pb	0.05	WHO	0.0013	0.0130537	0.261074	2.6	0.6787924
					$\Sigma W_i =$	1.00000309	$\Sigma Q_i W_i =$	120.6859976
					$\Sigma Q_i W_i / \Sigma W_i$		= 120.69	

Table 5. Water quality index in Ureje dam during the dry season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	W_i	Q_i	$Q_i W_i$
1	Temp	40	WHO	27.44	0.0130537	0.000326343	68.6	0.022387096
2	pH	8.5	ICMB/BIS	8.11	0.0130537	0.001535729	6.058823529	0.009304713
3	DO ₂	5	ICMB/BIS	6.86	0.0130537	0.00261074	80.625	0.210490913
4	BOD	5	ICMB/BIS	7.46	0.0130537	0.00261074	149.2	0.389522408
5	COD	10	WHO	11.8	0.0130537	0.00130537	118	0.15403366
6	TOT. ALK.	120	ICMB	53.6	0.0130537	0.000108781	44.66666667	0.004858877
7	TURBIDITY	5	WHO	2.78	0.0130537	0.00261074	55.6	0.145157144
8	TOT. HAR.	300	ICMB/BIS	97.05	0.0130537	4.35123E-05	32.35	0.001407624
9	TSS	25	NESREA	7.72	0.0130537	0.000522148	30.88	0.01612393
10	TDS	500	ICMB/BIS	87.26	0.0130537	2.61074E-05	17.452	0.000455626
11	TS			94.97	0.0130537			
12	COLOUR	5	BIS	5.42	0.0130537	0.00261074	108.4	0.283004216
13	CONDUCT.	300	ICMB	202.56	0.0130537	4.35123E-05	67.52	0.002937953
14	NO ₃	45	ICMB/BIS	0.143	0.0130537	0.000290082	0.317777778	9.21817E-05
15	NO ₂	0.2	NIS	0.033	0.0130537	0.0652685	16.5	1.07693025
16	PO ₄	0.1	USEPA	0.024	0.0130537	0.130537	24	3.132888
17	Na	200	NIS	10.74	0.0130537	6.52685E-05	5.37	0.000350492
18	Ca	75	WHO	23.18	0.0130537	0.000174049	30.90666667	0.005379285
19	K	10	WHO	11.6	0.0130537	0.00130537	116	0.15142292
20	Fe	0.1	WHO	0.31	0.0130537	0.130537	310	40.46647
21	Mn	0.1	BIS	0.19	0.0130537	0.130537	190	24.80203
22	Zn	3	NIS	0.12	0.0130537	0.004351233	4	0.017404933
23	Mg	30	BIS	4.21	0.0130537	0.000435123	14.03333333	0.006106231
24	Cu	0.05	BIS	0.12	0.0130537	0.261074	240	62.65776
25	Pb	0.05	WHO	0.001	0.0130537	0.261074	2	0.522148
						$\Sigma W_i =$	$\Sigma Q_i W_i =$	134.0786665
						$\Sigma Q_i W_i / \Sigma W_i$	$= 134.08$	

Table 6. Water quality index in Ureje dam during the rainy season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	Wi	Qi	QiWi
1	Temp	40	WHO	25.66	0.0130537	0.000326343	64.15	0.020934871
2	pH	8.5	ICMB/BIS	8.72	0.0130537	0.001535729	13.23529412	0.02032583
3	DO ₂	5	ICMB/BIS	7.65	0.0130537	0.00261074	72.39583333	0.189006698
4	BOD	5	ICMB/BIS	6.32	0.0130537	0.00261074	126.4	0.329997536
5	COD	10	WHO	9.53	0.0130537	0.00130537	95.3	0.124401761
6	TOT. ALK.	120	ICMB	47.41	0.0130537	0.000108781	39.50833333	0.004297749
7	TURBIDITY	5	WHO	3.43	0.0130537	0.00261074	68.6	0.179096764
8	TOT. HAR.	300	ICMB/BIS	86.32	0.0130537	4.35123E-05	28.77333333	0.001251995

Continued

9	TSS	25	NESREA	6.98	0.0130537	0.000522148	27.92	0.014578372
10	TDS	500	ICMB/BIS	92.62	0.0130537	2.61074E-05	18.524	0.000483613
11	TS			99.53	0.0130537			
12	COLOUR	5	BIS	7.29	0.0130537	0.00261074	145.8	0.380645892
13	CONDUCT.	300	ICMB	212.65	0.0130537	4.35123E-05	70.88333333	0.003084299
14	NO ₃	45	ICMB/BIS	0.2	0.0130537	0.000290082	0.444444444	0.000128925
15	NO ₂	0.2	NIS	0	0.0130537	0.0652685	0	0
16	PO ₄	0.1	USEPA	0	0.0130537	0.130537	0	0
17	Na	200	NIS	22.39	0.0130537	6.52685E-05	11.195	0.000730681
18	Ca	75	WHO	29.47	0.0130537	0.000174049	39.29333333	0.006838978
19	K	10	WHO	17.5	0.0130537	0.00130537	175	0.22843975
20	Fe	0.1	WHO	0.2	0.0130537	0.130537	200	26.1074
21	Mn	0.1	BIS	0.12	0.0130537	0.130537	120	15.66444
22	Zn	3	NIS	0.3	0.0130537	0.004351233	10	0.043512333
23	Mg	30	BIS	4.96	0.0130537	0.000435123	16.53333333	0.007194039
24	Cu	0.05	BIS	0.16	0.0130537	0.261074	320	83.54368
25	Pb	0.05	WHO	0.001	0.0130537	0.261074	2	0.522148
					$\Sigma W_i =$	1.00000309	$\Sigma Q_i W_i =$	127.3926181
						$\Sigma Q_i W_i / \Sigma W_i$	= 127.39	

Table 7. Water quality index in Ero dam during the dry season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	Wi	Qi	Q _i W _i
1	Temp	40	WHO	26.75	0.0130537	0.000326343	66.875	0.021824155
2	pH	8.5	ICMB/BIS	9.05	0.0130537	0.001535729	17.11764706	0.026288074
3	DO ₂	5	ICMB/BIS	8.85	0.0130537	0.00261074	59.89583333	0.156372448
4	BOD	5	ICMB/BIS	5.21	0.0130537	0.00261074	104.2	0.272039108
5	COD	10	WHO	8.62	0.0130537	0.00130537	86.2	0.112522894
6	TOT. ALK.	120	ICMB	46.1	0.0130537	0.000108781	38.41666667	0.004178997
7	TURBIDITY	5	WHO	2.76	0.0130537	0.00261074	55.2	0.144112848
8	TOT. HAR.	300	ICMB/BIS	76.07	0.0130537	4.35123E-05	25.35666667	0.001103328
9	TSS	25	NESREA	6.15	0.0130537	0.000522148	24.6	0.012844841
10	TDS	500	ICMB/BIS	52.17	0.0130537	2.61074E-05	10.434	0.000272405
11	TS			58.34	0.0130537			
12	COLOUR	5	BIS	5	0.0130537	0.00261074	100	0.261074
13	CONDUCT.	300	ICMB	124.93	0.0130537	4.35123E-05	41.64333333	0.001811999
14	NO ₃	45	ICMB/BIS	0.187	0.0130537	0.000290082	0.415555556	0.000120545
15	NO ₂	0.2	NIS	0.002	0.0130537	0.0652685	1	0.0652685
16	PO ₄	0.1	USEPA	0.002	0.0130537	0.130537	2	0.261074
17	Na	200	NIS	40.22	0.0130537	6.52685E-05	20.11	0.00131255
18	Ca	75	WHO	53.12	0.0130537	0.000174049	70.82666667	0.012327334

Continued

19	K	10	WHO	31.57	0.0130537	0.00130537	315.7	0.412105309
20	Fe	0.1	WHO	0.06	0.0130537	0.130537	60	7.83222
21	Mn	0.1	BIS	0.096	0.0130537	0.130537	96	12.531552
22	Zn	3	NIS	0.101	0.0130537	0.004351233	3.366666667	0.014649152
23	Mg	30	BIS	2.25	0.0130537	0.000435123	7.5	0.003263425
24	Cu	0.05	BIS	0.03	0.0130537	0.261074	60	15.66444
25	Pb	0.05	WHO	0.0031	0.0130537	0.261074	6.2	1.6186588
					$\Sigma W_i =$	1.00000309	$\Sigma Q_i W_i =$	39.43143671
						$\Sigma Q_i W_i / \Sigma W_i$	= 39.43	

Table 8. Water quality index in Ero dam during the rainy season.

S/N	Parameters	Sn	Agencies	Aver. Value	K	Wi	Qi	QiWi
1	Temp	40	WHO	26.14	0.0130537	0.000326343	65.35	0.021326482
2	pH	8.5	ICMB/BIS	9.07	0.0130537	0.001535729	17.35294118	0.026649422
3	DO ₂	5	ICMB/BIS	10.07	0.0130537	0.00261074	47.1875	0.123194294
4	BOD	5	ICMB/BIS	5.54	0.0130537	0.00261074	110.8	0.289269992
5	COD	10	WHO	9.13	0.0130537	0.00130537	91.3	0.119180281
6	TOT. ALK.	120	ICMB	36.61	0.0130537	0.000108781	30.50833333	0.003318722
7	TURBIDITY	5	WHO	2.39	0.0130537	0.00261074	47.8	0.124793372
8	TOT. HAR.	300	ICMB/BIS	75.34	0.0130537	4.35123E-05	25.11333333	0.00109274
9	TSS	25	NESREA	6.35	0.0130537	0.000522148	25.4	0.013262559
10	TDS	500	ICMB/BIS	57.42	0.0130537	2.61074E-05	11.484	0.000299817
11	TS			63.77	0.0130537			
12	COLOUR	5	BIS	5	0.0130537	0.00261074	100	0.261074
13	CONDUCT.	300	ICMB	129.67	0.0130537	4.35123E-05	43.22333333	0.001880748
14	NO ₃	45	ICMB/BIS	0.56	0.0130537	0.000290082	1.244444444	0.000360991
15	NO ₂	0.2	NIS	0	0.0130537	0.0652685	0	0
16	PO ₄	0.1	USEPA	0	0.0130537	0.130537	0	0
17	Na	200	NIS	53.9	0.0130537	6.52685E-05	26.95	0.001758986
18	Ca	75	WHO	52.54	0.0130537	0.000174049	70.05333333	0.012192736
19	K	10	WHO	26.11	0.0130537	0.00130537	261.1	0.340832107
20	Fe	0.1	WHO	0.081	0.0130537	0.130537	81	10.573497
21	Mn	0.1	BIS	0.24	0.0130537	0.130537	240	31.32888
22	Zn	3	NIS	0.39	0.0130537	0.004351233	13	0.056566033
23	Mg	30	BIS	5.57	0.0130537	0.000435123	18.56666667	0.00807879
24	Cu	0.05	BIS	0.069	0.0130537	0.261074	138	36.028212
25	Pb	0.05	WHO	0.0048	0.0130537	0.261074	9.6	2.5063104
					$\Sigma W_i =$	1.00000309	$\Sigma Q_i W_i$	81.84203147
						$\Sigma Q_i W_i / \Sigma W_i$	= 81.84	

show the seasonal WQI for Ero dam during dry season and wet season respectively. The WQI in Egbe dam ranges from 118.00 - 164.67 (dry season) with a mean seasonal value of 145.69 and from 89.39 - 161.86 (rainy season) with a mean seasonal value of 120.59. In Ureje dam, WQI ranges from 101.88 - 164.76 (dry season) with mean seasonal value of 134.08 and from 96.61 - 138.36 (rainy season) with a mean seasonal value of 123.39 while in Ero, WQI ranges from 32.28 - 45.13 (dry season) with a mean seasonal value of 39.43 and from 52.12 - 106.22 (rainy season) with a mean seasonal value of 81.84.

According to the rating of water status based on WQI by [21] and [22], the WQI of Egbe dam and Ureje dam during the dry season and rainy season indicated poor water quality that is was suitable for fisheries, recreational, industrial and irrigation purposes but unfit for drinking while in Ero dam, the WQI during the dry season indicated good quality water while during the rainy season, the water in the dam was polluted. The grossly polluted nature of Egbe dam is likely due to anthropogenic activities such as bathing, cleaning, fishing, intense farming activities around the dam and washing of farm produce into the dam while that of Ureje is likely due to fishing, leachates from solid wastes like the paper, polythene bags, plastic cups, sachets, straws, cloths and leaves that are scattered on the water and around the bank of the dam in addition to domestic effluents and sewage released directly into the dam from residential buildings around the dam (Plate 1), where it is situated in central part of Ado-Ekiti, the State Capital. In addition, the use of canoes as main transport around the dams' area in Egbe dam and Ero dam contributed to the polluted state of the dams. The impact of various anthropogenic activities was evident in the high BOD level in all the dams since BOD values indicate a possibility of organic pollution effect on the water of the dams. High BOD values obtained indicate maximum oxygen consumption and probably pollution load on the aquatic system [23].

Plate 1. Showing PVC carrying domestic effluents into Ureje dam.

Figure 2 shows the monthly variations in WQI in the three dams. The variations in WQI in the dams from month to month are likely due the variations in the physico-chemical parameters of the dams each month.

The correlation coefficient values between WQI and the water physico-chemical parameters show that COD, TSS, TDS, Total solids, NO_3 , PO_4 , Fe and Pb were the most affecting factors for computed WQI values in Egbe dam (**Table 9**) while BOD, Mn and Cu were most affecting parameters for the computed WQI in Ureje dam (**Table 10**). In Ero dam, temperature, turbidity and Ca values were the most affecting parameters for the computed WQI (**Table 11**). In this study, there was significant difference at $p \geq 0.05$ between WQI during dry season and the rainy season in Egbe dam and Ero dam while there was no significant difference at $P \geq 0.05$ in WQI during the dry season and wet season in Ureje dam. However, the average WQI in Egbe dam and Ureje dam during the rainy season was slightly lower than an average WQI for dry season (**Figure 3**). Thus, indicating better quality during the rainy season than the dry season in the dams. Similar observation was reported by [24] on Nokoue Lake. This observation indicate that rainfall doesn't have adverse effects on water quality but instead improve environmental water bodies possibly due to the increase in DO_2 .

Figure 2. Monthly variations in WQI in the dams.

Figure 3. Seasonal variations in values of WQI in the three dams.

Table 9. Correlations of WQI and physico-chemical parameters in Egbe dam during the year 2017/2018.

	WQI	Temp	PH	DO ₂	BOD	COD	Talk	Turb	Thard	TSS	TDS	Tslid	EC	NO ₃	NO ₂	PO ₄	Na	Ca	K	Fe	Mn	Zn	Mg	Cu	Pb
WQI	1																								
Temp	0.29	1																							
PH	-0.53	-0.122	1																						
DO ₂	-0.217	0.509	0.115	1																					
BOD	0.018	-0.146	0.473	0.123	1																				
COD	0.898**	0.31	-0.57	-0.302	-0.063	1																			
Talk	-0.242	0.206	0.774**	0.064	0.352	-0.337	1																		
Turb	-0.213	-0.089	0.599*	0.087	0.473	-0.301	0.800**	1																	
Thard	-0.174	0.315	0.537	0.106	-0.131	-0.156	0.762**	0.528	1																
TSS	-0.687*	-0.163	0.835**	0.079	0.288	-0.618*	0.779**	0.780**	0.624*	1															
TDS	-0.703*	-0.166	0.679*	0.024	0.022	-0.622*	0.698*	0.731**	0.632*	0.953**	1														
Tslid	-0.706*	-0.149	0.693*	0.04	0.041	-0.625*	0.710**	0.736**	0.636*	0.960**	0.999**	1													
EC	0.048	0.543	-0.06	-0.068	-0.572	0.264	0.283	0.105	0.623*	0.211	0.369	0.366	1												
NO ₃	0.686*	-0.047	0.03	-0.265	0.564	0.544	0.265	0.467	-0.01	-0.071	-0.182	-0.18	-0.161	1											
NO ₂	0.536	0.097	0.136	-0.103	0.578*	0.409	0.449	0.667*	0.135	0.134	0.04	0.046	-0.014	0.947**	1										
PO ₄	0.632*	-0.076	0.047	-0.253	0.554	0.499	0.293	0.541	0.02	-0.002	-0.097	-0.1	-0.133	0.994**	0.964**	1									
Na	0.424	-0.273	-0.838**	-0.343	-0.417	0.398	-0.592*	-0.28	-0.36	-0.588*	-0.414	-0.44	-0.035	0.128	0.008	0.143	1								
Ca	-0.087	-0.158	-0.688*	-0.02	-0.449	-0.061	-0.48	-0.13	-0.4	-0.273	-0.05	-0.07	0.05	-0.251	-0.191	-0.194	0.747**	1							
K	-0.321	0.131	-0.39	0.345	-0.131	-0.375	-0.19	-0.11	-0.27	-0.114	-0.027	-0.03	-0.119	-0.451	-0.33	-0.426	0.295	0.678*	1						
Fe	0.674*	0.12	0.088	-0.107	0.458	0.502	0.018	-0.15	-0.17	-0.387	-0.578*	-0.57	-0.359	0.617*	0.435	0.533	-0.22	-0.674*	-0.558	1					
Mn	0.244	0.397	-0.08	0.051	-0.409	0.337	-0.24	-0.661*	0.167	-0.372	-0.393	-0.39	0.289	-0.325	-0.46	-0.402	-0.22	-0.486	-0.373	0.367	1				
Zn	-0.127	-0.204	0.004	-0.645*	-0.499	0.18	-0.02	-0.12	0.344	0.191	0.307	0.293	0.594*	-0.227	-0.276	-0.212	0.13	-0.009	-0.377	-0.33	0.285	1			
Mg	-0.343	-0.415	0.704*	-0.479	0.055	-0.304	0.417	0.144	0.416	0.504	0.432	0.43	0.017	-0.078	-0.157	-0.091	-0.47	-0.627*	-0.603*	0.142	0.25	0.53	1		
Cu	0.054	0.466	-0.19	0.545	-0.021	-0.242	0.024	-0.07	-0.19	-0.27	-0.243	-0.24	-0.193	-0.127	-0.023	-0.142	-0.03	0.242	0.622*	0.041	-0.12	-0.769**	-0.547	1	
Pb	0.769**	-0.169	-0.18	-0.51	0.178	0.658*	-0.11	-0.11	-0.12	-0.43	-0.503	-0.51	-0.184	0.693*	0.464	0.639*	0.28	-0.33	-0.569	0.738**	0.195	0.062	0.162	-0.27	1

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

Table 10. Correlations of WQI and physic-chemical parameters in Ureje dam during the year 2017/2018.

	WQI	Temp	PH	DO ₂	BOD	COD	Talk	Turb	Thard	TSS	TDS	Tsld	Col	EC	NO ₃	NO ₂	PO ₄	Na	Ca	K	Fe	Mn	Zn	Mg	Cu	Pb
WQI	1																									
Temp	0.142	1																								
PH	0.169	-0.017	1																							
DO ₂	0.25	0.104	0.854**	1																						
BOD	0.693*	-0.08	0.468	0.391	1																					
COD	-0.308	0.094	-0.22	0.022	0.028	1																				
Talk	0.301	-0.184	0.436	0.371	0.606*	0.246	1																			
Turb	0.113	-0.287	0.759**	0.481	0.364	-0.448	0.582*	1																		
Thard	0.169	-0.098	0.526	0.345	0.652*	0.147	0.892**	0.681*	1																	
TSS	0.027	-0.194	0.597*	0.27	0.596*	-0.076	0.668*	0.718**	0.896**	1																
TDS	0.313	-0.312	0.650*	0.598*	0.571	0.02	0.914**	0.744**	0.816**	0.666*	1															
Tsld	0.295	-0.309	0.664*	0.584*	0.590*	0.012	0.918**	0.764**	0.848**	0.717**	0.997**	1														
Col	-0.44	-0.281	0.639*	0.438	-0.182	-0.256	0.177	0.756**	0.299	0.391	0.382	0.395	1													
EC	0.241	-0.296	0.674*	0.587*	0.587*	0.007	0.884**	0.769**	0.875**	0.774**	0.978**	0.987**	0.416	1												
NO ₃	-0.137	-0.295	0.643*	0.512	0.265	0.119	0.747**	0.811**	0.732**	0.606*	0.797**	0.803**	0.731**	0.787**	1											
NO ₂	0.397	0.006	0.071	0.268	0.383	0.481	0.803**	0.104	0.498	0.116	0.657*	0.625*	-0.194	0.545	0.432	1										
PO ₄	0.024	-0.079	-0.28	-0.148	0.236	0.800**	0.604*	-0.23	0.388	0.083	0.309	0.297	-0.354	0.241	0.245	0.801**	1									
Na	-0.116	-0.249	0.613*	0.611*	-0.141	-0.362	-0.02	0.391	-0.06	0.122	0.34	0.329	0.54	0.345	0.232	-0.177	-0.51	1								
Ca	0.197	-0.066	0.696*	0.696*	0.018	-0.572	0.005	0.493	-0.03	0.097	0.363	0.348	0.489	0.343	0.207	-0.136	-0.624* 0.914**	1								
K	0.032	-0.376	-0.19	-0.186	-0.392	-0.710**	-0.5	0.015	-0.5	-0.318	-0.229	-0.25	0.11	-0.222	-0.369	-0.493	-0.661*	0.438	0.448	1						
Fe	0.508	0.691*	-0.01	0.059	0.547	0.323	0.25	-0.21	0.312	0.126	0.004	0.016	-0.545	0.017	-0.154	0.357	0.364	-0.604*	-0.407	-0.661*	1					
Mn	0.752**	0.117	0.449	0.341	0.951**	-0.012	0.597*	0.335	0.637*	0.55	0.511	0.53	-0.211	0.513	0.208	0.413	0.239	-0.221	-0.005	-0.441	0.681*	1				
Zn	-0.23	-0.443	0.461	0.471	-0.258	-0.343	-0.2	0.297	-0.27	-0.069	0.149	0.132	0.568	0.122	0.188	-0.299	-0.52	0.897**	0.800**	0.508	-0.789**	-0.382	1			
Mg	0.096	-0.478	0.623*	0.626*	0.176	-0.374	-0.03	0.404	-0.01	0.176	0.333	0.327	0.466	0.347	0.188	-0.233	-0.51	0.835**	0.805**	0.476	-0.54	0.037	0.857**	1		
Cu	0.602*	-0.231	0.002	0.095	0.047	-0.707*	-0.21	0.088	-0.38	-0.351	0.028	-0.01	-0.127	-0.056	-0.291	-0.081	-0.48	0.353	0.554	0.754**	-0.3	0.023	0.4	0.466	1	
Pb	0.005	0.503	0.697*	0.744**	0.262	0.235	0.239	0.272	0.322	0.275	0.273	0.282	0.33	0.288	0.397	0.14	-0.03	0.247	0.328	-0.579*	0.367	0.309	0.12	0.161	-0	1

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

Table 11. Correlations of WQI and physic-chemical parameters in Ero dam during the year 2017/2018.

	WQI	Temp	PH	DO ₂	BOD	COD	Talk	Turb	Thard	TSS	TDS	Tsld	EC	NO ₃	NO ₂	PO ₄	Na	Ca	K	Fe	Mn	Zn	Mg	Cu	Pb
WQI	1																								
Temp	1	1																							
PH	1	-0.499	1																						
DO ₂	1	-0.086	-0.11	1																					
BOD	1	-0.464	0.239	0.264	1																				
COD	1	0.039	0.22	0.147	0.594*	1																			
Talk	1	0.449	-0.607*	-0.054	-0.694*	-0.384	1																		
Turb	1	-0.496	-0	0.534	-0.006	-0.34	0.353	1																	
Thard	1	0.413	-0.52	-0.062	-0.407	0.272	0.680*	-0.03	1																
TSS	1	0.014	-0.08	-0.52	-0.633*	-0.226	0.263	-0.25	0.49	1															
TDS	1	-0.204	-0.36	0.42	-0.47	-0.52	0.544	0.703*	0.327	0.339	1														
Tsld	1	-0.2	-0.36	0.38	-0.497	-0.522	0.548	0.674*	0.349	0.391	0.998**	1													
EC	1	0.076	-0.55	0.384	-0.591*	-0.536	0.714**	0.599*	0.448	0.308	0.953**	0.951**	1												
NO ₃	1	-0.705*	0.685*	0.296	0.475	0.514	-0.58	0.21	-0.13	0.015	0.012	0.013	-0.241	1											
NO ₂	1	-0.15	-0.02	-0.089	0.011	-0.175	0.374	0.462	0.018	-0.246	0.067	0.053	0.072	-0.149	1										
PO ₄	1	0.182	-0.11	-0.938**	-0.521	-0.342	0.336	-0.39	0.25	0.668*	-0.127	-0.09	-0.056	-0.443	0.16	1									
Na	1	0.131	-0.57	0.559	0.026	-0.021	0.01	0.027	0.196	0.061	0.448	0.441	0.465	-0.044	-0.403	-0.42	1								
Ca	1	0.054	-0.28	0.443	0.334	0.275	0.223	0.358	0.191	-0.51	0.037	0.007	0.065	-0.009	0.37	-0.434	0.298	1							
K	1	0.103	-0.53	0.002	-0.222	-0.641*	0.596*	0.485	-0.03	-0.227	0.357	0.337	0.456	-0.647*	0.5	0.155	-0.1	0.149	1						
Fe	1	-0.11	-0.02	0.118	-0.211	-0.128	-0.27	-0.22	-0.02	0.484	0.297	0.317	0.231	0.204	-0.561	-0.04	0.511	-0.431	-0.479	1					
Mn	1	-0.013	-0.38	0.498	0.185	0.023	-0.26	-0.07	-0.03	0.005	0.292	0.285	0.275	0.068	-0.503	-0.431	0.935**	0.145	-0.254	0.612*	1				
Zn	1	-0.24	0.082	0.372	0.293	0.306	-0.54	-0.19	-0.07	0.149	0.097	0.103	-0.027	0.509	-0.566	-0.413	0.719**	0.069	-0.692*	0.673*	0.837**	1			
Mg	1	-0.115	-0.1	0.438	0.194	0.195	-0.41	-0.16	-0.02	0.134	0.203	0.206	0.132	0.337	-0.590*	-0.421	0.827**	0.053	-0.569	0.726**	0.932**	0.969**	1		
Cu	1	-0.174	0.311	0.111	0.134	0.111	-0.627*	-0.36	-0.35	0.145	-0.126	-0.12	-0.218	0.353	-0.55	-0.193	0.394	-0.217	-0.731**	0.794**	0.616*	0.812**	0.793**	1	
Pb	1	-0.234	-0.05	0.342	0.477	0.567	-0.17	0.109	0.22	-0.208	-0.004	-0.02	-0.027	0.39	-0.047	-0.381	0.252	0.349	-0.395	0.246	0.355	0.416	0.429	0.336	1

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

during the rainy season and according to [26], it indicates the absence of dirty runoff entering the dams during the rainy season as the TSS, TDS and total solids levels in all the dams during the rainy seasons were far below the recommended limits. The study thus indicates quite significant seasonal influence of rainfalls on the dam aquatic ecosystems by improving the water quality. This observation is similar to the report of [26], that seasonal variations in precipitation, surface run-off, groundwater flow, interception and abstraction strongly affect lake volume and consequently the concentration of pollutants in a water body.

In Ero dam, the average WQI during the rainy season was significantly higher ($P \geq 0.05$) than an average water quality index for dry season (**Figure 3**). This was brought about by the increase in Cu concentration during the rainy season which was likely due to influx of Cu into the dam from the surrounding.

4. Conclusion

Conclusively, the application of the WQI is a very helpful tool that enables decision makers to evaluate water quality and compare water quality of two dams. The study revealed that the WQI of Egbe dam, Ureje dam and Ero dam indicated that the water is poor quality and not totally safe for human consumption, and that it needs treatment before consumption. Thus, there is an urgent need for proper management measures and suitable tools to restore the water quality of these dams for a healthy and promising human society.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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