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Determination of Water Quality Indices for Kofa Dam, Suleja, Nigeria

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Animashaun IM[1]*, Abubakar S[1,2], Mohammed AS[1], Adeoye PA[1] and Kuti IA[1]

[1]*Agricultural and Bioresources Engineering, Federal University of Technology, Minna, Nigeria*

[2]*Federal Ministry of Water Resources and Rural Development, Nigeria*

***Corresponding Author:** Animashaun IM, Agricultural and Bioresources Engineering, Federal University of Technology, Minna, Nigeria.

Abstract

Water quality can be affected by either natural or anthropogenic factors. In this study, Water quality indices of Kofa Dam were determined for drinking and irrigation purposes Water samples were analyzed for the selected physicochemical parameter (pH, Electrical conductivity, Chloride, Total dissolve solids, Salinity, Sulphate, Sodium, Nitrate, Calcium, Temperature, Turbidity and Bicarbonate). The results from the analysis were compared with the drinking and irrigation standards of NSDWQ, FAO and WHO. Also, the results in relation to the standards were used to compute indices for drinking and irrigation purposes using the weighted arithmetic index. The results of the physicochemical parameter from each of the sampling locations of Kofa Dam and the overall score show that the Dam failed the index. Therefore, the water is not suitable for drinking purpose. However, for irrigation purposes, the results of the indices show a need for caution in the usage of water. This suggests that anthropogenic activities such as farming around the Dam and the presence of residential houses which discharge their effluent into the Dam are already becoming a source of threat to the reservoir. Hence, there is a need for regulation of activities around the dam to prevent further deterioration of water.

Keyword: Drinking water; Indices; Irrigation; Kofa Dam; Suleja; Water quality; Nigeria

Introduction

Rivers are vital surface water resources that are essential for the survival of man and the maintenance of a sustainable hydrological cycle and ecosystem (Ahaneku and Animashaun, 2013; Hasan et al., 2020).. The functions served by this vital resource include but not limited to domestic, agricultural, industrial, transportation and tourism (Hasan et al., 2020). Aside from the aforementioned roles played by the river, it also serves as a major recipient of domestic, agricultural and industrial wastewater from point and nonpoint sources (Ewaid, and Abed, 2017; Animashaun et al., 2016). Thus, the health of the river and the biotic organisms, particularly man is at risk as water plays essential roles in the overall well-being of man and his environment (Animashaun et al., 2015).

Since surface water which serves as the principal source of drinking and irrigation water continues to be under the threat of pollutants from diverse sources that are difficult to control and evaluate, there is a need for continuous monitoring of these water qualities. To assess water quality for any of the functions it serves, the physical, chemical and biological parameters are often put into consideration. Nevertheless, some physical parameters (e.g., turbidity) can give a reflection or an indication of the value of other parameters that are not physical (e.g., microorganisms) (Ahaneku and Animashaun, 2013. Hence, careful selection of a few parameters can assist in saving the cost of analysis without losing its scientific basis or compromising the results of the assessment (Banda and Kumarasamy, 2020).

Research has shown that aside from the use of a number of physicochemical parameters, statistical analysis, as well as indices method, has also been reported for the assessment of water quality (Hasan et al., 2020). However, in water resources planning and management, particularly in the assessment of the water pollution status, the use of indices is gaining more acceptance recently (Akhtar et al., 2021). This is because the water quality index has helped in removing the challenge in describing water in a consolidated and simple way that can be understood by both technical and non-technical personnel (Lumb et al., 2011). Water Quality Index (WQI) is a method that makes use of a 'single value' to represent a group of parameters thereby reducing large amounts of information in a simple reproducible manner and generating a score, which describes water conditions in a simple term as excellent, good and poor (Majeed, 2018). Several water quality indices have been developed either by individuals (e.g., Weighted Arithmetic Index; WQI) or institutions (e.g., Canadian Council of Ministers of the Environment; CCME) (Akhtar et al., 2021). The development and usage of WQI has also been strongly advocated by the agencies that are responsible for water supply and control of water pollution.

Just like any scientific method, WQI is not completely free of weakness. The method lacks merit for determining the overall status of the river water system, as the process of selecting parameters and computing individual weighting values could be subjective and biased. More so, the complexity associated with water chemistry suggests that few/chosen parameters cannot be perfect representatives of all. Hence, a number of organizations and agencies have shown reservations for the use of the index method for establishing overall status worldwide (Akhtar et al., 2021; Sarkar and Majumder, 2021). However, when the index is used for a selective purpose, the aforementioned strengths and benefits of the methods show it is an indispensable tool in the present day for its simplicity and economic importance.

Considering the health implication of using water of compromised quality for drinking and irrigation purposes, there is a need for the assessment of the surface water system and communicating same to both the managers and users with a method that can be understood by all. More so, day to day introduction of pollutants into the easily accessible surface water system suggests a need for continuous monitoring of the water to prevent an unexpected outbreak of waterborne diseases. Despite the availability of pipe-borne water in urban cities, an appreciable number of the populace still depends on surface water whose pollution status has not been established. More so, Irrigated- agriculture is practised with indiscriminate use of surface water of no known quality status. Though a number of surface water has been assessed in Nigeria using the index method, no work seems to have been done on the Kofa dam, Suleja. Thus, the aim of this study is to determine the water quality status of Kofa Dam for drinking and irrigation purposes.

Materials and Methods

Description of the Study Area

The location under study is Kofa Dam Suleja, Niger State Nigeria. Suleja is located between latitude 9°6'13.8''N and 9°17'49.35''N and longitude 7°6'58.6'E and 7°12'18.41'E, having an elevation of 366m above sea level. It is situated about 110km southeast of Minna, Niger State Capital and about 65km away from Federal Capital Territory, Abuja, the city that bounded it at the west. Its proximity to FCT favoured its rapid economic growth, physical development and swift expansion in population. It covers an area of 153.4 sq km with an approximated population of 216,578 as of the last census of 2006 (State Bureau of Statistics, 2011).

Suleja has a special savannah climate with distinct rainy and dry seasons respectively. The dry season usually occurs between October/November and ends in March/April while the rainy season starts in about April/May and ends around September/October. Temperature prevailing in the area is generally high with values ranging from 26°C to 35°C and an average annual rainfall of about

1640mm (Ejaro and Abdullahi, 2013). The majority of the inhabitants are peasant farmers who cultivate yam, rice, guinea corn, maize, pepper, vegetables and tomatoes, which thrive abundantly due to the availability of sandy soil from the weathered rocks of the Minna batholiths. Suleja lies on the valley of the river, gorges and many small streams running across it and the inhabitants source their water through bore-holes, wells and streams.

The study was carried out on Kofa Dam Suleja which is constructed on the Iku River (Figure 1). The Dam lies on latitude 9° 13' 18'' N, longitude 7° 14' 5''E and is located in an area popularly known as Apia Village, Tafa. It was designed and constructed to accommodate one million cubic meters at a time. The Dam is sectioned Upstream with four spillways which are used when the Dam is over-flooded. Aside from the river on which the dam is situated, it has its water sources also from runoff from farms and hills around the dam.

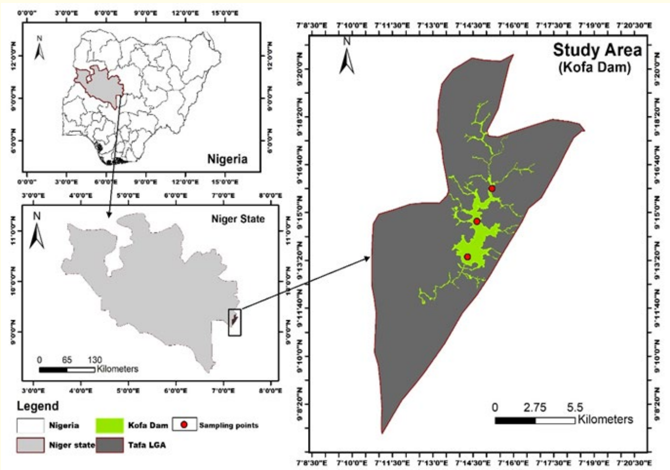

Figure 1: Map showing the study area.

Samples collection

Water samples were collected from three sampling points (Point A; Upstream, Point B; Midstream and Point C; Downstream) at Kofa Dam. The choice of chosen points is to reflect virtually all kinds of anthropogenic activities done on/around the dam.

The samples were collected in a sterilized plastic bottles and immediately transported to the Soil and Water Laboratory of the Federal Ministry of Agriculture and Rural Development, Kaduna for analysis.

Water Quality Index (WQI)
Water Quality Index for drinking purpose

The calculation of WQI for drinking purposes was done using the Weighted Arithmetic index method. Out of the twelve drinking water parameters assessed, the weighted arithmetic water quality index was computed using the eight most commonly measured water quality variables for drinking (Ewaid, and Abed, 2017; Chauhan and Singh, 2010). The eight parameters used are potential hydrogen (pH), Temperature, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Electrical Conductivity (EC), Chloride (Cl-), Sulphate (SO42-), Nitrate (NO3-) and Bicarbonate (HCO3-). The calculation of the water quality index (WQI) was done by using the following equation:

$$WQI \qquad (1)$$

The quality rating scale (Qi) for each parameter is calculated using the:

$$Qi = 100\{(Vi - Vo / Si - Vo) \qquad (2)$$

Where;
Vi is the estimated concentration of the parameter in the analyzed water.
Vo is the ideal value of this parameter in pure water.
Vo = 0 (except pH =7.0 and DO = 14.6mg/l).
Si is the recommended standard value of parameter.

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$Wi = K/Si \quad (3)$$

Where;
K = proportionality constant and can be calculated by using the following equation;

$$K = 1/\Sigma\left(\frac{1}{Si}\right) \quad (4)$$

The rating of water quality according to this WQI is given as Excellent (0-25), Good (26-50), Poor (51-75), Very Poor (76-100), and Unfit (> 100) (Table 1).

WQI Value	***Rating of water Quality***	***Grading***
0 – 25	Excellent Water Quality	A
26 – 50	Good Water Quality	B
51 – 75	Poor Water Quality	C
76 – 100	Very Poor Water Quality	D
Above 100	Unfit for Drinking/irrigation Purpose	E

Table 1: Showing water quality index grading (Chauhan and Singh, 2010).

Water Quality Index for irrigation purpose

As the use of water of compromised quality can have a detrimental effect on many through drinking, it can also have on soil through irrigation. The negative effect of using water of poor quality is felt on soil (through threats of salinity, alkalinity, sodicity, toxicity; reduction of water infiltration rate; and consequently, deterioration of soil fertility) and on plants (reduction of phosphorus availability, plants' osmotic activity, plants' growth; and delayed of crop maturity and consequently reduction of crop yield) (Akhtar et al., 2021). The weighted Arithmetic Water Quality Index Method was also used to determine the quality of the dam water for irrigation purposes using eight of the parameters that have mostly been reported for irrigation purposes (Akhtar et al., 2021; Majeed, 2018).

The eight parameters used are potential hydrogen (pH), Temperature, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Chloride (Cl-), Sulphate (SO42-), Nitrate (NO3-), Bicarbonate (HCO3-) and Sodium Adsorption Ratio (SAR). Aside from the eight parameters used as indicators in computing the index, other parameters used for assessing the water for irrigation are Sodium (Na), Magnesium (Mg), Calcium (Ca), magnesium adsorption ratio (MAR) and Kelly's ratio (KR).

Though some of the parameters are the same as that use for determining the status of water for drinking, the standards are often different. While NSDWQ and WHO were used as standards (except DO where CCME standard was used) in drinking water, the standards of FAO and WHO are used in computing the index for irrigation (Table 2). The classification of irrigation water is the same as drinking water.

Indicator	Usage	NSDWQ	FAO	WHO (CCME)	Remarks
pH	D, A	6.5 - 8.5	8.5	6.5 - 8.5	7.0 <pH < 8.0 High suitable; 6.5 < pH < 7.0; 8.0 < pH < 8.5 Medium suitable; pH < 6.5 or pH > 8.5 Low suitable
Tempt. (^{0}C)	D	-	-	25	
DO (mg/L)	D	-	-	(5)	
Turb. (NTU)	D, A	5	-	5 (5)	
EC (µS/cm)	D, A	1000	3000	250	
TDS (mg/L)	D, A	500	2000	600	<300 excellent; 300 to 600 good; 600 to 900 fair; 900 to1200 is poor and >1200 is unacceptable
NO_3 (mg/L)	D, A	50	44.3	45	
Cl^- (mg/L)	D, A	250	335	250	
SO_4^{2-} (mg/L)	D, A	200	200	250	
Na^+ (mg/L)	D, A	200	300	200	
Mg^{2+} (mg/L)	D, A	30	120	-	
Ca^{2+} (mg/L)	D, A		400	300	
SAR (meq/l)	A	-	15	-	< 10 Excellent; 10–18 Good; 18–26 Fair; > 26 Poor
SSP	A				< 20 Excellent; 20–40 Good; 40–80 Fair; > 80 Poor
MAR	A				< 50 Excellent; > 50 harmful to soil
% Na	A				< 40 Recommended; > 40 Not Recommended
KR	A				< 1 Excellent; >1 bad water, high level of Na+; > 3 unsuitable Excess levels of Na+
HCO_3^- (mg/L)	D, A		520	100	

Source: Hasan et al. (2020), Akhtar et al. (2021), WHO (2017), D is drinking; A is Agriculture, CCME is Canadian Council for Ministers of Environment.

Table 2: Standards for indicators used for WQI and their Interpretations.

Results and Discussions

Physicochemical Parameters of the Kofa Dam Water

pH value is an important parameter that determines the fitness of water for various purposes (Ahaneku and Animashaun, 2013. The pH values of the Dam water vary with the locations. The mean pH value at the three points A (Upstream, middle and downstream of the Dam) falls within the established limits of 6.5-8.5 for NSDWQ and WHO.

This suggests that based on pH value the water can be classified as suitable for irrigation and drinking purposes.

Though the temperature is not considered a parameter of high importance in clean water, it is of great importance in polluted water (Ahaneku and Animashaun, 2013). The mean temperature of the dam water ranges between 26.10°C and 26.50°C.

	A		***B***		***C***		***Overall***
	Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***
pH	6.79	0.20	6.97	0.06	6.99	0.03	6.92
Tempt. (OC)	26.50	0.17	26.10	0.44	26.07	0.15	26.22
HCO_3 (mg/L)	2.75	0.25	2.42	0.14	2.33	0.38	2.50
Turb. (NTU)	4.67	0.58	5.67	0.58	6.33	0.58	5.56
EC (ds/m)	50.00	0.00	60.00	0.00	50.00	0.00	0.05
DO (mg/L)	9.27	0.15	9.67	0.38	9.77	0.12	9.57
TDS (mg/L)	34.00	0.00	35.33	0.58	35.00	1.00	34.78
NO_3 (mg/L)	2.34	0.73	1.74	0.26	3.25	1.02	2.44
Cl^- (mg/L)	32.61	6.18	32.61	6.59	34.03	7.37	33.09
SO_4^{2-} (mg/L)	0.78	0.15	0.74	0.05	0.69	0.04	0.74
Na^+ (mg/L)	5.06	0.07	4.95	0.11	5.08	0.17	5.03
Mg^{2+} (mg/L)	2.71	0.38	2.79	0.12	3.18	0.06	2.89
Ca^{2+} (mg/L)	2.92	0.51	2.28	0.33	2.58	0.11	2.59

Table 3: Descriptive statistics of water quality parameters of Kofa Dam.

This obtained value is slightly above the value (25°C) recommended by WHO for drinking water. The temperature above 25°C reported in this work is in agreement with an earlier study by Okunlola et al. (2014) which reported similar values for the Usama dam within the same region. However, the temperature of the freshwater system could be influenced by the sampling time and temperature of the effluent entering the river (Ahaneku and Animashaun, 2013).

The bicarbonate content of the dam water varies between 2.42 and 2.79. Though NSDWQ has no standard for it in drinking water, the values are very low compared to the established standard for drinking (100 mg/L) and agriculture (520 mg/L) by WHO and FAO respectively. Low bicarbonate has also been reported in earlier studies (e.g., Okunlola et al., 2014).

Turbidity is a vital parameter when considering water for drinking purposes. It was observed that aside the point A (upstream) which has a turbidity level of 4.67 NTU within the recommended threshold of NSDWQ and WHO (5.00 NTU), the turbidity of the other two points (5.67 NTU for point B and 6.33 NTU for point C) are higher.

It was noted that the turbidity of the dammed river increases downstream. Since the turbidity rate of the river often reflects the amount of suspended particles such as clay, silt, finely divided organic and inorganic matters, plankton and other microorganisms, it means there is the probable presence of pollutants of diverse nature at the downstream (Ahaneku and Animashaun, 2013).

Electrical conductivity (EC) is used to quantify the dissolved solids and the salinity of the water. The high concentration of EC lessens the osmotic activity of plants which interferes with the absorption of water and nutrients from the soil (Tatawat and Singh, 2008). The average EC values were 50 µS/cm, 60 µS/cm and 50 µS/cm at upstream, midstream and downstream respectively. The values were all below the threshold limit of the NSDWQ, FAO and WHO.

The result of the water analysis for dissolved oxygen (DO) was found to be 9.27 mg/L, 9.67 mg/L and 9.77 mg/L at points A, B and C respectively. Though, NSDWQ and WHO have no standards for dissolved oxygen, the dissolved oxygen of the water samples was found to be above the minimum limit (5 mg/L) of the CCME-established standard in freshwater systems. The higher value of the DO is an indication of good water quality. Complete absence of DO results in anaerobic condition, putrefaction and the development of foul odour. DO in liquids provides a source of oxygen needed for the oxidation of organic matter when the concentration is high; while lack of it may result in acute cases where the water body becomes dead or devoid of aquatic life (Ahaneku and Animashaun, 2013).

Total dissolved solids (TDS) in water consist of dissolved organic matter and inorganic salts (e.g. chloride of calcium, potassium, magnesium and sodium). Its source in the freshwater system could be natural or/and anthropogenic (such as from urban runoff and sewage) (Ahaneku and Animashaun, 2013). Just like chlorine, it can affect the taste of water at a higher than the recommended level (500 mg/L) for drinking. The total dissolved solids (TDS) of the samples are between the ranges of 34.3 mg/L to 35.33 mg/L which are below the maximum tolerable value of NSDWQ (500mg/L) and WHO (1000 mg/L) values for drinking water. The obtained values in this study imply that, if only the TDS values were to be considered, the river in the dam could be classified as excellent (<300 mg/L) for irrigation purposes. The observed values are within the values (25.9 mg/L - 46.9 mg/L) reported by Mahi and Isah (2016) for Usuma Dam in Abuja.

The amount of NO3- present in the three water samples ranges from 1.74 mg/L to 3.25 mg/L. The concentrations of nitrate in the water samples were below the WHO (45 mg/L), NSDWQ (50 mg/L) and FAO (44.3 mg/L) established standards. The observed value is higher than what was reported by Mahi and Isah (2016), however, it is lower when compared to the value reported by Ahaneku and Animashaun, 2013 for the Asa dam. The presence of nitrate suggests the probable entry of industrial and agricultural wastes into the water (Ahaneku and Animashaun, 2013).

Chloride concentration varies with sampling locations. The highest chloride value (34.03 mg/L) was observed at downstream of the reservoir. Chlorides are generally limited to 250 mg/L in water intended for public use and their presence in water only become detestable when it is above stated values of WHO and NSDWQ. Hence, the observed chloride values suggest the probable good status of the water.

Sulphate is relatively common in water and it has a major impact on the soil by contributing to total salt content. Irrigation water that is high in SO_4^{2-} reduces phosphorus availability to plants. An amount that is less than 400 ppm is considered to be within the desired range but when it is greater than 400 ppm, it can lead to acidification of the soil. The SO_4^{2-} the content of the reservoir ranges from 0.69 mg/L to 0.78 mg/L and it is below the established maximum limit for drinking and irrigation purposes.

Surface water containing a large amount of sodium is of great concern due to sodium effects on the soil as it poses a sodium hazard. Sodium hazard is usually expressed in terms of SAR. SAR is calculated from the ratio of sodium, calcium and magnesium. The observed values for SAR range from 0.35 mg/L to 0.53 mg/L which is within the acceptable value of WHO and NSDWQ limits.

The calcium and magnesium in water mostly have their sources from the decomposition of calcium and magnesium aluminosilicates and the dissolution of minerals such as limestone and magnetite and the presence of both are mainly responsible for the hardness of water (Okunlola et al., 2014). The observed values for the two ions are within the established limit.

Water Quality Index: drinking purpose

The results of the physicochemical parameters show that some parameters were comparatively higher at the upstream, some at the midstream and some at the downstream. For a better assessment, WQI was determined. Table 4 shows the results of the sub-index and weight for each of the locations and the average value of all.

The annual WQI values at the downstream (Station A), midstream (Station B) and upstream (Station C) of the dam were found to be 42, 56, and 62 respectively, while the overall annual WQI was 53 (Figure 2). This shows that only the upstream can be classified as good, the remaining two stations were within the class of the 'poor' (51-75). The highest value at the downstream side (62) showed the worst condition and indicated the probable influence of anthropogenic input into the water. The overall index also shows that the river is not fit for domestic usage.

Water Quality Index for Irrigation

Table 5 shows the results of the sub-index and weight for each of the locations and the average value for all. The annual WQI values for the downstream, midstream and upstream of the dam were found to be 42, 56, and 61 respectively (Figure 3). The overall index for the dam was 53. While the index for the upstream falls within the class of good, the indices for the midstream and downstream are within the class of poor (51-75). The overall value also shows the poor quality of the river. The obtained index for each of the locations showed the reservoir is under threat. Aside from the Weighted Arithmetic Index, the value of other irrigation indices also suggests a need for caution while using the water for irrigation purposes. The sodium adsorption ratio (SAR) value (0.51 mEq/L) of the water shows that it can be classified as excellent (< 10; Excellent). However, the obtained value (61 mEq/L) for magnesium adsorption ratio (MAR) was not within the value of excellent (< 50 mEq/L) and could be classified as "harmful to the soil". This implies that if the activities responsible for the high MAR are not put to check, the water could cause harm to agricultural soil. The Kelly's ratio (KR) having a value of 61 mEq/L also showed that sodium content is relatively high and if such occur at an aggravated level, the water may not be fit for irrigation. It is important to note that the high value obtained in two (MAR and KR) of the three indices computed would not pose any threat to either soil or plant because the values used for their computation are all within the FAO threshold.

	Station	***Vi***	***Si***	***Qi***	***1/Si***	***Wi (k/Si)***	***QiWi***
pH	A	6.79	7.5	-42.222	0.133	0.077	-3.265
	B	6.97	7.5	-6.667	0.133	0.077	-0.516
	C	6.99	7.5	-2.222	0.133	0.077	-0.172
TDS (ppm)	A	34.00	500	6.800	0.002	0.001	0.008
	B	35.33	500	7.067	0.002	0.001	0.008
	C	35.00	500	7.000	0.002	0.001	0.008
NO_3 (mg/L)	A	2.34	50	4.680	0.020	0.012	0.054
	B	1.74	50	3.480	0.020	0.012	0.040
	C	3.25	50	6.500	0.020	0.012	0.075
CL (mg/L)	A	32.61	250	13.045	0.004	0.002	0.030
	B	32.61	250	13.045	0.004	0.002	0.030
	C	34.03	250	13.613	0.004	0.002	0.032
Turb. (NTU)	A	4.67	5	93.333	0.200	0.116	10.827
	B	5.67	5	113.333	0.200	0.116	13.147
	C	6.33	5	126.667	0.200	0.116	14.693
SO_4 (mg/L)	A	0.78	200	0.390	0.005	0.003	0.001
	B	0.74	200	0.370	0.005	0.003	0.001
	C	0.69	200	0.345	0.005	0.003	0.001
HCO_3 (mg/L)	A	2.75	100	2.750	0.010	0.006	0.016
	B	2.42	100	2.417	0.010	0.006	0.014
	C	2.33	100	2.333	0.010	0.006	0.014
DO (mg/L)	A	9.27	5	55.556	0.200	0.116	6.444
	B	9.67	5	51.389	0.200	0.116	5.961
	C	9.77	5	50.347	0.200	0.116	5.840

The K value is 0.580, ideal value for all parameter =0, except for pH and DO which 7 and 14.6 respectively.

Table 4: Computation of WQI of the river for drinking purpose.

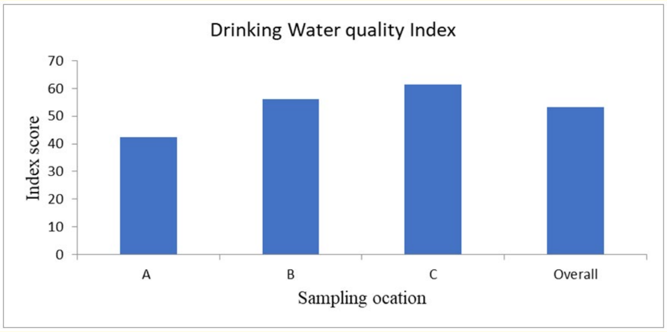

Figure 2: Water Quality Index: Drinking.

	Station	V_i	S_i	Q_i	$1/S_i$	Wi (k/S_i)	Q_iW_i
pH	A	6.79	8.5	-14	0.118	0.094	-1.316
	B	6.97	8.5	-2.222	0.118	0.094	-0.209
	C	6.99	8.5	-0.741	0.118	0.094	-0.070
TDS (ppm)	A	34.00	2000	1.700	0.001	0.000	0.001
	B	35.33	2000	1.767	0.001	0.000	0.001
	C	35.00	2000	1.750	0.001	0.000	0.001
NO_3 (mg/l)	A	2.34	45	5.200	0.022	0.018	0.092
	B	1.74	45	3.867	0.022	0.018	0.069
	C	3.25	45	7.222	0.022	0.018	0.128
CL (mg/l)	A	32.61	335	9.735	0.003	0.002	0.023
	B	32.61	335	9.735	0.003	0.002	0.023
	C	34.03	335	10.159	0.003	0.002	0.024
Turb. (NTU)	A	4.67	5	93.333	0.200	0.160	14.915
	B	5.67	5	113.333	0.200	0.160	18.111
	C	6.33	5	126.667	0.200	0.160	20.241
SO_4 (mg/l)	A	0.78	200	0.390	0.005	0.004	0.002
	B	0.74	200	0.370	0.005	0.004	0.001
	C	0.69	200	0.345	0.005	0.004	0.001
HCO_3 (mglL)	A	2.75	500	0.550	0.002	0.002	0.001
	B	2.42	500	0.483	0.002	0.002	0.001
	C	2.33	500	0.467	0.002	0.002	0.001
SAR	A	0.35	15	2.353	0.067	0.053	0.125
	B	0.53	15	3.547	0.067	0.053	0.189
	C	0.51	15	3.391	0.067	0.053	0.181

The value for K is 0.799; ideal value for all parameter =0, except for pH which is 7; Observed values (Vi), standard values (Si), Sub_index (Qi), Unit weight (Wi) and (Qi Wi).

Table 5: Computation of WQI of the river for Irrigation purpose.

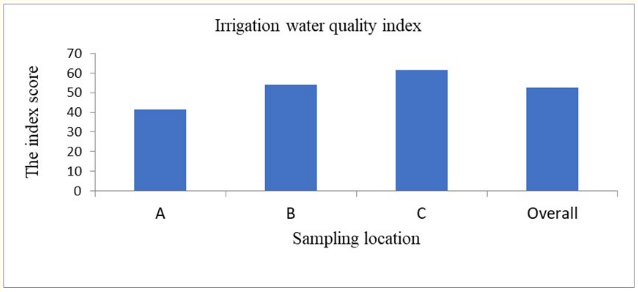

Figure 3: Water Quality Index; Irrigation.

Parameter	*Measured value (mg/L)*	*Computed value (mEq/L)*
Na	5.06	0.22
Mg	2.71	0.22
Ca	2.92	0.15
SAR		0.51
MAR		60.59
KR		59.59

Table 6: Indices for irrigation evaluation of water.

Conclusions

The physicochemical parameters of the Kofa reservoir were determined and the reservoir water quality was assessed for drinking and irrigation purposes using Weighted Arithmetic Index (WAI). The findings from the study showed that the reservoir can be ranked as good at the upstream and poor at the midstream, and downstream and for the average value of all the locations indicating the reservoir is not fit for drinking purposes. It follows the same pattern of classification for irrigation purposes at all locations as the quality of the water is more compromised downstream as compared to the mid and upstream. Considering other indices (such as SAR) the water could be considered fit for irrigation. However, there will be a need for treatment before its usage for domestic purposes. The ranking range of "good to poor" also indicated the cost of treatment will be minimal. More so, the study showed that the application of the Water Quality Index in summarizing the overall result of the physicochemical quality of surface water yielded results that could be understood by all.

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