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Groundwater quality using indices for domestic and irrigation purposes in Akure, Nigeria

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ABSTRACT

Groundwater exploration has become more critical for agricultural and domestic purposes due to the over-exploitation, depletion and widespread pollution of surface water bodies. The study is focused on evaluating these groundwater sources for their suitability for domestic and irrigation applications, as well as a quality-based investigation of these sources.

Thirty (30) boreholes were investigated across the study area Akure, Ondo State to achieve the aforementioned aim. This was carried out by the analysis of physico-chemical parameters, determination of water quality index and evaluating irrigation indices. Moreover, Gibbs diagram was used to characterize ground water samples.

Results: show the groundwater to be slightly acidic in nature with pH values falling below the 6.5 benchmark. According to evaluated indices, Sodium ratio also showed that 76.7% of the water samples is in “good” category, 20% is in “permissible” category, and 3.3% is in the “poor” category. the water is suitable for irrigation and can support plant yield. Based on Water Quality Index (WQI) assessment, majority of the water samples (82%) can be classified as “good”, 16% of the samples were excellent, while 2% were found to be moderate indicating that the water quality in terms of its drinking standard is generally good as obtained from this study. Data plotted in Gibbs diagram reveal that the groundwater chemistry is primarily controlled by rock-water interaction.

1. Introduction

Water is a fundamental and essential economic resource which contributes to sustainable social and environmental development [1–3]. The reduction in surface water bodies from the exploitation and pollution with different biological and chemical elements led to a move towards groundwater exploration [4]. The quantity of potable water required for domestic, agricultural, industrial purposes and the general well-being of people in any society is highly significant [5–7]. Groundwater is found in nearly every geological structure below the earth surface in large amount of local aquifer systems with comparable properties [8]. In many parts of the world, the most valuable source of drinking water is Groundwater [9]. Most especially in developing counties such as Nigeria.

The principal source of people’s means of living is Agriculture and the main source of irrigation is groundwater [5]. Irrigation water with excessive salinity promotes soil salinization and plant yield decrease and also influences the rate of soil infiltration [10]. The reliability of any irrigation water supply depends upon the quality, elemental structure, type of soil, plant salt tolerance characteristics, climate and soil drainage [11]. In addition, the amount as well as the type of salts found in the investigated water body. The most serious factors connected to water quality are degradation, increased salinity, reduced permeability, and exposure to highly harmful ions. As a result, physicochemical parameters are used to characterize the quality of irrigation water.

The quality of groundwater is regulated by several factors including geological layout, aquifer mineralogy, chemical composition of precipitation and geochemical processes within the aquifer [12]. The chemical composition of groundwater has also been changed by a variety of human activities and their by-products. All these factors can affect the spatial and temporal make up of its quality.

Water is considered to be contaminated when the quality or composition of water changes naturally or as a result of human activity and becomes inadequate for residential, agricultural, industrial,

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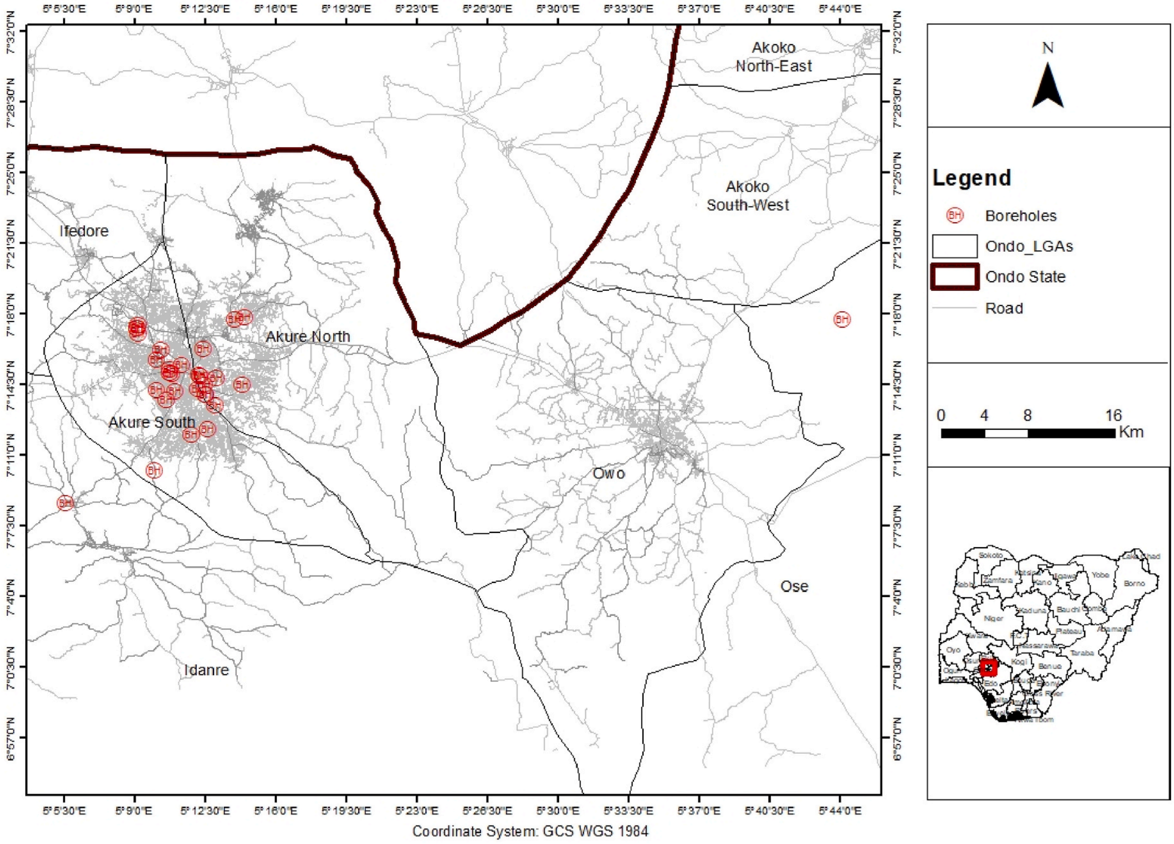

Fig. 1. Study map area for Akure.

Table 1
Summary of water quality indices for irrigation.

S/n	Water quality indexes	Acronym	Formula	Reference
1	Sodium soluble percentage	SSP	$Na^+/(Ca^{2+}+Mg^{2+}+Na^+)$	[18]
2	Kelley index	KI	$Na^+/(Mg^{2+}+Ca^{2+})$	[19]
3	Sodium percentage	%Na	$(Na^++K^+)/(Ca^{2+}+Mg^{2+}+Na^++K^+)$	[20,21]
4	Sodium absorption ratio	SAR	$Na^+/\sqrt{(Ca^{2+}+Mg^{2+}+Na)/2}$	[22]
5	Magnesium hazard	MH	$((Mg^{2+}/(Mg^{2+}+Ca^{2+}))x100$	[23]

recreational and wildlife survival [13,14]. Water pollution is an important factor in the management of water quality because of its impact on people and the environment. Previous research has indicated that contaminated water from inadequate sanitation and hygiene causes the most fatality in developing countries such as sub sahara Africa [15]. An estimated 1.6 million people die annually from water-related illnesses. In order to protect human health, the monitoring and assessment of changes in groundwater quality, identifying recharge areas in the groundwater zone and solute transport mechanism has become crucial. Pollution reduces the quality of water by introducing contaminants that either dissolves or remain insoluble and hence affects its various uses. Several water indices can be used to accurately represent the quality of groundwater in the study area. Irrigation indices and the Water Quality Index were used in this study to classify groundwater samples in Omu-Aran, Kwara state.

The chemical analysis of the groundwater is the conventional way of measuring water quality with an appropriate guideline value. The study is focused on evaluating groundwater for its suitability for domestic and agricultural applications since quality-based examination of groundwater is extremely significant.

2. Data description

2.1. Study area

Akure, the capital city of Ondo State is located between latitude 7° 15′ 0″ N and longitude 5° 11′ 42″ E. The city extends over an area of approximately 320 km^2 [6]. The town is located in Nigeria's tropical rainforest zone. The range as shown in Fig. 1 of temperature is from 25.2 °C to 28.1 °C, with an annual precipitation of 2378 mm and relative humidity of 80%.

3. Experimental design, materials and methods

3.1. Sampling and laboratory analysis

Groundwater samples were obtained from 30 boreholes across various locations to assess the groundwater quality for domestic and irrigation purposes. The samples were collected using polythene bottles, which were stored in a fridge for further analysis at a temperature of 4 °C in the Environmental Engineering Laboratory of Landmark University, Omu-Aran. Physiochemical parameters; (pH, electrical conductivity, total dissolved solids, and turbidity) were measured with a portable digital meter (Model Hach HQ40D) in-situ, while other parameters; alkalinity levels were assessed via titration method, Total hardness, calcium and magnesium ions were estimated using standard EDTA solution while flame photometer was employed for measuring sodium and potassium ions. Chloride and nitrate were determined using ion selective electrode methods while determination of sulphate and Iron was done via spectrophotometric technique. These were all done in

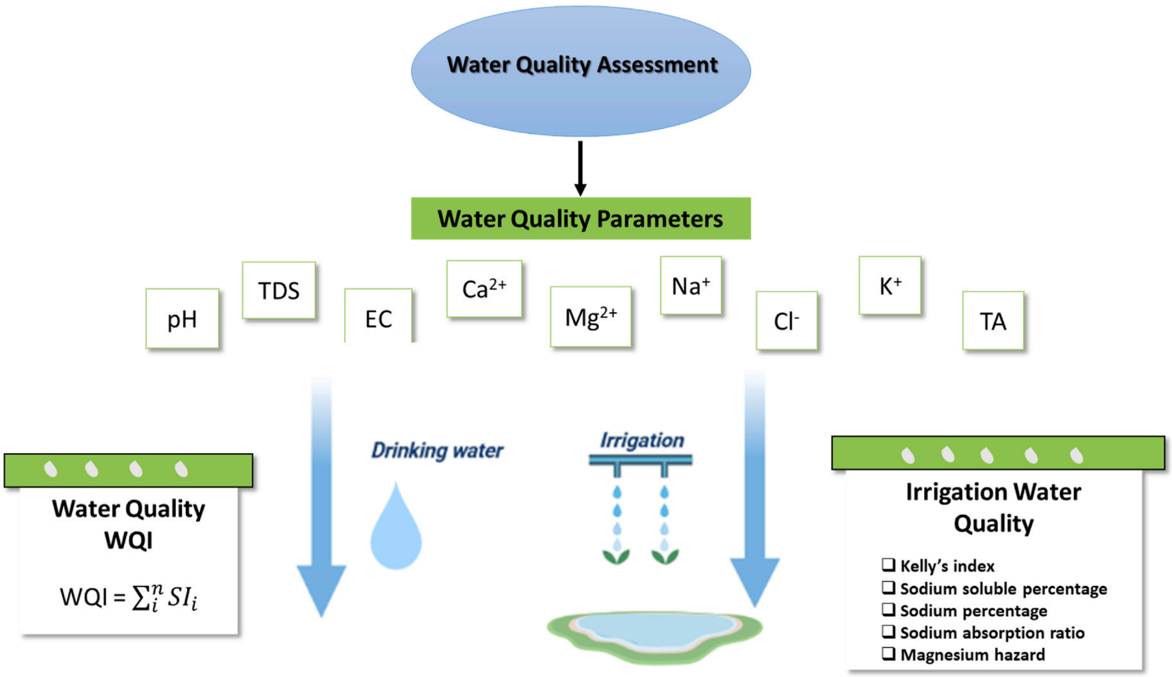

Fig. 2. Schematic; Groundwater quality assessment for irrigation and drinking purposes.

Table 2
Groundwater parameters with their respective assigned and relative weights for WQI computation with BIS standards.

Physiochemical parameters		W.H.O desirable limit	Weight (w_i)	Relative weight (W_i)
PH	–	6.5–8.5	4	0.129
TDS	mg/L	500	4	0.129
EC	μS/cm	1000	4	0.129
Ca^{2+}	mg/L	75	3	0.096
Mg^{2+}	mg/L	20	3	0.096
Na^{+}	mg/L	200	4	0.129
Cl-	mg/L	250	3	0.096
K^{+}	mg/L	12	2	0.064
TA	mg/L	**200**	4	0.132
			$\sum w_i =$ 31	$\sum W_i = 1.000$

accordance to the American Public Health Association's standard procedure [16]. Finally, there were comparisons between the measured physiochemical concentrations and W.H.O guideline values [17].

3.2. Evaluation of irrigation indices for groundwater quality

Various indices and ratios were derived from the measured water quality parameters in this study, including Sodium Absorption Ratio (SAR), Soluble Sodium Percentage (SSP), Magnesium Hazard (MH), Kelly's Ratio (KR), and Sodium percentage (Na %). The equations are described are shown in Table 1.

A summarized schematic of the water quality assessment and evaluation for the study area is shown in Fig. 2.

3.3. Evaluation of groundwater quality index for domestic use

Widely accepted is the approach employing the use of for assessing both groundwater and surface water sources for domestic purposes [24]. Water quality index has been reported as an effective tool for monitoring water quality [25]. It gives an overview of the water quality as a summarized composite effect of each parameter. Nine (9) physiochemical parameters were used to compute WQI following the outlined procedures/steps. Computation is seen in Table 2.

Step 1.

Assignment of Weights: Each parameter was assigned unit weights, W_i, ranging from 1 to 5 considering the magnitude and significant health impact.

Step 2.

Computation of relative weights: The previously assigned weights were then used to calculate relative weight (W_n) using Eq. (1) [26–28]:

Table 3a
Water quality parameters of ground water samples in comparison to W.H.O. standard.

	UNIT	STANDARD	BH1	BH2	BH3	BH4	BH5	BH6	BH7	BH8	BH9	BH10	BH11	BH12	BH13	BH14	BH15
PH	–	6.5–8.5	6.8	6.4	6.0	6.6	6.6	6.2	6.0	6.2	6.4	6.2	6.4	6.4	6.8	6.0	6.6
TDS	mg/l	500	72	74	50	74	92	64	56	62	70	74	44	64	66	80	110
EC	μS/cm	1000	16	100	140	200	100	80	160	80	100	80	220	80	14	160	32
Ca^{2+}	mg/l	75	54	50	30	40	56	42	34	32	46	40	40	30	68	44	46
Mg^{2+}	mg/l	20	16	12	10	10	14	8	18	12	14	14	10	12	8	ND	24
Na^{+}	mg/l	200	30	6	8	8	8	6	6	6	6	20	8	6	65	28	20
Cl-	mg/l	250	32	28	24	26	38	26	26	24	26	22	14	16	26	24	24
K^{+}	mg/l	12	40	30	10	16	22	22	18	16	16	6	16	12	45	8	30
TA	mg/l	200	48	60	60	60	64	54	80	62	60	54	80	66	80	36	62
WQI			37.5	28	16.1	22	27.6	23.1	22.3	19.3	21.9	16.8	21.1	16.6	42.8	17.7	32.7

Physico-chemical parameters (measured in mg/l) except EC in μmho/cm and PH which is unitless

Table 3b
Water quality parameters of ground water samples in comparison to W.H.O. standard.

	UNIT	STANDARD	BH16	BH17	BH18	BH19	BH20	BH21	BH22	BH23	BH24	BH25	BH26	BH27	BH28	BH29	BH30
PH	–	6.5–8.5	6.0	6.8	6.4	6.4	6.8	6.4	6.8	6.6	6.4	6.4	6.4	6.2	6.4	6.6	6.6
TDS	mg/l	500	112	76	60	60	84	68	66	54	60	60	76	50	64	66	88
EC	$\mu S/cm$	1000.00	16	140	180	80	280	100	100	180	100	100	180	100	140	120	260
Ca^{2+}	mg/l	75	12	40	54	28	34	40	46	22	26	26	34	40	42	38	42
Mg^{2+}	mg/l	20	10	10	14	12	12	18	16	8	6	6	12	10	14	10	12
Na^{+}	mg/l	10	50	8	6	8	6	6	6	8	6	6	6	6	6	8	8
Cl-	mg/l	250	26	24	32	20	36	40	34	12	8	8	34	20	26	18	24
K^{+}	mg/l	12	40	16	20	14	16	20	12	10	12	12	38	20	24	16	40
TA	mg/l	**200**	36	62	74	48	58	80	84	40	40	40	58	60	60	58	64
WQI			36.3	21.2	26.11	17.7	23.1	24.6	20.35	14.9	14.8	14.8	33.4	21.8	26.1	20.2	36.6

Physico-chemical parameters (measured in mg/l) except EC in μmho/cm and PH which is unitless.

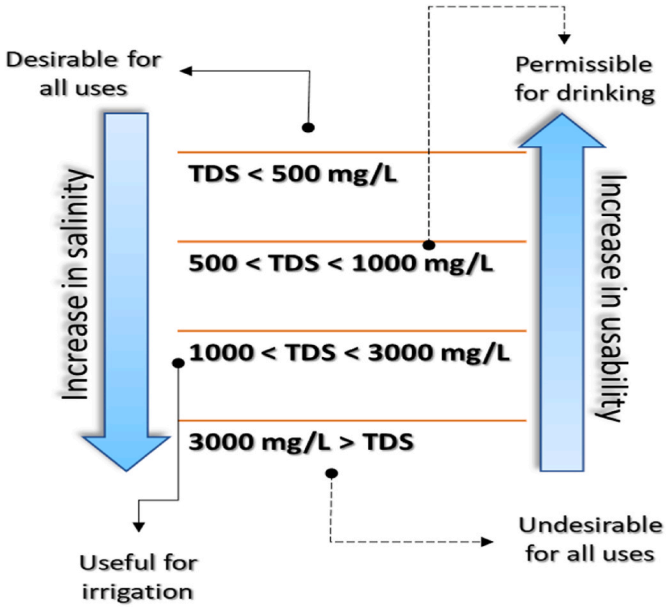

Fig. 3. Illustration- TDS classification of groundwater (adapted from Davis and De Wiest, 1966).

$$W_r = W_i \Big/ \sum\nolimits_{i=1}^{n} W_i \tag{1}$$

where W_r = Relative weight, W_i = Weight of each parameter, n = numbers of parameters.

Step 3.

Quality rating score (Q_n): The computation of the Quality rating score was carried out for all the parameters by dividing the concentration of each parameter with its respective guideline values as given by WHO. The value of this ratio is then multiplied by 100 as shown in Eq. (2).

$$Q_i = 100\left[\frac{C_i - C_{io}}{S_i - C_{io}}\right] \tag{2}$$

Where; C_i and C_{io} is the measured concentration and the ideal concentration of nth parameter respectively. S_i is the standard recommended value. The ideal value for hydrogen ion concentration (pH) in pure water is ($C_{\mathbf{io}}$ = 7.0).

Step 4.

Sub-index (SI_i) and Water Quality Index (WQI).

The sub-indices were generated and aggregated to obtain the WQI respectively described in Eq. (3) and Eq. (4).

$$SI_i = W_r X\, Q_i \tag{3}$$

$$WQI = \sum_{i}^{n} SI_i \tag{4}$$

Where SI_i is the sub-index of the ith parameter, Qi is the rating based on the concentration of ith parameter, and "n" is total number of parameters.

3.4. Gibbs diagram

Following the phenomenon of leaching of ions prior to dissolution in groundwater during the weathering and water circulation process, there is a need to understand this process. The Gibbs Diagram [29] was utilized to examine the geochemical governing factors as well as the characterisation of ground water. This was achieved using Eq. (5). and Eq. (6). for anion and cation concentrations respectively. The concentrations are expressed in meq/l:

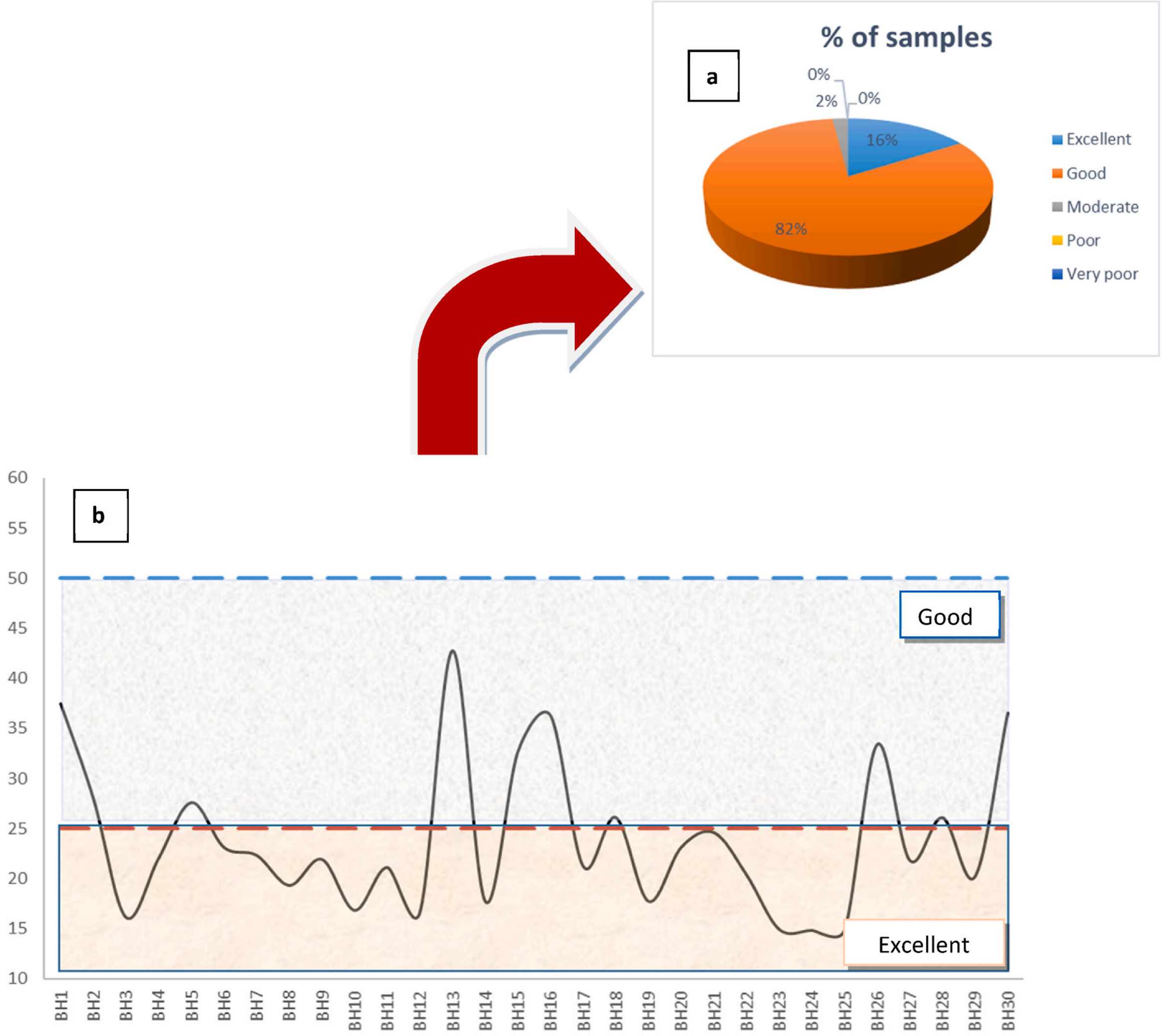

Fig. 4. Evaluated Water Quality Index based on; (a). Class category (in percentage) & (b). Spatial distribution.

$$\left(\frac{Na^{+}}{Na^{+} + Ca^{+}}\right) \tag{5}$$

$$\left(\frac{Cl^{-}}{Cl^{-} + HCO_{3}^{-}}\right) \tag{6}$$

4. Data analysis

The dataset contains physicochemical parameters which were investigated to the assess water quality. Microsoft Excel© (Version, 2019) was used to analyze the mean (average) value for Drinking and Irrigation Water Quality.

5. Results and discussion

Owing to the fact that groundwater quality is a crucial determinant of its suitability for drinking in the study area, physicochemical parameters of groundwater samples were assessed and compared to World Health Organization-recommended guideline values. This is reflected (Table 3a & 3b).

5.1. pH (hydrogen ion concentration)

A groundwater's pH is a fundamental property that determines its acidity or alkalinity. According to the findings, the groundwater samples are acidic, with pH ranging from 6.0 to 6.8 (Tables 3a and 3b). About 61.3% of the samples do not meet the minimum permissible limit recommended by Ref. [30] WHO, 2017 for pH concentration in water i.e., 6.50.

5.2. Total dissolved solids, TDS

TDS refers to the various forms of minerals found in dissolved form in water, which include large carbonates, bicarbonates, chlorides, sulfates, phosphates, silica, calcium, magnesium, sodium, and potassium [31]. It is therefore a critical parameter in evaluating the suitability of water for drinking, agricultural, and industrial uses. All groundwater samples show TDS content fall within the WHO (2017) standard value (Tables 3a and 3b) as they vary between 50 and 112 mg/L. Davis and De Wiest [32] proposed a method for classifying water types based on TDS concentration given as; ***Desirable for drinking*** (TDS: <500 mg/L); ***Permissible for drinking*** (TDS: 500–1000 mg/L); ***Useful for Irrigation*** (TDS: 1000–3000 mg/L), and ***Unfit for drinking and irrigation*** (TDS: >3000 mg/L). A schematic describes this (Fig. 3).

5.3. Electrical conductivity, EC

Electrical conductivity, EC has been used to evaluate concentration of ions present in groundwater samples [31]. Factors such as temperature, ion concentration, and type of ions present are notable influential

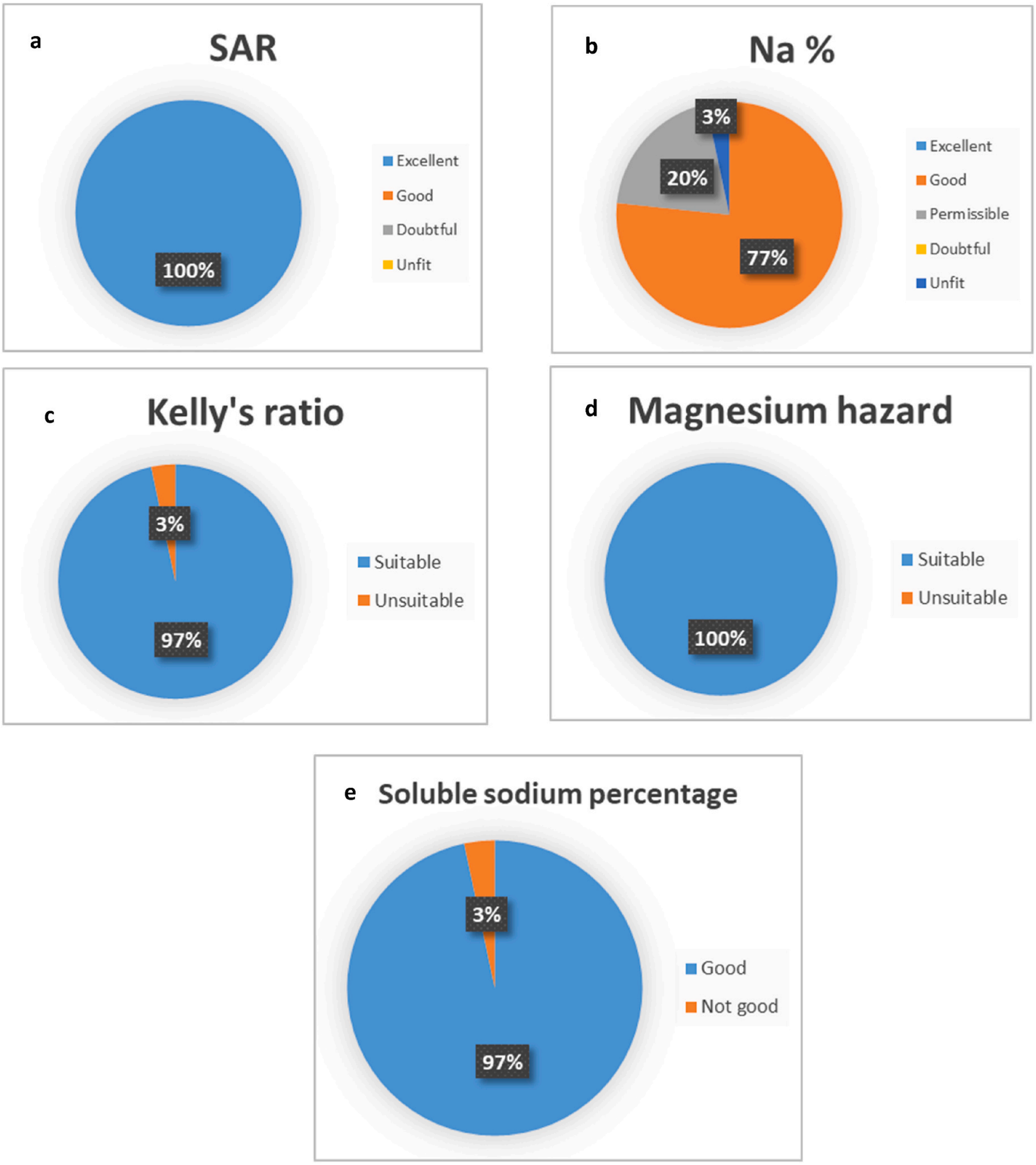

Fig. 5. Percentage of water quality of samples in terms of Irrigation indices.

parameters. The EC content of the study region's groundwater varied from 16 μS/cm, to 260 μS/cm (Tables 3a and 3b). As far as guidelines go, all the groundwater samples are within limit. The low EC values represents fast soil-water ion exchange, as well as insoluble mineral/geologic rocks.

5.4. Calcium, Ca^{2+} & magnesium, Mg^{2+}

The concentration levels of alkaline earth metals (calcium & magnesium) were in the range of 12–68 mg/L and 8–18 mg/L for both Ca^{2+} and Mg^{2+} ions respectively (Tables 3a and 3b). The trend of results in the study area shows the Ca^{2+} ions were more pronounced than their counterpart Mg^{2+}ions chiefly due to ion exchange and ferromagnetic minerals. All of the samples fell within the recommended maximum acceptable limit by Ref. [33].

5.5. Chloride, Cl^{-}

Leaching of chloride-containing rocks, industrial effluents, and irrigation operations all contribute to the presence of chlorides in ordinary water. The concentrations of chloride in the groundwater samples ranged from 8 to 40 mg/L (Tables 3a and 3b). They all fell within the standard value [30]. A high chloride concentration degrades the aesthetic qualities of water, especially its flavor, rendering it unfit for consumption. It might also leave a bad taste in your mouth and cause indigestion.

5.6. Sodium, Na^{+} & potassium, K^{+}

The concentration levels of alkaline earth metals (calcium & magnesium) were in the range of 6–65 mg/L and 6–45 mg/L for both Na^{+}

Table 4
Indices and resultant values for the purpose of irrigation.

WELL ID	SSP	KI	%Na	SAR	MH
BH 1	30	42.86	50	0.75	22.86
BH 2	8.82	9.68	36.73	0.17	19.35
BH 3	16.67	20.00	31.03	0.36	25.00
BH 4	13.79	16.00	32.43	0.27	20.00
BH 5	10.26	11.43	30.00	0.20	20.00
BH 6	10.71	12.00	35.9	0.20	16.00
BH 7	10.34	11.54	31.58	0.22	34.62
BH 8	12.00	13.64	33.33	0.25	27.27
BH 9	9.09	10.00	26.83	0.18	23.33
BH 10	27.03	37.04	32.50	0.67	25.93
BH 11	13.79	16.00	32.43	0.27	20.00
BH 12	12.50	14.29	30.00	0.26	28.57
BH 13	46.10	85.53	59.14	1.34	10.53
BH 14	38.89	63.64	45.00	0.90	0.00
BH 15	22.22	28.57	41.67	0.55	34.29
BH 16	69.44	227.27	80.36	4.53	45.45
BH 17	13.79	16.00	32.43	0.27	20.00
BH 18	8.11	8.82	27.66	0.15	20.59
BH 19	16.67	20.00	35.48	0.37	30.00
BH 20	11.54	13.04	32.35	0.24	26.09
BH 21	9.38	10.34	30.95	0.19	31.03
BH 22	8.82	9.68	22.50	0.17	25.81
BH 23	21.05	26.67	37.50	0.48	26.67
BH 24	15.79	18.75	36.00	0.32	18.75
BH 25	15.79	18.75	36.00	0.32	18.75
BH 26	11.54	13.04	48.89	0.24	26.09
BH 27	10.71	12.00	34.21	0.21	20.00
BH 28	9.68	10.71	34.88	0.19	25.00
BH 29	14.29	16.67	33.33	0.29	20.83
BH 30	12.90	14.81	47.06	0.26	22.22

Table 5
Summary of water quality indices for irrigation.

Parameters	Range	Water class	Samples (%)
SAR (Sodium adsorption ratio)	0–10	Excellent	100
	10–18	Good	0
	18–26	Doubtful	0
	>26	Unfit	0
MH (Magnesium hazard)	<50	Suitable	100
	>50	Unsuitable	0
Na % (Sodim percentage)	<20	Excellent	0
	20–40	Good	76.7
	40–60	Permissible	20
	60–80	Doubtful	0
	>80	Unfit	3.33
KR (Kelly's ratio)	<1	Suitable	96.7
	>1	Unsuitable	3.33
SSP (soluble sodium percentage)	<50	Good	96.7
	>50	Not good	3.33

and K^+ ions respectively (Tables 3a and 3b). The maximum sodium concentration in drinking water is 200 mg/L [30]. Concentrations above this limit may cause drinking water to taste salty. Considering that Na^+ is an abundant ion in most hard rocks, the primary origin can be attributed to rock weathering. However, for K^+, there is no guideline value given by WHO chiefly because it occurs naturally in concentrations lower than those of health concern [30,34]. The excess intake of could bring upon its consumer a laxative effect [35].

5.7. Total alkalinity, TA

The occurrence of bicarbonate, carbonate, and hydroxide compounds of calcium, sodium, and potassium determines water's ability to neutralize a strong acid, i.e., alkalinity. For drinking water, WHO has recommended 200 mg/l as desirable limits. It could be observed from the result that all values were well below the recommended value (Tables 3a and 3b).

5.8. Water quality index, WQI

The WQI index values were obtained for various groundwater sources as shown in Tables 3a and 3b Based on the assessment, 16% of the samples were excellent, 82% were good and 2% were found to be moderate (Table 2). Therefore, majority of the water samples had good water qualities based on WQI evaluation. Fig. 4a shows the water samples represented in their respective class category (in percentage) while Fig. 4b shows a spatial distribution for investigated boreholes.

5.9. Irrigation indices

In other to establish water quality of the groundwater samples for their suitability for irrigation, the following indices were evaluated. Sodium soluble percentage, SSP; Kelley index, KR; Sodium percentage, %Na; Sodium percentage, SAR; Magnesium hazard, MH.

5.10. Sodium adsorption ratio, SAR

For irrigation water, the SAR is an important tool for assessing its sodium hazard. In this study, the evaluated SAR showed that the groundwater was excellent and suitable for irrigation purposes (Fig. 5a) since they were all below the maximum threshold for that category (Table 4). High SAR values may reduce plant osmotic action and prevent water from reaching plant branches and leaves, reducing yield.

5.11. Sodium ratio, Na %

In irrigation water classification, sodium is considered an important ion because of its soil-reactivity [36]. Ion exchange of Ca^{2+} and Mg^{2+} ions is induced and controlled by sodium concentration. The reduction in soil permeability is as a result of this process, resulting in poor internal drainage. The results as indicated in Table 5 and by obtained Na% values, 76.7% of the water samples is in "good" category, 20% is in "permissible" category, and 3.3% is in the "poor" category is illustrated in Fig. 5b. Plants grow slower when they are irrigated with water that contains a high percentage of sodium [37].

5.12. Kelly's ratio, KR

The assessment of water quality via KR reflects the sodium quantity to determine its suitability for irrigation. As seen in Fig. 5c and Table 5, about 96.7% of the samples are categorized as suitable while the remaining 3.3% samples are not suitable. For $KR > 1$, values reflect excess sodium content while $KR < 1$ reflects sodium deficiency [38,39].

5.13. Magnesium hazard, MH

In an undisturbed natural condition/scenario, alkaline earth (Ca^{2+} and Mg^{2+}) usually exist in an equilibrium state in groundwater. Although essential to crops, they are also linked with soil friability and aggregation. An excess of magnesium ions in groundwater affects the soil quality by increasing its alkalinity which will in turn reduce crop yield [40,41]. This study by evaluating magnesium hazard showed that MH values varied from 0.00 to 45.45. As seen in Fig. 5d & Table 5, the results show that 100% samples had MH values (<50).

5.14. Soluble Sodium Percentage, SSP

As it relates to soil permeability, the proportion of soluble sodium is an important metric in categorizing irrigation water [42]. Sodium ion exchanged by Mg^{2+} and Ca^{2+} ions present in clay particles reduces the

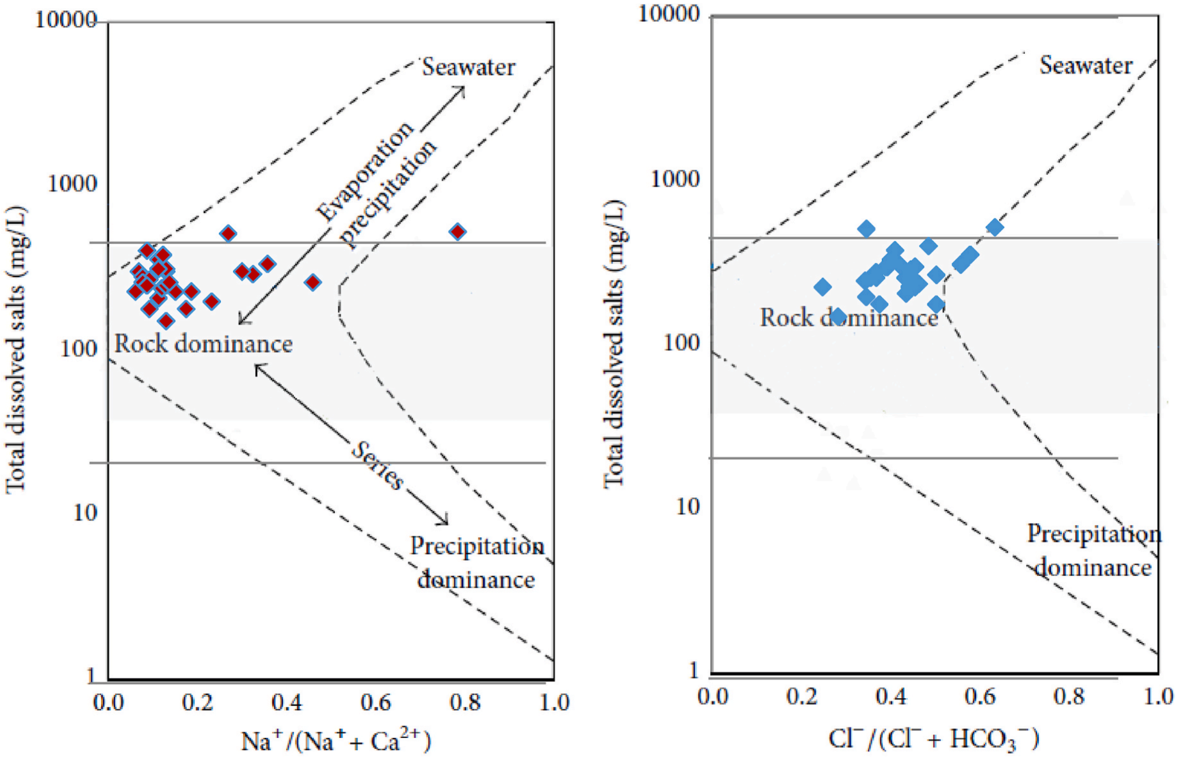

Fig. 6. Classification of irrigation waters using Gibbs plot.

permeability of soil and causes soil hardening [43]. Moreover, salinity and alkalinity resulting from combination of sodium with chloride and carbonates, are detrimental to plant growth and crop productivity. In the study, SSP varied from 8.82 to 64.44. All the locations except one were classified as "good" the purpose of irrigation (Fig. 5e & Table 5).

5.15. Gibbs diagram

Gibbs diagram has been used extensively to describe the relationship between water composition and corresponding aquifer characteristics [44]. The ratio of dominant cations is plotted against the values of TDS for which their positions are classified using three distinct fields; ***"precipitation dominance"***, ***"evaporation dominance"***, and ***"rock dominance"*** [45]. As seen in Fig. 6 the samples are under the ***"rock dominance"*** which was to some extent skewed towards the ***"evaporation dominance"*** field suggesting a water-rock interaction and to some extent evaporation-crystallization. Thus the origin of ions are from local geological sources. A similar finding was also observed and discussed by Ref. [34].

6. Conclusion

Findings from study revealed the potentiality and applicability of groundwater gotten from 30 boreholes in southern part of Akure, Ondo State, for domestic and irrigation purposes. The study showed that TDS, EC, Chloride and Alkalinity from the boreholes, were all within permissible limit as recommended by W.H.O. However, the pH value did not meet W.H.O requirement for drinking water which was observed to be slightly acidic in nature.

Furthermore, based on Water Quality Index (WQI) assessment, 16% of the samples were excellent, 82% were good and 2% were found to be moderate. The Sodium ratio also showed that 76.7% of the water samples is in "good" category, 20% is in "permissible" category, and 3.3% is in the "poor" category. Also based on Kelly's Ratio about 96.7% of the samples are categorized suitable for domestic purpose while the remaining 3.3% samples are considered not suitable. Meanwhile Magnesium Hazard analysis showed that 100% samples had MH values (<50), while Soluble Sodium Percentage revealed that all the locations except one were classified as "good" for irrigation purpose. This further indicates that the water quality in terms of its drinking standard is generally good as obtained from this study.

Credit author statement

Elemile Olugbenga: Supervision, Writing- Reviewing and Editing. Ibitogbe Enoch: Conceptualization, Methodology, Data curation, original draft preparation: Ejigboye Praise: Investigation: Boluwape Okikiola. Methodology.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that might have had an impact on the work reported in this paper.

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