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ASSESSMENT OF CLIMATE CHANGE IMPACT ON SURFACE WATER QUALITY IN SHARE-TSARAGI AND IT'S ENVIRON IN KWARA STATE, NIGERIA

Peter Mafimisebi[1], Grace Martins[2]

[1]*Department of Environmental Engineering and Hydrogeology, Geoearth Project LTD. Nigeria*
[2]*Department of Engineering Geology, RFI Integ Service. Nigeria*
Corresponding author: mafimisebipeter2023@gmail.com

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ABSTRACT

Climate change affects surface water resources through changes in evaporation, surface water recharge, temperature, runoff, and rainfall. Such changes affect the mobilization of nutrients and the distribution and mobility of pollutants in surface water systems. The present study attempts the physiochemical and hydrochemical characterization of surface-quality water in the Share-Tsaragi and its environs in Kwara State, Nigeria. A total of ten (10) water samples were collected from the study area. The physiochemical characteristics such as pH and total dissolved solids (TDS) were determined to understand the surface water characteristics, and the results showed that pH (6.39 to 7.67) and total dissolved solids (35 to 230 mg/l) were significantly moderate across the different stations. This indicated that all the water samples are good for drinking and irrigation. The hydrochemical data were utilized to generate graphical representations and scientific computations that determined the relationship between chemical components and water quality. The main elements found in the samples were Ca-HCO_3^-. Piper diagram indicates that the water samples are made of mixed Ca-Na-HCO_3^- and mixed Ca-Mg, indicating transient hardness. Gibbs plots show that water chemistry is primarily influenced by rock-water interactions and precipitation processes. The Gibbs plots show a change with increased bicarbonate and lower TDS, indicating salt intake through precipitation.

Keywords: Climate change, Water quality, Hydro-chemical, and Physiochemical characterization.

I. INTRODUCTION

Climate change is a critical worldwide issue that has a wide-ranging impact on our ecosystem, including surface water quality. Share-Tsaragi, an area in Nigeria, is no exception to this trend. Surface water quality, an important part of the hydrologic cycle, is critical for human consumption, agriculture, industry, and ecosystems [1, 2]. However, climate change is affecting the quality and availability of surface water, posing serious risks to human health, food security, and the environment.Share-Tsaragi's surface water resources rely mostly on rainfall and are subject to variations in precipitation patterns, temperature, and evaporation. Climate change is expected to impact these parameters, causing changes in surface water quantity and quality [3]. The necessity of monitoring climate change's effects on surface water in Share-Tsaragi cannot be understated. Surface water resources in the region are already suffering various issues, such as pollution, over-extraction, and insufficient management [3,4]. Climate change is expected to worsen these challenges, resulting in more frequent and severe water scarcity, poorer water quality, and an increased risk of waterborne infections [5]. To successfully manage the effects of climate change on surface water in Share-Tsaragi, it is critical to have a thorough understanding of the region's physiochemical and hydrochemical properties. This involves monitoring water temperature, pH, TDS, and main ions for Piper and Gibbs plots [2, 6, 7, 8, 9,10]. This study uses surface water samples from the study area to evaluate changes in water quality because of climate change's impact on surface water resources [11]. The study's findings will help establish effective management methods to counteract the effects of climate change on surface water quality in Share-Tsaragi and ensure the region's long-term water resource needs.

II. THE STUDY AREA

The study area falls between longitudes 4°E to 7'E and latitudes 7°N to 12'N, encompassing sections of Niger, Kwara, Kogi, and the Federal Capital Territory (Fig.1). Thornthwaite classified the climate as moist and subhumid. The mean yearly temperature ranges from 26.5°C to 27.8°C. The area has two different seasons: the rainy season, which lasts from April to October, and the dry season, which runs from November to March. The rainy season is distinguished by torrential downpours and groundwater infiltration and percolation. The average yearly rainfall varies from 1000 to 1500mm. The region features gentle to moderate terrain, with occasional laterite-capped hills and elevations typically staying below 400 meters. The earth typically has good drainage.

2.1. Geology of the Study Area

Share-Tsaragi is situated in Kwara State, in the north-central area of Nigeria (Fig. 1). The complex arrangement of Precambrian basement rocks and sedimentary strata characterizes the geological context of Share-Tsaragi, which is situated in Kwara State, Nigeria [12]. The region's geology is based on crystalline basement rocks, which are located under the area and include gneisses, schists, and migmatites [13].

Sedimentary layers of the Nupe Formation, which include claystone, siltstone, and sandstone, are found above the basement rocks [13,14]. The composition and structure of these rocks, which were created by the erosion and deposition of older rocks, provide insight into the region's geological history.

Fluvial and aeolian processes have changed the terrain over millions of years, resulting in alluvial deposits and recent sediments covering the area. These layers, which are made up of clay, sand, and silt, are probably quite fruitful and will help the area's agricultural endeavors [13]. The hydrogeology of Share-Tsaragi is greatly influenced by the region's geology, with sedimentary formations and basement rocks affecting the flow and storage of groundwater. It is probable that the aquifers in the region consist of sedimentary deposits and worn basement rocks, and they have the capacity to store and circulate large amounts of groundwater [15].

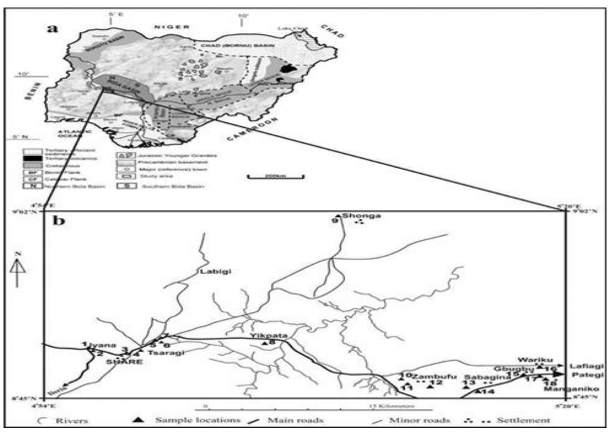

Fig. 1: Geological map showing the study area [15].

2.2. Hydrogeology of the Study Area

The hydrogeology of the Share-Tsaragi study area is a dynamic and intricate system that is essential to the environment and water resources of the area. The shallow aquifer and the deep aquifer are the two primary aquifer units that define the hydrogeology of the region [16,17]. The shallow aquifer is recharged by direct precipitation, infiltration from streams and rivers, and agricultural activities. It is made up of weathered basement rocks and alluvial deposits and has a thickness of around 10–20 meters. The 50–100-meter-thick deep aquifer is made up of fractured basement rocks and is recharged by deeper faults and fractures [18, 19].

Numerous elements, including geology, geography, climate, and human activity, affect the hydrogeology of the area. Groundwater recharge and storage are facilitated by the weathered basement rocks and alluvial deposits [20]. Conversely, deeper groundwater movement and discharge are made possible by the fractured basement rocks [21]. The area's moderate slopes and valleys have an impact on the patterns of groundwater flow and discharge. The high temperatures and erratic rainfall in the region have an impact on the aquifer units' rates of recharge and outflow. Increased recharge, pollution, and over-extraction of groundwater are some of the ways that human activities like mining, urbanization, and agriculture affect the hydrogeology of the area [18].

Share-Tsaragi's hydrogeology has a big impact on the environment and water supplies in the area. Surface water in the area is an essential source of water for industrial, agricultural, and residential uses [6]. Through baseflow management and wetland sustenance, the aquifer units sustain the surrounding ecology and act as a natural buffer against droughts and floods. The hydrogeology of the area is susceptible to pollution and over-extraction, though, which might have detrimental effects on the environment and public health [22].

III. METHODOLOGY

The fieldwork was done in north-central Nigeria, Kwara State, and Share-Tsaragi. Using the Geographic Positioning System (GPS) to identify specific locations, water samples were taken from the research area's streams at many points. Sampling was done in the dry season when the mapping was being done. A pH meter was used to measure the water's acidity and alkalinity, and a TDS meter was used to measure the total dissolved solids (TDS). Prior to the water samples being examined for different cations in the ACME laboratory in Canada using the ICP/MS method, concentrated nitric acid (HNO_3^-) was added to the samples for cations to prevent cations from precipitating in the sample. The samples were then packaged, stored, and treated before being sent to the laboratory for hydrochemical analysis.

IV. RESULTS AND DISCUSSION

The results of the data obtained on the field and the analyzed laboratory results are presented and interpreted for the ten (10) water samples obtained on the field.

4.1. Physiochemical Parameters

Table 1 shows the pH and total dissolved solid values for each water samples. The pH of the samples that were collected varies from 6.39 to 7.67 and the bar chart shows the variation between pH values against WHO standard values (Fig. 2). According to the [23], the maximum pH value that is suitable for irrigation and human consumption is between 6.5 and 9.5 (Table 3). Each sample falls within the range, indicating each sample of water is suitable for irrigation and human consumption.

The TDS value range (35 to 230 mg/l), this indicates that no of the water sample of the study area is above the concentration limit (Fig. 3). This classifies the water samples as safe for drinking and human consumption [23].

Table 1. Physiochemical Parameters

S/N	Parameters	**RA**	**KA1**	**KA2**	**SH1A**	**SH1B**	**SH2**	**SH3**	**TS5B**	**TS6A**	**TS7**
1	pH	6.7	6.39	6.41	7.2	7.67	6.93	6.88	6.98	6.99	6.75
2	TDS (mg/l)	70	35	35	190	230	155	150	80	80	100

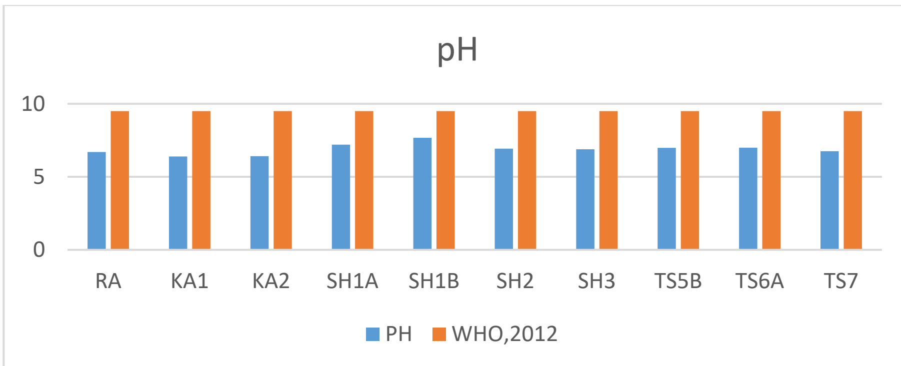

Fig 2. Bar chart showing the pH percentage in each location compare with [23] Standard.

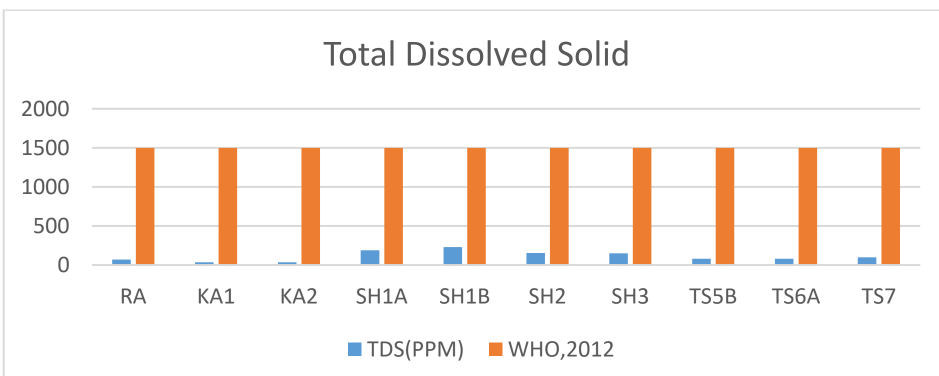

Fig 3. Bar chart showing the percentage of TDS in each location compare with [23] Standard

4.2. Hydrochemical Classification of Surface Water

Surface water quality's chemical dynamics are ongoing research interests across the globe. Variations and changes in surface water as a drinking water source composition have a deleterious impact on human health [8,24]. Table 2 shows that the values of anions and cations for evaluating the hydrochemical classification of the surface water of the study area. The Piper diagram is often used to explain problems with the geochemical development of surface water. This diagram has three separate fields: two triangular fields and a diamond-shaped field. Cations are represented as a single point on the left triangle as a percentage of total cations in meq/l, whereas anions are represented by the right triangle.

The trilinear diagram can identify similarities and differences between surface water samples since water with comparable properties tends to plot together as groups. Ca- HCO_3^- indicates freshwater as a recharge derivative. The interaction of this water with the aquifer material releases additional Ca^{2+}, Mg^{2+}, and HCO_3^-, resulting in temporary hardness [24] (Fig. 4).

Table 2. Milgram/L to Millequivalent/L and Percentage

Samples	Cation	Mg/L	Meq/L	%	ANION	Mg/L	Meq/L	%
19RA	Ca^{2+}	4.28	0.214	56.76	Cl^-	0.9	0.003	0.13
	$Mg2^+$	1.08	0.090	23.87	SO_4^-	22	0.462	20.47
	Na^+	0.2	0.009	2.39	HCO_3^-	112	1.792	79.40
	K^+	2.55	0.064	16.98				
TOTAL			**0.377**	**100**			**2.257**	**100**
19KA1	Ca^{2+}	0.64	0.032	56.14	Cl^-	0.9	0.003	0.51
	Mg^{2+}	0.23	0.019	33.33	SO_4^-	2	0.042	7.13
	Na^+	0.9	0.004	7.02	HCO_3^-	34	0.544	92.36
	K^+	0.08	0.002	3.51				
TOTAL			**0.057**	**100**			**0.589**	**100**
19KA2	Ca^{2+}	1.13	0.057	55.34	Cl^-	4	0.112	16.82
	Mg^{2+}	0.3	0.028	27.18	SO_4^-	2	0.042	6.30
	Na^+	0.9	0.004	3.88	HCO_3^-	32	0.512	76.88
	K^+	0.55	0.014	13.59				
TOTAL			**0.103**	**100**			**0.666**	**100**
19SH1A	Ca^{2+}	23.06	1.153	56.52	Cl^-	3	0.084	1.81
	Mg^{2+}	8.76	0.727	35.64	SO_4^-	28	0.588	12.67
	Na^+	0.6	0.026	1.27	HCO_3^-	248	3.968	85.52
	K^+	5.34	0.134	6.57				
TOTAL			**2.040**	**100**			**4.64**	**100**
19SH1B	Ca^{2+}	23.21	1.161	56.47	Cl^-	3	0.084	
	Mg^{2+}	9.00	0.747	36.33	SO_4^-	28	0.588	
	Na^+	0.4	0.017	0.83	HCO_3^-	250	4.000	
	K^+	5.24	0.131	6.37				
TOTAL			**2.056**	**100**			**4.672**	**100**
19SH2	Ca^{2+}	7.59	0.380	47.50	Cl^-	3	0.084	2.28
	Mg^{2+}	2.74	0.227	28.38	SO_4^-	10	0.210	5.70
	Na^+	0.2	0.009	1.13	HCO_3^-	212	3.392	92.02
	K^+	7.34	0.184	23.00				
TOTAL			**0.800**	**100**			**3.686**	**100**
19SH3	Ca^{2+}	7.73	0.387	47.78	Cl^-	3	0.084	2.23
	Mg^{2+}	2.53	0.210	25.93	SO_4^-	11	0.231	6.13
	Na^+	0.2	0.009	1.11	HCO_3^-	216	3.456	91.65
	K^+	8.17	0.204	25.19				
TOTAL			**0.810**	**100**			**3.771**	**100**
19TS5	Ca^{2+}	6.48	0.324	62.67	Cl^-	0.9	0.003	0.10
	Mg^{2+}	1.72	0.143	27.66	SO_4^-	18	0.378	12.45
	Na^+	0.1	0.004	0.77	HCO_3^-	166	2.656	87.45
	K^+	1.82	0.046	8.90				
TOTAL			**0.517**	**100**			**3.037**	**100**
19TS6A	Ca^{2+}	0.55	0.328	62.00	Cl^-	0.9	0.003	0.10
	Mg^{2+}	1.81	0.150	28.36	SO_4^-	16	0.336	11.34
	Na^+	0.9	0.004	0.76	HCO_3^-	164	2.624	88.56
	K^+	1.86	0.047	8.88				
TOTAL			**0.529**	**100**			**2.963**	**100**
19TS7	Ca^{2+}	5.42	0.271	71.13	Cl^-	1	0.028	1.20
	Mg^{2+}	0.84	0.070	18.37	SO_4^-	18	0.378	16.25
	Na^+	0.1	0.004	1.05	HCO_3^-	120	1.920	82.55
	K^+	1.43	0.036	9.45				
TOTAL			**0.381**	**100**			**2.326**	**100**

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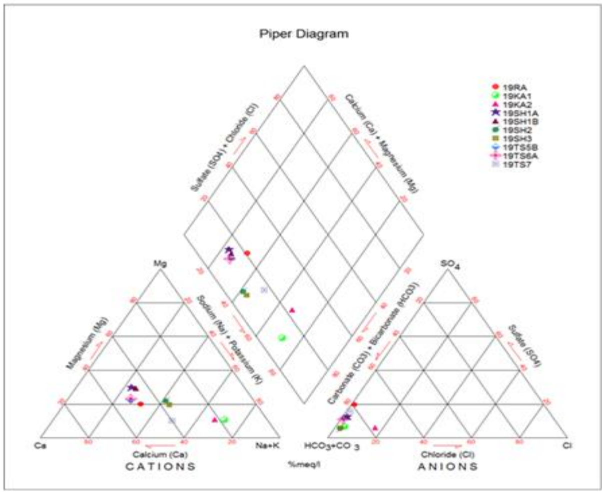

Fig 4. Piper's diagram showing major ions.

The values of Gibbs data are presented in Table 3. The Gibbs diagram is frequently used to deduce the correlation between water composition and aquifer lithological properties [25]. The Gibbs diagram depicts three separate fields: precipitation dominance, evaporation dominance, and rock-water interaction dominance regions. Gibb's plot has three separate fields: precipitation dominance, evaporation dominance, and rock dominance.

The Gibbs plot (Fig. 5 and 6) indicates that most of the sample points fall within the rock dominance field, implying that water-rock interaction is the primary mechanism controlling water chemistry. The mechanisms enable calcium and bicarbonate to dissolve from the substratum during movement. A considerable change in samples indicates precipitation dominance, which is also evident from the plot. The change is characterized by increased bicarbonate and lower TDS levels, suggesting that salts were introduced by precipitation.

Table 3. Gibb's Table.

Samples	Cation	Anion
RA	0.3912	0.0008
KA1	0.2099	0.0026
KA2	0.3616	0.1111
SH1A	0.2048	0.0120
SH1B	0.1955	0.0119
SH2	0.4983	0.0140
SH3	0.5199	0.0137
TS5B	0.2286	0.0005
TS6A	0.2294	0.0005
TS7	0.2201	0.0083

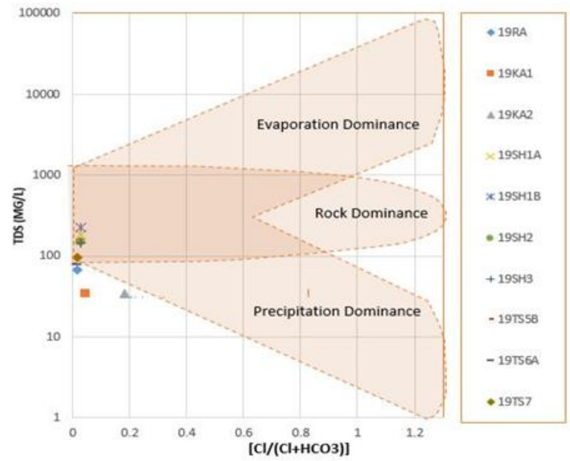

Fig 5. Gibbs diagram showing the relationship of water composition and aquifer lithological characteristics.

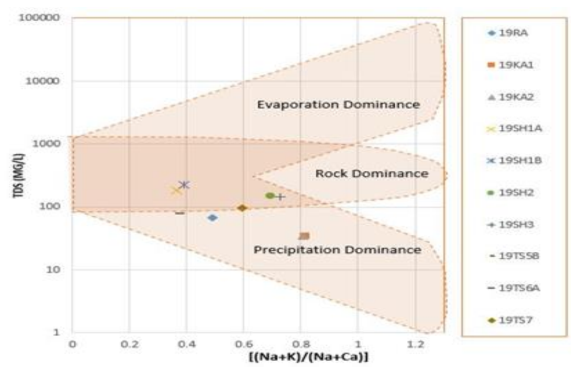

Fig 6. Gibbs diagram showing the relationship of water composition and aquifer lithological characteristics.

V. CONCLUSIONS

The present research assesses the surface water quality in the share-tsaragi in Kwara State, Nigeria, through examination of its physiochemical and hydrochemical characteristics. All the water samples that were taken from the study area had a pH that is suitable for both irrigation and human consumption. Furthermore, according to the TDS results, each water sample that was collected is safe for human consumption. Less of an impact from climate change was seen in the water samples in the study's area, according to the pH and TDS values.
The Ca-HCO_3^- and mixed Ca-Mg water types can be identified from the surface water by the Piper diagram. While the Gibbs diagram suggests that the main factor controlling the water chemistry is the water-rock interaction, which includes mineral dissolution and chemical weathering, Ca-HCO_3^- suggests that surface water has transitory hardness.

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