

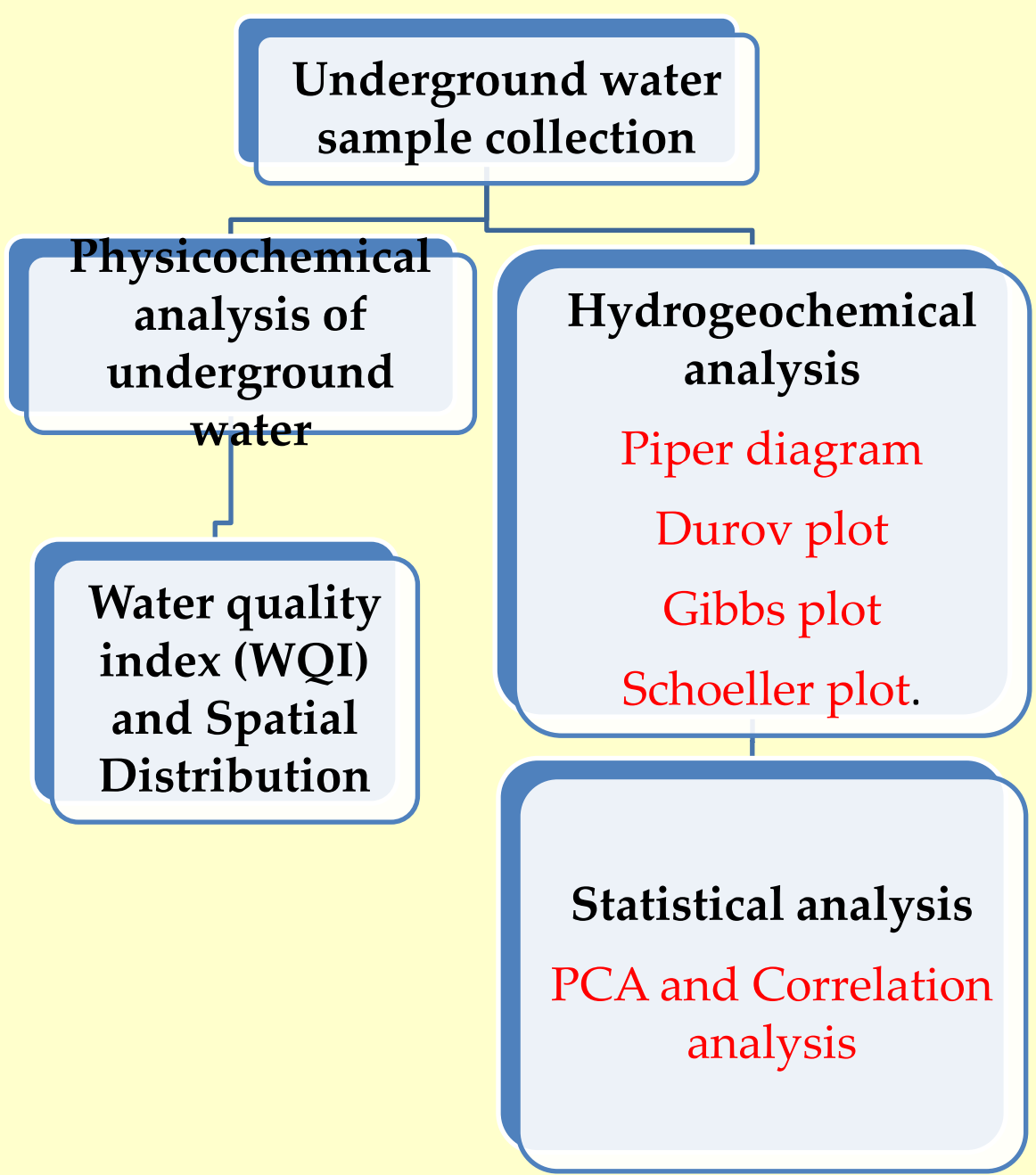
ABSTRACT

The current study describes the primary water source for the Zaria community in Kaduna State, Nigeria, which is located in the Kubanni River Basin. Piper, Gibbs, and Durov diagrams were used to explain the hydrogeochemistry and physical processes of the groundwater samples that were examined. The Ca^{2+} - Na^{2+} - Cl - HCO_3 type predominated in 87 % of the samples, according to the Piper plot, while the Ca-Na-Cl type predominance was higher in 13 % of the samples with normal alkaline earth water. The Ca^{2+} , Mg^{2+} , Na^+ , and K^+ reverse ion exchange and simple mixing amongst these ions in the aquifer were the causes of the Durov plot indices, which showed the preponderance of alkali earth elements over normal alkali. Rock weathering was shown to be the predominant physical process in Gibbs' figure. Two principal components (PC1 and PC2), each accounting for 53.51 and 25.24 percent of the total, were obtained through PCA. 78.75% of the parameters with positive loadings > 0.75 on PC1 and PC2 were primarily in charge of hydrochemical processes. At 100, 90, and 90% of the samples, the SAR, salt content, and water quality index (WQI) all indicated that the samples were suitable for residential and irrigation use.

INTRODUCTION

The hydrochemistry of groundwater in aquifers is influenced by minerals from source rocks (Sunkari et al., 2023). The features of aquifers, which are primarily impacted by elements including water type, source, and the degree of contamination, can be understood by the hydrochemical study of groundwater. (Ige et al., 2022; Ferhati et al., 2023). The previous investigations conducted within our study area have predominantly concentrated on examining the impacts of industrial effluents and chemical pollutants on surface water resources in Zaria (Chigor et al. 2012). Nonetheless, limited consideration has been given to the assessment of groundwater quality, particularly concerning its appropriateness for domestic and irrigation applications. This study's major objective was to determine whether groundwater from the Kubanni River Basin was suitable for drinking and agriculture. In order to do this, the study gathered 30 samples of groundwater from wells and hand pumps in order to analyze their physicochemical characteristics. The Water Quality Index (WQI) was then used to compare the results to the World Health Organization (WHO) criteria for drinking water and household use. The samples' hydrogeochemistry was also assessed, and the study produced maps showing the key cations and anions that were present in the local groundwater. The GIS's IDW interpolation method was used to create these maps.

METHODS



RESULTS

The piper plot (Fig. 1) shows that out of the 9 samples, 6 samples (or 20 %) fall under the Ca-Na-Cl- HCO_3 type, while 4 samples (or 13 %) fall under the Ca-Cl type. 90 % of the samples grouped together in the no-dominance zone, suggesting that the cation may be present because of sodium and calcium-containing minerals or salts..

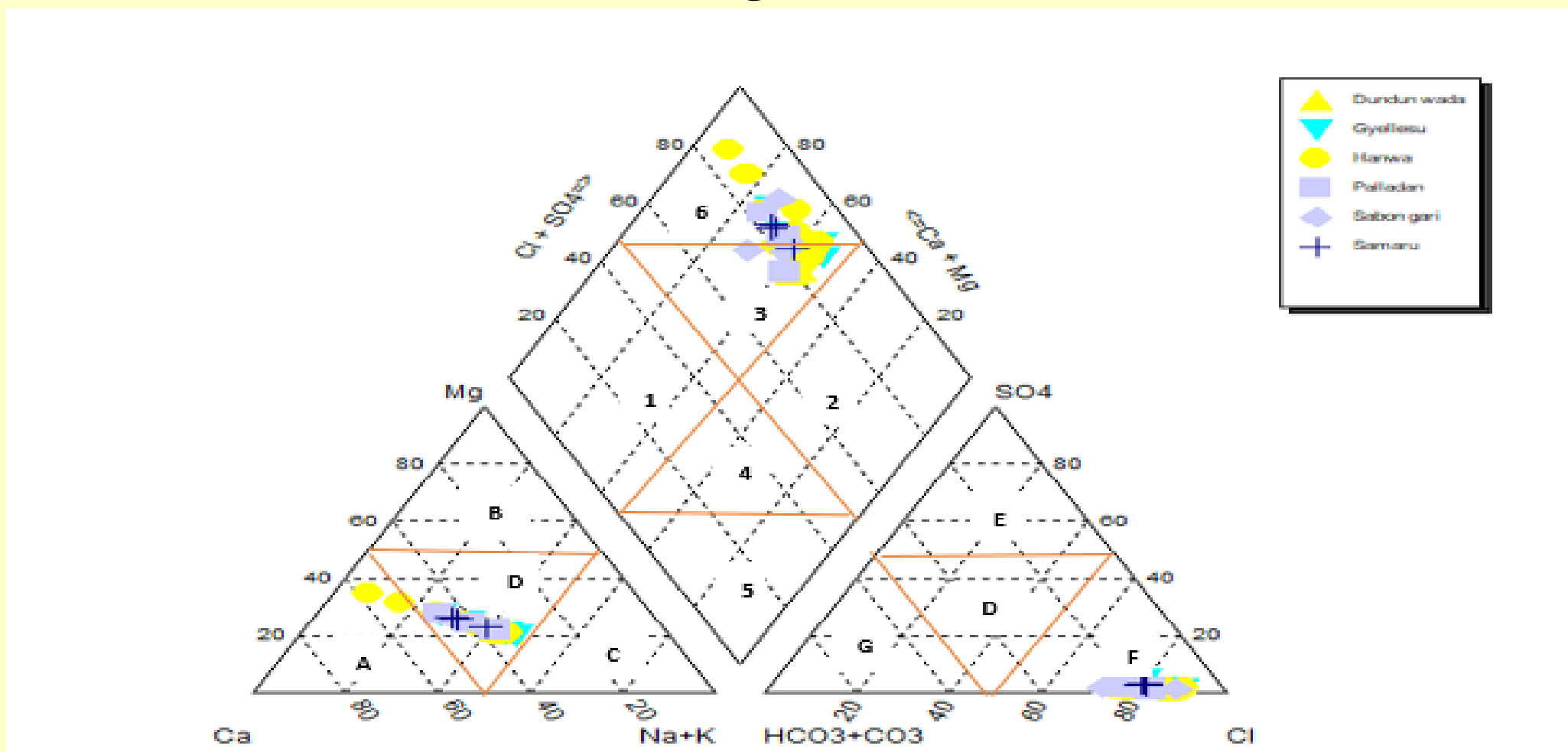


Figure 1: Piper diagram of the groundwater samples from the region.

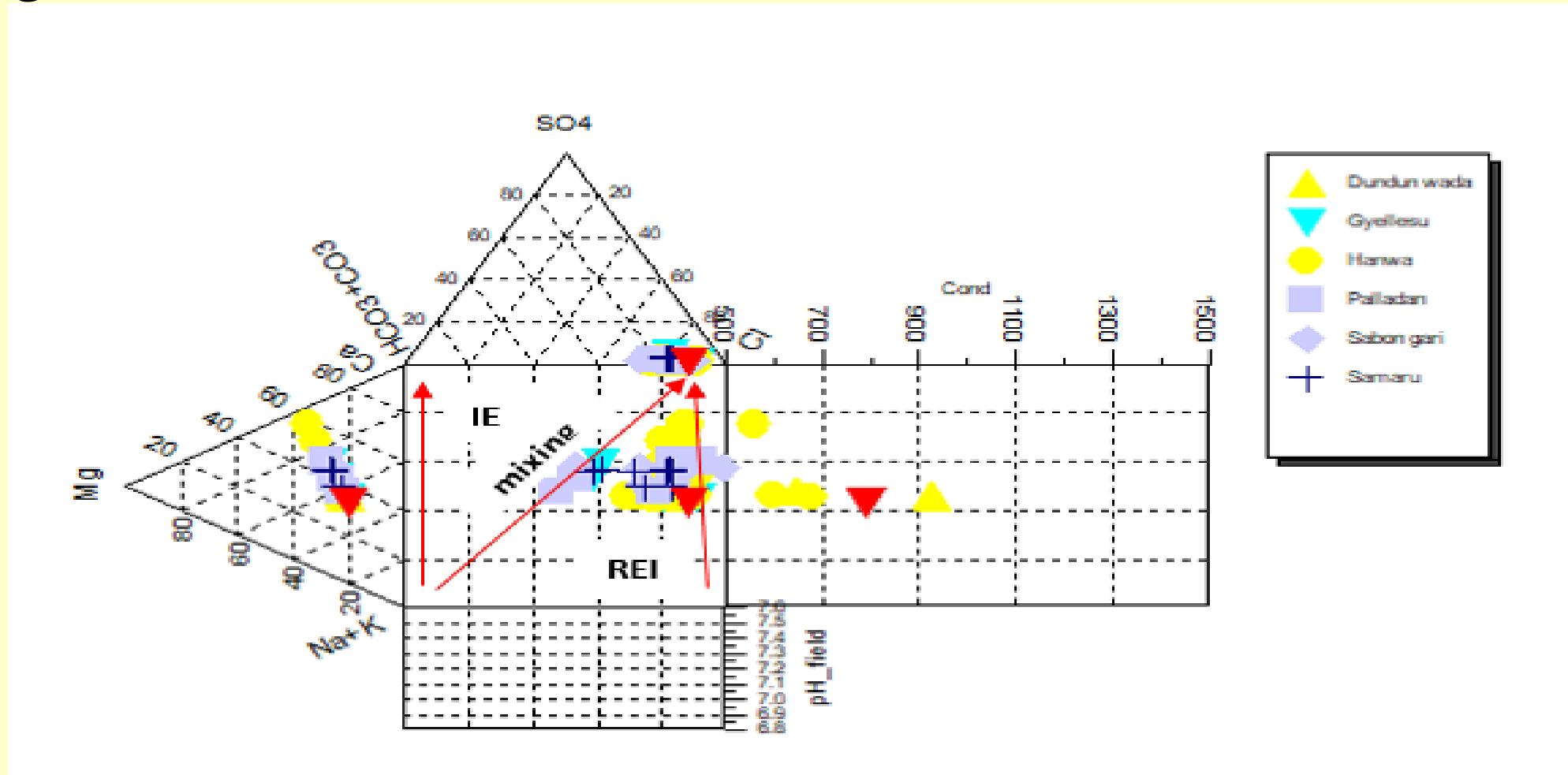


Figure 2: Durov plot depicting hydrogeochemical processes IE-ion exchange, RIE-Reverse ion exchange .

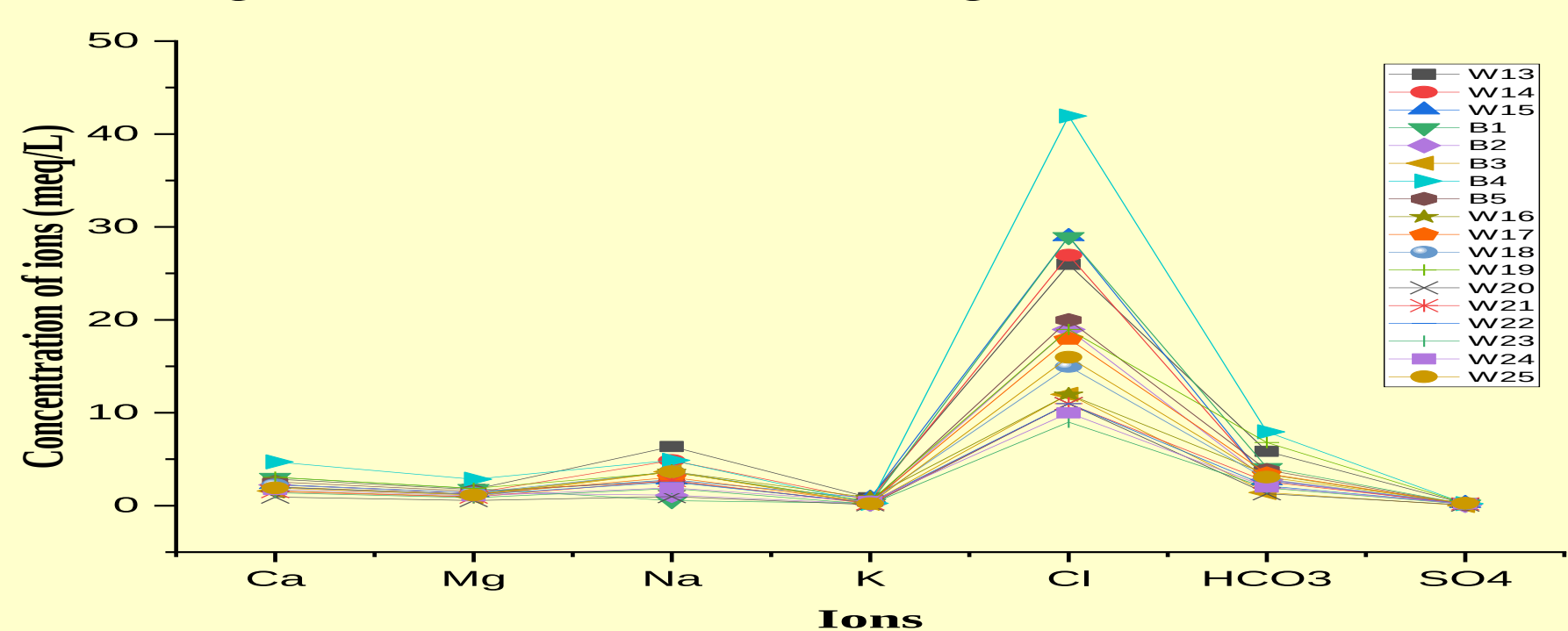


Figure 3: Schoeller's plot for Samples W1–W12

Table 1: Summary of the classification of groundwater for irrigation based on different parameters

Sodium hazard class	SAR in equivalent per mole	Number of samples	EC in $\mu\text{S}/\text{cm}$	Salinity hazard class	Number of samples	Water class
S1	< 10	30	100-250	C1	7	Excellent
S2	10-18	0	250-750	C2	20	Good
S3	18-26	0	750-2250	C3	3	Doubtful
S4 and S5	> 26	0	>2250	C4 and C5	0	unsuitable

DISCUSSION

- The order of abundance of the major cations was $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{Na}^+ > \text{K}^+$
- Durov plot (Fig. 2) shows that the groundwater is connected to the reverse ion exchange of Na-Cl waters came from a small percentage of samples (13%) that indicated Cl^- and Na^+ as the main anion/cation
- 90 % of the samples grouped together in the no-dominance zone, suggesting that the cation may be present because of sodium and calcium-containing minerals or salts.
- The Schoeller diagram (Fig. 3) clearly shows that the dominant elements in the study region are Na^+ , Ca^{2+} , Cl^- , and HCO_3^- ions.
- The sample distribution reveals that 30 samples, or 100 %, are affected by rock weathering (Fig. 4). The results suggest that the weathering of silicate and carbonate minerals in the nearby rock formations can be used to explain the chemical composition of the ionic compounds found in the research area.
- The soil of the Kubanni Basin, which is formed on regoliths rich in oligoclass and fine-grained quartz, is typically categorized as leached ferruginous tropical soil. Lateritic strata often underlie the shallow basin soil, which is frequently less than 1 m deep. Feldspar, quartz, mica, and amphiboles are only a few of the many minerals found in the undifferentiated basement complex rocks (Fig 6)
- The score plot (Fig. 7) these parameters on PC 1 shows that the effects of weathering, rock-water interaction, and leaching processes are the main regulators of groundwater parameters in the research area.

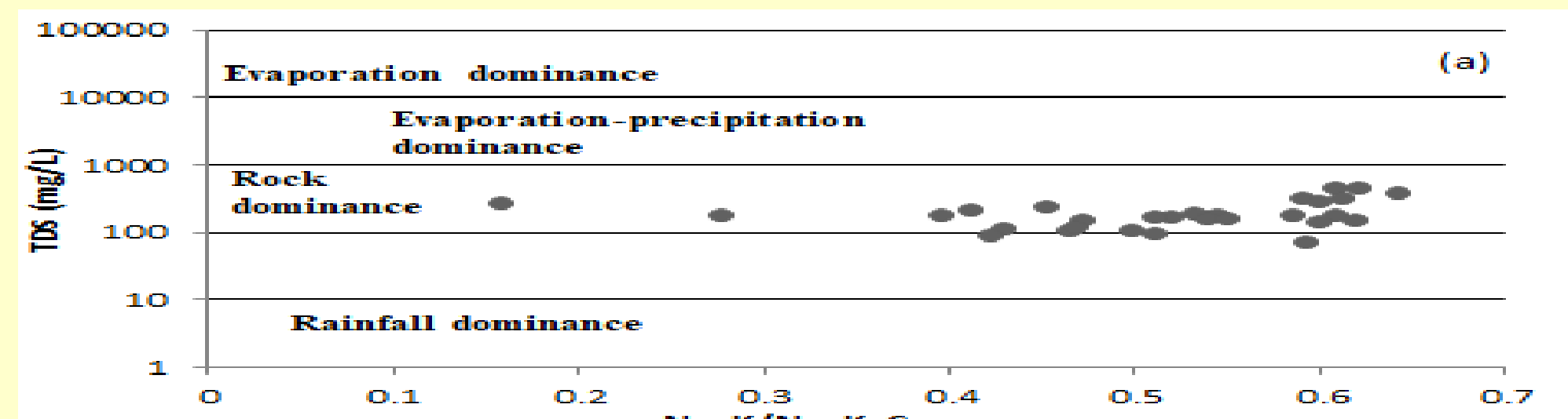


Figure 4: Gibbs diagram of the groundwater samples in the study area of Cations

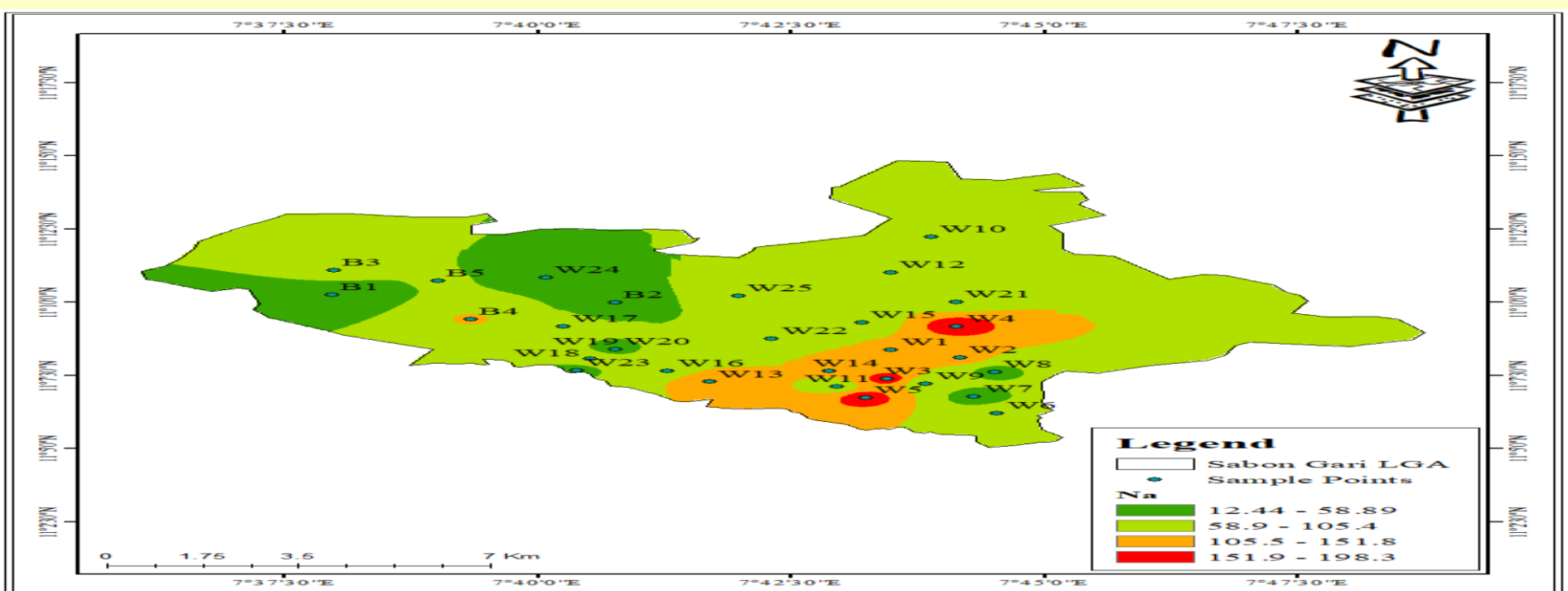


Figure 5: Spatial disparity map of Ca^{2+}

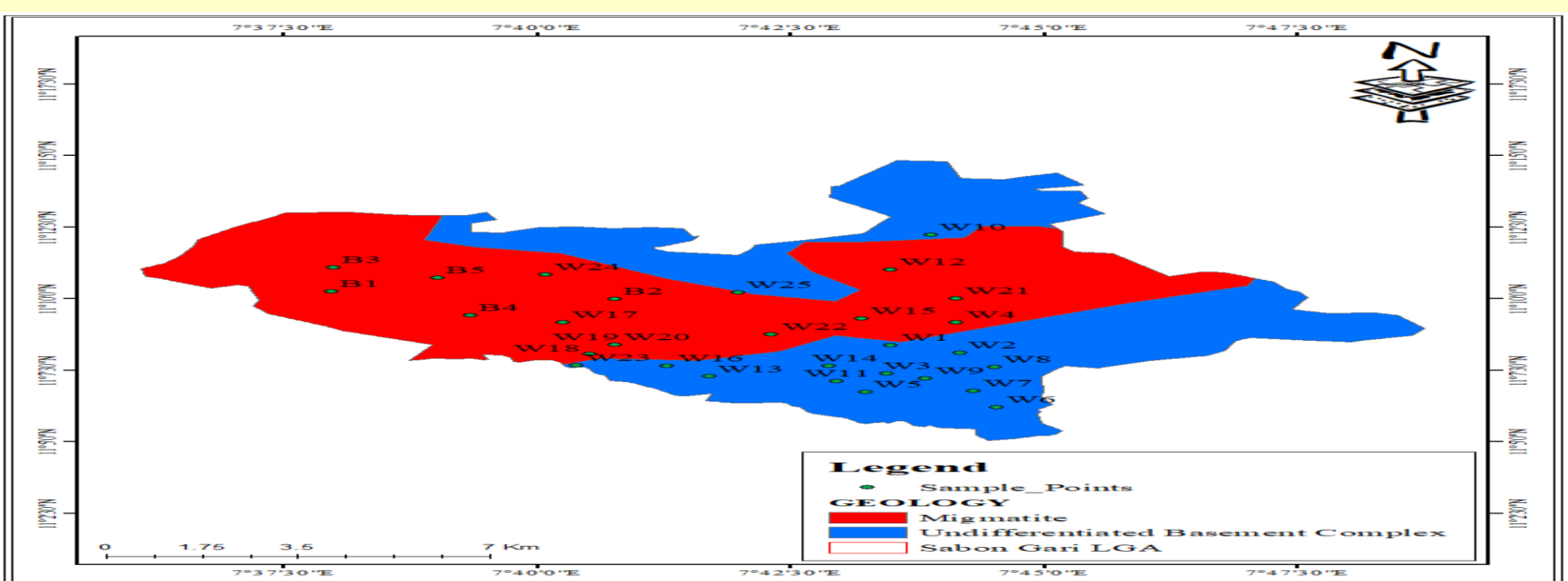


Figure 6: Geology map of the study area

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