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Geochemical Appraisal of Groundwater Quality to Determine its Suitability for Irrigation Purpose: A Case

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Abstract

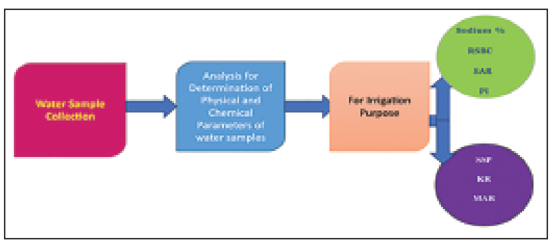
The goal of the current study is to evaluate groundwater samples for irrigation. When determining the classification and quality of water, the chemical characteristics of groundwater are crucial. The Kasari River basin is the research area. From the Kasari River Basin region, 42 groundwater samples were gathered and their irrigation quality examined. Samples' SAR values fall between low and moderate. Ca and Mg ions are seen to be dominant. According to the analysis, the dominant cations are Ca+Mg > Na+K, and the anions are Cl+SO4 > HCO3+CO3. K has the lowest value, Na is higher than K, and Mg is even higher than both Na and K combined. In all lithological domains of the study area, the chemical composition of ground water has evolved due to the weathering of rock-forming minerals. The quality of groundwater is confirmed to be appropriate for irrigation after all parameters have been examined.

Key words : Water Quality, lithological domain, irrigation quality, groundwater.

Irrigation with subpar water quality causes incorrect seed germination and crop retardation, which lowers yield. A major consideration in the classification and evaluation of water quality is the chemical parameters of groundwater. A better outcome can only be achieved by considering the combined chemistry of all the ions rather than individual or paired ionic characters. It was found that the criteria used to classify water for a specific purpose may not find its suitability for other purposes when considering the individual parameters. Groundwater chemistry is influenced by various factors, including topography, climate, residence time, and aquifer characteristics8. The hydrogeological and geochemical characteristics of groundwater are also caused by anthropogenic influences. Contamination may result from increased demand and overuse of groundwater resources. Consequently, understanding the physicochemical properties of groundwater requires an understanding of its hydrochemistry.

Therefore, knowledge of hydrochemistry of groundwater is essential for understanding its physicochemical behavior, its suitability for optimum usage for the drinking, domestic, industrial, and agricultural purpose. Parameters like Na%, RSBC, SAR, PI, SSP, KR and MAR have been tested and analyzed further to check their suitability for irrigation purpose.

Study area : The study area is Kasari River Basin. Kasari is one of the main tributaries of Panchganga River. Kasari River originates near Gajapur Village (Taluka-Shahuwadi) at Latitude 16° 39’ 51’’ to16° 55’ 13’’ N and Longitude 73° 42’ 51’’ to 74° 42’ 51’’ E.



Graphical Abstract

Methodology

Proper sampling sites from part of the study area have been selected for groundwater quality evaluation. Bore wells as well as dug wells were chosen for collecting samples. Standard methods APHA were followed (APHA 2005)1. Samples were collected in polythene containers. Laboratory Analysis was carried out to determine the parameters like Electrical Conductivity (EC), pH and total dissolved solids were determined using pH and conductivity meters. Samples were then analyzed for determination of various cations (Ca, Na, K, Mg) and anions (HCO3, Cl, SO4 and NO3).

Ground water for agriculture use : Ground water quality has a major impact on plant growth and yield. The quality of ground water and its suitability for agricultural use are determined by the quantity and makeup of different elements dissolved in the water. Changes in soil permeability and character brought about by excess elements have a direct impact on plant growth. Because excessive salt concentrations change metabolic processes, they can impede plant growth. When considering water quality for irrigation, the following parameters are crucial: EC, salinity, Na percent, Sodium Absorption Ratio (SAR), Residual Sodium Bicarbonate (RSBC), Soluble Sodium Percentage (SSP), Permeability index (PI), Kelley's Ratio (KR), and Magnesium Adsorption Ratio (MAR).

Result and Discussion

1. Classification of ground water samples based on electric conductivity and sodium percent. (Wilcox, 1955)

2. **U. S. Salinity Diagram (1954) :** The values plotted in above diagram indicate that the samples fall in the field of C1S1 that is suitable for all plants and C2S1 that is suitable to all plants but requires good

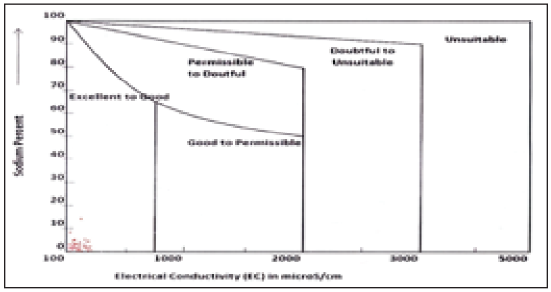


Fig. 1. Wilcox diagram for classification of KRBWS for irrigation uses

drainage. SAR values are low for all the samples and salinity is low- moderate for all the samples.

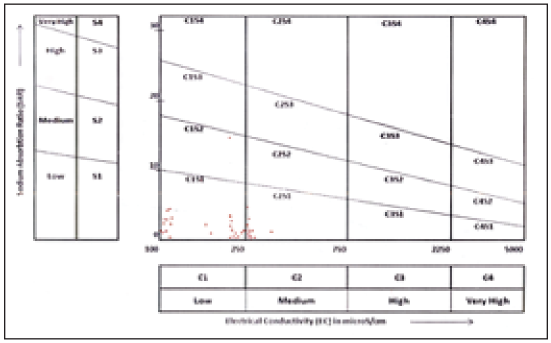


Fig. 2. USSL Classification of KRBWS for irrigation

3. **Durov diagram (1948) :** Intersection of lines extended from the points in ternary diagrams and projected on the sub-divisions of binary plot of Durov diagram define the hydro chemical processes involved along with water type.

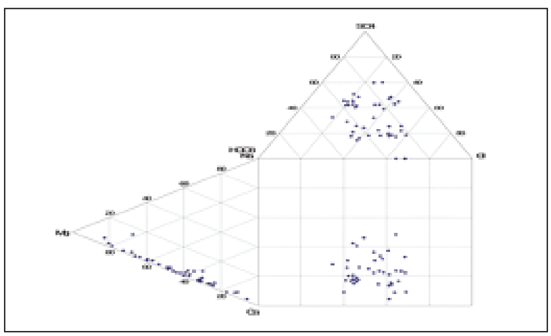


Fig. 3. Durov Diagram showing water types for KRBWS

The Durov diagram shows that the samples belong to the field of reverse ion exchange. This process is responsible for the dominance of Ca and Mg ions. Ca and Mg have been replaced by Na at favorable sites.

3. **Hydro chemical Facies (Piper, 1944) :** From the Piper Trilinear Diagram, it is seen that all the samples fall in area 1 of the diamond shaped field belonging to Ca+ Mg indicating the dominance of alkaline earth over alkali (*viz*. Ca +Mg > Na+ K) and strong acidic anions over weak acidic anions i.e. (Cl+SO4 > HCO3+CO3)

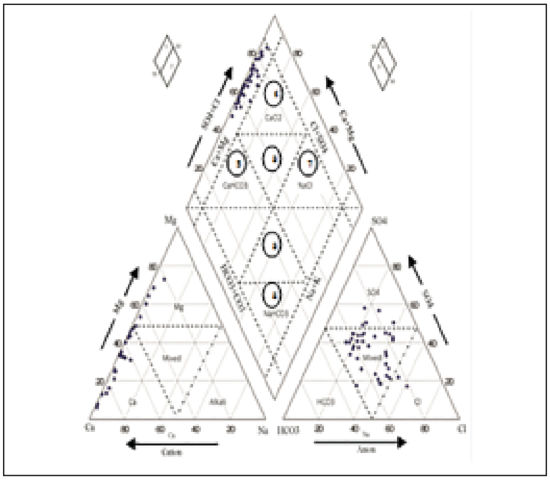


Fig. 4. Piper Trilinear Diagram showing water types for KRBWS

5. **Shoelloer Diagram (1965) :** The main ionic concentrations (as equivalent per

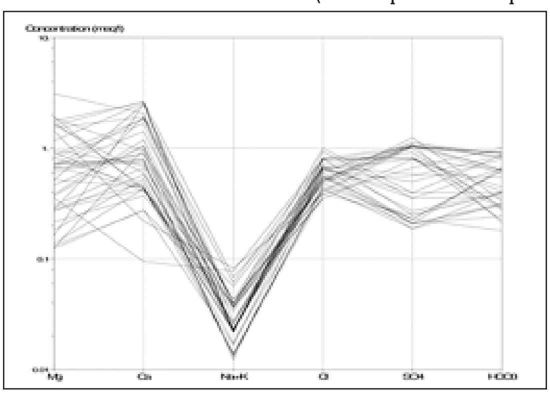


Fig. 5. Schoeller diagram for KRBWS

million) are plotted on six equally spaced logarithmic scale and the points so plotted are then jointed by straight lines.

The Scholler Diagram shows that the values of HCO3 is greater than that of Cl and Cl has greater than SO4. The value of K is least; Na has greater value than that of K and Mg has still higher value than Na and K together. Mg> Na + K and that of HCO3 > Cl > SO4.

6. **Gibbs Diagram (1970) :** Gibbs (1970)4 proposed a diagram to understand the relationship of the chemical components of water from their respective aquifer lithology. The Gibbs diagrams suggest that chemical weathering of the rock forming minerals and evaporation are the main processes which contribute the ions to the water.

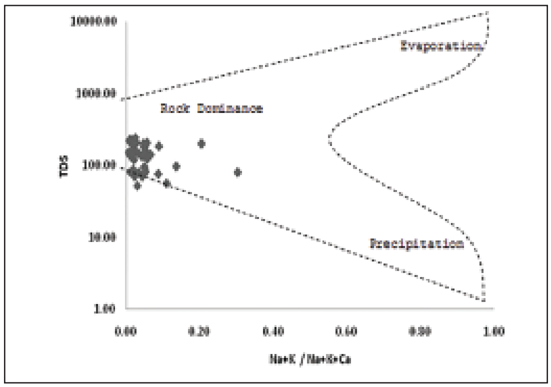


Fig. 6. Mechanism controlling the groundwater chemistry Anions-Gibbs for KRBWS

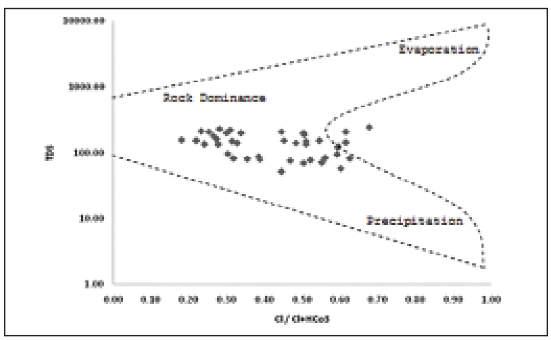


Fig. 7. Mechanism controlling the groundwater chemistry Cations-Gibbs for KRBWS

The samples fall in the plot which indicates weathering. It means that rock forming minerals are chemically weathered and are responsible for the evolution of chemical composition of ground water occurring in all lithological domain of study area.

Conclusion

Most of the study area is covered by flows of basalt. Laterite covers the basalt at various elevations and creates plateaus in the region. These are mostly limited to hill ranges with flat summits. Alluvium is also found in certain locations. Salinity is low to moderate and SAR values are low for all samples; this is appropriate for all plants but necessitates adequate drainage. The dominance of Ca and Mg ions is depicted in the Durov diagram. At favorable locations, Na has replaced Ca and Mg.

It is clear from the Piper Trilinear Diagram that alkaline earth predominates over alkali (viz. Ca+ Mg > Na+ K). Strong acidic anions are preferred over weak acidic anions i.e. (Cl+SO4 > HCO3+CO3). According to the Scholler Diagram, HCO3 has higher values than Cl, and Cl has higher values than SO4. K has the lowest value; Na is higher than K, and Mg is still higher than both Na and K combined. The Gibbs diagram indicates that the minerals that form rocks are chemically weathered and are responsible for the evolution of chemical composition of ground water occurring in all lithological domain of study area. After examining all parameters, it is verified that the quality of groundwater is suitable for irrigation purpose.

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