Ramesh Kumar Rathinam[1], Jai Ganesh Ramajayam, Vanjinathan Mahalingam[2], Muniraj Sarangapani[1]*

[1]Department of Chemistry, Ramakrishna Mission Vivekananda College, Chennai, India, [2]Department of Chemistry, Dwaraka Doss Goverdhan Doss Vaishnav College, Chennai, India

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Assessment of hydrogeochemical characteristics and potable quality of groundwater around Retteri lake in Thiruvallur district, Tamil Nadu, India

ABSTRACT

Hydrogeochemical characteristics of groundwater are significantly affected by its interaction with aquifer minerals. This in turn affects the quality of groundwater for its intended usage. The objective of the present research is to identify the processes controlling the hydrogeochemical characteristics of groundwater around Retteri lake and to assess its potable quality. Ground water samples from 26 sites were collected from the study area and physicochemical analysis were performed to evaluate the water quality parameters such as pH, Electrical Conductivity(EC), Total Dissolved Solids(TDS), Total Hardness(TH), Total Alkalinity(TA), Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, CO_3^{2-}, $HCO_3^{-}$and NO_3^{-}. Correlation analysis for the water quality parameters was performed to identify the nature and degree of correlation among the various parameters. A strong positive correlation was observed between pH and HCO_3^{-}. EC and TDS shows a strong positive correlation with Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-} and SO_4^{2-}. TH exhibits a strong positive correlation with Ca^{2+}, Mg^{2+}, Cl^{-} and SO_4^{2-}. Scatter plots were drawn among major ions to identify the geogenic processes responsible for the hydrogeochemical evolution of groundwater in the study area. The Gibbs plots of the study region indicate that water-rock interaction is the major process that influences the composition of groundwater. The Piper diagram reveals that Na-Cl and mixed Ca-Mg-Cl are the major hydrochemical facies of the groundwater in the study region. The potable quality of groundwater was examined through the evaluation of water quality index (WQI) by weighted arithmetic method. The WQI calculations reveals that 19% samples of groundwater are of excellent quality, 62% samples are of good quality and 19% samples are of poor to very poor quality.

Keywords: *Scatter plot, water quality index, groundwater, total dissolved solids, total hardness andtotal alkalinity*

1. INTRODUCTION

Groundwater is the primary water resource for a significant percent of the human population in the world, especially in arid and semiarid regions [1-3]. It is an important component of the hydrological cycle and its principal sources are precipitation, surface runoff, lakes, rivers and reservoirs [4]. A significant portion of water supply for various purposes is extracted from groundwater resources. The quality requirement of such groundwater largely depends upon its intended usage and varies widely for drinking, irrigation and industrial purposes [5]. Groundwater used for water supply is mainly obtained through precipitation and the various factors affecting its composition are chemical characteristics of rain water, the soil minerals and rock formations through which the water has passed, the lithology of the aquifer and its residence time in the aquifer [4,6]. The impact of various human activities such as rapid industrialisation and urbanisation leading to increased disposal of waste, excessive fertilisation, pesticide usage, irrigation, etc. can have a detrimental effect on the groundwater quality [3]. The knowledge of the nature of constituents and its composition in groundwater is thus essential to identify the various geogenic and anthropogenic sources responsible for the evolution of groundwater chemistry [7]. The study area chosen is a residential area and majority of the local

*Corresponding author: Ramesh Kumar Rathinam
E-mail: srisairamviveka@gmail.com
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residents rely upon the groundwater for their day to day consumptions. In the present work the suitability of groundwater for its potability and a preliminary hydrogeochemical study was performed to determine the origin of the chemical characteristics of groundwater and the nature of water-rock interactions leading to the particular groundwater quality around Retteri lake, Thiruvallur district, Tamil Nadu, India.

Study Area

The study area is located around Retteri lake in Thiruvallur district, Tamil Nadu, India (Fig. 1). The lake spreads over 5.42 million square meters and fed by two adjacent surface water resources comprising Redhills reservoir and Korattur lake. 26 spatially distributed locations around the lake area were identified to carry out the present study.

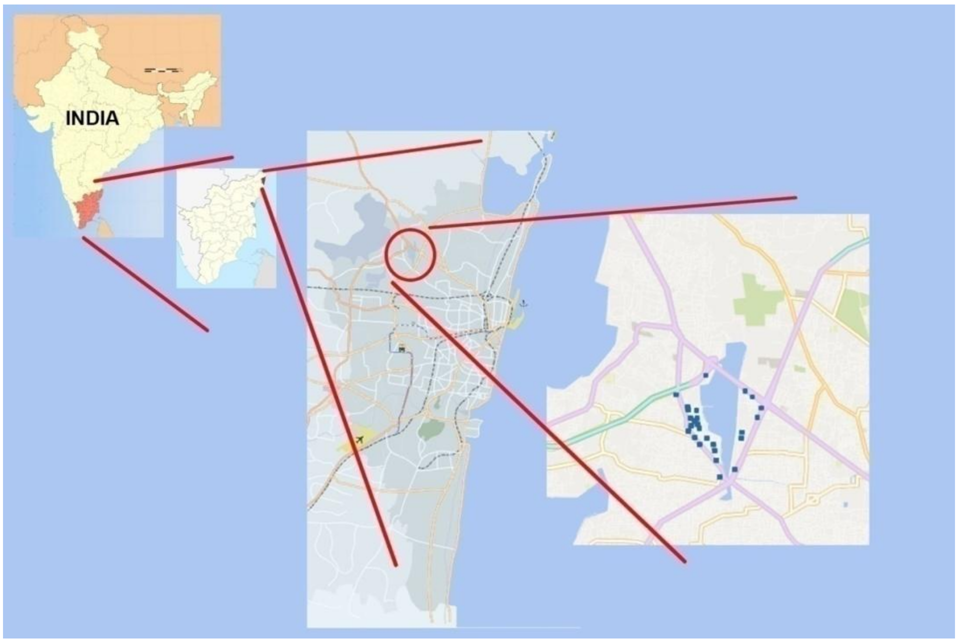

Figure 1. Map of the study area around Retteri lake

2. MATERIALS AND METHODS

Groundwater samples for the present study were collected from 26 bore wells located in spatially distributed sites around Retteri lake in Thiruvallur district. The samples were collected and analysed for pH, EC,TDS, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, CO_3^{2-}, $HCO_3^{-}$and NO_3^{-} by following the protocols recommended by the Standard Methods for the Examination of Water and Wastewater, American Public Health Association (APHA) [8]. The quality of groundwater in the study area was ascertained by considering the Bureau of Indian Standards (BIS) [9]. Geographic coordinates of the sampling locations were recorded using Global Positioning System (GPS). Piper plot, Gibbs diagram and scatter plots were drawn to decipher the hydrogeochemical characteristics of the study area. Correlation analysis was performed to assess the strength of correlation among various water quality parameters using SPSS software (SPSS 2001). Potable quality of groundwater in the study area was assessed through the evaluation of WQI by weighted arithmetic method [3, 10-12].

Correlation Study

Correlation is the mutual relationship between two variables [13, 14]. The two variables are said to possess a direct correlation, when an increase or decrease in the value of one variable is associated with a corresponding increase or decrease in the value of the other. The variables are said to be positive correlated, when increase in one parameter causes the increase in other parameter and it is negatively correlated when increase in one parameter causes decrease in the other parameter. The nature and degree of correlation between two variables 'x' and 'y'is expressed by a quantity called correlation coefficient (r) and whose value lies between -1 and +1. The correlation coefficient in the range of ±0.8 to ±1.0 signifies a strong correlation, in the range of ±0.5 to ±0.8 indicates a moderate correlation and weak when in the range of 0.0 to ±0.5 . The correlation coefficient (r) is given by the expression:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \qquad (1)$$

Where x and y are two water quality variables, $\bar{x}$ and $\bar{y}$ are the mean values of x_i and y_i respectively.

Correlation analysis was performed to assess the nature and strength of correlation among various water quality parameters using SPSS software (SPSS 2001).

WQI Calculation

The suitability of a particular water sample for its potability can be assessed by assigning a numerical value called Water Quality Index [10]. It reflects the combined influence of various water quality parameters on the overall quality of water. Weighted arithmetic index method was used to arrive at the WQI, using a set of nine water quality parameters such as pH, TDS, TH, TA, Ca^{2+}, Mg^{2+}, Cl^{-}, SO_4^{2-}, and NO_3^{-} [3,11,12]. The quality rating scale (Q_i) and relative weight (W_i) for all parameters were calculated by the following method to arrive at WQI.

$$Q_i = [(V_{actual} - V_{ideal})/(V_{standard} - V_{ideal})] \times 100 \quad (2)$$

Where, Q_i is the quality rating of 'i'th parameter

V_{actual} is the experimental value of the water quality parameter

V_{ideal} is the ideal value of the water quality parameter

V_{ideal} for all water quality parameters except pH is assigned zero and for pH it is 7

$V_{standard}$ is the standard value of a particular water quality parameter as recommended by BIS

$$W_i = I/S_i \quad (3)$$

Where, S_i is the standard permissible value for the 'n'thwater quality parameter and I is a constant given by the equation:

$$I = 1/\sum(1/S_i) \quad (4)$$

Finally the WQI of the water sample is calculated using the equation:

$$WQI = \sum Q_i W_i / \sum W_i \quad (5)$$

3. RESULTS AND DISCUSSIONS

The statistical data of physicochemical parameters and major ion concentrations were tabulated in Table 1. The pH of groundwater samples from the study area varies from 6.6 to 7.6 with an average of 7.2 indicating essentially the neutral characteristic of groundwater. The EC varies from 920 μScm^{-1} to 5320 μScm^{-1} with an average of 2040 μScm^{-1}. The TDS shows a variation from 478 mgL^{-1} to 2509 mgL^{-1} with an average of 1009 mgL^{-1}.The TH exhibits a variation from 180 mgL^{-1} to 1781 mgL^{-1} with an average of 571 mgL^{-1}.In most of the samples the order of abundance of cations and anions are $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+}$ and $HCO_3^{-} > Cl^{-} > SO_4^{2-} > NO_3^{-}$ respectively.

Table 1. Statistical data of water quality parameters of the study area

Water quality parameter	Min.	Max.	Avg.	Acceptable limit of BIS
pH	6.6	7.6	7.2	6.5-8.5
TDS	478	2509	1009	500mg/L
TH	180	1781	571	200mg/L
TA	150	485	303	200mg/L
Ca^{2+}	32	311	120	75mg/L
Mg^{2+}	15	244	66	30mg/L
Cl^{-}	103	1294	352	250mg/L
SO_4^{2-}	32	543	161	200mg/L
NO_3^{-}	0	45	12	45mg/L

Evolution of Hydrochemical Facies

The analytical results of major-ion chemistry can be used to identify the composition of water and subsequently can be assigned to an identifiable group called hydrochemical facies. Hydrochemical facies are identifiable distinct zones with a definite composition type, which can be assigned to the natural water of the particular region based on its major-ion composition [15]. Piper trilinear diagram is an effective graphical tool widely used to decipher the hydrochemical facies of natural water [16, 17].As shown in Fig.2, most of the groundwater samples of the study area appear in zones 7 and 9 in the diamond field of the Piper diagram, indicating that Na-Cl and mixed Ca-Mg-Cl are the major hydrochemical facies types of groundwater in the study area.

Processes affecting groundwater chemistry

The groundwater quality and its composition is significantly affected by its interaction with aquifer minerals [18]. Gibbs has developed a graphical method to decipher the natural processes affecting the composition of natural water [19-21]. Gibbs diagram consists of three regions corresponding to three major processes affecting the composition of water, namely, evaporation, precipitation and water-rock interaction. The Gibbs diagram drawn for the study region indicates that water-rock interaction is the predominant process affecting the composition of groundwater (Fig. 3).

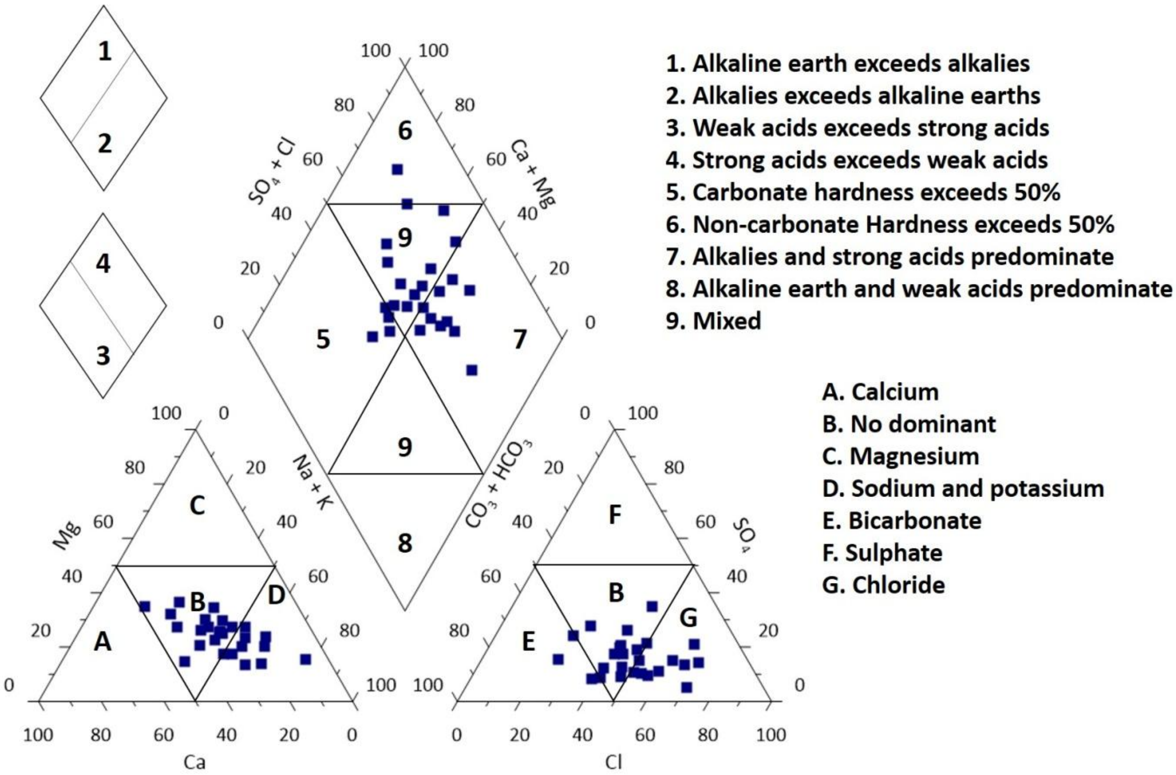

Figure 2. Piper diagram of groundwater in the study area

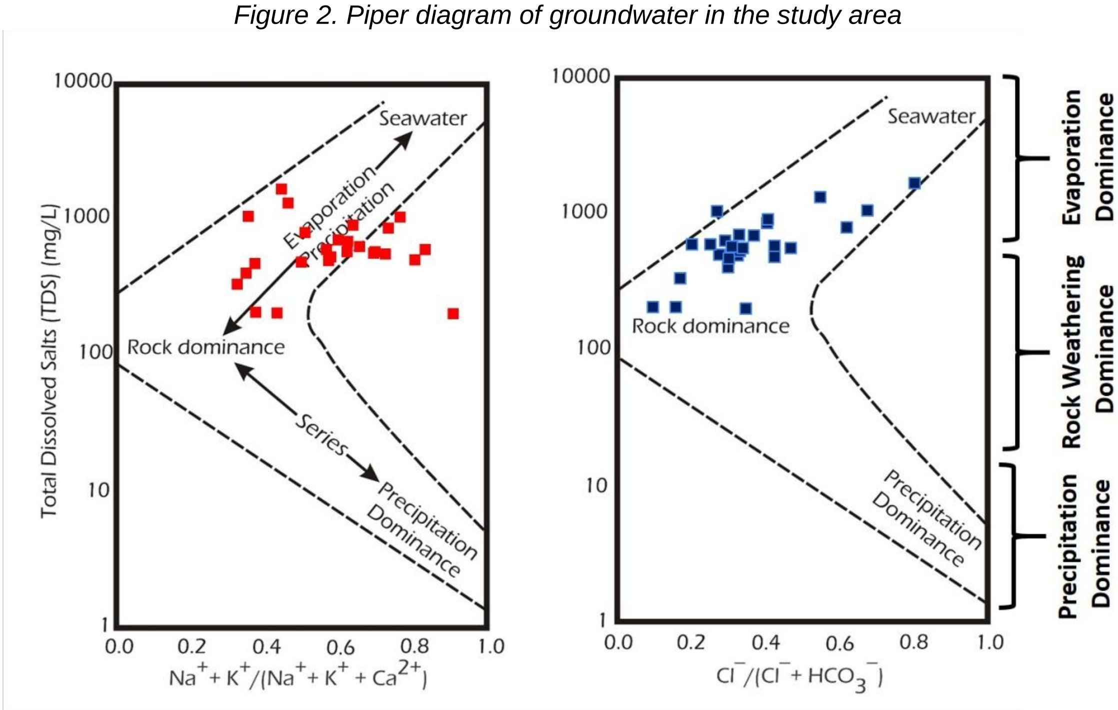

Figure 3. Gibbs plots of groundwater in the study area

Hydrogeochemical Characteristics

The chemical composition of groundwater is largely influenced by the occurrence of various chemical weathering processes during water-rock interaction [22]. Dissolution of halite, gypsum and carbonate minerals, silicate weathering, oxidation reactions and cation exchange are the major mineral dissolution reactions leading to a characteristic chemical composition to groundwater [23-27]. The combined results of correlation analysis and scatter plots can be used to identify the nature of water-rock interaction leading to the characteristic suite of major ions in groundwater [25].The results of correlation analysis of water quality parameters are expressed in the Table 2. pH exhibits a strong positive correlation with HCO_3^- (closely correlates with anionic order of abundance from the experimental results). TDS and EC have a strong positive correlation with Ca^{2+}, Mg^{2+}, Na^+, Cl^- and SO_4^{2-} indicating that these ions contributes significantly to a greater extent to TDS and EC of groundwater.TH shares a strong positive correlation with Ca^{2+}, Mg^{2+},Cl^- and SO_4^{2-}.

Table 2. Correlation matrix of the water quality parameters of groundwater in the study area

Water quality parameters	pH	EC	TDS	Ca^{2+}	Mg^{2+}	Na+	K+	Cl-	SO_4^{2-}	NO_3-	HCO_3-	TH
pH	1											
EC	0.305	1										
TDS	0.312	**1**	1									
Ca2+	0.194	**0.787**	0.785	1								
Mg2+	0.19	**0.92**	**0.917**	**0.885**	1							
Na+	0.283	**0.861**	**0.863**	0.416	0.643	1						
K+	0.156	-0.104	-0.108	-0.073	-0.059	-0.147	1					
Cl-	0.199	**0.961**	**0.958**	**0.819**	**0.94**	0.743	-0.117	1				
SO_4^{2-}	0.247	**0.862**	**0.864**	0.617	**0.731**	**0.868**	-0.068	0.724	1			
NO_3-	-0.021	-0.393	-0.401	-0.323	-0.327	-0.452	0.183	-0.34	-0.406	1		
HCO_3-	**0.66**	0.565	0.573	0.373	0.436	0.564	0.173	0.413	0.51	-0.255	1	
TH	0.198	**0.886**	**0.883**	**0.964**	**0.976**	0.557	-0.067	**0.912**	**0.7**	-0.335	0.42	1

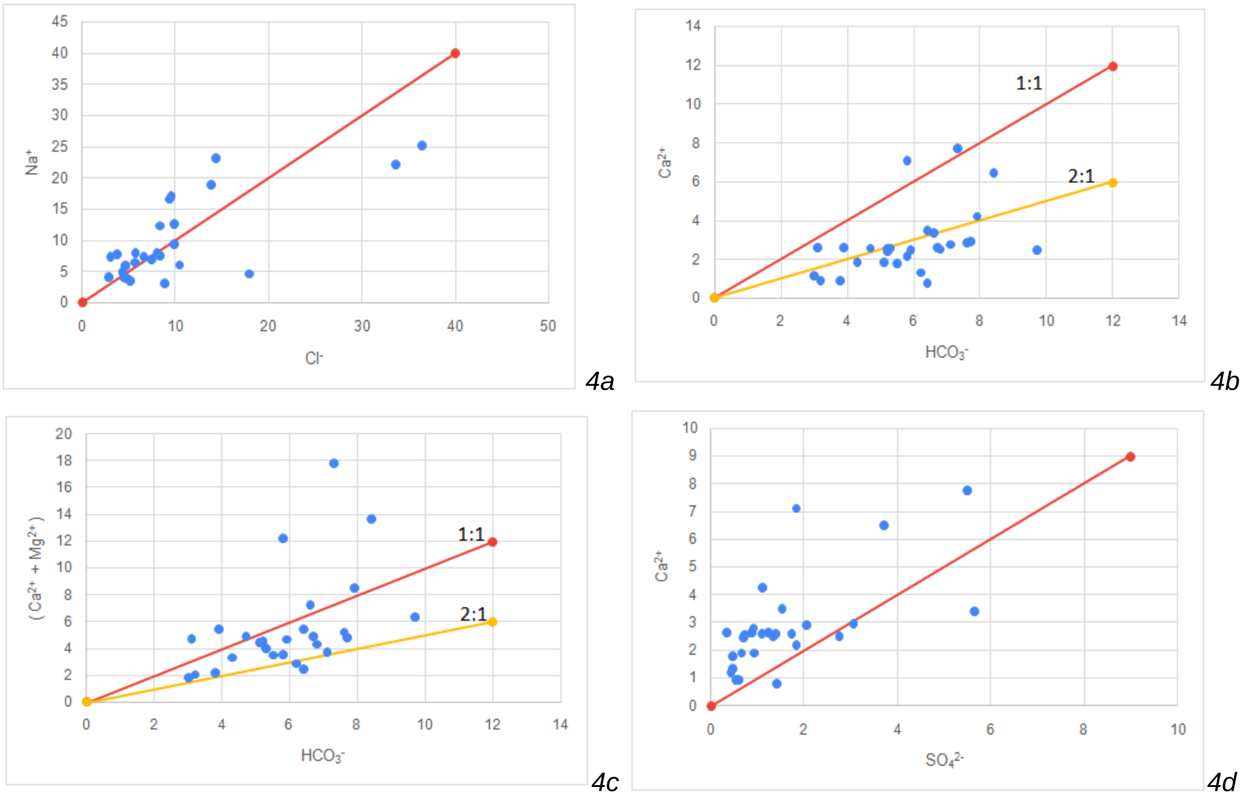

Figure 4. Scatter Plots of a) [Ca^{2+}] vs [HCO_3^-], b) [Ca^{2+}+ Mg^{2+}] vs [HCO_3^-], c) [Na^+] vs [Cl^-], d) [Ca^{2+}] vs [SO_4^{2-}], in mmol/L

Na^+ exhibits a moderate positive correlation with Cl^- and few samples lies along the 1:1 line of Na^+ vs Cl^- scatter plot(Fig. 4a), indicating that halite dissolution probably be one of the source of Na^+ and Cl^- in groundwater [28–30]. However, some of the samples spotted above the 1:1 line indicate that processes such as silicate weathering and cation exchange also contribute Na^+ to the groundwater.

$$NaCl \rightarrow Na^+ + Cl^- \quad (6)$$

$NaAlSi_3O_8 + 8H_2O \rightarrow Na^+ + Al(OH)_4^- + 3H_4SiO_4$ (7)

$ClayNa\ (s) + Ca^{2+}\ (aq) \rightarrow Clay_2Ca\ (s) + 2\ Na^+\ (aq)$ (8)

Presence of carbonate minerals such as calcite and dolomite in the aquifer matrix will tend to dissolve in groundwater through weathering reactions leading to increase in the concentrations of Ca^{2+},Mg^{2+} and HCO_3^- ions. However, their relative amount depends on the amount of dissolved CO_2 present in the water as per the following reactions.

$CaCO_3 + H^+ \rightarrow Ca^{2+} + HCO_3^-$ (9)

$CaCO_3 + H_2O + CO_2 \rightarrow Ca^{2+} + 2HCO_3^-$ (10)

$CaMg(CO_3)_2 + 2H^+ \rightarrow Ca^{2+} + Mg^{2+} + 2HCO_3^-$ (11)

$CaMg(CO_3)_2 + 2H_2O + 2CO_2 \rightarrow Ca^{2+} + Mg^{2+} + 4HCO_3^-$ (12)

Theoretically,if weathering of calcite and dolomite are the only source of Ca^{2+} in groundwater,then the samples should get plotted in the region between the 1:1 and 2:1 lines of the [Ca^{2+} + Mg^{2+}] vs [HCO_3^-] scatter plot. As shown in Fig. 4b & 4c, most of the samples fall in the theoretical region, indicates that calcite and dolomite dissolution are the primary sources of Ca^{2+} in groundwater. The scatter plot of Ca^{2+}vs SO_4^{2-}(Fig. 4d) reveals that most of the samples falls above the 1:1 line, indicating that gypsum dissolution contributes Ca^{2+} ions to a lesser extent to the groundwater.

Water Quality Index

The potable quality of groundwater in the study region was assessed from the calculated WQI using weighted arithmetic method [11, 29,.31,32}

Table 3. Percentage groundwater samples with its potable quality rating in the study area

Range of WQI value	Rating of suitability of groundwater for drinking purpose	% of groundwater samples
0 – 25	Excellent	19
26 – 50	Good	62
51 – 75	Poor	11
76 – 100	Very Poor	8
> 100	Unsuitable for drinking	0

The potable quality rating (Table 3) of the study region was arrived at by considering the acceptable limits of various water quality parameters set by Bureau of Indian Standards (BIS). The calculated values of WQI shows that 19% samples of groundwater are of excellent quality, 62% samples are of good quality and 19% samples are of poor to very poor quality.

4. CONCLUSIONS

The physicochemical analysis reveals that groundwater in most of the sites of the study region is fresh but at few sites brackish in nature. The total hardness of the study region indicates that groundwater is predominantly very hard. The order of abundance of major cations and major anions in most of the samples are Na^+ > Ca^{2+}> Mg^{2+}> K^+ and HCO_3^- > Cl^- > SO_4^{2-}> NO_3^-respectively. Piper trilinear diagram reveals the major hydrochemical facies of groundwater in the study region as Na-Cl and mixed Ca-Mg-Cl types. The Gibbs diagram indicates that water-rock interaction is the major process affecting the composition of groundwater. The combined study of correlation analysis and scatter plots reveals that chemical weathering processes such as dissolution of halite, calcite and dolomite, cation exchange and silicate weathering are responsible for the evolution of groundwater quality in the study region. The potable quality of groundwater from WQI calculations shows that the majority of samples are of good to excellent quality and few samples are of poor to very poor quality. The poor quality of groundwater in few of the sample location arises due to much higher concentrations of Ca^{2+}, Mg^{2+}, Na^+ and Cl^-, exceeding the permissible limit of BIS. The higher concentrations of these ions in the water samples may be due to the significant dissolution of halite, calcite and dolomite minerals through water-rock interactions. This line of reasoning is also supported by the Gibbs and scatter plots. Since the study area being of residential nature and no agricultural and industrial activities were observed, only potable water quality parameters as recommended by BIS were considered in the present study. In some of the sample locations as the groundwater being of poor quality, it is proposed to adopt an appropriate water treatment measure for the safe consumption of groundwater.

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5. REFERENCES

[1] D. Han, X. Song, M. Currell, G. Cao, Y. Zhang, Y. Kang (2011) A survey of groundwater levels and hydrogeochemistry in irrigated fields in the Karamay Agricultural Development Area, northwest China:

implications for soil and groundwater salinity resulting from surface water transfer for irrigation. *Journal of Hydrology*, *405*(3-4), 217-234, https://doi.org/10.1016/j.jhydrol.2011.03.052.

[2] P.Li, H.Qian (2018) Water resource development and protection in loess areas of the world: a summary to the thematic issue of water in loess. *Environmental Earth Sciences*, *77*(24), 796, https://doi.org/10.1007/s12665-018-7984-3.

[3] Q. Zhang, H. Qian, P. Xu, P. Hou, F. Yang (2021) Groundwater quality assessment using a new integrated-weight water quality index (IWQI) and driver analysis in the Jiaokou Irrigation District, China. *Ecotoxicology and environmental safety*, *212*, 111992, https://doi.org/10.1016/j.ecoenv. 2021. 111992.

[4] L. J. West, N. E. Odling (2014) Groundwater. In *Water Resources* (pp. 123-160). Routledge, https://doi.org/10.4324/9780203489413.

[5] S. Krishna Kumar, S. HariBabu, P. EswarRao, S. Selvakumar, C. Thivya, S. Muralidharan, G. Jeyabal (2017) Evaluation of water quality and hydrogeochemistry of surface and groundwater, Tiruvallur District, Tamil Nadu, India. *Applied Water Science*, *7*(5), 2533-2544, https://doi.org/10.1007/ s13201-016-0447-7.

[6] P. L. Patrick, W. A. Arnold (2022) *Water Chemistry*, Oxford University Press, New York.

[7] A. H. Cheng (2000) *Multilayered Aquifer Systems: Fundamentals and Applications*. CRC Press.

[8] APHA (2022) Standard methods for the examination of water and wastewater, 24th edn. American Public Health Association, Washington.

[9] BIS (2012) Bureau of Indian Standards drinking water – Specification (second revision) IS 10500.

[10] R. K. Horton (1965) An index number system for rating water quality. *J Water Pollut Control Fed*, *37*(3), 300–305.

[11] A. K. Chaurasia, H. K. Pandey, S. K. Tiwari, R. Prakash, P. Pandey, A. Ram (2018) Groundwater quality assessment using water quality index (WQI) in parts of Varanasi District, Uttar Pradesh, India. *Journal of the Geological Society of India*, *92*(1), 76-82, https://doi.org/10.1007/s12594-018-0955-1.

[12] M. Agarwal, M. Singh, J. Hussain (2020) Evaluation of groundwater quality for drinking purpose using different water quality indices in parts of GautamBudh Nagar District, India. *Asian Journal of Chemistry*, *32*(5), 1128-1138, https://orcid.org/0000-0003-3595-750X.

[13] P. Shroff, R. T. Vashi, V. A. Champaneri, K. K. Patel (2015) Correlation study among water quality parameters of groundwater of Valsad district of south Gujarat (India). *Journal of fundamental and applied sciences*, *7*(3), 340-349, http://dx.doi.org/ 10.4314/jfas.v7i3.3.

[14] A. D. Mohammad, R. F. Rind (2020) An Application of WQI and Correlation Matrix to Evaluate Groundwater Quality Around Brick Kilns of Loralai District Balochistan. *Journal of Asian Scientific Research*, *10*(2), 88, https://doi.org/10. 18488/journal.2.2020.102.88.95.

[15] P. Ravikumar, R. K. Somashekar (2017) Principal component analysis and hydrochemical facies characterization to evaluate groundwater quality in Varahi river basin, arnataka state, India. *Applied Water Science*, *7*(2), 745-755, https://doi.org/10. 1007/s13201-015-0287-x.

[16] A. M. Piper (1944) A graphic procedure in the geochemical interpretation of water-analyses. *Eos, Transactions American Geophysical Union*, *25*(6), 914-928, http://dx.doi.org/10.1029/TR025i006p00914.

[17] A.Zaporozec (1972) Graphical interpretation of water-quality data. *Groundwater*, *10*(2),32-43, https://doi.org/10.1111/j.1745-6584.1972.tb02912.x.

[18] L. Elango, R. Kannan (2007) Rock–water interaction and its control on chemical composition of groundwater. *Developments in environmental science*, *5*, 229-243, http://dx.doi.org/10.1016/ S1474-8177(07)05011-5.

[19] R.J.Gibbs (1970) Mechanisms controlling world water chemistry. *Science*, *170*(3962),1088-1090, https://doi.org/10.1126/science.170.3962.1088.

[20] A. Marandi, P. Shand (2018) Groundwater chemistry and the Gibbs Diagram. *Applied Geochemistry*, *97*, 209-212, http://dx.doi.org/10. 1016/j.apgeochem.2018.07.009.

[21] N. S. Rao, B. Sunitha, L. Sun, B. D. Spandana, M. Chaudhary (2020) Mechanisms controlling groundwater chemistry and assessment of potential health risk: a case study from South India. *Geochemistry*, *80*(4), 125568, http://dx.doi.org/ 10.1016/j.chemer.2019.125568.

[22] P. Li, J. Wu, H. Qian (2013) Assessment of groundwater quality for irrigation purposes and identification of hydrogeochemical evolution mechanisms in Pengyang County, China. *Environmental Earth Sciences*, *69*, 2211-2225, http://dx.doi.org/10.1007/s12665-012-2049-5.

[23] J. Wu, P. Li, H. Qian, Z. Duan, X. Zhang (2014) Using correlation and multivariate statistical analysis to identify hydrogeochemical processes affecting the major ion chemistry of waters: a case study in Laoheba phosphorite mine in Sichuan, China. *Arabian Journal of Geosciences*, *7*, 3973-3982, http://dx.doi.org/10.1007/s12517-013-1057-4.

[24] P. Li, J. Wu, H. Qian, Y. Zhang, N. Yang, L. Jing, P. Yu (2016) Hydrogeochemical characterization of groundwater in and around a wastewater irrigated forest in the south eastern edge of the Tengger Desert, Northwest China. *Exposure and Health*, *8*, 331-348, https://link.springer.com/article/10.1007/ s12403-016-0193-y.

[25] P. Li, J. Wu, H. Qian (2016) Hydrochemical appraisal of groundwater quality for drinking and irrigation purposes and the major influencing factors: a case study in and around Hua County, China. *Arabian Journal of Geosciences*, *9*, 1-17, https://doi.org/10.1007/s12517-015-2059-1.

[26] N. Adimalla, P. Li, S. Venkatayogi (2018) Hydrogeochemical evaluation of groundwater quality for drinking and irrigation purposes and integrated interpretation with water quality index studies. *Environmental Processes*, *5*, 363-383, https://link.springer.com/article/10.1007/s40710-018-0297-4.

[27] X. Ren, P. Li, X. He, F. Su, V. Elumalai (2021) Hydrogeochemical processes affecting groundwater

chemistry in the central part of the Guanzhong Basin, China. *Archives of environmental contamination and toxicology*, *80*, 74-91, https://link.springer.com/article/10.1007/s00244-020-00772-5.

[28] S. Krishna Kumar, A. Logeshkumaran, N. S. Magesh, P. S. Godson, N. Chandrasekar (2015) Hydro-geochemistry and application of water quality index (WQI) for groundwater quality assessment, Anna Nagar, part of Chennai City, Tamil Nadu, India. *Applied Water Science*, *5*, 335-343, https://doi.org/10.1007/s13201-014-0196-4.

[29] F. Khan, S. Krishnaraj, P. Raja, G. Selvaraj, R. Cheelil (2021) Impact of hydrogeochemical processes and its evolution in controlling groundwater chemistry along the east coast of Tamil Nadu and Puducherry, India. *Environmental Science and Pollution Research*, *28*(15), 18567-18588, http://dx.doi.org/10.1007/s11356-020-10912-y

[30] Z. Gao, C. Han, Y. Xu, Z. Zhao, Z. Luo, J. Liu (2021) Assessment of the water quality of groundwater in Bohai Rim and the controlling factors—a case study of northern Shandong Peninsula, north China. *Environmental pollution*, *285*, 117482, https://doi.org/10.1016/j.envpol. 2021. 117482.

[31] T. K. Das, M. R. Shaibur, M. M. Rahman (2021) Groundwater Chemistry at Deep Aquifer in Koyra: Khulna, Bangladesh. *Current World Environment*, *16*(2), 460, http://dx.doi.org/10.12944/CWE.16. 2. 12.

[32] M. Bahir, O. El Mountassir, D. Ouazar, P. M. Carreira (2021) Hydrochemical analysis and evaluation of groundwater quality in Ouazi Basin (Essaouira, Morocco). In *Advances in Geoethics and Groundwater Management: Theory and Practice for a Sustainable Development* (pp. 247-250). Springer, Cham, http://dx.doi.org/10. 1007/978-3-030-59320-9_50.

IZVOD

PROCENA HIDROGEOHEMIJSKIH KARAKTERISTIKA I KVALITETA PITKE PODZEMNE VODE OKO JEZERA RETTERI U OKRUGU THIRUVALLUR, TAMIL NADU, INDIJA

Na hidrogeohemijske karakteristike podzemnih voda značajno utiče njihova interakcija sa mineralima vodonosnog sloja. Ovo zauzvrat utiče na kvalitet podzemne vode za njenu predviđenu upotrebu. Cilj ovog istraživanja je da se identifikuju procesi koji kontrolišu hidrogeohemijske karakteristike podzemnih voda oko jezera Retteri i da se proceni njihov kvalitet za piće. Uzorci podzemne vode sa 26 lokacija su prikupljeni sa područja istraživanja i izvršena je fizičko-hemijska analiza da bi se procenili parametri kvaliteta vode kao što su pH, električna provodljivost (EC), ukupne rastvorene čvrste supstance (TDS), ukupna tvrdoća (TH), ukupna alkalnost (TA), $Ca^{2+,}$ Mg^{2}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, $CO_3^{2-,}$ HCO^{3-} *i* NO^{3-}*. Korelaciona analiza za parametre kvaliteta vode je izvršena da bi se identifikovala priroda i stepen korelacije između različitih parametara. Uočena je jaka pozitivna korelacija između pH i HCO3-. EC i TDS pokazuju jaku pozitivnu korelaciju sa Ca2+, Mg2+, Na+, Cl- i SO42-. TH pokazuje jaku pozitivnu korelaciju sa Ca2+, Mg2+, Cl- i SO42-. Raspršene su dijagrame među glavnim jonima da bi se identifikovali geogeni procesi odgovorni za hidrogeohemijsku evoluciju podzemnih voda u oblasti istraživanja. Gibsovi dijagrami regiona istraživanja pokazuju da je interakcija vode i stene glavni proces koji utiče na sastav podzemnih voda. Pajperov dijagram otkriva da su Na-Cl i mešani Ca-Mg-Cl glavne hidrohemijske facije podzemnih voda u proučavanom regionu. Kvalitet podzemnih voda za piće je ispitivan kroz procenu indeksa kvaliteta vode (VKI) ponderisanom aritmetičkom metodom. Proračun VKI otkriva da je 19% uzoraka podzemnih voda odličnog kvaliteta, 62% uzoraka dobrog kvaliteta i 19% uzoraka lošeg do veoma lošeg kvaliteta.*

Ključne reči: *dijagram rasejanja, indeks kvaliteta vode, podzemne vode, ukupne rastvorene čvrste materije, ukupna tvrdoća i ukupni alkalitet.*

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Vanjinathan Mahalingam https://orcid.org/0000-0003-4823-2751
Muniraj Sarangapani https://orcid.org/0000-0003-4315-3069