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Hydro Geochemistry Of Groundwater Resources

L. Muthulakshmi¹*, P.Thillai Arasu¹, A.Murugan¹

¹Department of Chemistry, Kalasalingam University, Krishnankoil – 626 126, India

*Corres. Author: Imuthulakshmi2011@gmail.com & I_muthulakshmi@yahoo.co.in Mobile No – 9486613769

Abstract: The present study is aimed at assessing the water quality index (WQI) for the ground water in summer season. WQI gives quickly assess the any water system. Water samples from thirty bore wells at various locations in Virudhunagar district area were collected and analyzed for Temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), permanent hardness(PHA), temporary hardness (THA), carbonate, bicarbonate, Cl⁻, SO₄²⁻, SO₃²⁻, Ca²⁺, Mg²⁺, Na⁺, K⁺, dissolved oxygen(DO), biological oxygen demand (BOD), chemical oxygen demand (COD) using standard analytical procedure. The WQI for these samples ranges from 877 to 1475 in summer season. The high values of WQI have been formed to be mainly from the higher values of TDS, TA, TH, Cl⁻ Ca²⁺ and Mg2⁺ in the ground water. Hydrochemical facies of ground water samples have been ascertained by using piper-trilinear diagram which shows that the study areas are of high saline in nature, evidenced by lime nature of soil. The analysis revels that the ground water of the area needs some degree of treat before consumption.

Keywords: Ground water quality, Summer season, Piper-trilinear diagram, Water Quality Index.

Introduction And Experimental

Hydro geochemical study of ground waters depend on a number of factors including the nature of recharge, hydrologic gradient, and residence time in the aquifer, pollution by anthropogenic activities and rock-water interactions. Water demand has increased over the years, which leads to water scarcity, in many parts of the world. India is now heading towards a groundwater crisis, mainly, due to improper management of water resources and environmental degradation. Little research work is available on ground water quality and water pollution in Tamil Nadu¹⁻⁴. Many towns in South India are facing significant shortage of drinking water supply due to the lack of monsoon rainfall and water flow in South Indian Rivers, originated from Western ghats. The present study is to investigate the suitability of ground water for potability, impacts on quality and hydrochemical trends with summer season in the period from April to May in Virudhunagar.

Twenty water quality parameters (WQPs) have been examined by using standard recommended procedure⁵. The exact location of the study area in Virudhunagar district namely Srivilliputtur, Rajapalayam, Sivakasi, Sattur, Virudhunagar and Aruppukkottai lies between 11° 00' to 12° 00' latitude and 77° 28' to 78° 50' longitude. In order to ascertain the hydro chemical trend, thirty ground water (bore well) samples undertaken in summer season and analyzed.

Ground water potability for potable purposes and interrelationship of hydrochemical trends have also been analyzed by WQI⁶⁻⁸. Graphical methods such as Piper-trilinear diagram have also been applied in order to understand the impact of hydro-geochemistry or anthropogenic sources on ground water quality.

Water Quality Index (WQI)

WQI may be defined as a quality rating factor reflecting the composite influence on the overall quality of a number of WQPs. The extent of pollution can be understood by means of WQI in the case of fresh waters/ surface waters as well as effluents/ industrial waste waters. The need to determine various WQPs towards the definition of criterion for water quality has been well emphasised⁹. In the present study, WQI proposed by Tiwari and Manzoor Ali¹⁰ has been followed. The WQPs employed in the calculation of WQI and the procedures employed are discussed here.

The formation of a WQI is closely related to the intended use of water. It is a well known fact that the more harmful a given pollutant is, the lesser is its permissible value/ tolerance level for drinking water and hence the weights for various WQPs are assumed to be inversely proportional to the recommended standards for the corresponding parameters¹¹.

The unit weight (W_i) is given by the formula $W_i = K/S_i$, where, S_i is the recommended standard value for the ith WQP. K = 4.90, a constant. The quality rating, q_i , for the ith parameter is given by the equation: $q_i = 100 \times V_i/S_i$, where,

 V_i = experimental/ observed value of the ith parameter, except for pH and S_i = recommended standard for the ith parameter. For pH value, the relationship is

 $q_{pH} = 100 \left[\frac{\left(V_{pH} - 7.0\right)}{\left(8.5 - 7.0\right)} \right] \text{ where, } V_{pH} \text{ values are the observed pH values.}$

The WQI value can be calculated by employing the following relationship:

$$WQI = \frac{\sum_{i} (q_i w_i)}{\sum_{i} (w_i)} = \sum_{i} (q_i w_i)$$

Since, $\sum_{i} (w_i) = 1.0$ according to the condition for unit weight,

 $WQI = \sum_{i} (q_i w_i)$

From the observed values in the present investigation, water quality index (WQI) values are evaluated for various sub-urban in Virudhunagar district. Parameter wise ICMR, WHO, and EEC standards assigned unit weights are shown in Table 1.

Results And Discussion

In the present study, we have analyzed thirty water samples from various sources including tube well and dug well of different taluk of Virudhunagar district. The physico-chemical parameters of water quality were analyzed using standard methods given in APHA. The observation and graphical representation of physico chemical characteristics of collected water sample are given in table 2 and figure 1. WQI is established through the measure of various important physico chemical parameter of the ground water. The values of various physico chemical parameters for the calculation of WQI are present in table 3.

The observed range of WQI values in summer season was 877 for Srivilliputtur, 1158.7 for Rajapalayam, 1475, 1332, 1031, 1402 for Sivakasi, Virudhunagar, Sattur and Aruppukkottai respectively. The Water at almost all the sites showed the increasing trend of the WQI in summer season. Piper diagram is used to illustrate the major ions composition of groundwater samples (Figure 1). This diagram is particularly useful for detecting changes or trends in ground water chemistry across an area or through time.

WQI value is a measure of the pollution load. WQI =100 reveals that the water is unpolluted and suitable for the human comsumption¹². WQI >> 100 reveals that the water is highly polluted and not suitable for human consumption without further purification. From the observed values, in the present investigation,

water quality index (WQI) values are evaluated for various sub-urban in Virudhunagar district. It has been found that the WQI of Virudhunagar district is very high and water quality is completely unsuitable for drinking purposes.

S.No.	Parameter	Standard Value, S _i	Recommending Agency*	Unit Weight (w _i)		
1	рН	7.0 - 8.5	ICMR	0.0196		
2	Electrical conductance (µmho /	4.00	ICMR	0.0122		
	cm)					
3	Total dissolved solids	500	WHO	0.0098		
4	Total hardness (as CaCO ₃)	300	ICMR	0.0162		
5	Calcium	75	ICMR	0.0652		
6	Magnesium	50	ICMR	0.0980		
7	Chloride	250	ICMR	0.0196		
8	Sulphate	200	ICMR	0.0245		
9	Sodium	20	EEC	0.2450		
10	Potassium	10	EEC	0.4899		
Total	L			1 0000		

Table 1. Unit weightage factor of WQP for calculation of WQI *

* ICMR = Indian Council of Medical Research

WHO = World Health Organisation and

EEC = European Economic Community

Table 2. Statistica	l values o	f physico	chemical	l parameter
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	S	rivillipu	ttur	R	ajapala	yam	Sivakasi		
WQPs	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
pН	7.24	7.4	7.318	7.3	7.5	7.42	7.6	8.2	7.95
EC	1970	2390	2192	2140	2620	2284.6	2785 3266	3266	3035.6
TDS	1224	1550	1409.2	1346	1690	1457.2	2005	2182	2086.6
TA	376	398	389.2	340	363	351.6	534	578	557.4
TH	800	905	862.6	600	830	725.6	1015	1175	1111
Cl ⁻	275	468	387.6	510	715	579	680	842	755.8
SO4 ²⁻	147	164	155	135	159	145	187	206	196.8
Ca ²⁺	310	400	374.4	210	366	273.2	430	505	462.2
Mg ²⁺	230	246	236.6	122	246	172	280	370	318
Na ⁺	72	87	81.8	50	84	71	67	67 94 7	
\mathbf{K}^+	53	67	60.6	31	47	40.6	27	167	82.6
	Vi	rudhun	agar		Sattur	•	Aruppukottai		
WQPs	Min	Max	Avg	Min	Max	Avg	Min Max		Avg
pH	7.6	8.1	7.8	7.3	7.6	7.44	8.3	8.8	8.56
EC	2645	3406	2966.2	1715	2650	2373.6	2990 3174		3050.2
TDS	1685	2264	1983.8	1527	1693	1641.8	2051	2130	2078
TA	500	520	506.8	460	500	477.6	470 503		486.8
TH	1030	1210	1126	1020	1040	1029	1035 1070		1048
Cl ⁻	413	825	630.6	335	505	450	796	873	829.8
SO4 ²⁻	187	207	197.8	158	165	161.6	176	192	185.4
Ca ²⁺	508	550	524	516	557	533.2	510	603	540.6
Mg ²⁺	362	402	388.8	394	405	399.4	333	369	349.2
Na ⁺	60	126	99.6	48	86	69	97	117	104.8
12+	45	70	57 /	35	48	43	52	66	60.6



Figure 1: Piper – Trilinear diagram of chemical facies of ground water samples in summer season

Conclusion

On the basis of the above discussion, it may conclude that the underground water in almost all the sites at Virudhunagar district is highly polluted in summer season. Therefore, the use of ordinary hand pumps should be discouraged. People dependent on this water are often prone to health hazards due to polluted drinking water. Therefore, indigenous technologies should be adopted to make water fit for drinking after treatment of desalination. The safe drinking water in quality affected areas could also be provided by sanctioning schemes based on surface water sources.

Srivilliputtur							Rajapalayam					
WQPs	Si	Vi	Wi	Qi	Wi log Qi	WQI	Si	Vi	Wi	Qi	Wi log Qi	WQI
pН	8.5	7.42	0.196	87.294	0.380433		8.5	7.318	0.196	86.094	0.3793	
EC	300	2284.6	0.0122	761.53	0.035157		300	2192	0.0122	730.67	0.0349	
TDS	500	1457.2	0.0098	291.44	0.024153		500	1409.2	0.0098	281.84	0.024	
TA	200	351.6	0.0245	175.8	0.055003		200	389.2	0.0245	194.6	0.0561	
TH	300	725.6	0.0163	241.87	0.038852		300	862.6	0.0163	287.53	0.0401	
Cl -	250	579	0.0196	231.6	0.046349	877	250	387.6	0.0196	155.04	0.0429	1158.7
SO4 ²⁻	200	145	0.0245	72.5	0.045578		200	155	0.0245	77.5	0.0463	
Ca ²⁺	75	273.2	0.0652	364.27	0.167005		75	374.4	0.0652	499.2	0.1759	
Mg ²⁺	50	172	0.098	344	0.248583		50	236.6	0.098	473.2	0.2622	
Na ⁺	20	71	0.245	355	0.624806		20	81.8	0.245	409	0.6399	
K ⁺	10	40.6	0.4899	406	1.277917		10	60.6	0.4899	606	1.3631	
			Sivak	asi				1	Viru	idhunaga	ır	
WQPs	Si	Vi	Wi	Qi	Wi log Qi	WQI	Si	Vi	Wi	Qi	Wi log Qi	WQI
pН	8.5	7.95	0.196	93.529	0.386306		8.5	7.8	0.196	91.765	0.3847	
EC	300	3035.6	0.0122	1011.9	0.036663		300	2966.2	0.0122	988.73	0.0365	
TDS	500	2086.6	0.0098	417.32	0.025681		500	1983.8	0.0098	396.76	0.0255	
TA	200	557.4	0.0245	278.7	0.059906		200	506.8	0.0245	253.4	0.0589	
TH	300	1111	0.0163	370.33	0.041868		300	1126	0.0163	375.33	0.042	
Cl -	250	755.8	0.0196	302.32	0.048617	1475	250	630.6	0.0196	252.24	0.0471	1332.3
SO4 ²⁻	200	196.8	0.0245	98.4	0.048828		200	197.8	0.0245	98.9	0.0489	
Ca ²⁺	75	462.2	0.0652	616.27	0.181893		75	524	0.0652	698.67	0.1854	
Mg ²⁺	50	318	0.098	636	0.274739		50	388.8	0.098	777.6	0.2833	
Na ⁺	20	78.4	0.245	392	0.635355		20	99.6	0.245	498	0.6608	
K ⁺	10	82.6	0.4899	826	1.429029		10	57.4	0.4899	574	1.3516	
	r.		Sattu	ır			Aruppukkottai					
WQPs	Si	Vi	Wi	Qi	Wi log Qi	WQI	Si	Vi	Wi	Qi	Wi log Qi	WQI
pН	8.5	7.44	0.196	87.529	0.380662		8.5	8.56	0.196	100.71	0.3926	
EC	300	2373.6	0.0122	791.2	0.035359		300	3050.2	0.0122	1016.7	0.0367	
TDS	500	1641.8	0.0098	328.36	0.02466		500	2078	0.0098	415.6	0.0257	
ТА	200	477.6	0.0245	238.8	0.058262		200	486.8	0.0245	243.4	0.0585	
TH	300	1029	0.0163	343	0.041325		300	1048	0.0163	349.33	0.0415	
Cl ⁻	250	450	0.0196	180	0.044203	1031.3	250	829.8	0.0196	331.92	0.0494	1402.1
SO_4^{2-}	200	161.6	0.0245	80.8	0.046732		200	185.4	0.0245	92.7	0.0482	
Ca ²⁺	75	533.2	0.0652	710.93	0.185939		75	540.6	0.0652	720.8	0.1863	
Mg ²⁺	50	399.4	0.098	798.8	0.284439		50	349.2	0.098	698.4	0.2787	
Na ⁺	20	69	0.245	345	0.621766		20	104.8	0.245	524	0.6662	
K ⁺	10	43	0.4899	430	1.290136		10	60.6	0.4899	606	1.3631	

Table 3. Water Quality Index Calculation (WQI) of Ground water in Summer season

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