Hydrochemical Investigation Of Groundwater In Some Parts Of Thanthoni And Karur Region, Tamilnadu, India

Jafar Ahamed, A, Loganathan, K, Ananthakrishnan, S.

Abstract: - The current study is focused on groundwater quality assessment of some parts of Thanthoni and Karur block in Karur District, Tamilnadu. Groundwater quality of the study area was evaluated for its suitability for drinking purposes by collecting ten samples during pre-monsoon season (August 2012) by adopting standard analytical techniques of APHA (2005). The water samples collected in the stations were analyzed for Electrical Conductivity (EC), pH, Total Dissolved Solids (TDS), Total Hardness (TH), major cations like calcium, magnesium, and anions like bicarbonate, chloride, nitrate, fluoride and sulphate. The study revealed that some water sources in the region are not suitable for drinking with respect to total hardness, calcium and magnesium content. Proper maintenance and treatment of water can improve the quality of drinking water and thereby a safer life.

Index Terms:- Groundwater, Hydrochemistry, Water Quality Index, Thanthoni, Karur

1 INTRODUCTION

WATER chemistry is a focal point of environment factors such as hydrology, precipitation, stratum, soil, vegetation, chemical and physical weathering and shows a sensitive response to regional and global environment change [1]. Scarcity of water resources can have both quantitative and qualitative aspects. When demand exceeds availability, supplies are insufficient to meet the needs of growing populations and economic development, and such situations can be aggravated by irrational use of water or the unfavorable climatic conditions. At the same time, water quality can be compromised as a result of the disposal of solid wastes, discharge of untreated industrial and domestic effluents, and agricultural activities involving the use of fertilizers and pesticides. Poor land management can further exacerbate the problem, due to deforestation, erosion, and the silting up of waterways [2]. Groundwater is highly valued because it constitutes the major drinking water source in most of the parts in India. Groundwater accounts for about 88% of the safe drinking water in rural areas where water treatment and transport do not exist. According to the Central Groundwater Board, the dynamic fresh groundwater resources of India have been estimated at 432 km^3/year, of which 396 km^3 is estimated to be utilizable [3]. Depletion of groundwater levels and deterioration of water quality requires immediate attention. The results of this present investigation are of direct importance to the local residents, though groundwater is important source of drinking purpose.

- Dr. A. Jafar Ahamed, (Corresponding author), Associate Professor, Department of Chemistry, Jamal Mohamed College (Autonomous), Tiruchirappalli-620 020, Tamilnadu, India. HP: +91-9003576896;
  E-mail: agjafar@yahoo.co.in
- K. Loganathan, Research Scholar, Department of Chemistry, Jamal Mohamed College (Autonomous), Tiruchirappalli-620 020, Tamilnadu, India.
  E-mail: chemistrylogu@gmail.com
- S. Ananthakrishnan, Assistant Professor, Department of Chemistry, Rover Engineering College, Perambalur-621 212, Tamilnadu, India.
  E-mail: ananthajmc2011@yahoo.com

2 MATERIALS AND METHODS

2.1 Site description

Thanthoni is one of the municipal towns in Karur district which lies between 10° 45' and 11° 45' northern latitude and between 77° 45' and 78° 07' eastern longitude. The town is situated on plain fertile lands at an average elevation of 391 meters above MSL. The general topography of the town is flat slope along northern direction towards Amaravathi River, which is the major primary drain in the town. Amaravathi River runs to an approximate length of 1 km along the northern boundary of the town. Black soil is the predominant soil type in the town accounting for 35% followed by lateritic soil for 23%. The remaining is comprised of sandy and alluvium soil.

2.2 Sampling

Ten groundwater samples were collected in August 2012 from deep hand pumps after flushing water for 5-10 minutes to remove the stagnant water. The sampling stations are shown in Fig 1. Sampling containers were washed, rinsed with distilled water and dried before use. Water samples were collected in 2L polyethylene bottles, transported to the laboratory and the experiments were carried out.

2.3 Analytical procedure

Water samples were analyzed for 12 physico-chemical parameters, which include pH, EC, TDS, TH, Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^-, F^-, SO_4^{2-} and NO_3^-. The parameters were determined using the standard methods for the examination of water and wastewater suggested by American Public Health Association [4]. pH, EC and TDS were measured on the field utilizing the portable meter (Elico PE 138) and other parameters were determined in laboratory. TH, Ca^{2+} and Mg^{2+} were determined titrimetrically using standard EDTA. HCO_3^- was measured by acid-base titration. Chloride was estimated by $AgNO_3$ titration, while sulphate was determined using the Vogel's method. Nitrate determination was performed by using the Brucine method. Fluoride was determined by SPADN'S method using spectrophotometer.

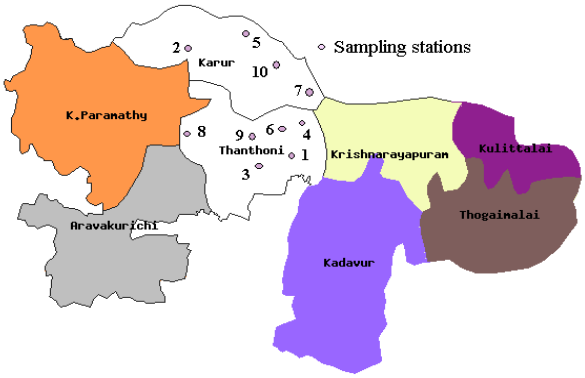

Fig. 1 Location map of the study area

2.4 Data analysis

Water quality index (WQI) provides the overall water quality at a certain location and time, based on several water quality parameters. A water quality index based on some very important parameters can provide a simple indicator of water quality. To determine the suitability of the groundwater for drinking purposes, Water Quality Index [5] is computed by adopting the method which is formulated as

$$WQI = \Sigma^{n}_{i=1} (QiWi) / \Sigma^{n}_{i=1} (Wi) \quad (1)$$

Where, W_n, weightage = K/S_n and K, constant = $1/ [1/s_1 + 1/s_2 +....1/S_n]$ and S_n correspond to the WHO/ICMR standard value of the parameters. Quality rating (Q_i) is calculated as $Q_{ni} = [(V_{actual} – V_{ideal})/ (V_{standard} – V_{ideal})]*100$ where Q_{ni} = quality rating of 'i'th parameter for a total of 'n' water samples V_{actual} = value of the water quality parameter obtained from the analysis. $V_{standard}$ = value of the water quality parameters obtained from the standard tables. V_{ideal} for pH=7 and for the other parameters it is equal to zero [6].

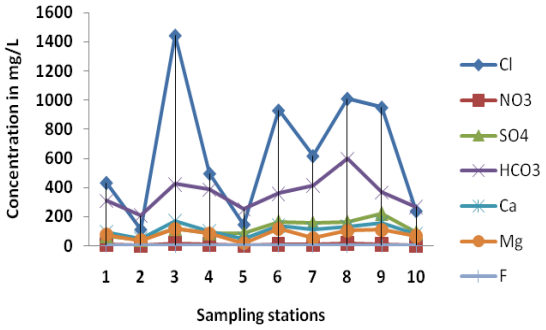

Fig. 2 Major cations and anions

3 Results and Discussion

Quality of groundwater determines its suitability for different purposes depending upon the specific standards. Chemically, the water used for drinking should be soft, low in dissolved salts and free from toxic constituents. The drinking water standards of WHO [7] and Bureau of Indian Standards [8] was the basis for the groundwater quality evaluation for drinking use. The values of water quality parameters are furnished in Table 1.

TABLE 1
CONCENTRATION OF PHYSICO-CHEMICAL WATER QUALITY PARAMETERS

Stations	pH	EC	TDS	TH	Cl^-
S1	7.81	1879	1315	557	432
S2	7.34	831	582	287	111
S3	7.70	4792	3354	915	1444
S4	7.45	2382	1667	597	495
S5	8.06	1065	745	199	145
S6	7.63	3438	2407	826	929
S7	8.05	2716	1901	498	616
S8	7.12	4240	2968	776	1010
S9	6.99	4110	2877	866	949
S10	7.71	1384	969	490	238
NO_3^-	SO_4^{2-}	HCO_3^-	Ca^{2+}	Mg^{2+}	F^-
7	70	310	96	76	1.2
3	43	207	48	40	0.6
16	118	422	171	117	0.8
7	89	386	100	84	0.8
4	89	251	48	19	0.6
11	166	358	139	115	1.0
9	157	414	111	53	1.4
15	163	597	135	105	0.2
12	221	366	159	112	1.0
6	92	267	83	68	0.8

3.1 Major ion chemistry

The groundwater samples have the pH values ranging from 6.99 to 8.06 indicating faintly alkaline nature. Electrical conductivity is a useful and reliable index for the measurement of water salinity or total dissolved solids in water. EC is an indicator of dissolved solids-minerals, salts, metals, cations or anions that dissolved in water [9]. The EC ranges from 831 to 4792 µS/cm. TDS range from 582 to 3354 mg/L. The desirable limit of TDS is 500 mg/L [7] all the samples exceed the desirable limit. The presence of high level of TDS may be due to water pollution caused by the waste water runoff from mine waste, industrial waste and residential area which are discharged into water bodies. Mineral ions start migration down to the water table and increase the TDS in groundwater [10]. The phenolphthalein alkalinity value in the samples is zero indicating absence of carbonate and hydroxyl ions. The maximum total alkalinity was recorded as 597 mg/L and the minimum was recorded as 207 mg/L, none of the samples are in desirable limit of 200 mg/L (Fig 2). Hardness of water is caused by the presence of multivalent metallic cations and is largely due to calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. Hardness value ranges from 199 to 915 mg/L which indicates water is hard to very hard in the study area. Calcium concentrations in the samples were found to vary from 48 to 171 mg/L except S2 and S5. All the other samples show higher value than desirable limit of 75 mg/L. Magnesium in the water sample ranges from 19 to 117 mg/L, showing magnesium is not under desirable limit of 30 mg/L, except S2 and S5. The Chloride concentration of the samples ranges from 111 to 1444 mg/L (Fig 2) which is much higher than desirable limit [7]. The sulphate content varies between 43 and 221 mg/L which are within the desirable limit except sample

S9. Concentration of fluoride is found to be low (< 1.5 mg/L) in all the samples. Nitrate concentrations in all the water samples are within the desirable limit of 45 mg/L.

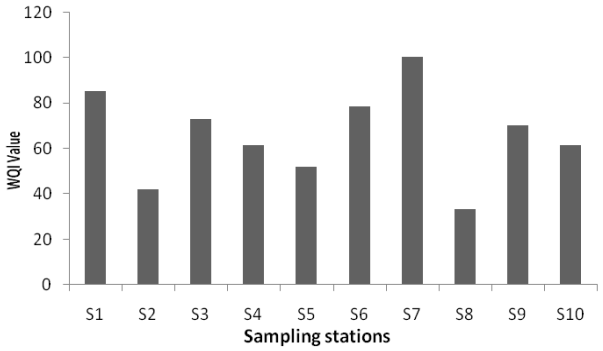

Fig. 3 WQI for sampling stations

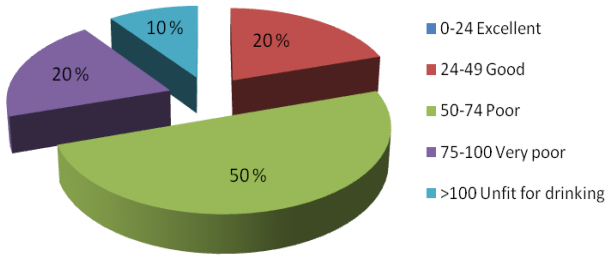

Fig. 4 Water Quality Index rating and their categories

3.2 Water quality index

Value of WQI of Thanthoni and Karur block were presented in Fig 3. The water quality rating analysis reveals that 20 % of the samples were found as good category, while 50 % samples (Fig 4) were poor, which may be due to weathering and man-made pollutants. Similarly, 20 % samples are in very poor condition and one sample is not fit for drinking. None of the samples are in excellent category.

4 Conclusion

Groundwater quality varies from place to place and also with the water table depth. High values of TDS, TH, chloride, alkalinity, calcium and magnesium were found in most of the groundwater samples. WQI value also reveals that water is not suitable for drinking except station S2 and S8. Special care should be taken to protect this essential resource from being polluted by agricultural fertilizers and other human activities.

Acknowledgment

The authors are thankful to the University Grants Commission (UGC), New Delhi for providing major research fund and the Members of the management committee and the Principal of Jamal Mohamed College for providing the necessary facilities.

References

[1] Tao Pu, Yuanqing He, Guofeng Zhu, Huijuan Xin, Weihong Cao and Hewen Niu, (2012). Hydrochemical characteristics of typical rivers in a temperate glacier basin, China. Environment Earth Science., DOI 10.1007/s12665-012-1764-2.

[2] Garcia, C.A.B., Hora Alves, J.d.P., de Aguiar Netto, A.O., Ferreira, R.A., Gonzaga da Silva, M, (2012). Physical and chemical characteristics of water from the hydrographic basin of the Poxim River, Sergipe State, Brazil. Environmental Monitoring Assessment, DOI 10.1007/s10661-012-2880-x.

[3] Mohan, D., Singh, V.K., Bikundia, D.S., Sarswat, A, (2012). Groundwater quality assessment in the village of Lutfullapur Nawada, Loni, District Ghaziabad, Uttar Pradesh, India. Environmental Monitoring Assessment, 184: 4473-4488.

[4] APHA (2005). Standard methods for the examination of water and waste water (21st edn). American Public Health Association, Washington DC.

[5] Tiwari, T.N., Mishra, M.A, (1985). A preliminary assignment of water quality index to major Indian rivers. Indian Journal of Environmental Protection, 5: 276-279.

[6] Rizwan Reza, and Gurdeep sing, (2010). Assessment of groundwater quality status by using Water Quality Method in Orissa, India. World Applied Science Journal, 9 (12); 1392-1397.

[7] WHO (2005). International standards for drinking water. World Health Organization, Geneva.

[8] BIS (2003). Indian standards specification for drinking water 15:10500. Bureau of Indian Standard, New Delhi.

[9] Ogunfowokan, A.O., Obisanya, J.F., Ogunkoya O.O, (2012). Salinity and sodium hazards of three streams of different agricultural land use systems in Ile-Ife, Nigeria. Applied Water Science, DOI 10.1007/s13201-012-0053-2.

[10] Shyamala, R., Shanthi, M., Lalitha, P, (2008). Physiochemical analysis of bore well water Samples of Telungupalaym area in Coimbatore district, Tamil Nadu, India. E- Journal of Chemistry, 5(4): 924–929.