Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Special Issue [1]2022 : 840-843

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Water Quality Index of Groundwater Proximity to Ramanathapuram District, Tamil Nadu, India

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ABSTRACT

Groundwater samples were collected from in and around Ramanathapuram and analyzed for their physicochemical characteristics. Thirty groundwater samples were collected andsubjected for the period from November-2019 to May-2020 for three different seasons.A detailed study was made in the study area for the quality of groundwater for drinking in rainy, winter and summer seasons respectively based on the Water Quality Index (WQI). The present investigation is focused on the determination of physicochemical parameters such as pH, Electrical Conductivity, Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}), Nitrate (NO^{3-}), Sulphate (SO_4^{2-}),Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^{-}) and chloride (Cl^{-})were analyzed. The results were compared with the World Health Organization standards. The quality of groundwater samples were discussed with respect to these parameters and thus an attemptwas made to ascertain the quality of ground water is fit or not for drinking and other purposes.

Keywords: Physico-chemical, parameters, Groundwater, WQI, WHO

Received 24.02.2022 Revised 19.03.2022 Accepted 09.04.2022

INTRODUCTION

The quality of groundwater is as important as its quantity because it is the major factor in determining its suitability for drinking, domestic, irrigation and industrial purposes. The purpose of ground water analysis is to assess the adequacy, surplus, or deficiency of available nutrients for vegetation growth and to monitor the changes brought about by the mining practices. Applications of piper diagram and water quality index for the quality assessment of groundwater in Senthaneer puram and Sempattu areas, studied by R. Abdul Vahith, [1].J. Sirajudeen reported the Applications of water quality index for groundwater quality assessment on Tamilnadu and Pondicherry[2]. Soil disturbance and associated compaction results in conditions conducive for erosion examined by Arvind Kumar Rai [3]. Studies on heavy metal pollution of ground water sources between Tamilnadu and Pondicherry analysed by A. Abdul Jameel[4].A case study on the effects of coal mining in the environment particularly in relation to Soil, Water and Air causing a socio-economic hazard in Asansol- Raniganj Area, investigated by Debasis [5]Edmunds WM, studied Groundwater chemistry and health: an overview [6].Chemometrics in environmental analysis by Einax JW [7]. Frengstad B investigate the chemistry of Norwegian groundwaters [8]. The chemical evolution of ground water in the Milk river aquifer, studied by Henry JM [9]. Assessment of heavy metal pollution in water using multivariate statistical techniques in an industrial area examined by Krishna AK [10]. Lad, R. J reported the Impact of bauxite mining on soil [11]. Groundwater arsenic contamination examined by Lado LR [12]. Spatial characterization of dissolved trace elements and heavy metals in the upper Han River investigated by Li S [13]. Assessment of environmental soil quality around Sonepur Bazari mine of Raniganj coalfield has been examined by Masto [14]. Moncur MC has been investigated the release, transport, and attenuation of metals from an old tailings impoundment [15]. The drinking quality of water depends on various suspended, dissolved and biological constituents.The World Health Organization (WHO 2006)have prescribed maximum permissible limits for various dissolved ions in water used for human intake. Researchers around the world have studied the quality of water based on these standards.

MATERIAL AND METHODS

STUDY AREA

Ramanathapuram is one of the coastal district.The district is bounded on the south by Thoothukudi and Thirunelveli district, on the west by Sivagangai and Virudhunagar district, north by Pudukkottai district, on the east by Bay of Bengal and the Gulf of Mannar.The district headquarters is located at Ramanathapuram. The district lies between 9^{o} 05' and 9^{o} 50' North Latitude and 78^{o} 10' and 79^{o} 27' East Longitude Shows in Figure.1. The general geographical information of the district is simple and flat. Vaigai river and Gundar river are flowing in the district and they will be dry during the summer season. The total geographical area of the district is 4,175 sq.km. Ramanathapuram district commonly referred as a drought prone region in Tamil nadu. The district has a dry, hot weather condition throughout the year except the North East monsoon season in November and December.It consists of 7 taluks, 11 blocksand 429 Panchayat villages. Based on census (2011), the district of Ramanathapuram had a population of 1,353,445 individuals, with a sex-ratio of 983 females for every 1,000 males, much above the national average of 929. The soils of Ramanathapuram District can be assorted into the main types viz., clay, coastal alluvium, sandy loam, alluvium, sandy and red soil clay, black cotton soil is believed to have been derived from the Archaen gneisses where calcareous formation are abundant. Calcium carbonate concretions of various sizes and shapes are present in majority of the black soil area and this affects the fertility of the soils. Black soil, as a whole constituted about 46 per cent of the total soil. River alluvium includes alternate layers of sand and clay for a huge thickness. River alluvium occurs in areas bordering the Vaigai River. Coastal alluvium occurs in Kadaladi, R.S.Mangalam, Mandapam, Ramanathapuram, Thiruppullani and Thiruvadanai blocks. There are vast stretches of saline and alkaline soils found in the coastal blocks. Rameswaram Island contains mainly sandy soil. The fertility status of soil showed that nitrogen status of soil is low in all blocks and phosphorus status of soil is also low in all blocks except Thiruppullani, Kamudhi and Kadaladi where it is medium. The potash content of soil is high in all the blocks. The mineral resources of the soil include gypsum, limestone and magnesium. While Mudukulathur and Keelakarai regions account for sizable deposits of gypsum. Rameswaram Island contains large quantities of limestone deposits. The North western part of the Ramanathapuram district exposes isolated patches of Archaeans crystallines and Cuddalore Sandstone is capped by laterite/lateritic soil. The samples were collected in polyethylene bottles (2.0 litres capacity) which have been thoroughly washed, filled with distilled water and then taken to the sampling site. The bottles were emptied and rinsed several times with the water to be collected. Also, the sample bottles were partially filled with the collected water and vigorously shaken to note the odour. The sample bottles were tightly covered immediately after collection and the temperature taken. They were then stored in a refrigerator at 4^{o}C to slow down bacterial and chemical reaction rates. All the parameters were analysed using standard procedure of APHA (1995). The sample numbers and their corresponding village names are given in Table 1. Water samples were collected during the month of November 2019- May 2020. A statistical summary indicating minimum, maximum, mean and standard deviation of the geochemical parameters are also made in the different seasons.Suitability of the groundwater samples for drinking in both the seasons was interpreted based on the water quality index for drinking water. WQI was calculated based on pH, Electrical Conductivity, Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potassium (K^{+}), Nitrate (NO^{3-}), Sulphate (SO_4^{2-}), Carbonate (CO_3^{2-}), Bicarbonate (HCO_3^{-}) and Chloride (Cl^{-})

RESULTS AND DISCUSSIONS

Water Quality Index (WQI)

Water Quality index (WQI) is defined as a technique of rating which provides the composite influence of individual water quality parameter on the overall quality of water. It is calculated from the point of view of human consumption. The average means concentration of the ten physico-chemical parameters such as pH, EC, TDS, TH, Ca, Mg, Na, NO_3^{-}, SO_4^{2-}, $CO_3^{2-}HCO_3^{-}$and Cl^{-} was used for the calculation of WQI.

The calculation involves the following steps

First, the calculation of weightage of ithparameter.

Second, the calculation of the quality rating for each of the water quality parameters.

Third, the summation of these sub-indices in the overall index.

The weightage of ith parameter

$W i = k/Si$ (1)

Where

Wi is the unit of weightage,

Si them recommended standard for ith parameter (I =1-6) and

k is the constant of proportionality.

Individual quality rating is given by the expression

$Qi=100V/Si$ (2)

Where

Qi is the sub index of ith parameter,

Vi is the monitored value of the ith parameter in mg/l and

Si the standard or permissible limit for the ith parameter.

The Water Quality Index (WQI) is then calculated as follows

$WQI = \Sigma_i^{n=1}(QiWi)/ \Sigma_i^{n=1}Wi$ (3)

Where,

Qi is the sub index of ith parameter,

Wi is the unit weightage for ith parameter and

n is the number of parameters considered.

Generally, the critical pollution index value is 100.

Table 1: Calculation of WQI values of ground water samples collected near Ramanathapuram District during November 2019- May 2020

Parameters	Mean value in ppm (V_i)	Highest permitted value (WHO) (S_i)	Unit weightage (wi)	Wi×Qi
pH	8.0	8.5	0.117	11.0
EC	3315.7	500	0.002	1.32
TDS	1983.1	500	0.002	0.793
TH	566.7	500	0.002	0.226
Ca	75.9	100	0.01	0.759
Mg	82.7	150	0.006	0.330
Na	462.3	200	0.005	1.155
NO_3^-	80.0	50	0.02	3.2
SO_4^{2-}	266.9	250	0.004	0.427
CO_3^-	8.4	600	0.0016	0.002
HCO_3^-	401.7	350	0.0028	0.321
Cl^-	735	250	0.004	1.176

$WQI=\sum_{i=1}^{n}(QiWi)/ \sum_{i=1}^{n}Wi$ **WQI=123.2**

Table 2: Status Categories of WQI

WQI	Quality of Water
0-25	Very Good
26-50	Good
51-75	Poor
Above 75	Very Poor(Unsuitable for Drinking)

In this study, the computed WQI value is 123.2 and therefore can be categorized into unsuitable water for drinking purposes (Table 2) the high value of WQI at is mainly due to the higher values of EC, TDS, Na and Cl in the ground water.

CONCLUSION

The groundwater of study areas was collected and analysed for various physico-chemical parameters. Ramanathapuram district is underlain entirely by Archaean rocks comprising granite gneiss, charnockite, granites and other associated consolidated crystalline rocks devoid of primary porosity but rendered porous and permeable with the development of secondary fracturing, inducing relatively longer residence time of groundwater. The WQI calculated values showed that the water quality of the study area is very poor and not suitable for drinking purpose. The results confirm that the ground water quality of this area is highly affected by the Ramanathapuram district. So that they will play their role in improving the quality of water for a safe and healthy life.

ACKNOWLEDGEMENT

We thank DBT star college scheme and DST- FIST Funded instrumentation centre for providing instrumentation specialty to this work.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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CITATION OF THIS ARTICLE

R. Abdul Vahith, A.Mohamed Mahadir, J.Sirajudeen, J.Muneer Ahamath and S.S.Syed Abuthahir. Water Quality Index of Groundwater Proximity to Ramanathapuram District, Tamil Nadu, India. Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022 : 840-843