International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 3(K); March 2018; Page No. 11183-11187
DOI: http://dx.doi.org/10.24327/ijcar.2018.11187.1929

Research Article

EVALUATION OF HYDROCHEMICAL CHARACTERIZATIONS OF GROUNDWATER IN LOWER TAMIRABHARANI RIVER BASIN, SOUTHERN INDIA

Mohammed Musthafa K[1]., Thirukumaran© V[2]., Suresh M[3] and Suresh R[1]

[1]Department of Geology, Periyar University, Salem-11
[2]Department of Geology, Government Arts College (Auto), Salem-636007
[3]Narasu's Sarathy Institute of Technology, Poosaripatty, Salem – 636 305

ARTICLE INFO

Article History:

Received 16th December, 2017
Received in revised form 20th January, 2018 Accepted 4th February, 2018
Published online 28th March, 2018

Key words:

Tamirabarani River, Irrigation, groundwater, Wilcox's Doneen's.

ABSTRACT

For the evaluation of the groundwater irrigation quality in lower Tamirabarani river basin, systematic samples were carried out during the month of January 2017. Fifty-eight water samples from agricultural and domestic usage wells this region. The proper equal grid methodology was adopted in the sample collection. Analyzed for major and minor ions such as EC, pH, TDS, Ca, Mg, HCO3, Cl, SO_4, Na, Fe, K, NO3 and F etc., These data were assessed fi or unfit for an irrigational uses based on the various guidelines. As per the SAR and RSC classification shows that more than 70% of the samples fell under suitable for irrigational purposes. The Gibbs' outlines recommend that rock weathering and precipitation are the primary processes that contribute water chemistry. Evaporation does not have a dominating effect on groundwater quality. U.S. Salinity Laboratory diagram, Wilcox's and doneens's interpretation reveals that more than 70% of the samples fell under appropriate for irrigational purposes. This category was chief in the upper Tamirabharani region and it is appropriate for irrigation uses. Over view of the research work shows that the unfit groundwater samples were located in the coastal track. So it may be sea water intruded in land portion.

INTRODUCTION

Groundwater is one of the earth's renewable resources that occur as part of hydrogeological formation of permeable structured zone of rocks, sand or gravel where the geological setup is congenial to the inflow and storage of water (Ballukraya and Ravi 1999). This resource becomes usable when the subsurface formations are porous and permeable enough to release appreciable quantities of water for extraction. It contributes 0.61% of earths total water resources (Subramani, 2005), which forms one of the potential sources of drinking water all over the world. It is estimated that by the year 2025 about 350km 3 of ground water will be required for our country (Von Der Gracht *et al*. 2010). Irrigation potential increased from 23 million hectares in 1951, since attaining independence to about 100 million hectares now. The production of support food grains has extended from around 50 million tons in the fifties to around 200 million tons, would require 450 million tons by the year 2050. Most of the scientists have utilized hydrogeochemical framework was executed for the quality of irrigational status in numerous nations everywhere throughout the world, such as India (Kumar *et al*. 2014 and Srinivas *et al*. 2015), China (Li *et al*. 2013; Wei *et al* 2015), Astralia (Skrzypek and Dogramaci 2013), Brazil (Marimon *et al*. 2013), Italy (Cucchi *et al*. 2008; Ghiglieri *et al*. 2009; Vigna *et al*. 2010), Bangladesh (Rahman *et al*. 2016; Islam *et al*. 2017; Traditionally rural water supply systems are based on ground water sources (more than 85%). About 85% of the groundwater sources are drawn for irrigation and rural drinking water draws hardly 3%. Ground water development in Delhi, Haryana, Punjab & Rajasthan is more than 100% and in States of Gujarat, Karnataka, Tamil Nadu and Uttar Pradesh it is more than 70%. (CGWB report 2006).

Corresponding author:* **Mohammed Musthafa K
Department of Geology, Periyar University, Salem-11

Study Area

Tamirabarani River originated from Agastyarkoodam peak in Pothigai hills at the Western Ghats. The river flows through Tirunelveli and Tuticorin districts of Tamil Nadu. The stretch of the Tamirabarani River is nearby 125 km. The study area (Figure 1) forms a lower Tamirabharani River Basin which falls within the longitudes 77°38'50" and 78°8'22" E and Latitude of 8°26'35" and 8°54'09" N in Survey of India (SOI) toposheet 58H10, 13, 14 and 58L/2 of 1:50000 scale which lies in parts of Thirunelvelli and Thoothukudi district. It has a total study area of an about 1175.79 Sq.km. Easternportion of the region is a coastal zone of the Gulf of Mannar. The Westernportion of the region is underlined by the Archaean crystalline rocks.

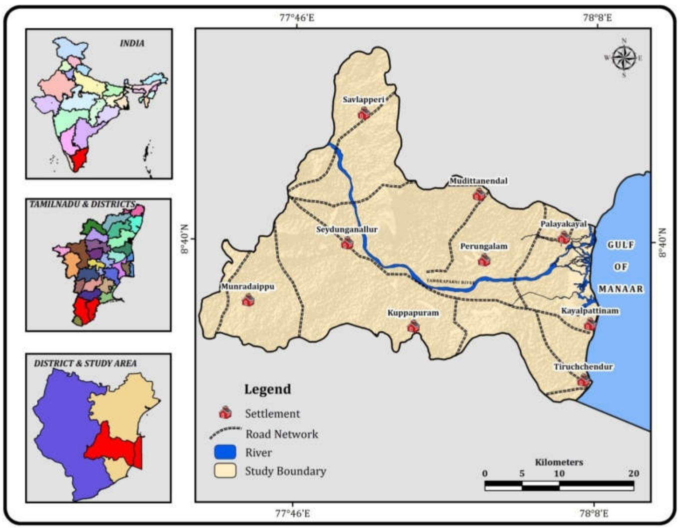

Fig 1 Key Map of the Study Area

METHODOLOGY

Hydrochemical studies were carried out in lower Tamirabarani river basin; systematic samples were carried out during the month of January 2017. 58 representative groundwater samples were collected from different locations of the study area. Fifty-eight water samples from agricultural and domestic usage wells this region. The proper equal grid methodology was adopted in the sample collection. The proper equal grid methodology was adopted in the sample collection. Analyzed for major and minor ions such as EC, pH, TDS, Ca, Mg, HCO3, Cl, SO_4, Na, Fe, K, NO3 and F etc.,

pH and EC were estimated at the field utilizing Elico pH and conductivity meter. Ca and Mg were resolved titrimetrically utilizing standard EDTA technique and chloride was dictated by silver nitrate titration (Vogel, 1968) strategy. Carbonate and bicarbonate were appraised with standard sulphuric acid. Sulfate was resolved gravimetrically by accelerating $BaSO_4$ from $BaCl_2$. Na and K were measured by Elico flame photometer (APHA, 1996). For assurance of appropriateness for water system utilize SAR, %Na and PI were ascertained and plotted on USSL chart (Richards, 1954; Hem, 1985), Wilcox graph (1955) and Doneen outline (1948) individually.

Hydrogeochemical Processes

The role of groundwater in the environment is considered as a geologic agent (Toth, 1995), therefore the groundwater chemistry takes into account both geologic and hydrogeological features. Identification of the chemical character, as well as the reactions responsible for groundwater composition is necessary to evaluate the lithologic controls. The hydrochemical attributes generated for monsoon (January) season have been processed by applying the data (Table 1) in certain plots, equations and also by generating some ionic ratios to identify and evaluate the groundwater quality for irrigational purposes.

Table 1 Statistical Analyzed Hydrochemical Data

Sl.No.	Parameters	Minimum	Maximum	Std.Dev.
1	Ca	0.47	39.76	7.09
2	Mg	0.47	16.19	2.92
3	Na	1.09	130.64	18.48
4	K	0.06	13.62	1.79
5	Fe	0.00	0.15	0.04
6	HCO_3	0.89	50.66	8.69
7	CO_3	0.00	0.00	0.00
8	SO_4	0.12	21.94	3.58
9	Cl	0.64	139.32	19.27
10	NO_3	0.03	2.25	0.45
11	F	0.01	0.17	0.04
12	EC	208.73	15993.45	2679.95
13	TDS	146.11	11195.41	1875.96
14	pH	6.87	8.97	0.36

Sodium Absorption Ratio (SAR)

The sodium or soluble base peril in the utilization of groundwater for water system is dictated by the total and relative convergence of cations is communicated as far as Sodium Absorption Ratio (SAR). SAR is expressed as, Na/√ (Ca + Mg)/2, where the concentration is expressed in mg/l. Classification of water with reference to SAR is given by Herman Bouwer, (1978). The SAR ranged from 0.91 to 34.60 during Post-Monsoon periods. 89.66% of the samples fall under suitable category for irrigational purposes. Rest of the samples unfit for irrigational uses. Sodium fixation in groundwater is critical since an expansion of sodium focus in water impacts decay of the dirt properties lessening penetrability (Kelley, 1951 and Tiwary, 1994).

Table 2 Sodium Absorption Ratio - Classification

Sl.No.	Variations	Water Quality	Samples	Percentage
1	0 – 6	No problem	2,3,4,5,6,7,8,9,11,12,13,14, 15,16,17,18,19,20,21,23,24 ,25,26,27,28,29,30,31,32,3 3,34,35,36,37,38,39,40,41, 42,43,44,45,46,47,48,52,53 ,54,55,56,57,58. **(52)**	89.66%
2	6 – 9	Increasing problem	1,10,22,51. **(4)**	6.90%
3	>9	Severe problem	49,50. **(2)**	3..45%

Residual Sodium Carbonate (RSC)

The higher soluble percentage of the sodium water is unsuitable for irrigational purposes (Eaton, 1950 and Richards, 1954). From this study, seventy four percent of samples were fit for all the crops. 24.14 % of the samples fell under marginal category and rest of the 1.72% of the samples fall under unsuitable condition in this season.

Table 3 Classification of Residual Sodium Carbonate

Sl.No.	Variations	Water Quality	Samples	Percentage
1	<1.25	Safe	1,2,3,4,5,8,10,11,12,13,14,15,17,19,20,21,22,23,25,26,27,28,30,31,32,33,34,36,37,39,40,42,45,46,47,48,49,51,52,53,55,56,57. **(43)**	74.14%
2	1.25 – 2.5	Marginal	6,7,9,16,18,24,29,35,38,41,43,44,54,58. **(14)**	24.14%
3	>2.50	Unsuitable	50. **(1)**	1.72%

GIBBS Diagrams

During the year 2017, post-monsoon season GIBBS diagrams (Figures 2 and 3). The groundwater samples widely distributed in rock water interaction and exclusive two groundwater samples are noted in the precipitation dominance zone in cations and anions. The diagram indicates that the rock role of weathering is major mechanism controlling the groundwater chemistry. The onesample fall outside the field indicating that varies other processes also exist in controlling the water chemistry.

Doneen Diagram

According to Doneen (1948) diagramis representthe three zones such as Class I, (100% of permeability) Class II (75%) and Class III (25%). Present study reveals that 17.27% of the groundwater sample fell under Class I (100% of permeability) and 53.45% of the groundwater samples fell under Class II (Figure 4 and Table 4). The Class III sites (29.31% of sits)are unfitfor irrigational purposes.

The groundwater samples are widely distributed in Class I and II. It is more fit for agricultural uses. Minor representation of samples also falls in poor class.

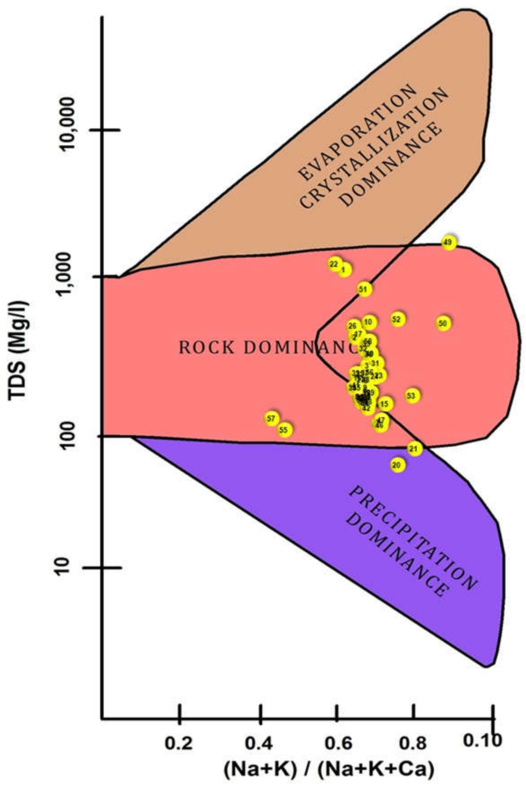

Figure 2 GIBBS Diagram - Cation

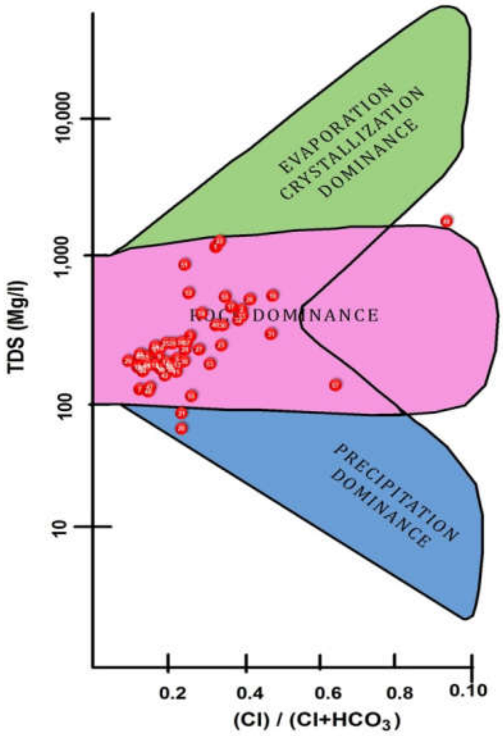

Figure 3 GIBBS Diagram - Cation

Table 4 Results of Doneen's Diagram

Sl.No.	Classes	Samples	Percentage
1	Class - 1	9,16,25,30,31,32,39,48,50,52. **(10)**	17.27%
2	Class - 2	2,4,5,7,8,11,12,13,14,15,18,20,21,23,24,27,28,29,34,35,36,37,38,41,42,43,44,46,47,55,57. **(31)**	53.45%
3	Class - 3	1,3,6,10,17,19,22,26,33,40,45,49,51,53,54,56,58. **(17)**	29.31%

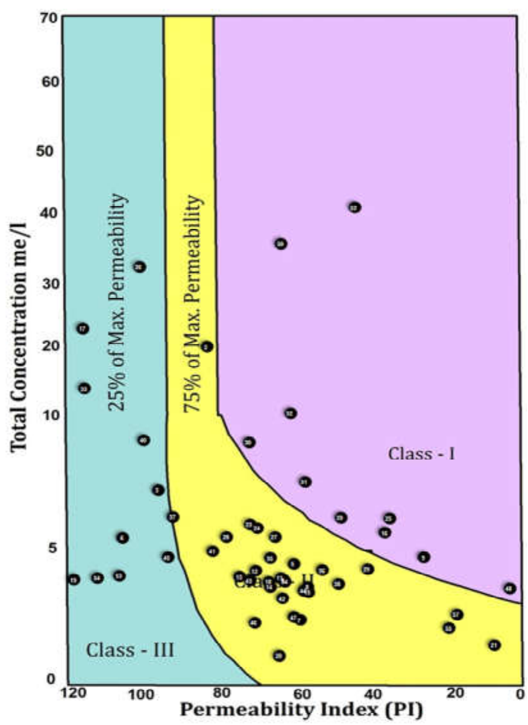

Figure 4 Doneen's Diagram for Irrigation suitability

Wilcox classification (1955)

According to Wilcox'sdiagram (1955)is representing the 5classes followed from Excellent to Unsuitable classes. Present study shows that (Figure 5) as per the Wilcox's classification Excellent to Good (22.41%), Good to Permissible (24.14%), Permissible to Doubtful(29.31%), Doubtful to Unsuitable (8.62%) and Unsuitable (15.52%) regions. Some few sample fall in Excellent to Good category. In Na% Eaton (1950) classification of groundwater for irrigation purposes (Table 5). In 2017, 75.86% of samples in safe zone and 24.14% samples in unsafe zone for the study period. In Doubtful to Unsuitable and Unsuitable categories, indicating the water unfit for irrigation purpose due to higher Na%.

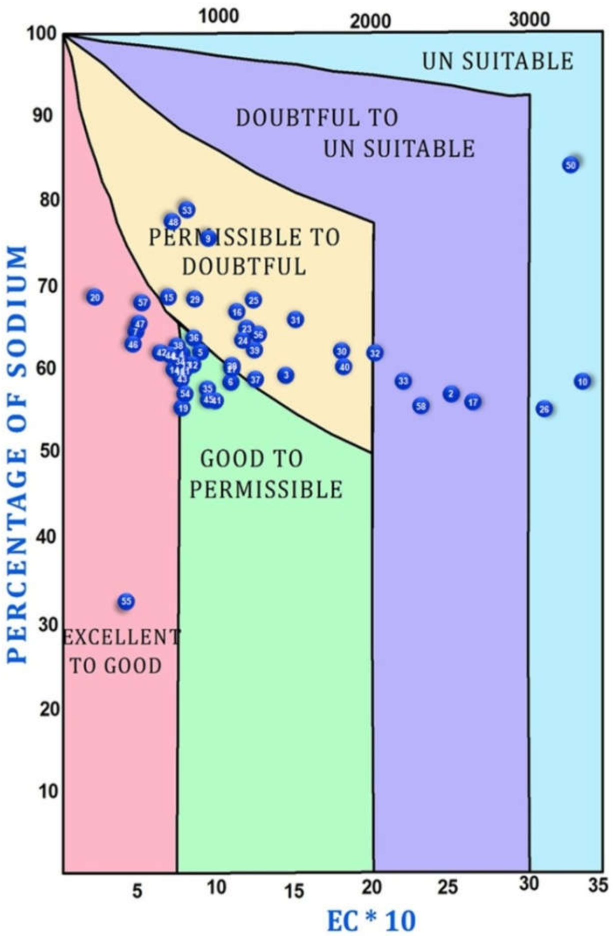

Figure 5 Wilcox's Diagram for Irrigation suitability

Table 5 Results of Wilcox's Diagram

Sl.No.	Classes	Samples	Percentage
1	Excellent to Good	7,8,14,18,20,34,38,42,44,46,47, 55,57. **(13)**	22.41%
2	Good to Permissible	4,5,6,11,12,13,19,27,35,36,41,43, 45,54. **(14)**	24.14%
3	Permissible to Doubtful	3,9,15,16,23,24,25,28,29,30,31,37, 39,40,48,53,56. **(17)**	29.31%
4	Doubtful to Unsuitable	2,17,32,33,58. **(5)**	8.62%
5	Unsuitable	1,10,21,22,26,49,50,51,52. **(9)**	15.52%

U.S. Salinity Laboratory diagram

According to U.S. Salinity Laboratory diagram (1954) representing the sixteen classes such as C1S1 to C1S4, C2S1 to C2S4, C3S1 to C3S4 and C4S1 to C4S4. This diagram good class as C1S1, C2S1, C3S1 classes good for agricultural purposes. Present research reveals that Figure6 and Table 6. The post-monsoon season samples fell under 1 Location (1.72%), 12 Locations (20.69%) and 30 Location (51.72%) samples occurred within C3–S1, C2–S1 and C1–S1 categories. This group was chief in the upper Tamirabarani river basin.

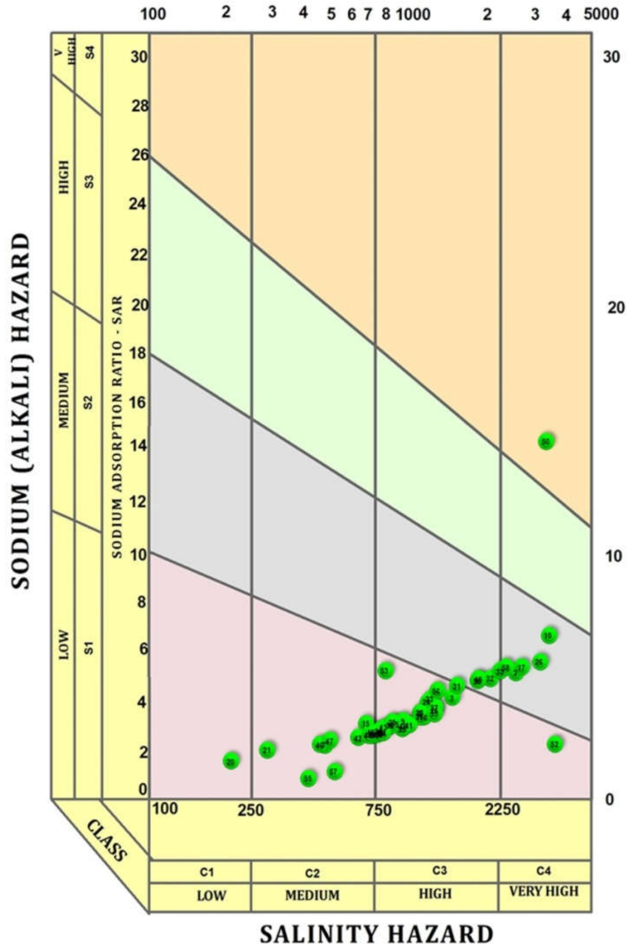

Figure 6 USSL Diagram for Irrigation suitability

Table 6 Results of USSL Diagram

Sl.No.	Classes	Samples	Percentage
1	C1S1	20. **(1)**	1.72%
2	C2S1	7,8,14,15,21,42,44,46,47,48,55,57. **(12)**	20.69%
3	C3S1	3,4,5,6,9,11,12,13,16,18,19,23,24,25,27, 28,29,31,34,35,36,37,38,39,41,43,45,53, 54,56. **(30)**	51.72%
4	C4S1	52. **(1)**	1.72%
5	C3S2	30,32,33,40. **(4)**	6.90%
6	C4S2	2,10,17,26,58. **(5)**	8.62%
7	C4S4	1,22,49,50,51. **(5)**	8.62%

CONCLUSION

As per the SAR and RSC classification shows that more than 70% of the samples fell under suitable for irrigational purposes. The

Gibbs' outlines recommend that rock weathering and precipitation are the primary processes that contribute water chemistry. Evaporation does not have a dominating effect on groundwater quality.

U.S. Salinity Laboratory diagram, Wilcox's and doneens's interpretation reveals that more than 70% of thesamples fell under appropriate for irrigational purposes. This category was chief in the upper Tamirabharani region and it is appropriate for irrigation uses. Over view of the research work shows that the unfit groundwater samples were located in the coastal track. So it may be sea water intruded in land portion.

References

APHA (American Public Health Association) (1996) Standard methods for the Examination of water and wastewater, 19th eds. Public Health Association, Washington, DC.

Ballukraya PN, Ravi R (1999) Characterisation of groundwater in the unconfined aquifers of Chennai City, India. Part I Hydrogeochemistry. *J GeolSoc of India* 54: 1 – 11.

CGWB (2006), "Report on the working group on the estimation of groundwater resources and irrigation potential of India", CGWB report.

Cucchi F, Franceschini G, Zini L (2008) Hydrogeochemical investigations and groundwater provinces of the Friuli Venezia Giulia Plain aquifers, northeastern Italy. *Environ Geol* 55(5):985-999.

Doneen, L.D., (1948) *The quality of irrigation water and soil permeability*, *Proc. Soil sci. Amer*., v. 13, pp. 523.

Eaton, E.M., (1950) Significance of Carbonate in Irrigation Water. *Soil.Sci*., v.69, pp.123-133.

Ghiglieri G, Oggiano G, Fidelibus MD, Alemayehu T, Barbieri G, Vernier A (2009) Hydrogeology of the Nurra region, Sardinia (Italy): basement-cover influences on groundwater occurrence and hydrogeochemistry. *Hydrogeol J* 17(2):447-466

Hem, J.D., (1985) Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geol. Surv. Water supply, pp.264.

Herman Bouwer.(1978) Groundwater Hydrology, International Student Edition.

Islam MA, Zahid A, Rahman MM, Rahman MS, Shammi M *et al* (2017) Investigation of groundwater quality and its suitability for drinking and agricultural use in the south central part of the coastal region in Bangladesh. *J Expo Health* 9(1):27-41. doi:10. 1007/s12403-016-0220-z

Kelley, W.P. (1951) Alkali Soils-their formation properties and reclamation. Reinhold Pub, New York.

Kumar SK, Bharani R, Magesh NS, Godson PS, Chandrasekar N (2014) Hydrogeochemistry and groundwater quality appraisal of part of south Chennai coastal aquifers, Tamil Nadu, India using WQI and fuzzy logic method. *Appl Water Sci* 4(4):341–350

Li P, Qian H, Wu J, Zhang Y, Zhang H (2013) Major ion chemistry of shallow groundwater in the Dongsheng Coalfield, Ordos Basin, China. Mine Water Environ 32(3):195-206.

Marimon MPC, Roisenberg A, Suhogusoff AV, Viero AP (2013) Hydrogeochemistry and statistical analysis applied to understand fluoride provenance in the Guarani aquifer system, Southern *Brazil. Environ Geochem Health* 35(3):391-403.

Rahman MM, Sultana R, Shammi M, Bikash J, Ahmed T, Maruo M, Kurasaki M, Uddin MK (2016) Assessment of the status of groundwater arsenic at SingairUpazila, Manikganj Bangladesh; exploring the correlation with other metals and ions. *Expo Health* 8(2):217–225.

Richards, L.A., (1954) Diagnosis and improvement of saline and alkali soils.Agri. Hand Boock 60, U.S. Dept. of.Agriculture, Washington, D.C., pp.160.

Richards, L.A., (1954) Diagnosis and improvement of saline and alkali soils. Agri. Hand Boock 60, U.S. Dept. of.Agriculture, Washington, D.C., pp.160.

Skrzypek, Grzegorz, ShawanDogramaci, Pauline F Grierson (2013) Geochemical and hydrological processes controlling groundwater salinity of a large inland wetland of northwest Australia. *ChemGeol* 357:164-177.

Srinivas Y, Aghil TB, Oliver DH, Nair CN, Chandrasekar N (2015) Hydrochemical characteristics and quality assessment of groundwater along the Manavalakurichi coast, Tamil Nadu. *India Appl Water Sci.* doi:10.1007/s13201-015-0325-8.

Subramani, T., Elango, L. and Damodarasamy, S.R. (2005) Groundwater quality and its suitability for drinking and agricultural use in Chithar river basin, Tamilnadu, India. *J. Environ Geol*, v.47, pp.1099-1110.

Tiwary, R.K. and Dhar, B.B., (1994) Effect of coal mining and coal based industrial activities on water quality of the Damodar with specific refrence to heavy metals. *Int J Surf Min Reel Environ*., v.8, pp.11-115.

Toth, T., S. Matsumoto, R. Mao and Y. Yin, (1995), "Precision of predicting soil salinity based on vegetation categories of abandoned lands", *Soil Sci.,* 160, pp. 218-231.

U.S. Salinity Laboratory., (1954) Diagnosis and Improvement of Saline and Alkali Soils. U.S. Dept. Agriculture Hand book - 60, Washington, D.C., pp.160.

Vigna B, Fiorucci A, Ghielmi M (2010) Relations between stratigraphy, groundwater flow and hydrogeochemistry in Poirino Plateau and Roero areas of the Tertiary Piedmont Basin, Italy. MemorieDescrittive Della CartaGeologicad'Italia 90:267-292.

Vogel, A.I. (1968) A Text Book of Quantitative Inorganic Analysis including Elementary Instrumental Analysis. 3rd Edn., ELBS/Longman, 121p.

Von Der Gracht HA, Darkow IL (2010) Scenarios for the logistics services industry: A Delphi-based analysis for 2025. *Int J Prod Econ* 127:46–59. doi: 10.1016/j.ijpe.2010.04.013.

Wei C, Guo H, ZhangD,Wu Y, Han S, An Y, Zhang F (2015) Occurrence and hydrogeochemical characteristics of high-fluoride groundwater in Xiji County, southern part of Ningxia Province. *China Environ Geochem Health*:1-16.

Wilcox, L.V., (1955) Classification and use of irrigation waters. US Department of Agriculture, Arc 969, Washington DC.

How to cite this article:

Mohammed Musthafa K *et al* (2018) 'Evaluation of Hydrochemical Characterizations of Groundwater in Lower Tamirabharani River Basin, Southern India', *International Journal of Current Advanced Research,* 07(3), pp. 11183-11187. DOI: http://dx.doi.org/10.24327/ijcar.2018.11187.1929

****