Application of Unnatural Recharge in Groundwater Quality

A. Geetha Selvarani* and G. Maheswaran
Department of Civil Engineering
Vel Tech Rangarajan Dr. Sangunthala R& D Institute of Science and Technology
Email: geethacivi1201l@gmail.com

Abstract: Prediction of Groundwater Quality for A Well Before Drilling At A Location Based On The Parameters Governing The Groundwater Chemistry Are Highly Drastic And Non Linear. The Dissolution Due to Higher Meteorologic Precipitation During Premonsoon Season Was Found To Be Primary Cause For The Quality Variations. Hence, The Dissolution Has Been Taken as The Right Mechanism To Improve The Groundwater Quality Or To Maintain Consistent Groundwater Quality All Over The Year. It Is Recognized That the Most Appropriate Method Which Is Readily Available Now For The Improvement Of Groundwater Quality Through Dissolution Is Artificial Recharge. The Various Aspects of Artificial Recharge Were Studied In The Study Area And Design Methodology For Artificial Recharge System Has Been Formulated Based On The Local Hydrological Conditions Using Gis. For That, The Weighted Overlay Analysis Proves That the Study Area Contains Potential Artificial Recharge Zones Of Moderate To Very Good Categories. Tds Is Taken Aas The Index Of Water Quality In The Study Area. The Amount of Water Required for Dissolution Is Calculated Based On The Tds Content In The Groundwater Of The Locality Where The Groundwater Of Suitable Quality Is Expected. The Vertical Recharge Shaft Method, Which Is Similar To The Existing Pumping System, Is Suggested As The Suitable Method For Achieving Dissolution Of Groundwater By Infiltration. The Results Are Validated With The Results From The Twad Board, Govt. Of Tamil Nadu It Is Found That The Results Are Satisfactory.

Keywords: Groundwater; Water Quality; Artificial Recharge; Gis; Tds

1. Introduction

Groundwater has been a vital natural resource due to its significant use for drinking, irrigation and industrial purposes. The amount of groundwater is over thirty times the amount of fresh water in lakes and reservoirs. At present about one fifth of all the water used in the world is obtained from groundwater resources (Raghunath, 2007). The quality of groundwater varies mostly with respect to the depth of its availability and it is more so in the vicinity of the sea due to seawater intrusion. Even within the inland the water quality gets diluted in the monsoon period and gets aggravated in the premonsoon period. Almost 80% of the groundwater has been used in the whole of Tamil Nadu and Noyyal river basin is no exception to this depletion since it is an agricultural and industrial based

area. So the available groundwater cannot be used for the above purposes. It can be used based upon the quality of water. The quality of groundwater depends upon its physical and chemical characteristics which play a major role in the health of the people. Noyyal river is a tributary of river

Cauvery and it ordinates from Vellingiri hills within the Western Ghats of Tamil Nadu, India. Noyyal has seven essential tributaries, all are starting as the first or 2nd order streams on the foothills of Nilgiris (Veena Srinivasan et.al 2014). The limit of the river basin is among north range 10° 54' 00" to 11° 19' 03" and east longitude 76° 39' 30" to 77° 55' 25". It is a hundred and eighty km long and twenty five km wide and it covers a place of 3,500 km^2 that's proven in Figure 1(Ravichandran and Sundararajan 2017).
The study location is characterized through undulating topography with a slight slope from west to east and underlined by using a extensive range of high-grade metamorphic rocks of the peninsular gneissic complicated. It turned into a significant supply of water in Coimbatore, Tirupur, Erode and Karur district in the length from 1980 to 1990. Finally, it is entering again into the river Cauvery. Since 1990, the effluents discharged from dyeing and bleaching gadgets in and around the river basin have environmentally harmed the river basin and thereby bringing agriculture to a standstill (Shantharam and Elangovan (2016), Elangovan and Rani (2017), Mohanraj et.al 2016).

II. Materials and Methodology/Study Area and Methods

Water samples were collected during the month of January 2016 (Postmonsoon) and May 2016 (Premonsoon) in cleaned polythene bottles by grab sampling. The collection, preservation and chemical analysis for major physic chemical of water samples were collected by following the standard methods given by the American Public Health Association (APHA 1998, APHA, 1995). The base map of examine region was created using topographical maps issued with the aid of the survey of India (SOI) in 1:50000 scale. The sample locations are marked on the basemap. The land use and land cover map has interpreted from satellite imageries. The thematic maps along with geomorphology, geology, soil, slopes and lineament density of the observe region were prepared. The observe place base map is overlaid with other thematic maps and the diverse floor and subsurface parameters of the sample locations are arrived via interpolation. The influences of rainfall and water degree fluctuations on TDS content are studied. The artificial recharge technique had been cautioned in this work for dissolution and thereby to improve the high-quality of groundwater. The weighted overlay analysis became carried out with the assist of ArcGIS, It is used here to apprehend the groundwater recharge potential of any region of the have a look at region.

3. Results

Spatial distribution study is a critical device to recognize the spatial distribution of ionic concentrations of hydro-chemical parameters. The Spatial distribution affords a pictorial representation of the spread of ionic concentration. The sample places are represented as

a factor characteristic layer. Each place is attributed to region identification, physical and chemical content concentrations. The spatial distribution is presented in three classifications namely very good, exact and poor. The water first-class parameter whose content is within the proper limit is assessed as very good and the water satisfactory parameter whose content material is among acceptable to the permissible restrict is classed as true and the water first-rate parameter whose content material is above the permissible restrict is assessed as poor. The limits advocated by way of IS: 10500 are accompanied to define class and it is given in table 1.

Table 1: Suitability Assessment of Groundwater

Parameter	IS 10500 -2012		Sample location exceeding the permissible limits in both the seasons
	Desirable	Permissible	
Turbidity	5	10	26
pH	6.5 to 8.5	No relaxation	41,52
Total Dissolved Solvent (TDS)	500	2000	9,11,14,15,16,17,19,,20,21,22,23,24,25,26,27,28,29,30,31,33, 34,35,38,39,40,41,42,43,44,46,47,48,49,52,53,57,60,61,626
Total Hardness (TH)	200	600	8,9,15,16,17,18,19,20,21,22,23,25,26,27,28,29,30,31,33,38,39 ,40,41,42,43,46,47,48,49,53,63
Total Alkalinity	200	600	11,12,17,19,21,22,23,26,27,29,30,31,33,35,38,40,41,42,43,47, 48,49,50,52,57
Chloride (Cl)	250	1000	9,11,12,14,16,17,19,20,21,22,23,25,26,27,28,31,33,38,42,46,4 7,49,53,63
Sulphate (SO4)	200	400	27,28,33,38,42,46,49,53,60,63
Nitrate (NO3)	45	No relaxation	10,11,12,14,17,19,21,22,26,27,28,31,33,36,38,42,49,50,53,57, 63
Fluoride (F)	1.0	1.5	
Calcium (Ca)	75	200	9,21,22,27,31,33,49,52,53,54,57
Magnesium (Mg)	30	100	12,14,17,21,22,23,26,27,28,29,30,31,33,35,36,38,42,47,48,53, (32%)
Iron	0.3	No relaxation	-

The take a look at vicinity is generally included with dendritic drainage pattern having pleasant drainage density within the western a part of the river basin. The duration of the lineaments extended from a few kilometers to numerous kilometers and majority are orientated in northeast to southwest route. The lineaments are fundamental in Palladam and Sulur, trending within the guidelines of northwest to southeast and north to south. A few of them are oriented in eastwest and northwest to southeast direction also. The take a look

at area has been categorized as hardrock terrain that is predominantly covered through unclassified gneiss which is maximum within the centre part of the basin. Charnockite, is observed in south and southeast a part of the take a look at location. Most of the region is protected through pediment, which makes groundwater capability to be terrible because of runoff. Major part of the slope in the study area falls under nearly level to gentle slope class (0 – 3°).

4. Discussion

From the table1 it suggests that pH of groundwater samples within the investigation region tiers from 7.25 to 9.09 and 7.4 to 9.9 in both the season correspondingly because of byproduct of anthropogenic activities or carbonate rich rock kinds found within the river catchment. The awareness of alkalinity in postmonsoon samples range from 96 to 928 mg/l with a ordinary of 458.5 mg/l and in the premonsoon range from 76 to 956 mg/l with a normal of 383.19 mg/l. It might be because of the nonstop launch of commercial effluents containing acids and bases. The values of general hardness in postmonsoon vary from 86 to 1435 mg/l with an ordinary of 718.89 mg/l and within the premonsoon groundwater samples vary from 88 to 1255 mg/l with an average of 604.68 mg/l. This might be because of the steady launch of the synthetic materials and salts used in conjunction with dyes from the production. The values of calcium and magnesium in premonsoon range from 13 to 319 mg/l with a median of 490.89 mg/l and 7 to 168mg/l and 8 to 88 mg/l with an average of 114.03 mg/l and 8 to 126mg/l respectively. Based on chloride, 20.6% and 33% of the groundwater samples in pre- monsoon and premonsoon have been bad for consuming. The estimation of chlorides in postmonsoon range from 89 to 1820 mg/l with an average of 726.71mg/l and in the pre- monsoon range from 52 to 1656mg/l with an average round of 524.83 mg/l. It is probably due to the nonstop use of chloride salts inside the industries ideally in dyeing and bleaching and also the incidence of soluble chlorides from rocks. Based on sulphate, 23% and 36.5% of the groundwater samples in premonsoon and postmonsoon had been bad for drinking. The groundwater exam zone changed into totally loose from fluoride and iron confirmed 1% and 1.6% of the groundwater samples in pre and postmonsoon season. The interpretation of nitrate confirmed that 1.6% and 14.3% of the groundwater samples in premonsoon and publishes rainstorm were bad for drinking.

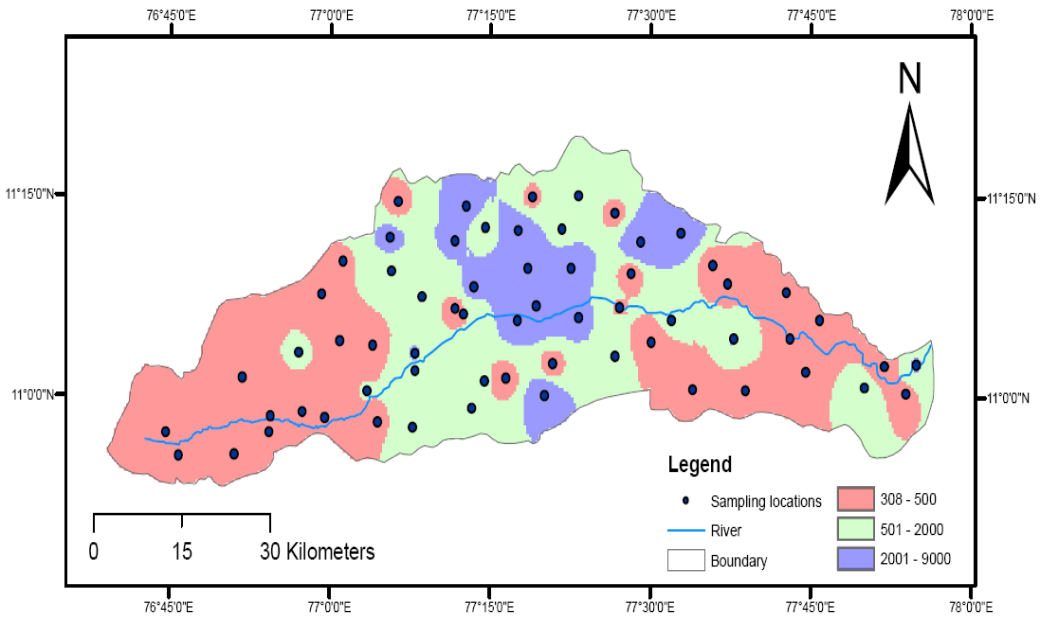

Figure 1 Spatial Distribution of TDS (mg/l) in Premonsoon

Figure 1: Reveals that TDS was exceeding the permissible limit except at the western part of the study area. After entering into the centre part of the Coimbatore district it gets polluted and it continues up to the eastern side of the river basin. Out of 63 groundwater samples 41 groundwater samples were above the permissible limit, 13 groundwater samples were between desirable to permissible limit and remaining 9 groundwater samples were below the desirable limit. The range of TDS vary from 308 to 9000 mg/l. TDS content was high in sampling locations S33, S42 and S49 due to continues effluent discharge from the dyeing and bleaching industries.

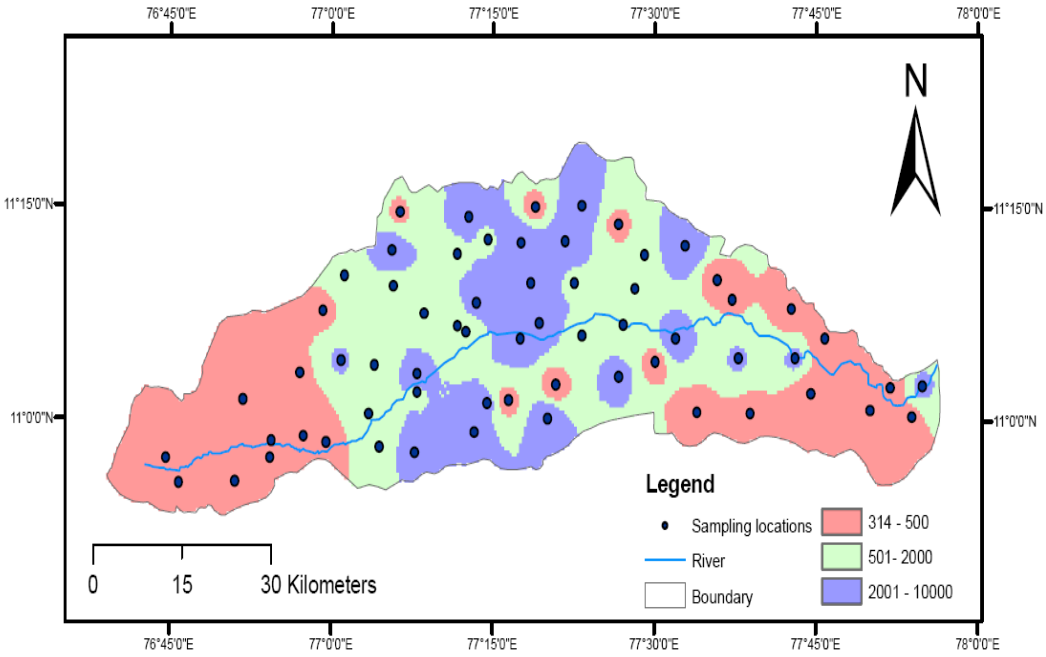

Figure 2 Spatial Distribution of TDS (mg/l) in Post-monsoon

Figure 2 reveals that based on TDS, 50 groundwater samples were above the permissible limit, 10 groundwater samples were between desirable to permissible limit and remaining 3 groundwater samples were below the desirable limit. The range of TDS varies from 300 to 9800 mg/l. The maximum groundwater samples have TDS value ranging above 1000 mg/l. TDS in postmonsoon range from 300 to 9800 mg/l and in premonsoon from 308 to 8590 mg/l respectively. In both, the intervals, greater than 60 % of the samples are over the permissible limit of 1000 mg/l due to inhabitant time of groundwater in aquifers, close by topographical conditions, weather and waste release (Syed et al 2002).

Weighted Index Overlay Analysis (WIOA) in spatial analysis is an easy and clear-cut approach for a blended evaluation of multi-magnificence layers. In WIOA, the person thematic layers and also their training are assigned weights on the idea in their relative contributions closer to the output. There isn't any well known scale for an easy weighted overlay technique (Saraf and Choudhary 1998). The dedication of the weights of each class is a critical component inside the incorporated analysis. The venture of appropriate weights controls the price of enter within the weighted index overlay method. Consideration of the relative significance between the parameters results in a better representation of the real floor state of affairs (Choudhary 1999).The ability zones for artificial recharge of groundwater also are managed by way of different factors. Each issue considered is assigned a weight relying on its have an impact on at the storage and transmission of groundwater. Lithology and the geomorphology of the vicinity play a outstanding position in groundwater recharging (Elango and Mohan 1997). The deep water level is given the very best weightage because it affords space for the recharge. Land use influence over recharge is assigned less weight. As the role of soil depends on different factors in recharge, it's far given a decrease weight, (Saraf et al 2007).

In this study, artificial recharge zones are identified based on integration of the thematic layers in the GIS environment. The area which is categorized as excellent for an artificial recharge zone possess high storativity, deep water table and good water holding capacity for constructing an artificial recharge structure. Eight thematic layers which include geology, geomorphology, lineament density, land use/land cover, soil, slope, rainfall and groundwater level are used to identify recharge potential zones. Various thematic maps are reclassified on the basis of weightage assigned and brought into the spatial analysis tool for integration (Saraf and Choudhary 1998). The weight influence for identifying artificial recharge sites are given in Table 2.

Table 2: Percentage influence for groundwater prospects and for identifying artificial recharge sites

Factors	Weightage	Very good	Good	Moderate to good	Moderate	Less	Total	Percentage of Influence
Geology	2.5	12.5	10	0	5	2.5	32.5	8
Lineament density	2.5	12.5	10	7.5	5	2.5	40	10
Land use /land cover	2.5	0	10	7.5	5	0	25	6
Geomorphology	4	20	16	12	8	4	64	16
Soil	3	15	12	0	6	3	39	10

Drainage density	2	10	8	6	4	2	32	8
Slope	3.5	17.5	14	10.5	7	3.5	56	14
Rainfall	2.5	12.5	10	7.5	5	2.5	40	10
Groundwater level	4	20	16	12	8	4	64	16

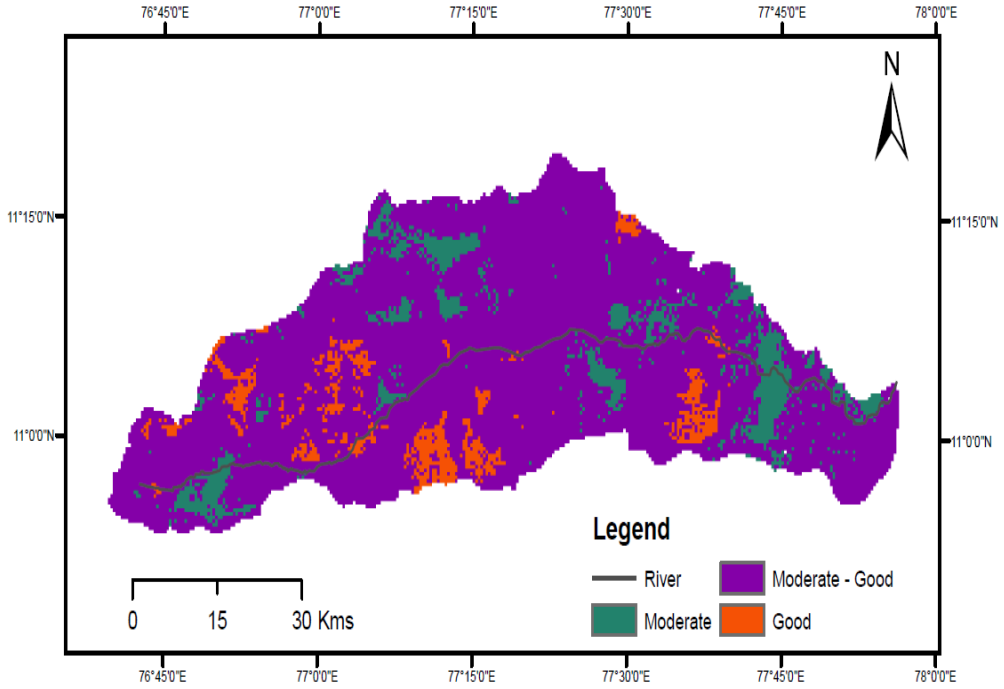

Figure 3: Artificial recharge zone map of the study area

Based on Figure 3, artificial recharge sites were predominant in moderate to good category (occupies 83.52% of the study area) due to the presence of pediments and gneiss, red calcareous and thin red soil with high lineament density. Artificial recharge was found under good category (occupies 6.12% of the study area) in few patches of south western side and western side of the study area. The artificial recharge was found under moderate category (occupies 10.36% of the study area) in western, south eastern and north eastern side of the study area due to the presence of red calcareous, black soil, colluvial and alluvial soil, shallow buried pediment, shallow pediment, pediment, charnockite, complex and unclassified gneiss. As the groundwater table is available at very high depth in the study area, the deep bore well pumps are commonly used to extract ground water. Hence the recharge wells or vertical shafts are suggested in this work as appropriate methods for artificial recharge in the study area.

5. Conclusions

The groundwater quality is good during premonsoon season of the study area. In this period, the rainfall is also high. Hence from the earlier studies, it is understood that the groundwater quality can be improved by dissolution. Since the dissolution is found to be an important mechanism in improving the groundwater quality, it is concluded to try artificial recharge method to increase

dissolution. The weighted overlay analysis proves that the study area contains potential artificial recharge zones of moderate to very good categories. It is concluded that there is no restriction in substratum for recharge process. The vertical shaft artificial recharge method, which is similar to the prevailing pumping gadget, is usually recommended as the perfect method for accomplishing dissolution of groundwater with the aid of infiltration.

References

American Public Health Association (APHA) (1998). Standard methods for the examination of water and wastewater, 20th edn. American Public Health Association, *American Water Works Association, Water Environment Federation*, Washington, DC

APHA (1995). Standard methods for the examination of water and wastewater, 19th edn. *American Public Health Association, Washington, pp 1–467*

Raghunath. (2007) H.M., Ground Water. 3rd Edition., *New Age International (P) Ltd, Publishers*, New Delhi,.

Appelo, C.A., Postma, D. 1993. Geochemistry Groundwater and Pollution. Balkema, Rotterdam.

Choudhary, P.R. (1999). Integrated Remote Sensing and GIS Techniques for Groundwater Studies in Part of Betwa Basin, Ph.D thesis, Department of Earth Sciences, University of Roorkee, India.

Saraf, A.K. and Chowdhury, P.R. (1998). Integrated Remote Sensing and GIS for Groundwater Exploration and Identification of Recharge Sites. *International Journal of Remote sensing*, Vol.19, No.10, pp.1825-1841.

Saraf, A.K., Jasrotia, A.S., Kumar, R. (2007). Delineation of Groundwater Recharge Sites Using Integrated Remote Sensing and GIS in Jammu District, India", *International Journal of Remote Sensing*, Vol. 28, No. 22, pp.5019-5036.

Veena Srinivasan., Suresh Kumar., Pennan Chinnasamy., Sulagna S.., Sakthivel D. Paramasivam., Sharachchandra Lele.(2014) Water Management in the Noyyal River Basin: A Situation Analysis Adapting to Climate Change in Urbanising Watersheds (ACCUWa) (2012-2016).Ashoka Trust for Research in Ecology and the Environment.

Mohanraj R, Somasundram L and Nishadh K A (2016), Water Pollution in River Noyyal, Pollution, Vol.15, Issue 94

Syed R, Qasim Edward, Motley and Guang Zhu (2002), Water work Engineering, Prentice Hall of India Pvt LTD., New Delhi.

Shantharam Y, and Elangovan, K (2016), ground water chemical studies using Statistical Analysis in Coimbatore Corporation, Tamil Nadu, *Indian Journal of Advances in Chemistry*. Vol. 12, No. 26, pp.5752-5762.

Elangovan, K and Rani, R (2017) Study on suitability of groundwater for irrigation purpose in ParambikulamAliyar project area, India. Indian. *Journal of Geo Marine Sciences*. Vol. 46 (05), pp. 1052-1060

Ravichandran K. and Sundararajan R., (2017), "Improving Trend Of Ground Water Quality Of River Noyyal Basin In Tiruppur District ,*International Journal of Civil Engineering and Technology (IJCIET)* , Volume 8, Issue 10, pp. 1321–1329.