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Groundwater Quality Assessment in Arjuna Watershed, Vaigai River Madurai and Virudhunagar Districts, Tamil Nadu

KEYWORDS: Groundwater Quality, Spatial Distribution, Major Ions, Arjuna Watershed.

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ABSTRACT *The Arjuna Watershed is of particular importance in the study of groundwater quality for drinking and irrigation purposes. The present investigations are focusing on groundwater quality of Arjuna Watershed in Madurai and Virudhunagar Districts of Tamil Nadu. Since, remediation of groundwater is very difficult, knowledge of the existing nature, magnitude, and sources of the various pollution loads is a prerequisite to assessing groundwater quality. Fifty groundwater samples were collected from wells based on grid method and the groundwater samples have been analyzed for various chemical parameters like pH, Conductivity, Total dissolved solids, Hardness, Calcium, Magnesium, Alkalinity, Chloride and Nitrate. Geologically, this study area made up metamorphosed gneiss and granite variety. An attempt has been made to study on the quality of ground water for the Arjuna Watershed is very urgent need for various agricultural and drinking purposes. the maximum concentration of phosphate (0.93) is observed in the study area. In general, groundwater in the study area is influenced by both natural and anthropogenic activities. Using the BIS (1998) standards, the quality of drinking water was categorized. The erratic behaviors of groundwater geochemical elements were spatially given through GIS study. It shows that in the study area, Calcium, Magnesium, Sodium, Potassium, Chloride, Sulphate, Iron, Nitrate, Total Dissolved Solids (TDS), Electrical Conductivity (EC) and Hydrogen ionic concentration (pH) were observed in potable and not potable limit. To find out the spatial distribution of these elements in the study area, GIS was employed. Results of GIS Spatial Distribution of Ca, Mg of samples are potable for drinking purposes. Maximum concentration of Potassium in groundwater is observed 84 ppm and the majority of samples are influenced by potassium in the study area due to agriculture activity.*

INTRODUCTION

The quality of groundwater at any point below the surface reflects the combined effects of many processes along the groundwater flow path. Chemical reactions such as weathering, dissolution, precipitation, ion exchange of rock water interaction and various biological processes commonly take place below the surface. Hydrogeochemical study is a useful tool to identify these processes that are responsible for groundwater chemistry. Several authors have reported about the presence of contaminants in soils (Muir & Baker, 1978; Wu, 1980) and waters (Kolpin, Barbash, & Gillion, 1998) in various part of the globe and also in India (Elango, Kannan, & Senthil Kumar, 2003. Under these circumstances a comprehensive hydrogeochemical study is necessary to identify the chemical processes that affect the groundwater quality of this area.

STUDY AREA

The study area forms the Madurai and Virudhunagar Districts, about 828 km^2 in area and lies latitudes 77°29 ' 0 " E and 9°27' 30'' N longitudes (Figure 1). Major part of the study area is devoted to agricultural activities, which include paddy, sugarcane, groundnut and gingili cultivation.

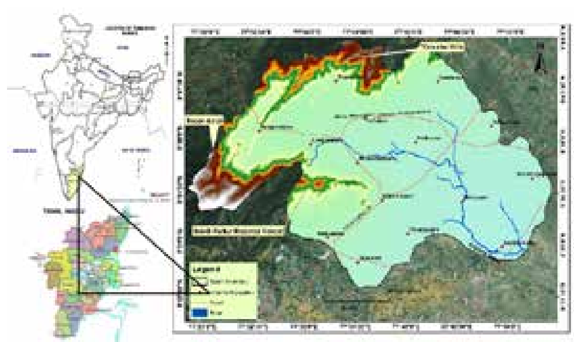

Figure 1: Study area and well location map

OBJECTIVES

- To identified groundwater quality data compared with world health organization (WHO) and Bureau of Indian Standards (BIS).
- To understand hydrogeochemical patterns various thematic layers generated and intersected in GIS platform.
- To delineate spatial variation of ionic concentration.

METHODOLOGY

Groundwater samples were collected after well inventory survey from 50 representative wells during July 2015 (Figure 1).

The samples were collected after 10 min of pumping and

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stored in Poly Ethylene bottles at 10°C. Immediately after sampling, pH and electrical conductivity were measured in the field.

Total dissolved solids (TDS) were calculated from EC multiplied by 0.64 (Brown, Skougstand, & Fishman, 1970).

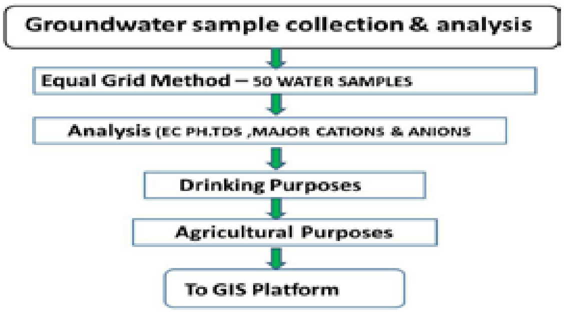

Figure 2: Flow chart showing detailed methodology

RESULTS AND DISCUSSION

The samples have been analyzed for physico-chemical parameters (pH, EC), major cations (Ca, Mg, Na, K), major anions (CO_3, HCO_3, SO_4, Cl), minor cations (Mn, Fe) and minor anion (NO_3, F) as per standard procedures and the results in epm value are given table (Table 4.2). For the drinking water purposes, World Health Organization (WHO) standard limit was used to demarcate sample suitability.

Spatial analysis tools were used for the preparation of spatial distribution maps.

Their attributes are added and analyzed in ArcGIS software. In the present study, detailed investigation of water chemistry, from dug well and bore well was carried out for groundwater quality. Groundwater chemistry results are given in Table.1

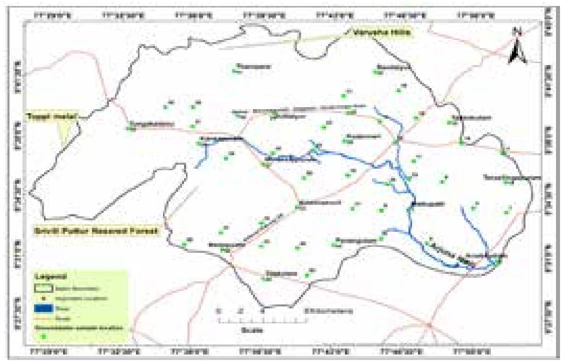

Figure 3: Groundwater Samples – Location Map

TABLE-1
SUMMARY OF MEASURED PARAMETERS FROM WHO AND BIS APPROVED STANDARD FOR DRINKING WATER

Parameters	Average	Min	Max	WHO (2006)	BIS (1998)	Potable (%)	Not Potable(%)
PH	7.3588	5.81	8.41	6.5-8.5	6.5-8.5	88	12
TDS (ppm)	1172.02	148	3680	500	2000	14	86
EC (µs/cm)	1661.76	211	5220	0.60	NG	-	-
CO3	18	0	204		NG	-	-
HCO3	353.556	0	744.2	NG	NG	-	-
Ca	63.2	8	420	75	200	78	22
Mg	45.024	4.8	120	30	100	36	64
Cl	320.747	17.72	1471.17	200	1000	50	50
Na	234.2	138	365	200	200	32	68
K	50.58	23	84	NG	10	-	-
SO4	3.974	2.5	5.8	200	400	100	-
PO4	0.1626	0.059	0.93	-	0.3	100	-
NO3	0.16008	0.061	0.96	45	-	100	-
F	0.78394	0.309	1.25	1.5	1.5	100	-

TABLE-2
CORRELATION MATRIX OF GROUNDWATER SAMPLES

	PH	TDS	EC	Ca	Mg	Cl	Na	K	F	SO4	PO4	NO3	CO3	HCO3
PH	1													
TDS	-0.05	1												
EC)	-0.05	1	1											
Ca	-0.05	0.82	0.82	1										
Mg	-0.28	0.6	0.6	0.51	1									
Cl	-0.04	0.9	0.91	0.85	0.54	1								
Na	-0.03	0.19	0.19	0.05	0	0.15	1							
K	-0.22	-0.19	-0.19	-0.19	-0.07	-0.24	0.05	1						
F	-0.05	-0.17	-0.17	-0.3	0.09	-0.18	0.05	0.06	1					
SO4	-0.2	0.19	0.2	0.14	-0.09	0.18	-0.07	-0.26	0.05	1				
PO4	0.21	-0.16	-0.16	-0.07	-0.17	-0.11	-0.14	0.06	-0.25	-0.14	1			
NO3	-0.22	0.15	0.14	0.01	0.12	0.15	-0.02	0.04	0.22	0.19	0.15	1		
CO3	0.11	0.04	0.05	0	0.2	0.09	-0.31	-0.01	0.12	0.23	-0.05	-0.08	1	
HCO3	-0.18	-0.15	-0.15	-0.45	-0.06	-0.36	0.08	0.22	0.41	-0.03	-0.27	0.1	-0.01	1

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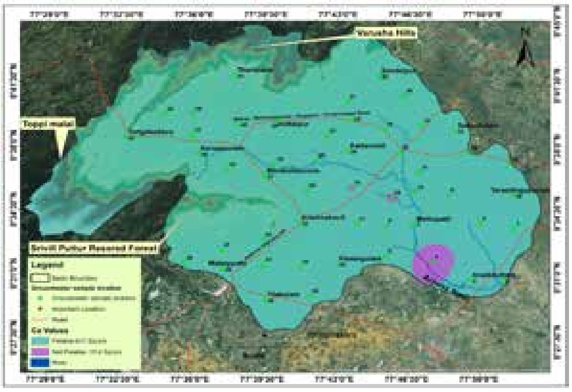
Correlation matrix was useful because it can point out associates between variables that can show the overall coherence of the data. The Positive and inverse relation between those parameters classified above. Highest positive correlation was observed between Ca, Mg, Cl.

HYDROGEOCHEMISTRY USING GIS TECHNIQUE



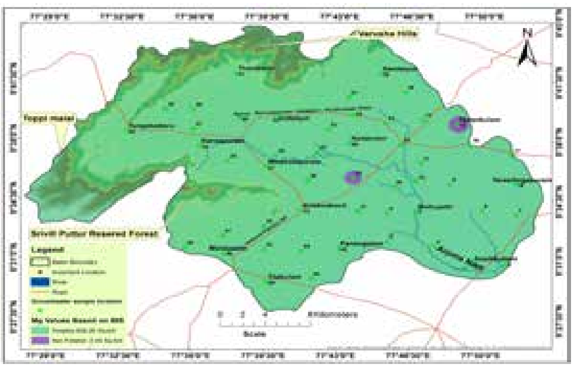


Figure 4: Spatial Distribution of CalciumFigure 5: Spatial Distribution of Mg

The Erratic behaviours of groundwater quality were spatially derived using the WHO standards for drinking and irrigation water quality was categorized difference cations and anions concentration such as area, Calcium, Magnesium, Sodium, Potassium, Chloride, Iron and Fluoride were observed in not potable limit of the study area. To find out the spatial distribution (Fig.4,5,6,7,8,9,10,11,12,13,14) of these elements in the study area, GIS was employed. The geochemical locations were digitized and the corresponding values of its attributes were given as an input. Using this data, the interpolation raster maps were generated. Subsequently, these maps were classified with respect to our interest and converted in to vector maps. These maps were clipped with the boundary to arrive within the boundary of the study area.

Figure 6: Spatial Distribution of Potassium

Among the cations, potassium occupies the last position in the order of abundance in the groundwater of the study area. Potassium concentration is good if it is less than 10 mg/l for drinking water (WHO, 1996). Potassium concentration ranged from 23 to 84 mg/l in pre monsoon season. Potassium content in water more than few tens of ppm is indicative of pollution (Table 4.9). The maximum admissible level of potassium in drinking is 10 mg/l.

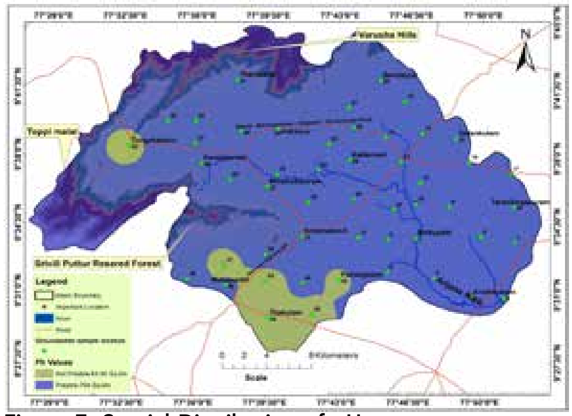


Figure 7: Spatial Distribution of pH

The Hydrogen Ion Concentration is clear from the table 2 that the pH value of water samples were varying from 5.81 to 8.81 and these values are within the limits prescribed by WHO (Table 4.2). As per the WHO standards the study area, most of the samples are falls within the recommended limit for human consumption except some location.

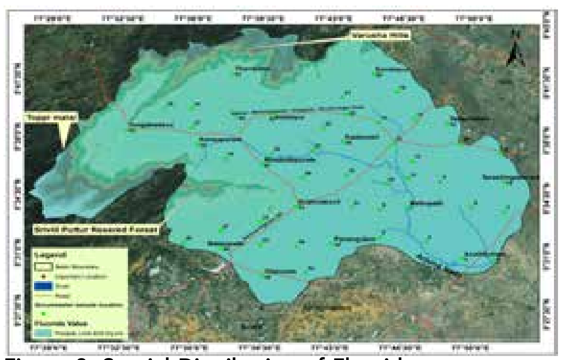


Figure 8: Spatial Distribution of Fluoride

The maximum level of fluoride which the human body may tolerate is 1.5 mg/L (ppm). This is based on the fluoride content in water. Keeping in view the various sources through which fluoride finds entry into the body, a level of + 1.0 mg/L fluoride in water is considered as the optimum level to prevent both dental caries and various forms of fluorosis. The maximum limit prescribed by BIS (Bureau of Indian Standards) for fluoride in drinking water is 1.5 mg/L. In pre monsoon 2015, the minimum concentration values of Fluoride were observed as 0.3 mg/L. Maximum concentration values were observed as 1.2 mg/L .

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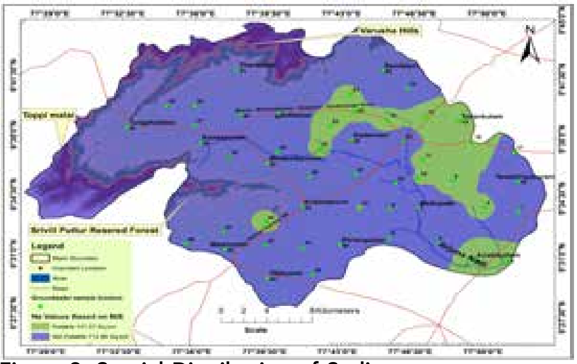

Figure.9. Spatial Distribution of Sodium

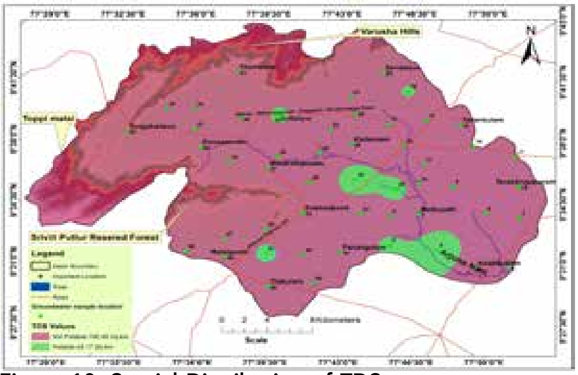

Figure 10: Spatial Distribution of TDS

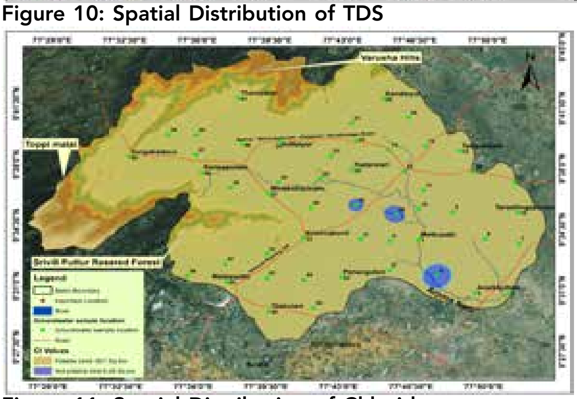

Figure 11: Spatial Distribution of Chloride

Figure.12. Spatial Distribution of Sulphate

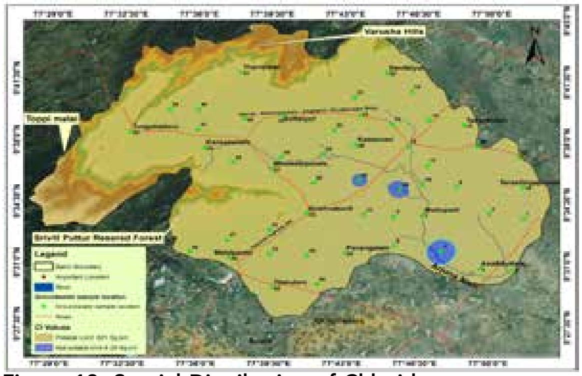

Figure 13: Spatial Distribution of Chloride

Most of samples fall in potable region that is used for drinking purpose. The groundwater quality based on salinity index Class I and II not considered very harmful to soil .Class III and IV suitable for irrigation. Class v are not suitable for irrigation. Most of groundwater samples fall in class I and class II suitable for irrigation is shown in fig.14.

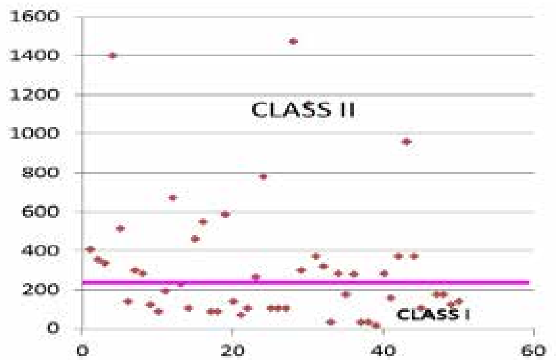

Figure 14: Chlorinity index for the groundwater samples

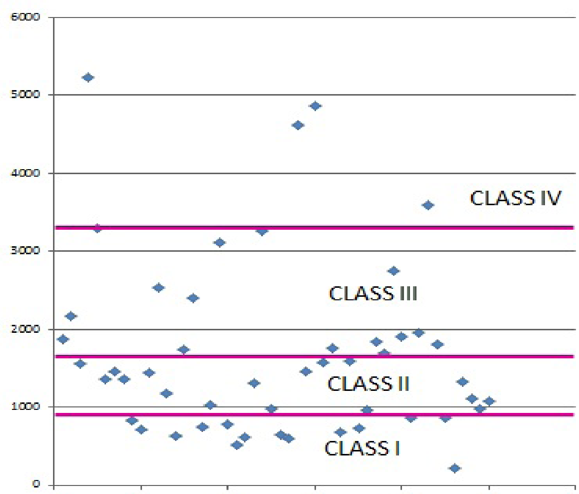

Figure 15: Salinity index (Handa 1969) for the groundwater samples

CONCLUSION

Most of Groundwater samples fall in Potable category (88%) was classified good quality for drinking purposes Based on the PH value. Results of GIS spatial distribution of Fluoride (F), Iron (Fe) ion indicates that all samples are potable zone limits and chloride samples that is indicates that potable (50%) to not potable (40%) zone limits. It affect the soil fertility and also affect the growth and yield

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of the plant reduces in the concentration level are suitable treatment of groundwater possible to change crop yield Based on salinity index classification water samples fell class III and class IV domains and are suitable for irrigational purposes. The Chlorinity indexes of the groundwater were calculated using the measured chloride ion concentration in water. It is found that majority of the groundwater samples belonged to classes 1 and are suitable for irrigation.

REFERENCE [1]. Brown, E., Skougstand, M. W., & Fishman, M. J. (1970). Methods for collection and analyses of water samples for dissolved minerals and gases. Techniques of Water Resources Investigation of the US Geological Survey 5. | | [2]. BIS (1998). Drinking water specif ications (revised 2003). Bureau of Indian Standards, IS: 10500. | [3]. Elango, L., Kannan, R., & Senthil Kumar, M. (2003). Major ion chemistry and identification of hydrogeochemical processes of groundwater in a part of Kancheepuram District, Tamil Nadu, India. Environmental Geosciences, 10(4), 157–166. | | | | | | | | | | | | [4]. Wu, T. L. (1980). Dissipation of the herbicides atrazine and alachlor in a Maryland corn field. Journal of Environmental Quality, 9(3), 459–465. | | [5]. Muir, D. C. G., & Baker, B. E. (1978). The disappearance and movement of three triazine herbicides and several of their degradation products in soil under field conditions. Weed Research, 18, 111–120. | | [6]. Handa, B. K. (1969). Description and classification of media for hydro-geochemical Investigations. In Symposium on ground water studies in arid and semiarid regions, Roorkee. | | [7]. Kolpin, D. W., Barbash, J. E., & Gillion, R. J. (1998). Occurrence of pesticides in shallow groundwater of the United States; initial results from the National Waterquality Assessment Program. Environmental Science and Technology, 32, 558–566. | | [8]. Wilcox, L. V. (1995). Classif ication and use of irrigation waters (p. 19). Washington: US Department of Agriculture | | [9]. Venkateswaran S, Satheeshkumar S and Ayyandurai R . Suitability of Groundwater Resources for Irrigation in the Upper Gadilam River Basin Villupuram District, Tamil Nadu, India, ISSN 0974-5904, Volume 08, No. 02, International Journal of Earth Sciences and Engineering |