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Groundwater quality in the nagavati watershed of Tamil Nadu, India by correlation method

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ABSTRACT

The World cannot exist without Water. It is an important component to human survival. Water should be purified for a better life style. It is the basic duty of every individual to conserve water resources. Nagavati watershed is located in a part of Dharmapuri district of Tamil Nadu in South India. It lies between latitudes 11°45'N to 12°15' N and 77°30' E to 78°30 E longitudes. It covers within the Survey of India toposheet nos. 57H/16, 57L/4, 58E/13, and 58I/1 covering an area of about 500 sq.km. Fourty six representative groundwater samples were collected from pre-monsoon season during 2015 and those water samples were analysed by standard analytic methods and physical and chemical parameters such as pH, Electrical Conductivity, Total Dissolved Solids, Alkalinity, Hardness, Na+, K+, Ca2+, Mg2, Cl , HCO3, CO3 , SO4, NO3 and F. Correlation study indicates that different parameters are strongly interrelated. The correlation and regression provide an excellent tool for the prediction of parameter values within a reasonable degree of accuracy.

Introduction

Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organisms. About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes groundwater (Rajesh Kumar et al 2011). Increasing access to ground water plays a key role in elevating poverty, stabilizing populations and reducing the need for rural folk to migrate when drought threatens livelihood. Apart from quantity, quality plays an important role in the use of ground water for utilitarian aspects. With depleting ground water levels and deterioration of water quality on account of geogenic as well as anthropogenic pollution, there is an urgent need for quality evaluation necessitating greater surveillance and monitoring of its quality In addition to human influence on ground water quality, it also gets the chemical constituents because of its long residence time in the aquifers. Change in chemical quality of groundwater from place to place reflect variation in aquifers and the medium through which it moves, the degree of weathering, ion exchange activities, and a process of withdrawal etc. In the present paper an attempt has been made to discriminate the qualitative aspects of ground water and to undertake statistical analysis to know the correlation between different water quality parameters (Hem et al., (1970), Gunnar Jacks et al., (1974), Gupta et al., (2001), Janardhana et al., (2006), Asa Rani et al., (2008), Handa et al., (1969), Vekateswaran et al., (2011), Reghunath et al., (2002) and Singh et al., (2005).

Study area

Nagavati watershed is located in a part of Dharmapuri district of Tamil Nadu in South India. It lies between latitudes 11°45'N to 12°15' N and 77°30' E to 78°30 E longitudes covering an area of about 500 sq.km (Fig.1). The climate of the Dharmapuri district is generally warm. The hottest period of the year is generally from the months of March to May, the highest temperature going up to 38 C in April. The Climate becomes cool in December and continuous so up to February, touching a minimum of 17 C in January. The Soil type ranges from black to mixed loam, Red sandy soils and Black and loam soil are found in the watershed. Generally the soil is low in Nitrogen and Phosphate content and the charnockites and associated pink migmatities mostly occupy the study area. Champion gneiss is the dominant rock in the study area. It is highly pink migmatized at many places and show deep weathering.

Methodology

Ground water samples were collected for chemical analysis from 46 bore wells spread over different geological horizons. The techniques and methods for collection and analysis of water samples followed in these study major chemical constituents were determined by following standard method .The analytical precision for measurements of cations and anions. The chemical data is subjected to multivariate analysis 10-13 and the results are tabulated. Analysis of correlation coefficient was performed by SPSS 16.0 version. The present study attempts to quantitatively analyze the relationship between various parameters. The chemical analysis data has been correlated with different graphical procedures and water quality standards are used to evaluate the suitability of groundwater for different purposes.

Hydrogeomorphology

Dome and Ridge type Residual hills are with an area of 68.05 Sq.Km. They are scattered in the south-western part of the study area. The groundwater prospect in this zone is also described as poor. Dome type Denudational hills (48.43 Sq.Km) are formed due to differential erosion and weathering. These occupy the center of the study area. The groundwater prospect in this zone is also described as poor.

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Inselberg (8.11 Sq.Km) Isolated, very steep conical hill and groundwater potential in poor. Shallow weathered Pediplain (211.90 Sq.Km): These areas are covered with shallow weathering material ranging from 0 to 6.5 m. Most of the study area is occupied by this unit. The groundwater prospect in such zone is described as Medium. Moderately buried pediplain. These areas are described as nearly flat terrain with the gentle slope. These are found almost along all the major drainage courses. In the study area, this unit covers an area of 0.27 Sq.Km and good groundwater potential. Valleys fill (48.40 Sq.Km) of different shapes and sizes occupied by valley fill partly detrital and partly weathered material. The groundwater potential ranges from good to very good. These valleys are developed along the fractures and such places can be exploited for groundwater through deep bores. In general, it is observed that adequate recharge source of groundwater is met within valley fillings it is shown in (Fig.2).

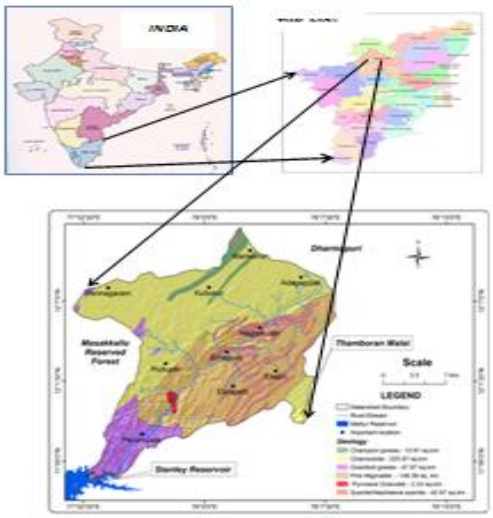

Fig 1. Geology and location map.

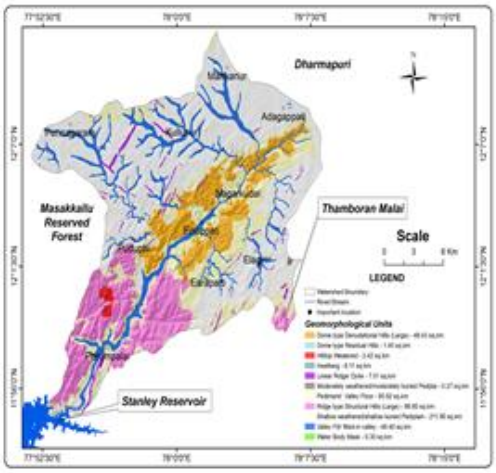

Fig 2. Hydrogeomorphology Map.

Geology

Geology of area is underlined by a wide range of igneous and metamorphic rocks. The geological formations of the study area are under Archean group of rocks. Crystalline rocks comprising Charnockite, Champion gneiss, syenite, pink pegmatite and pyroxene granulite. The charnockites and associated pink migmatities mostly occupy the study area. Recent alluvial and colluvial deposits and it is highly pink migmatized at many places and show deep weathering.

Result and Discussion

The pH value of drinking water is an important index of acidity or alkalinity. A number of minerals and organic matter interact with one another to give the resultant pH value of the sample. In the present study, pH ranges from 6.11-7.59, which lies within the range prescribed by WHO. The EC values for most samples range between 270-1954 (µ mho/cm). The EC value is directly proportional to the Total dissolved matter. All the samples show Low to Medium EC values than the permissible limit. The crops good yield Agriculture. The level of TDS is one of the characteristics, which decides the quality of drinking water. In the present study, TDS ranged from 188-1380mg/L and Calcium is a maximum permissible limit of calcium and magnesium in drinking water is 36 mg/L and 88 mg/L. All samples exceed beyond the maximum acceptable limit. The bicarbonate alkalinity is expressed as a total alkalinity, which ranges between 106-608mg/L. The alkalinity value of all the samples is within the permissible limit of 600ppm. However, the little abnormal value of alkalinity is not harmful to human beings. In the present study, the amount of sulphate ion is estimated to vary from 4-7 mg/L Table.1. The chloride content in the samples lies between 78-768 mg/L. chloride is normally the most dominant anion in water. According to WHO the maximum permissible limit for chloride in drinking water is 250mg/L. In the present study; the value of chloride content in four samples has been found to be high, which can cause corrosion and pitting of iron plates or pipes.

Table 1. Regression Statistics.

Multiple R	0.772448375
R Square	0.596676493
Adjusted R Square	0.395014739
Standard Error	10.44021925

Correlation of Physicochemical Parameters of groundwater

The correlation coefficient is a commonly used measure to establish the relationship between two variables. It is simply a measure to exhibit how well one variable predicts the other. It is used to account for the degree of mutually shared variability between individual pairs of water quality variables. The application has been broadened to study the relationship between two or more hydrologic variables, and also to investigate the dependence between successive values of a series of hydrologic data. The analytical data of 46 groundwater samples for the season spread over the study area are correlated. The groundwater quality parameters considered for correlation are Turbidity, TDS, pH, TH, Ca, Mg, Cl, F, SO4, Na, K, HCO3. In general, highly polluted groundwater samples have low oxidation-reduction potential because of the reducing atmosphere. During the pre-monsoon (2015), the study illustrated that TDS showed good positive correlation with Na and K. Also the pairs of TDS pH, TDS-Ca, TDS-SO4, Cl-Na, Cl-K, Na-SO4 and Na-K have more significant correlations. Further, Mg- CO3, Mg-Na, Mg-K, Mg-HCO4, Ca-Mg, Ca-SO3, Cl-SO4, Cl-HCO3, Ca-K, Ca-HCO, Na-HCO, Mg-SO4, Mg-K, Mg-NO in the positive correlations. The results are summarized in Tables 1 and 3 for the season.

Conclusion

The quality of ground water sample collected from seven different locations of Nagavati is analysed and studied. On the basis of these analytical findings, the following conclusions can be drawn. The pH of the entire water sample is well within permissible limits.

Table 2. Maximum, Minimum groundwater quality parameters.

SI.No	PH	EC (µs/cm)	TDS (ppm)	Ca	Mg	Na	K	HCO_3	CO3	Cl	F	SO_4	NO_3	PO_4
Mean	6.63	1129.52	805.67	59.22	51.93	215.46	56.00	317.52	12.26	284.84	1.07	4.71	0.11	0.10
Median	6.62	1158.00	825.50	60.00	46.60	235.50	56.00	314.80	14.00	191.73	1.04	4.80	0.08	0.10
Minimum	6.11	270.00	188.00	36.00	16.80	125.00	38.00	106.70	0.00	78.68	0.69	3.20	0.05	0.08
Maximum	7.59	1954.00	1380.00	88.00	98.80	347.00	74.00	608.20	36.00	768.42	1.98	6.80	0.34	0.14

Table 3. Correlation Matrix.

SI.NO	*PH*	*EC (µs/cm)*	*TDS (ppm)*	*Cl*	*Mg*	*Ca*	*CO3*	*HCO3*	*SO4*	*NO3*	*PO4*	*H2SiO4*	*F*	*Na*	*K*
PH	1.00														
EC (µs/cm)	0.17	1.00													
TDS (ppm)	0.18	0.99	1.00												
Cl	-0.20	0.02	0.05	1.00											
Mg	0.11	0.06	0.07	0.30	1.00										
Ca	0.04	0.02	0.02	0.13	0.08	1.00									
CO3	-0.01	0.21	0.18	0.08	-0.08	0.05	1.00								
HCO3	-0.07	0.00	0.02	-0.13	0.10	0.03	-0.07	1.00							
SO4	-0.17	0.32	0.28	0.27	-0.10	0.07	0.36	0.01	1.00						
NO3	0.15	0.67	0.71	0.17	0.03	0.00	0.10	-0.06	0.25	1.00					
PO4	-0.17	0.09	0.06	0.15	0.04	0.08	0.28	-0.10	0.25	0.16	1.00				
H2SiO4	-0.07	-0.02	0.00	0.05	0.03	-0.18	0.04	0.09	0.13	-0.12	0.07	1.00			
F	-0.07	-0.04	0.00	0.00	-0.05	0.18	0.09	0.23	0.06	-0.20	-0.13	0.12	1.00		
Na	-0.24	-0.08	-0.08	0.01	0.14	-0.18	-0.04	0.35	0.09	-0.30	-0.03	0.15	0.14	1.00	
K	0.10	0.15	0.17	-0.20	-0.06	0.01	-0.01	0.17	-0.18	0.00	-0.13	0.00	-0.03	0.04	1.00

The TDS values of all the water sample permissible limits. Calcium and Magnesium content for all samples have high value above permissible limits. Chlorides content of four samples is in the higher range than permissible limits. Sulphate content for all samples is within permissible limits. The quality of ground water is controlled by lithology apart from other factors like land use patterns, rock-water interaction and the host rock mineralogy and environmental conditions. From the correlation studies of different chemical parameters, it is observed that fairly high degree of linear correlation coefficient exists between different chemical parameters, hence the correlation is significant.

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