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RESEARCH ARTICLE

ASSESSMENT OF GROUNDWATER QUALITY FOR VEPPANTHATTAI TALUK, PERAMBALUR DISTRICT, TAMIL NADU USING REMOTE SENSING AND GIS TECHNIQUES

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ABSTRACT

Groundwater is one of the most impotent natural resources. Groundwater has become a necessary resource over the past decades due to the increase in its usage for drinking, water supply, irrigation and industrial uses etc. Groundwater resources are now facing threats due to anthropogenic activities. The groundwater quality is equally important as that of quantity. Mapping of spatial variability of groundwater quality is of vital importance and it is particularly significant where groundwater is primary source of potable water. The present study has been undertaken to analyze the spatial variability of groundwater quality for Veppanthattai Talk, Perambalur District located in the Tamil Nadu state. Geographical Information System (GIS) is used for the spatial analysis and it is a powerful tool for representation and analysis of spatial information related to water resources. The major water quality parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids, Total hardness, Sulphates, Fluorides and Calcium have been analyzed. The spatial variation maps of these groundwater quality parameters were derived and integrated through GIS. The final integrated map shows three priority classes such as High, Medium and Low groundwater quality zones of the study area and provides a guideline for the suitability of groundwater for domestic purposes.

INTRODUCTION

Groundwater is a valuable natural resource that is essential for human health, socio-economic development, and functioning of ecosystems (Steube *et al*, 2009). In India severe water scarcity is becoming common in several parts of the country, especially in arid and semi-arid regions. Due to rapid growth of population and anthropogenic activities, the quality of groundwater is deteriorating day by day. The possibility of groundwater contamination is due to the prevailing drought-prone conditions, the improperly treated and unplanned release of effluents of industry, municipal and domestic into the nearby streams and ponds and the majority usage of groundwater for irrigation are increasing the ionic concentration of the groundwater and making it more saline. Temporal changes in the origin and constitution of the recharged water, hydrological and human factors may cause periodic changes in groundwater quality. Ascertaining the quality is crucial before its use for various purposes such as drinking, agricultural, recreational and industrial use. Hence monitoring of groundwater quality has become indispensable. The present study attempts to map the spatial variation of groundwater quality parameters for Perambalur District using GIS. GIS is an effective tool for groundwater quality mapping and essential for monitoring the environmental change de-tection. GIS has been used in the map classification of groundwater quality, based on correlating total dissolved solids (TDS) values with some aquifer characteristics or land use and land cover (Asadi, 2007). Other studies have used GIS as a database system in order to prepare maps of water quality according to concentration values of different chemical constituents. In such studies, GIS is utilized to locate groundwater quality zones suitable for different usages such as irrigation and domestic (Yammani, 2007). Babiker *et al*. (2007) proposed a GIS-based groundwater quality index method which synthesizes different available water quality data by indexing them numerically relative to the WHO standards. Perambalur District is a waterscarce region and it is under threat due to the excess of dissolved salts like Fluoride and Sulphate etc. The groundwater samples were collected from 6 locations randomly distributed in the study area. The physico-chemical parameters namely pH, Electrical Conduc-tivity (EC), Total Dissolved Solids, Total hardness, Sulphates, Fluorides and Calcium of the samples were analyzed. GIS is used to assess the existing condition of groundwater quality and stress areas can be identified for further monitoring and management.

In order to assess the ground water quality of the study area, the following objectivess are

1. To assess the ground water quality of the study area.

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2. To develop precautionary measures to prevent ground water contamination

Study Area

The district lies in the Southern plateau & hill zone of Agro-climate regional planning with characteristics of semi-arid climate. Perambalur District having geographical area of 1,752 sq.kms, in the South eastern starting portion of Tamil Nadu. It lies between 11°30' and 11°10' of the Northern latitude and 78°40' and 78°10' of Eastern longitude.The district is located in the southern part of Tamil Nadu and surrounded by Salam, cuddalur District on the north, thirichirapalli on the West, and on the south, Ariyalur District on the East. Cauvery is the major river flowing in the region and the composite district has a canal system covering.The study area falls in the survey of India Toposheet . no C44A15 and lies between North Latitude : 11° 20' to 11° 30' and East Longitude : 78°40' to 78° 60' .The Occurrence, movement and storage of groundwater are influenced by lithology, thickness and structure of the rock formation. The presence of black clayey soils has resulted in reduced natural recharge to groundwater system. It has also resulted in water quality problem.

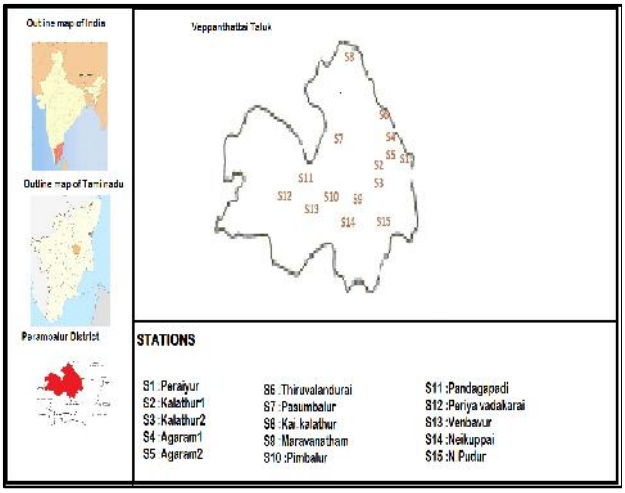


Fig1 Study area

MATERIALS AND METHODS

Sample Collection

The water samples were collected in polythene contains of 2 liters capacity for physicochemical analysis after pumping out sufficient quality of water from the sources such that, the sample collected served as a representative samples.The samples were transpoted to the laboratory at freezer condition (4^0C).

Analysis of ground water samples

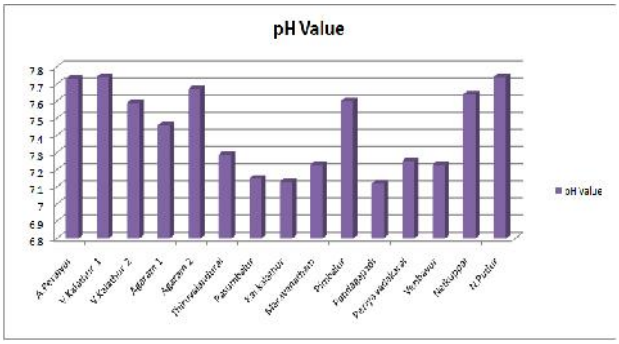
Ground water quality was assessed by the analysis of physico-chemical parameters are compared with the permissible limits. The major parameters namely pH, Electrical Conductivity (EC), Total Dissolved Solids, Total hardness, Sulphates, Fuorides, Nitrates, Chlorites, alklinty, iron, and Calcium of the samples were analyzed using standard methods.

RESULTS AND DISCUSSION

Groundwater quality is useful in assessing the usability of the water for different purposes. The spatial and the attribute database generated are integrated for the generation of spatial variation maps of major water quality parameters like pH, Electrical Conductivity (EC), Total Dissolved Sol-ids, Total hardness, Sulphates, Fluorides and Calcium. Based on these spatial variation maps of major water quality parameters, an Integrated Groundwater quality map of the study area was prepared using GIS. This integrated groundwater quality map helps us to know the existing groundwater condition of the study area.

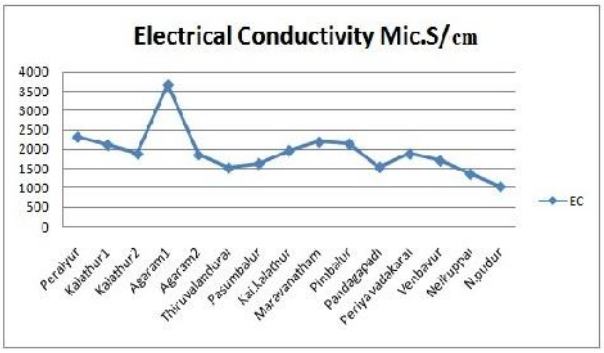
pH

pH is one of the important parameters of water and deter-mines the acidic and alkaline nature of water. The pH value of water ranged between 7 and 7.83. The pH of the samples was well within the prescribed standards for drinking water. The pH values are prepared and presented in Fig 2.



Electrical Conductivity (EC)

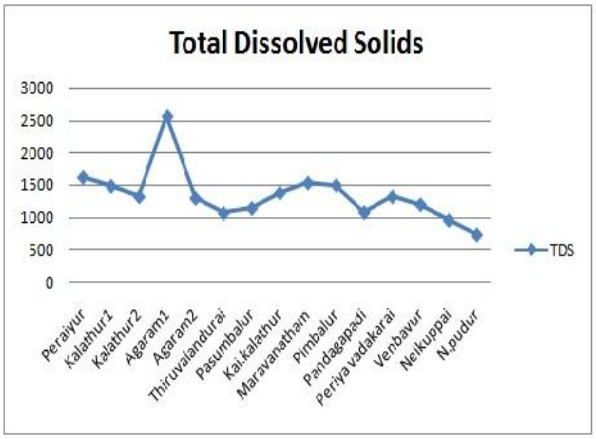
The Electrical Conductivity (EC) was classified in to three ranges (0-2250 µmhos/cm, 2250-3000 µmhos/cm and >3000 µmhos/cm). The spatial variation map for Electrical Conductivity (EC) was prepared and presented in Fig 3. From the map it has been observed that very small portion of the study area, the EC value is within 2250 µmhos/cm. For the South-west part of the district the Electrical Conductivity (EC) value is in the medium range (2250-3000 µmhos/cm) and the remaining area falls under the poor range (>3000 µmhos/cm) and constitutes major part of the study area.



Total Dissolved Solids (TDS)

The mineral constituents dissolved in water constitute dis-solved solids. The total concentration of dissolved minerals in

water is a general indication of the over-all suitability of water for many types of uses. The Total Dissolved Solids (TDS) was classified to three ranges (0-500 mg/l, 500-1000 mg/l and >1000 mg/l). The spatial variation map for TDS was prepared based on these ranges and presented in Fig 4. From the spatial variation map it was observed that Northern part of the study area, the TDS value is in the poor range (>1000 mg/l). For the Southwestern part of the study area, the TDS value is in the medium range (500-1000 mg/l) and the smaller portion of the study area has TDS under the good range (0-500 mg/l). Water contains less than 500 mg/L of dissolved solids; it is generally satisfactory for domestic use and for many industrial purposes. If the Water with more than 1000mg/L of dissolved solids usually gives disagreeable taste or makes the water unsuitable in other respects.



Total Hardness

Hardness in water is caused primarily by the presence of carbonates and bicarbonates of calcium and magnesium, sulphates, chlorides and nitrates. The Total hardness was classified in to three ranges (0-300 mg/l, 300-600 mg/l and >600 mg/l) and based on these ranges the spatial variation map for total hardness has been obtained and presented in Fig 5. From the map it was observed that for major areas, the total hardness value is in the poor range (300-600 mg/l) and medium range (>600 mg/l) was observed in North Western part of the study area.

Sulphates

Sulphates occur in natural waters at concentration up 50 mg/l and concentration of 1000 mg/l can found in water having contact with certain geological formations such as pyrite, lignite and coal. Sulphates was classified in to three ranges (0-200 mg/l, 200-400 mg/l and >400 mg/l) and based on these ranges the spatial variation map for Sulphates has been obtained and presented in Fig 6. From the spatial variation map, it was observed that Western part of the study area, the Sulphates value is in the good range (0-200 mg/l). For the Central part the Sulphate value is in the medium range (200-400 mg/l) while the considerable portion of North Eastern and Southern part is under the poor range (>400 mg/l).

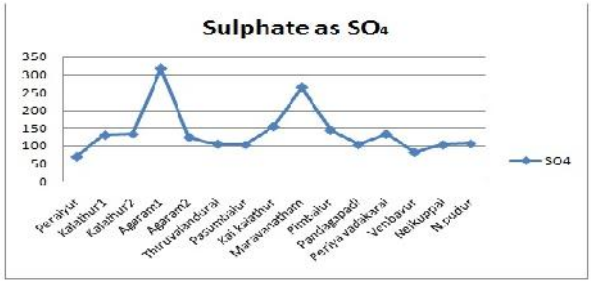


Table 2 Criterion table showing Weightages and Ranking assigned for different Water Quality parameters

S.NO	Parameter	Parameter Range	Rank	Weightages
1	**pH**	7 to 7.5 7.5 to 8.5 >8.5	1 2 3	20%
2	Electrical conductivity (µmhos/cm)	0-2250 2250-3000 >3000	1 2 3	15%
3	Total Dissolved Solids (mg/l)	0-500 500-1000 >1000	1 2 3	15%
4	Total Hardness (mg/l)	0-300 300-600 >600	1 2 3	15%
5	Sulphates (mg/l)	0-200 200-400 >400	1 2 3	10%
6	Fluorides (mg/l)	1-1.5 <1.5 >1.5	1 2 3	10%
7	Calcium (mg/l)	0-75 75-200 >200	1 2 3	15%

Table 1 Major cat ions and anions in Groundwater of Veppenthattai Taluk (2012)

S.NO	Village Name	Tur	EC	TDS	PH	ALK	TH	Mg	Na	K	CL	NO_3	F	SO_4	PO_4	Tidys
1	Peraiyur	1	2325	1627	7.73	590	597	81	178	54	223	8	0.6	69	0.16	0.28
2	Kalathur.1	1	2124	1787	7.74	570	547	74	178	24	232	14	0.4	130	0.57	0.40
3	Kalathur.2	1	1892	1324	7.59	477	577	79	182	36	222	8	0.4	133	0.15	0.32
4	Agaram.1	1	3668	2568	7.46	970	846	117	245	45	374	0	1.0	317	0.18	0.40
5	Agaram.2	1	1858	1300	7.87	511	527	70	189	56	202	9	0.8	124	0.12	0.20
6	Thiruvalandurai	1	1525	1067	7.29	424	422	54	165	41	158	9	0.2	105	0.14	0.28
7	Pasumbalur	1	1635	1145	7.15	352	450	46	141	90	222	17	0.4	103	0.06	0.12
8	Kai.kalathur	1	1974	1382	7.13	404	581	65	174	36	222	25	0.4	154	0.47	0.04
9	Maravanatham	1	2195	1536	7.23	263	468	55	265	67	323	0	0.6	264	0.3	0.40
10	Pimbalur	1	2144	1501	7.60	541	597	65	197	66	273	5	0.4	144	0	0.36
11	Pandagapadi	1	1543	1080	7.12	420	498	58	147	37	170	5	0.2	103	0.18	0.12
12	Periyavadakarai	1	1877	1321	7.25	465	597	80	146	29	222	12	0.4	113	0.14	0.16
13	Venbavur	1	1716	1202	7.23	461	557	70	159	48	162	15	0.6	82	0.23	0.12
14	Neikuppai	1	1369	958	7.64	412	410	46	105	24	113	6	0.8	103	0.06	0.20
15	N.Pudur	1	1047	753	7.74	283	338	38	78	15	89	6	0.4	106	0.27	0.08

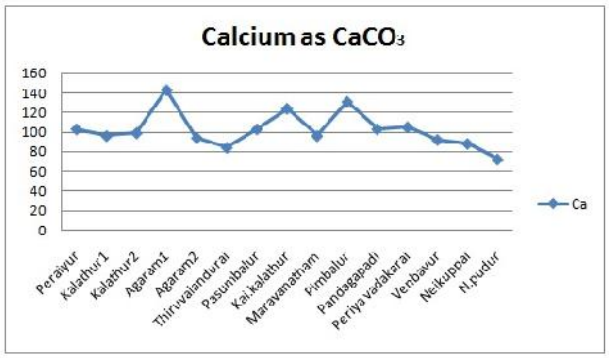
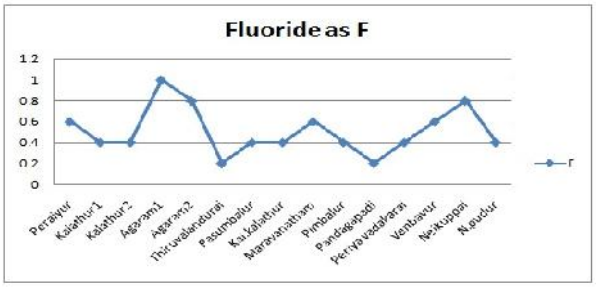


Table 3 Drinking water specifications of Veppenthattai Taluk comparison with WHO (1984)

Parameters	Minimum	Maximum	Mean	WHO (1984)
EC	1047	3668	2357.5	-
TDS	753	2568	1660.5	500
PH	7.12	7.87	7.495	6.5
ALK	283	970	626.5	200
TH	338	846	592	300
Mg	38	117	77.5	30
Na	78	265	171.5	200
K	15	90	52.5	12
Cl	89	374	231.5	250
NO3	5	25	15	< 0.1
F	0.2	1.0	0.6	1.5
SO4	69	317	193	200
PO4	0	0.27	0.135	-
Tidys	0.08	0.40	0.24	-

on these range the spatial variation map for Fluorides has been obtained and presented in Fig. 7. From the figure it is evident that major parts of the district have good range (1-1.5 mg/l) of Fluorides. A smaller portion of Southern part of the study area have poor range (<0.97 and >1.55 mg/l) of fluoride contents and also a small part have mod-erate quality range (0.97-1 mg/l and 1.5-1.55 mg/l).



Calcium

Calcium occurs in water mainly due to the presence of li-mestone, gypsum and dolomite minerals. Calcium was clas-sified in to three ranges (0-75 mg/l, 75-200 mg/l and >200 mg/l) and based on these ranges the spatial variation map for Calcium has been obtained and presented in Fig 8. From the figure it is evident that major part of the district have moderate range (75-200 mg/l) of Calcium and considerable portion of North eastern part of the district have poor value (>200 mg/l) of Calcium.

Table 4 Electrical conductivity of groundwater of Veppenthattai Taluk

Electrical conductivity (µS/cm)	Classification	Sample numbers	No. of samples	Percentage of samples
< 1500	Permissible	14,15	2	13.34
1500- 3000	Not permissible	1,2,3,5,6,7,8,9,10,11,12,13	12	80.4
> 3000	Hazardous	4	1	6.67
Total			15	100.05

Table 5 Groundwater classification of Veppenthattai Taluk based on hardness

Total Hardness as CaCO3 (mg/l)	Type of water	Sample numbers	Number of samples	Percentage of samples
<75	Soft	Nil	Nil	-
75–150	Moderately high	Nil	Nil	-
150–300	Hard	Nil	Nil	-
>300	Very hard	All samples	15	100.05
Total			15	100.05

Data Integration Using GIS

In this study, the criterion table with suitable ranks and weightages were given. The spatial variation map of major groundwater quality parameters were integrated and integrated groundwater quality map of Perambalur District was prepared. The integrated map shows the broad idea about good, moderate and poor groundwater quality zones in the study area. The groundwater quality has been classified quantitatively as good, moderate and poor depending on the final weightage values assigned to polygons in the final layer.

Table 6 Groundwater quality classification of Veppenthattai Taluk according to Davis and DeWiest (1966)

TDS (mg/l)	Classification	Sample numbers	No. of samples	Percentage of samples
< 500	Desirable for drinking	NIL	NIL	NIL
500- 1000	Permissible for drinking	13,14	2	13.34
1000- 3000	Useful for irrigation	1,2,3,4,5,6,7,8,9,10, 11,12,13,	13	86.71
> 3000	Unfit for drinking and irrigation	Nil	-	-

Fluorides

Groundwater usually contains fluoride dissolved by geological formation. The desirable limit of Fluorides is 1-1.5 mg/l, beyond this limit the water is considered as poor quality. Based

From the map, it is evident that the groundwater quality in the Northern part of the study area is in the good condition while the Central part of the study area groundwater quality is in the moderate condition and Southern part of the study area groundwater quality is in poor condition.

CONCLUSIONS

Water is an indispensable natural resource on earth. Groundwater is the major source of drinking water in both urban and rural areas. Increasing population and its necessi-ties have lead to the deterioration of surface and subsurface water. Groundwater quality depends on the quality of re-charged water, atmospheric precipitation and inland surface water. The groundwater quality is equally important as that of quantity.

Assessing and monitoring the quality of groundwater is therefore, important to ensure sustainable safe use of these resources for the various purposes. The present study has been undertaken to analyze the spatial variation of major groundwater quality parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids, Total hardness, Sulphates, Fluorides and Calcium using GIS approach. GIS can provide appropriate platform for convergent analysis of large volume of multi-disciplinary data and decision making for groundwater based studies can be done effectively. The groundwater quality of six wells randomly distributed in Perambalur district, Tamil Nadu was selected for the present study. The spatial variation maps of major groundwater quality parameters were prepared and finally all these maps were integrated.

The integrated groundwater quality map shows the broad idea about good, moderate and poor groundwater quality zones in the study area. This study demonstrates that the use of GIS could provide useful information for groundwater quality assessment. The results obtained gave the necessity of making the public, local administrator and the government to be aware on the crisis of poor groundwater quality prevailing in the area. The study helps us to understand the quality of the water as well as to develop suitable management practices to protect the groundwater resources.

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